

General Information	
Name of Research Unit:	(LA-LVT-Lisboa-9) Instituto de Sistemas e Robótica - ISR - Lisboa
Coordinator:	Victor Alberto Neves Barroso
Main Scientific Domain:	Engenharia Electrotécnica e Informática
Other Subdomains:	Engenharia Mecânica

Host Institutions	
Leading Host Institution:	Instituto Superior Técnico - Universidade Técnica de Lisboa
Other Institutions Involved:	Instituto do MarFundação da Faculdade de Ciências - Faculdade de Ciências da Universidade de Lisboa Instituto Superior Técnico - Universidade Técnica de Lisboa

Objectives & Achievements

Unit Description

The management structure of the LA has the following organization: Coordinating Board (CB) and the Executive Board (EB), one manager for each thematic area and an external advisory board.

The EB is composed by the coordinators of the units involved and presided by the scientific coordinator of the ISR-Lisbon. The role of the EB is to ensure the current management of the activities resulting from the collaborative links among the participant units and to guarantee that the main goals set forth are fulfilled.

The CB is composed by the scientific coordinators of the units involved and the managers of the thematic areas and is presided by the President of the EB that will ensure that the CB will meet at least once a year. The CB meetings can be convened by any one of its members. The role of the CB is: (i) to supervise and provide guidance (in very general terms) for the cooperative activities of the four participating R&D units and (ii) to decide in case of doubts arising from different interpretations of the terms of the signed protocol.

Each thematic area has a manager elected for a period of 3 years by the researchers involved in that particular area. The area manager's tasks include: planning the activities to be carried out in the scope of the thematic area and to promote its strategic orientation; securing the necessary human resources; guaranteeing cooperation among and integration of the activities of the various groups; preparing, in cooperation with the area researchers, project proposals and securing financial support for these projects (FCT, EU, others); preparing annual activity plans and reports in the domain of the thematic area, to be submitted to the consideration of the Coordinating Board.

The activities of the associate laboratory have been followed by an Advisory Board, consisting of national and international experts, selected by decision of the Coordinating Board. The Advisory Board can be asked to evaluate the state of progress of the associated laboratory and / or state its opinion regarding organizational issues whenever the Coordinating Board considers it adequate and timely, and under proposal of the Executive Board.

General Objectives

The main objective of ISR is to develop research and development activities in the main focus areas of public interest. These areas are: (A) Technologies for Ocean Exploration, (B) Robotic Monitoring and Surveillance, (C) Sustainable Technologies and Environmental Systems and (D) Signal Processing for Communication Networks and Multimedia.

These research activities are driven by a systemic approach, where fundamental science perspectives are considered right from the start in order to appropriately influence and shape technology development.

For example, in area A the main goal is to carry out R&D in marine science and technology for a better understanding of the oceans, and to use this knowledge for the sustainable benefit of society. This far-reaching goal set the stage for the work program that has been adopted. Area A brings to the core of its R&D activities research groups with different, yet complementary expertise and encompasses a wide spectrum of activities that touch upon theoretical and practical issues in marine science and technology, including the development of advanced sensor suites and autonomous vehicles for the execution of challenging scientific missions. In area B, the cross fertilization of ideas and methods arising from engineering, computer science, neurosciences and social sciences play a very important role when human learning and/or behavioural paradigms are called upon to help in the design and development of intelligent robots or interacting networked sensors/robots as well as for a deeper understanding of human cognition and social interaction. Multidisciplinary research is also fundamental to the development and evaluation of emerging alternative complex engineering systems (technologies) that promote sustainability (area C), e.g., by taking into consideration such aspects as secure (safe) socio-economic development, coupled with environmental quality.

In fact, multidisciplinary is key to the design of new complex engineering systems that must necessarily rely on the optimization of large scale, complex, and usually non linear systems and on the processing of massive amounts of data often transmitted over distributed communication networks with stringent communication constraints. To achieve truly innovative solutions, sophisticated mathematical tools must be brought to the forum. Together with multidisciplinary engagement bringing together technology and science (including natural, life and human sciences), a solid theoretical foundation is a major driving force of the LA activities, for it gives support to and cuts across all of ISR's focus areas. This is especially visible in area D, which is more focused on theoretical developments related to a diversity of multidisciplinary problems in areas such as wireless radio/acoustic communications, sensor networking, and video processing.

The above is a global overview of the fundamental objectives of ISR, which are steadily being met through a number of activities of which the following are of paramount importance:

- 1- A major build up of the technical infrastructures to enable science and technology driven research;
- 2- Active participation in networks of excellence;
- 3- Training: besides the well established PhD programs at IST, University of Azores and the Faculty of Sciences of the Univ. Lisbon, the LA is at the core of the collaborative initiatives with top American and European Schools with a strong involvement at the management and scientific level;
- 4- International Events: the LA has been and is strongly committed to the organization of international conferences and workshops as well as

Objectives & Achievements

the dissemination of technical and scientific results to the public at large.

Main Achievements during the year of 2008

The main achievements of each focus area must necessarily be also viewed as main achievements of ISR. Here, however, we highlight those achievements that, in our opinion, have imparted noteworthy momentum towards the acquisition of increased knowledge, the development of new and/or improved technologies, and the availability of training offers.

In what concerns advanced training, we wish to emphasize the involvement of ISR in the creation of two new Doctoral Programs on Sustainable Energy Systems and on Engineering and Public Policy, the former in the context of the MIT | PORTUGAL partnership, and the latter under the CARNEGIE MELLON | PORTUGAL program. ISR has also a substantial (scientific and managerial) involvement with the recently created Joint Doctoral Initiative between IST and EPFL, in the areas of Cognitive and Distributed Robotics and Biological and Biomedical Imaging.

From a theoretical point of view, we mention contributions in several areas:

- development of methodologies and tools to both assess and design new products (Eco-design) and new policies (Life Cycle Activity Analysis); developments on cooperative navigation and mapping using discrete event systems, cooperative perception and decentralized decision;
- novel navigation, guidance, and control systems for autonomous vehicles, including geophysical based navigation systems for the execution of long range oceanographic missions in unstructured environments and algorithms for terrain following;
- studies and developments on biological models grounded in neuroscientific and psychophysic studies to be applied in the design of learning, sensorimotor loops and high level imitation and plan execution for advanced humanoid(-like) robots;
- novel methods for cooperative mapping, localization and decision making under uncertainty for sensor and robot networks deployed in large (e.g. urban) spaces;
- work on the design of optimum space/time codes for wireless communication systems; developments in convex analysis with applications in different research lines within ISR; the new result in matrix completion under rank constraints, which is a very important achievement in mathematics.

From a scientific standpoint, considerable progress continued to be done towards developing the infrastructures and carrying out the research programs required to understanding of key challenging scientific issues in the fields of biological, chemical, geological, and physical oceanography. Representative examples include the establishment of LabHorta, a new world class international laboratory for the study of hydrothermal vents, the use of a set of cross theme technologies and data/information collection systems (including autonomous robots and advanced acoustic equipment) for extensive mapping of selected habitats and biodiversity in the Azores islands , the discovery of a new, large hydrothermal field in the Arctic, and the observation of on submarine lava eruptions in the Azores seas.

Considering practical application driven results, we underscore the design and implementation of an experimental platform and middleware to test people/robot tracking methodologies, cooperative perception, decision making under uncertainty and sensor selection algorithms; the participation in the developments on humanoid platforms, notably the iCub that is the most sophisticated humanoid robot worldwide; the development of biomedical systems, e.g., a volume reconstruction system from ultrasound images; the development of advanced systems for multiple autonomous marine vehicle cooperative control that has culminated with representative demonstrations in the Azores seas.

Activities

Integrative/multidisciplinary activities during the year of 2008

Joint Mathematics-Engineering Seminar/Discussion. ISR and the Center for Mathematical Analysis, Geometry, and Dynamical Systems (Mathematics Dept, IST) organize monthly seminars/meetings where researchers from the mathematics and engineering communities present and discuss problems and methodologies involving advanced mathematics. The participation is open to the scientific community as a whole.

The research line in cognitive robots has for a long time been based on a tight collaboration with other scientific communities such as neurophysiology, developmental psychology or linguistics. These efforts have been conducted on a regular basis in the context of large scale EU projects over the last decade. The goal of this specific research line twofold: (i) to contribute to a better understand of natural systems through computational and physical models (analysis by synthesis) and (ii) use the understanding of biological systems to develop more advanced and sophisticated artificial systems.

Outreach activities during the year of 2008

- Promotion of S&T: The Intelligent Systems and Mobile Robotics Laboratories have actively nurtured the development of several types of activities aimed at promoting scientific and technological culture among the citizens in general, and the youngsters in particular. Among those, the following should be pointed out:

a. Talks at High Schools.

b. Participation in Programme Ciência Viva – “Ocupação de Jovens nas Férias”, organized by the Electrical and Computer Engineering Department of IST, 1 week in July.

- Public outreach through Creminer continued to be particularly noteworthy, with involvement in the National Museum of Natural History and in the setting-up of the Lousal "live science" center in Southern Portugal and the Quartz Museum in Viseu.

- Public outreach through IMAR led to the second edition of a DVD simulating a journey to deep-sea ecosystems on board a simulated submersible (Santos, R. S., C. de la Cerda Gomes, F. M. Porteiro & L. Gallagher 2008).

- Virtual Center of Marine Interpretation (CIMV) – An Amazing Journey to the Marine Ecosystems of the Azores (2 DVD: Interactive Educational DVD + 3D Movie DVD). ImagDOP/ Universidade dos Açores [ISBN 978-972-8612-33-7] (Portuguese, English, French, Spanish) (2nd edition: enhanced and expanded)

Funding

	2004	2005	2006	2007	2008
LA FCT	1.258.379,00	1.353.151,00	1.557.659,00	1.537.408,00	1.789.596,00
Units FCT	0,00	0,00	0,00	0,00	0,00

Funding

	2004	2005	2006	2007	2008
Projects FCT	752.044,14	1.538.785,68	958.820,26	2.805.122,34	2.167.102,00
Other (National)	1.397.993,87	1.445.687,63	787.199,76	1.798.581,06	1.331.553,00
Other (International)	941.448,62	970.763,57	949.277,24	733.304,64	1.508.329,00
National Industry	114.366,02	181.500,68	105.357,65	127.216,63	389.639,00
International Industry	0,00	0,00	0,00	0,00	0,00
	4.464.231,65	5.489.888,56	4.358.313,91	7.001.632,67	7.186.219,00

General Indicators

	2004	2005	2006	2007	2008	Total
No. of Researchers Proposed	3,00	4,00	3,00	0,00	0,00	10,00
No. of Researchers Hired (LA)	0,00	2,00	7,00	0,00	0,00	9,00
Balance	-3,00	-2,00	4,00	0,00	0,00	-1,00
No. of Researchers Hired (Ciência Programme)	0,00	0,00	0,00	0,00	7,00	7,00
No. of Researchers (FTE) (*)	43,00	48,00	77,00	73,00	73,00	
Training Masters (Master thesis completed)	20,00	23,00	10,00	33,00	58,00	144,00
Training PhDs (PhD thesis completed)	7,00	5,00	5,00	21,00	12,00	50,00

Researchers Hired

Name	Start Date	End Date	Other Institution
Ana Natália Domingues Dias	01-03-2008	01-03-2009	
Antonio Miguel Areias Dias Amaral	01-09-2008	01-09-2009	
Christos Ioakimidis	01-02-2008	01-02-2009	
Gianluca Grimalda	01-04-2008	01-04-2009	
Helena Margarida Guerra Pinheiro Vieira Reis	01-03-2008	01-03-2009	
Maria Ana Almeida Colaço	01-03-2008	28-02-2011	
Murat Karaöz	01-09-2008	01-09-2009	
Raul Silva Bettencourt	06-06-2008	31-05-2011	
Sérgio Stefanni	01-03-2008	28-02-2011	

Technical Personnel Hired

Name	Start Date	End Date	Other Institution
Ana Filipa Rodrigues Silva	01-09-2008	31-01-2010	
Janaina Gomes de Merícia	01-04-2008	01-04-2009	

Additional Comments**Additional Comments**

The hiring of researchers and technicians was initially slow, when compared with the hiring rate required to fill all the positions. Later, the hiring rate increased to a satisfactory figure but started decreasing again due to the unclear situation concerning the evaluation of the LA and the possibility of drawing new (or extending existing) contracts beyond the initial contracting period.

Research Groups

Reference	Title / Principal Investigator
RG-LVT-Lisboa-750009-3422	<u>Evolutionary Systems and Biomedical Engineering</u> (Agostinho Claudio da Rosa)
RG-Centro-Coimbra-750009-3433	<u>Centre of IMAR of the University of the Azores/ Department of Oceanography and Fisheries (IMAR-DOP/UAz)</u> (Ricardo Piedade Abreu Serrão Santos)
RG-LVT-Lisboa-750009-3438	<u>DSORL - Dynamical Systems and Ocean Robotics Laboratory</u> (António Manuel dos Santos Pascoal)
RG-LVT-Lisboa-750009-3447	<u>Signal and Image Processing Group</u> (Isabel Maria Gonçalves Lourtie)
RG-LVT-Lisboa-750009-3503	<u>Mobile Robotics Laboratory - MRLab</u> (Maria Isabel Lobato de Faria Ribeiro)

Research Groups

Reference	Title / Principal Investigator
RG-LVT-Lisboa-750009-3505	<u>Intelligent Systems Laboratory</u> (Pedro Manuel Urbano de Almeida Lima)
RG-LVT-Lisboa-750009-3508	<u>VisLab - Computer and Robot Vision Laboratory</u> (Jose Alberto Rosado Santos Victor)
RG-LVT-Lisboa-750009-3583	<u>Laboratory for Energy and Environmental Studies at IN+ Center for Innovation, Technology and Policy Research</u> (Paulo Manuel Cadete Ferrao)
RG-LVT-Lisboa-750009-3584	<u>Laboratory of Thermofluids, Combustion and Energy Systems, at IN+ Center for Innovation, Technology and Policy Research</u> (Antonio Luis Nobre Moreira)
RG-LVT-Lisboa-750009-3585	<u>Laboratory of Technology Policy and Management of Technology, at IN+ Center for Innovation, Technology and Policy Research</u> (Rui Miguel Loureiro Nobre Baptista)
RG-LVT-Lisboa-750009-3589	<u>Centre of Mineral Resources, Mineralogy and Crystallography of the Faculty of Science of Lisbon University (CREMINER)</u> (Fernando José Arraiano de Sousa Barriga)

Research Lines

Reference	Title / Principal Investigator
RL-COMP-750009-133	<u>Robotic Monitoring and Surveillance</u> (Jose Alberto Rosado Santos Victor)
RL-MECH-750009-137	<u>Sustainable Technologies and Environmental Systems</u> (Paulo Manuel Cadete Ferrao)
RL-COMP-750009-145	<u>Signal Processing for Communicatio Networks and Multimedia</u> (Joao Paulo Salgado Arriscado Costeira)
RL-COMP-750009-151	<u>Technologies for Ocean Exploration</u> (António Manuel dos Santos Pascoal)

Other Activities

Internal Services and Resources

During 2008, we have installed a camera and sensor network in the north tower ISR facilities of the IST-Alameda campus that serves as a rich test bed for researchers interested in human activity recognition, tracking across multiple (non overlapping cameras), surveillance and distributed robot navigation, planning and decision making. In addition to the physical infrastructure, we middleware was developed and is now available to interested researchers.

This platform is also made available internationally in the context of the EU Project URUS.

External Services and Resources

• Public Service:

- Victor Barroso. National Director of the CARNEGIE MELLON | PORTUGAL program
- Isabel Ribeiro: Adviser to the Board of FCT (Portuguese Foundation for Science and Technology) for the area of R&D projects
- J.Sequeira: Member of the Executive Board of the Dept. of Electrical and Computer Eng-IST
- Pedro Lima: IST Scientific Board Vice-President for Scientific Affairs
- José Santos-Victor: IST Vice-President for International Affairs
- José Santos-Victor; IST Director for the IST-EPFL Joint Doctoral Program
- José Santos-Victor; National Delegate to the ESA-Aurora/Exploration Program
- Paulo Ferrão; National Director of the MIT | PORTUGAL program
- João Paulo Costeira; IST Director for the Electrical and Computer Engineering Dual Doctoral Program with Carnegie Mellon University
- Pedro Ferreira; IST Director for the Engineering and Public Policy Dual Doctoral Program with Carnegie Mellon University
- Rui Baptista; IST Director for the Technological Change and Entrepreneurship Dual Doctoral Program with Carnegie Mellon University
- Fernando Barriga, Director National Museum of Natural History
- Fernando Barriga, National delegate ECORD
- Fernando Barriga, National delegate InterRidge
- Fernando Barriga, Member of Scientific Council of the Faculty of Sciences of the University of Lisbon

Museu Nacional do Azulejo: MNaz is the national museum of tiles, one of the most genuine Portuguese art production. Through the engagement of undergraduate students both from arts (Univ Lisboa, Univ Nova) and engineering (IST), ISR-LA developed a collection of software tools to help the museum in the daunting task of cataloguing dozens of thousands of tiles (azulejos). These tools are able to capture images and automatically correct them, measure the tile size and input the data into the museum's database.

Networking Actions

Other Activities

ISR-AL has been involved since 2001 in the Portuguese Robotics Society, whose main goal is to promote Robotics in Portugal, through I&D and outreach activities, including the annual organization of the Portuguese Robotics Open, that counts with the participation of around 800 people, approximately 700 of which come from High-Schools and 100 from Universities and Polytechnic Institutes. The event includes a Scientific Meeting and it is jointly organized by Professors from other Portuguese groups with activity in Robotics, namely from U. Minho, U. Porto, Polytechnic Institute of Porto, U. Aveiro and U. Coimbra. ISR-AL member Pedro Lima is currently the President of the Portuguese Robotics Society.

FREESUBNET – a Marie Curie Research Training Network (EC contract number MRTN-CT-2006-036186 (<http://www.freesubnet.eu>, 2006-2010). The purpose of FREESUBNET is to provide a European-wide excellence in quality training to young and experienced researchers in the emerging field of Cooperative Autonomous Intervention Underwater Vehicles (AUVs) which are steadily becoming the tool of choice to carry out missions at sea without tight human supervision.

Consortium partners:

- 1- University of Southampton (coordinator); School of Engineering Sciences, Ship Science; United Kingdom
- 2- Commissariat à l'Energie Atomique; CEA/DRT/DTS/SRSI; France
- 3- CNR-ISSIA-Sez di Genova-Robotlab; Italy
- 4- Centre National de la Recherche Scientifique; Laboratoire d'Informatique, de Robotique et de la Microélectronique; Franc
- 5- Cybernétix; Offshore Department; Franc
- 6- Hellenic Centre for Marine Research; Institute for Oceanography; Greec
- 7- Heriot-Watt University; Ocean Systems Laboratory; United Kingdo
- 8- Institut Français de Recherche pour l'exploitation de la mer; Département des Systèmes sous Marins; France
- 9- Instituto Superior Técnico; Institute for Systems and Robotics; Portugal
- 10- European Commission- Joint Research Centre; Institute for the Protection and Security of the Citizen; Italy
- 11- Norwegian University of Science and Technology; Department of Engineering Cybernetics; Norwa
- 12- Universität Hannover; Institut für Werkstoffkunde; Germany
- 13- University of Craiova; Mechatronics Department; Romani
- 14- University de Girona; Department of Electronics, Computer Engineering and Automation; Spain
- 15- Instituto do Mar; Department of Oceanography and Fisheries; Portugal

Training Activities

The ISR-LA is strongly involved in several international programs involving research and educational activities.

- a. Dual degree in Electrical and Computer Engineering under the framework of the Carnegie Mellon-Portugal Program: Several faculty members of the LA lecture courses in this program as well as co-advising 6 PhD students enrolled in academic years 2008-2009 (plus 4 in 2009-2010). These courses are accredited by Carnegie Mellon and offered nationally (to all universities participating in the program) using distance learning mechanisms such as videoconferencing. For the first time, one course was offered from IST to Carnegie Mellon students (in Pittsburgh)
- b. Strong involvement in the IST-EPFL Joint doctoral program, established in 2008, in the areas of Distributed and Cognitive Robotics as well as Biological and Biomedical imaging.
- c. Involvement of ISR researchers in the creation of a double Master Degree Program on Systems, Decision and Control with the Royal Institute of Technology in Stockholm.

Internal Evaluations

Summary of internal evaluations during 2008

NA

We didn't have any internal evaluation during 2008 because that was the year when ISR should have been evaluated by an independent international panel.

It is important to note that due to a last minute cancellation of one of the members, not all thematic areas were adequately covered by the Advisory Board visit. The plan to nominate an additional member of this board and the corresponding visit have been postponed since then, as it was found desirable to wait for LA evaluation that is still pending.

During 2007 and 2008 this concern has been communicated to FCT together with a proposal for possible Advisory Board Members that could cover the missing areas and topics.

Future internal Evaluations plan for 2009

NA

The 2008 international evaluation was postponed to 2009. This is the reason why we didn't plan any internal evaluation to take place during 2009.

Future Objectives

Summary of proposed future objectives

The future objectives of the AL are in line with those presented in the 2003-07 report, which are re-iterated and expanded below.

Future objectives aim at consolidating and reinforcing the strong interdisciplinarity of ISR-AL and exploiting complementarities and formal analogies among different fields in the natural, social and engineering sciences. Future activities should foster tight symbiosis between science and technology and show strong societal and economical impact. It is envisioned to further enhance the cooperative links between engineers

Future Objectives

and scientists. Also, keeping the key strategic investment in methodologies from basic sciences is expected to produce new theoretical and practical results of great impact. In line with this strategy, we intend to aggregate to the AL isolated researchers or a research group in Mathematics. Due to the increasing involvement of the AL in the development of experimental platforms and networked systems with far reaching commercial and scientific applications, the AL must attract other research groups of excellent quality in such areas as embedded and distributed systems. The interaction between robots and humans appeals to the close cooperation of research teams in the areas of neural and cognitive sciences, psychology, design, etc. There is also an interest in Public Policy that cuts across all the lines of research, namely in topics such as environmental management, sustainable development of biological systems, fisheries, exploitation of energy and mineral resources, sustainable energy systems, technological management, and networked industries. This may evolve to the creation of a line of research addressing subjects that are at the core of those topics.

At this moment we can say that the aggregation of research groups in mathematics and in human-computer interaction is in preparation.

In the near future we will address the reformulation of the actual AL, as is somehow envisaged in the previous paragraphs. This reformulation will hinge on the creation of new research groups and/or research lines and also on the integration of other research units. Out of this process will probably emerge a different organizational structure for the new AL which will be reflected in its name: Institute for Systems Research in Science, Technology and Policy (ISR-STP).

Group Description	
Title of Research Group:	(RG-LVT-Lisboa-750009-3422) Evolutionary Systems and Biomedical Engineering
Principal Investigator:	Agostinho Claudio da Rosa
Main Scientific Domain:	Engenharia Electrotécnica e Informática
Group Host Institution:	Instituto Superior Técnico - Universidade Técnica de Lisboa

Funding, source, dates	
Funding, source, dates	
Pluriannual Base: (2003-2008) Agostinho C da Rosa – 2.500€ per year total 12.500€ in the 5 years period Vitor Lopes – 2.500€ per year since 2007, total 5000€	
Pluriannual Programmatic: (2003-2007) 0€	
FCT Project OpenMicroBio PTOC/BIO/693/2006 (total budget = 57652.4€) 2007 – 10,046.4 €	

Objectives & Achievements	
Objectives	
<p>The long term objective of LaSEEB group is to develop model-based real-time detection and classification of brain states using the multi-channel Electroencephalogram (EEG) signal, where models and classifiers are optimized by bio-inspired algorithms. The final goal is not only to provide a better understanding of the brain functions but also providing affordable efficient training, prevention and therapy techniques.</p> <p>Modeling and Classification of brain States during awake and sleep for Neurocognitive training using Self-Organized Swarm Intelligence techniques.</p>	
Main Achievements	
<p>Agent Based Modelling of the Dengue transmitting mosquito aedes aegypty.</p> <p>PSO and GA tuned Model for bio-reactors of bacteria for food-industry.</p> <p>New global evolutionary search algorithms Binary Ant System</p> <p>New unsupervised hybrid classifier (Kohonen Ants System).</p>	

Group Productivity	
Publications in peer review Journals	
C Fernandes, A Rosa. Self-Adjusting the Intensity of Assortative Mating in Genetic Algorithms. <i>J of Soft Computing</i> 12(10), pp. 955-979, 2008.	
R. C. Martins, V. V. Lopes, A. A. Vicente, and J. A. Teixeira. Computational shelf-life dating: complex systems approaches to food quality and safety. <i>Food and Bioprocess Technology, An International Journal</i> , 1(3):207–222, 2008	
R. C. Martins, V. V. Lopes, P. Valentão, B. M. Silva, J. C. M. F. Carvalho, P. Amaral, M. T. Batista, M. R. Seabra, and P. B. Andrade. Relevant principal component analysis applied to the characterization of Portuguese heather honey. <i>Natural Product Research</i> , , vol 22, issue 17, pp 1560-1582. Nov 2008.	
R. C. Martins, V. V. Lopes, and A. A. Vicente. Sistemas computacionais para a previsão da qualidade e segurança alimentar: evolução e sistemas complexos. <i>Ingenium</i> , 104:57-60, 2008.	
Cristian Munteanu, Francisco Cabrera, and Agostinho C. Rosa. Enhancing Obstetric and Gynecology Ultrasound Images by Adaptation of the Speckle Reducing Anisotropic Diffusion Filter. <i>Artificial Intelligence in Medicine</i> . 43, pp 223-242, 2008.	
R. C. Martins, Raquel Oliveira, F. Bento, D. Geraldo, V. V. Lopes, P. Guedes de Pinho, C. M. Oliveira, and A. C. Silva Ferreira. Oxidation management of white wines using cyclic voltammetry and multivariate process monitoring. <i>Journal of Agricultural and Food Chemistry</i> . 2008, 56, 12092-12098.	
MC Lopes, C Guillemainault, A Rosa, C Passarelli, S Roizenblat, S Tufik. "Delta Sleep Instability in children with chronic arthritis". <i>Brazilian Journal of Medical and Biological Research</i> (2008) 41:938-943.	
R. C. Martins, V. V. Lopes, A. A. Vicente, and J. A. Teixeira. Chapter 1.4: Numerical solutions - finite element and finite volume methods. <i>Optimization in Food Engineering</i> , Ferruh Erdogdu (Ed.), pp 49-108, 2008.	
Carlos Fernandes, Agostinho Rosa. Evolutionary Algorithms with Dissortative Marting in Static and Dynamic Environments. In "Evolutionary Algorithms", Witold Kosinski (Edt), Ch 10, pp 181-206, ISBN 978-3-902613-32-5. ARS Press, Vienna, Austria.	
AM Mora, CM Fernandes, JJ Merelo, V Ramos, JL Laredo, AC Rosa. KohonAnts: A Self-Organizing Ant Algorithm for Clustering and Pattern Classification. <i>ALIFE XI</i> , pp 428-435, 2008, MIT Press.	
JL Laredo, PA Castillo, AM Mora, JJ Merelo, A Rosa, C Fernandes. Evolvable Agents in Static and Dynamic Optimization Problems. <i>PPSN, Lectures</i>	

Group Productivity

Notes in Computer Sciences 5199, Springer-Verlag, ISBN 978-3-540-87699-1, pp. 488-497, 2008.

C Fernandes, AM Mora, JJ Merelo, V Ramos, JL Laredo, A Rosa. KANTS: Artificial Ant System for Classification. Lectures Notes in Computer Science, Vol 5217, Springer-Verlag, ISBN 978-3-540-87256-1 pp 339-346. <http://dx.doi.org/10.1007/978-3-540-87527-735>, 2008.

Other publications International

C Fernandes, C Lima, A Rosa. UMDA for Dynamic Optimization Problems. Proc of GECCO 2008, pp 399-406.

C Fernandes, J Merello, V Ramos, A Rosa. A Self-organized Criticality Mutation operator for Dynamic Optimization Problems. Proc of GECCO 2008, pp 937-944.

Claudio Lima, C Fernandes. Investigating Restricted Tournament Replacement in ECGA for Non-Stationary Environments. Proc. of GECCO 2008, pp 439-446.

C Fernandes, JJ Merelo, A Rosa. Tracking Extrema in Dynamic Fitness Landscapes with Dissortative Mating Genetic Algorithm. IEEE Proceedings of HIS 2008, Hybrid Information Systems, pp 59-64.

Nuno Fachada, V. V. Lopes, and Agostinho C. Rosa. Simulation of immune system response to bacterial challenge. Eurosis – Proc of ESM 2008 - European Simulation and Modeling, 2008, pp 252-257.

P.A. Castillo, J.L.J. Laredo,, A.M. Mora, C. Fernandes, J.J. Merelo, Addressing Churn in a Peer-to-Peer Evolutionary Algorithm. First Int Workshop on Prralel Architecture and Bioinspired Algorithms, pp 5-12, 2008. ISBN 978-84-691-6513-3.

Master and Ph.D. thesis completed

Nuno Fachada "LAIS: Agent Based Simulator for Artificial Immune System", MSc in EEC at MEEC-IST, June 2008.

Organization of conferences

ACM Symposium of Applied Computing 2008 – Computational Intelligence and Image Analysis Track

Internationalization

Stanford University – USA and Federal University of Sao Paolo - Brazil

MC Lopes, C Guilleminault, A Rosa, C Passarelli, S Roizenblat, S Tufik. "Delta Sleep Instability in children with chronic arthritis". Brazilian Journal of Medical and Biological Research (2008) 41:938-943.

University of Granada - Spain

AM Mora, CM Fernandes, JJ Merelo, V Ramos, JL Laredo, AC Rosa. KohonAnts: A Self-Organizing Ant Algorithm for Clustering and Pattern Classification. ALIFE XI, pp 428-435, 2008, MIT Press.

JL Laredo, PA Castillo, AM Mora, JJ Merelo, A Rosa, C Fernandes. Evolvable Agents in Static and Dynamic Optimization Problems. PPSN, Lectures Notes in Computer Sciences 5199, Springer-Verlag, ISBN 978-3-540-87699-1, pp. 488-497, 2008.

C Fernandes, AM Mora, JJ Merelo, V Ramos, JL Laredo, A Rosa. KANTS: Artificial Ant System for Classification. ANTSI08. Lectures Notes in Computer Science, Vol 5217, Springer-Verlag, ISBN 978-3-540-87256-1 pp 339-346. <http://dx.doi.org/10.1007/978-3-540-87527-735>.

P.A. Castillo, J.L.J. Laredo,, A.M. Mora, C. Fernandes, J.J. Merelo, Addressing Churn in a Peer-to-Peer Evolutionary Algorithm. First Int Workshop on Prralel Architecture and Bioinspired Algorithms, pp 5-12, 2008. ISBN 978-84-691-6513-3.

University of Canarias - Spain

Cristian Munteanu, Francisco Cabrera, and Agostinho C. Rosa. Enhancing Obstetric and Genecology Ultrasound Images by Adaptation of the Speckle Reducing Anisotropic Diffusion Filter. Artificial Intelligence in Medicine. 43, pp 223-242, 2008.

Future Research

Objectives

Besides the continuation of current research work LaSEEB future main research activity is oriented towards the development of novel and integrative approaches for the modeling and simulation of biological systems. LaSEEB research activities have been focused mainly in the development of agent based models/algorithms inspired by nature to be used in a variety of different engineering tasks, such as: optimization algorithms, simulation of biological systems and modeling, identification and classification of biomedical signals. The future research goals defined for the next years are a natural consequence of the work developed so far. Research effort will be focused in four synergistic research areas, describe in the 1.1 - 1.4 paragraphs.

1.1 Development of a new framework for the simulation of biological systems based on agent based methodologies – this framework aims to assist the biological research in test qualitatively and quantitatively new biological theories. The framework will be developed as part of an ongoing research project with the University of Minho – OpenMicroBIO. Specifically, it aims to describing cell dynamics (cycle and metabolism), cell to cell communications and networking and colony dynamics (quorum sensing) inside bio-reactors for modeling and simulation of flocculating yeast (*Saccharomyces cerevisiae* - eukaryotic cell) growth during fed-batch fermentations.

1.2 Development of novel multi-way data decomposition algorithms to help in the characterization of biological samples and assist in the validation of experimental biologic analytical data (process analytical techniques – PAT) – the development of novel computational tools to assist to process of biological data collection and validation is an important aspect identified from our existent collaborative research. Techniques based on the low rank data decomposition can provide an important role in dealing with the high-throughput biological analytical methods such as the gas chromatography - mass spectroscopy or hyper-spectral chemical imaging (under the collaboration with the project CLARO: cancer light assisted receding oncological therapies which aims at using hyper-spectral FTIR microscopic data for tumorous tissue classification).

1.3 Development of new algorithms that can exploit the computational capabilities of the new multi-core and many-core processing hardware of heterogeneous systems (GPU, CeLL and multi-core Intel processors) – the development of agent based modeling strategies for the simulation of biological systems requires an huge computational power. Research will address the development of special purpose algorithms that will allow

Future Research

distributing the computational workload characteristic of ABM systems among different heterogeneous processing units. This research will benefit from the existent high-performance computational capabilities at LaSEEB (5 PS3 and 10 multi-GPU Quad & Core7 machines).

1.4 Development of a fully automatic analysis system for Advanced Diagnosis of Sleep Disorders in collaboration with industry partners incorporating a new model for the micro structural organization of the Sleep process in partnership with Stanford University and State University of Sao Paulo, culminating with the proposal of a new Paradigm for Sleep Classification.

Funding, source, dates

The research will be partial supported by OpenMicroBIO research project (total 57652.4 EUR) and by the existent pluri-annual base funding (5000 EUR per year). An extra funding of 36460 EUR for the acquisition of a hyper-spectral imaging system is still pending approval by the ISR pluri-annual programmatic funding.

Future research activities will benefit from data collected from the existent collaborative research projects and, thus magnify the existent research collaboration initiatives with: a) the Centro de Biologia Molecular and Centro de Engenharia Biologica of the Instituto de Biotecnologia e BioEngenharia at Universidade do Minho; b) the Departamento de Engenharia Biomédica of Faculdade de Engenharia at Universidade Católica Portuguesa; and, c) Departamento de Biotecnologia at LNEG.

Special requirements

For the LaSEEB research is necessary be integrated and access to a fair share of the ISR programmatic pluri-annual research funding in order to take full advantage of the existent research environment conditions. It is believed that this additional funding would: a) provide an additional contribution from ISR to the complex systems research field; b) increase ISR leverage in existent and future scientific research collaborations; and c) increase ISR aptitude to be integrated new multidisciplinary research networks. In a short time period, it could magnify the scientific outcome of existent collaborations.

For a more synergetic effort inside ISR human resources, LaSEEB is proposing the formation of a new Bio-Systems Group integrating current member, all other members interested to join and specially boosted by new contracted researchers in order to achieve the necessary critical mass to address more ambitious longer term objectives.

This new group will comprise horizontal activities in most bio related areas and more important to strive for excellence in a specific domain to be defined by the institution strategic policy.

Group Description	
Title of Research Group:	(RG-Centro-Coimbra-750009-3433) Centre of IMAR of the University of the Azores/ Department of Oceanography and Fisheries (IMAR-DOP/UAz)
Principal Investigator:	Ricardo Piedade Abreu Serrão Santos
Main Scientific Domain:	Ciências do Mar
Group Host Institution:	Instituto do Mar

Funding, source, dates	
Funding, source, dates	
There were four main sources of funding during 2008: (the information on the amount concerns the research group as partner, not the overall funding of the project):	
1) Protocols with the Azorean Regional Government (Fisheries/ Environment/ Science and Technology) concerning aspects of monitoring, evaluation and implementation of policies e.g. Common Fisheries Policies, EC Habitats and Birds Directives, OSPAR convention, etc, and other contracts e.g. Ship Management. The contracts for 2008 were on the amount of €1 million.	
2) Research cooperative projects funded by the EC through DG Research (5 projects FP6 and 4 projects FP7: totalling around €1 million), 3 projects DG Regio (the case of InterReg/Macaronesia: totalling around €600 thousand).	
3) Research projects funded by FCT/MCTES on the general calls (4 projects), Ciencia 2007, Pluriannual + Programatic totalling around: €500 thousand.	
4) Other international projects: EEA Grants (€800 thousand) + FLAD, CoML: around €50 thousand.	

Objectives & Achievements	
Objectives	
The conservation of marine life and the sustainable use of living resources in the North-East Atlantic Ocean and the ecosystems of islands slopes, the Deep-Sea and Open Ocean at large are the main objectives of the research and outreach activities developed at the Centre of IMAR of the University of the Azores/Department of Oceanography and Fisheries (IMAR-DOP/UAz). Those objectives are shared with the generations of young students and newly graduated researchers in marine sciences that integrate IMAR-DOP/UAz. The members of IMAR-DOP/UAz have been involved in the development of different activities within these fields, in a multidisciplinary effort to integrate the research for a better understanding of the dynamics of this region, and its biological, physical, chemical and geological backgrounds.	
The Research Group operates in 5 flexible Working Groups and 6 Laboratories. The actual WGs are dedicated to: "Ecosystem Based Approaches to Marine Habitats & Biodiversity", "Ecosystem Based Management to Fisheries", "Chemosynthetic Ecosystems", "Seamounts and Cold Water Corals", "Oceanography". The main fields of research are: molecular genetics, eco-toxicology, satellite oceanography, physical oceanography, fisheries dynamics, behavioural ecology, bio-telemetry, acoustic of the seabed and water column in view of the mapping of habitats and biodiversity and scenarios for sea-going technologies.	
This centre supports and helps pure and applied research. It is highly involved in co-operation activities with public and private institutions from Portugal and other countries, including universities, research centres and institutes, enterprises and professional associations. IMAR-DOP/UAz is part of the national network of IMAR- Institute of marine Research (www.imar.pt) and of the Associated Laboratory ISR-Lisbon in a successful effort of opening horizons and framing research activities in larger partnerships. IMAR-DOP/UAz also carries out services for industry and public administration. It is also involved in activities of promotion and divulgation of research activities in media, museums, at the primary and high school system and through the internet	

Main Achievements	
The group was successful in terms of reaching national and international recognition in ocean studies. It became one of the leading worldwide teams in terms of seamount and hydrothermal vent studies, being considered by the Research*EU: Magazine of the European Research Area one of the 9 "main pillars of European oceanographic excellence" (...) "all of which are setting very high standards". (December 2007 Issue: pg. 42 or http://ec.europa.eu/research/research-eu/sea/article_mer42_en.html).	
The research group achieved important milestones, devising and proceeding to the installation of new technological capabilities which are leading to a breakthrough in advanced areas of research, both pure and applied.	
One of the achievements was the up-grade of LabHorta (the International Laboratory for Deep-Sea Ecosystems), a unique feature of its gender, enabling the study of deep-sea live organisms, including those leaving at hydrothermal vents. The lab which is now is equipped with two hyperbaric chambers, with video systems and regulation of gazes incorporated, that may simulate depths down to -4000m. LabHorta operates in association with a system of deep-sea retrievable cages enabling the provision of organisms throughout the year. These facilities have clearly improved our national and international collaboration in deep-sea biology and helped to create new knowledge concerning the physiology, eco-toxicology, immunology, genomics and proteomics of some deep-sea organism thus enhance our role in biotechnology research. In the end of 2008 we have established all new capabilities to do experimental work with Cold Waters with the installation of a new set of aquaria.	
A second achievement is the research concerning the mapping of habitats and biodiversity which involved a set of cross theme technologies and data/information collection involving acoustics (hydrophones, sounders, side and multi-beam scans), SST and Chl satellite oceanography, biotelemetry (acoustic and satellite), data-loggers for physical parameters, video mosaiking, molecular tools, etc. A great part of these studies were made in association with our technological partners of underwater robotics.	
The Research Group (DOP) was award in June 2008 by the President of the Republic as "Member of the Military Order of Sant'Iago of the Sword" as national recognition of scientific merit	

Group Productivity	
Publications in peer review Journals	

Group Productivity

A full list of 58 publications in 2008, and respective PDFs may be downloaded from: <http://www.horta.uac.pt/temp9/publications2008/>

Other publications International

Person R, Beranzoli L, Berndt C, Dañobeitia JJ, Diepenbroecke M, Favali P, Gillooly M, Lykousis V, Miranda JM, Mienert J, Priede IE, Santos RS, Thomsen L, Van Weering T, Waldman C 2008 ESONET: An European sea observatory initiative. Oceans 2008 - Mts/IEEE Kobe Techno-Ocean Vols 1-3:1215-1220 [ISIP:000257943100211].

Santos, R. S. & T. Morato 2008. Conservation and utilization of biodiversity in seamounts. Pp. 135-142. In: Sandlund, O. T. & L. Saksgård (Eds.) 2008. Proceedings of the Norway/UN Conference on Ecosystems and People – Biodiversity for Development – The Road to 2010 and Beyond – Directorate for Nature Management, Trondheim. 179pp. [ISBN: 978-82-7072-725-4]

Monteiro, J., C. Almeida, R. Freitas, A. Delgado, F. Porteiro, R.S. Santos, 2008. Coral assemblages of Cabo Verde: preliminary assessment and description. Proceedings of the 11th International Coral Reef Symposium, Ft. Lauderdale, Florida, 7-11 July 2008, Session number 26

Heino, M. D.S. Boukal, T. Falkenhaus, U. Piatkowski, F.M. Porteiro and T.T. Sutton, 2008. Length structure of deep-pelagic fishes sheds new light to their life histories. ICES CM 2008/C: 14, 6p

Heino, M. D.S. Boukal, T. Falkenhaus, U. Piatkowski, F.M. Porteiro and T.T. Sutton, 2008. Size structure, age-size dynamics and life history variation. ICES CM 2008/F: 13

Bertoncini, A. A., L. F. Machado, J. P. Barreiros, G. Paulay & F. A. D. Cardigos 2008. In situ observation of sexual reproduction of *Holothuria tubulosa* Gmelin 1788 (Echinodermata: Holothuroidea) in the Azores (NE Atlantic). Beche-de-Mer Information Bulletin 27: 43-45.

Other publications National

Santos, R. R. 2008. Prefácio. Pg. 5. In: N. V. Rodrigues, P. Maranhão, P. Oliveira & J. Alberto. Guia de Espécies Submarinas (Portugal – Berlengas). Instituto Politécnico de Leiria. [ISBN 978-972-8793-25-8]

Santos, R. S., F. M. Porteiro & L. Gallagher 2008. Fish of the Azores of commercial interest (English/Portuguese). Fishpics & ImagDOP/University of the Azores (Poster 4th edition).

Santos, R. S., F. M. Porteiro & L. Gallagher 2008. Large Pelagic Fishes of the Azores (English/Portuguese). Fishpics & ImagDOP/University of the Azores (Poster 1st edition).

Santos, R. S., F. M. Porteiro, P. Afonso & L. Gallagher 2008. Coastal Fishes of the Azores (English/Portuguese). Fishpics & ImagDOP/University of the Azores (Poster 2nd edition).

Santos, R. S., J. Bried, M. Magalhães, P. Pedro, V. Neves & L. Gallagher 2008. Seabirds of the Azores (English/Portuguese). Fishpics & ImagDOP/University of the Azores (Poster 1st edition).

Santos, R. S., E. Isidro, J. Gonçalves, O. Melo, F. M. Porteiro, G. Carreira & L. Gallagher 2008. Crustacean of the Azores – of commercial interest (English/Portuguese). Fishpics & ImagDOP/University of the Azores (Poster 1st edition).

Santos, R. S., J. Gonçalves, M. Silva, R. Prieto, & L. Gallagher 2008. Whales and Dolphins of the Azores (English/Portuguese). Fishpics & ImagDOP/University of the Azores (Poster 2nd edition).

Santos, R. S., C. de la Cerda Gomes, F. M. Porteiro & L. Gallagher 2008. Virtual Center of Marine Interpretation (CIMV) – An Amazing Journey to the Marine Ecosystems of the Azores (2 DVD: Interactive Educational DVD + 3D Movie DVD). ImagDOP/ Universidade dos Açores [ISBN 978-972-8612-33-7] (Portuguese, English, French, Spanish) (2nd edition: enhanced and expanded)

Bried, J. 2008a. *Sterna hirundo* Gaivinha-comum, *Andorinha-do-mar-comum*, Garajau. In Atlas das aves nidificantes em Portugal (Equipa Atlas, eds.). Instituto da Conservação da Natureza e da Biodiversidade, Sociedade Portuguesa para o Estudo das Aves, Parque Natural da Madeira e Secretaria Regional do Ambiente e do Mar. Assírio & Alvim, Lisboa. Pp 240-241.

Bried, J. 2008b. *Sterna fuscata* Gaivinha-de-dorso-preto. In Atlas das aves nidificantes em Portugal (Equipa Atlas, eds.). Instituto da Conservação da Natureza e da Biodiversidade, Sociedade Portuguesa para o Estudo das Aves, Parque Natural da Madeira e Secretaria Regional do Ambiente e do Mar. Assírio & Alvim, Lisboa. Pp 242-243.

Master and Ph.D. thesis completed

Mirko De Girolamo – SFRH/BD/6916/2001: Genetic interpretation of the social mating system and larval dispersal in a fish with male parental care, the redlip blenny *Ophioblennius atlanticus atlanticus*. (University of the Azores)

Jorge Fontes – SFRH/BD/12788/2003: Larval dispersal and recruitment patterns in Azorean coastal fishes (Implications for Marine Reserves). (Submitted in May 2008, University of the Azores)

MSc

Dora Maria Rodrigues da Costa Neto (2008). "A contribution for the management and conservation of the African elephant (*Loxodonta africana*) in the Maputo Elephant Reserve, Mozambique" (University of the Azores).

Patents/propotypes

There is a pending process for a patent for "FishMetrics" an automation method for the visual measurement and sampling of fish at the fish auctions. The project won the 4th Edition of the National BES Innovation Prize in 2008.

Organization of conferences

ICES Working Group on Marine Habitat Mapping (WGMHM) Horta (Azores, Portugal). 31 March - 3 April 2008

Geographic Information Systems applied to Marine Sciences (Course). Horta.

Permanent Forum for Sea Affairs. 7- 8 August, Horta

South Atlantic MAR-ECO Project Workshop. 14-15 June, Argentino Hotel – Casino & Resort, Piriápolis, Uruguay.

Geographic Information Systems applied to Marine Sciences (Course). 14-18 April, Horta, Azores

Azores Fisheries Observer Program: past, present and future – Workshop. 13-14 October, Horta, Azores

Group Productivity

Industry contract research

The Azores Fisheries Observer Program (POPA: www.popaobserver.org) has contracts with the fishing industry namely PÃO-DO-MAR (Azores Fish Canning Association), APASA (Tuna Producers Association of the Azores), LotAçor Azorean Market Company, and in an irregular basis with different fishing boat owners.

A consortium was established with the enterprise SeaExperts in view of the development of aquaculture projects in the Azores, namely the giant barnacles.

Internationalization

The Research Group is member of the Marine Association of Research Stations (MARS) since 1996, and one of its researchers is member of the Scientific Steering Committee (SSC). The Research Group is also member of the European Network of Excellence on Marine Biodiversity (MarBEF), and the European Seas Observatory Network (ESONET) and of their respective SSC. Members of the RG participate in the SSC of three Census of Marine Life projects (www.coml.org): ChEss (Biogeography of Chemosynthetic Ecosystems), MAR-ECO (Patterns and Processes of the Ecosystems of the Mid-Atlantic Ridge) e CenSeam (A Global Census of Marine Life on Seamounts). The RG is partner of the Ocean Tracking Network initiative (<http://oceantrackingnetwork.org>), and two FP6 Marie Curie Training Networks, with two PhD students involved: "RTN/2003/505026: MoMARNET – Monitoring deep sea floor hydrothermal environments on the Mid-Atlantic Ridge: A Marie Curie Research Training Network" and "RTN/2006/2/036186-2: FREESUBNET – A European Research Training Network on Key technologies for Intervention Autonomous Underwater Vehicles".

Members of the RG are involved in many committees and international working groups: e.g. Co-Chair of the WG of Monitoring and Observatories of InterRidge (<http://interridge.whoi.edu/en/WG/MonObs>), Co-Chair of the ESF/ICES/EFARO WG on "Science Dimensions of Ecosystems Approaches to Management of Biotic Ocean Resources" (SEAMBOR), Chair of the WG of Research and Statistics of ICCAT. One of the members of the RG is co-delegate to the Committee of Research Infrastructures (FP6 and FP7). Members of RG participate in several of the ICES WGs, e.g. WGMHM, WGDeep, WGEIasmobranchs, WGDEC, etc. Members of the RG are part of the editorial board of the following scientific journals: The Scientific World Journal, Journal of Marine Biology, Acta Ethologica, Marine Biodiversity. Members are regularly invited to give plenary talks in International Scientific Conferences and Policy.

Government/Organization contract research

The Research Group (RG) has been involved in contracts with Government Bodies concerning, e.g. the following International Policies: International Whaling Commission, Common Fisheries Policies, Habitats and Birds Directives (Natura 2000), OSPAR Commission for the Protection of the Marine Environment of the North-East Atlantic, Convention of Biological Diversity. The RG was involved in several reports and publications among which.

OSPAR (www.ospar.org)

OSPAR Principles of Responsible Marine Research

Proposal for an OSPAR area of interest for establishing an MPA on the Mid Atlantic Ridge/Charlie Gibbs Fracture Zone

Background Document for Oceanic Ridges with Hydrothermal Vents/Fields

Background Document for Seamounts

Background Document for Limpets

CBD (www.cbd.int)

AZORES SCIENTIFIC CRITERIA AND GUIDANCE for identifying ecologically or biologically significant marine areas and designing representative networks of marine protected areas in open ocean waters and deep sea habitats. CBD Secretariat, Ottawa, Canada. 2008

Future Research

Objectives

Research will be focused on key issues of ecosystem functioning in a time of changes, climate change and anthropogenic exploration of ocean biotic resources. We will keep the focus on island slopes, deep-sea ridge systems and open ocean. A lot is still left to do in view to have a synoptic and holistic perspective integrating these components of the ecosystem, and there is a need to accomplish the ecosystems approach for management. Thus said we intend to keep the WGs mentioned above, since we understand that a global vision still needs sectoral approaches.

Our research will be based on the funded projects listed in the following section. Focus will be given to bio-telemetry studies of top predators together with habitat mapping at the level of seafloor and water column. These studies will serve to characterize essential habitats of priority species namely cold water corals and deep-sea fishes, and large pelagic predators.

New sensors and permanent stations, including landers, will be deployed. Together with the fixed observatory type studies of seamount and vents ecosystems, we will continue tagging several species with acoustic and satellite transmitters incorporating data-loggers for different types of environmental and physiological data acquisition.

We expect to make use of the sea on-going facilities now available in Portugal, in particular in conjunction with our partners of the Institute of Systems and Robotics. Many of the scenarios and work at sea will employ robotic equipments. With this we intend to contribute with answers for some key scientific questions raised by the European Science Group on Deep-sea frontier on whose synthesis a member of the RG was involved: 1) How do deep-sea and other oceanic ecosystems respond to global change? 2) What is the relative importance of biotic and abiotic time-varying factors in structuring deep sea communities? 3) How does biodiversity and ecosystem functioning vary over very small regional and global scales, and with environmental heterogeneity, latitude and depth? 4) What are the effects of geobiological processes on deep-sea ecosystem functioning? 5) What are the life cycles and dispersal for deep-sea/ open ocean organisms, and what are their physiological adaptations? 6) How resilient are deep-sea ecosystems to deep-sea fisheries? 7) Can deep-sea resources be managed in an ecologically sustainable way? What ecosystems/ecoregions should be given conservation priority?

Taking the opportunity of the missions at sea and the conditions available at LabHorta and satellite laboratories we intend to continue developing advanced experimental research in the areas of genomics, proteomics, immunology, eco-toxicology, molecular biology, physiology, processes of calcification, enzymology. The studies will be primarily done under controlled experimental conditions and are intended to explore new molecules for bio-technology with from organisms living at the deep-sea both in chemosynthetic and photosynthetic driven environments. This is also a clear follow up of the capabilities and know how acquired and developed by the team during the last 5 years.

Facing the new global economical reality, special efforts will be also applied in the local economy, namely looking and encourage research

Future Research

initiatives or entrepreneurs aiming to rise the local value chains through the development of new products or services with potential to be commercialized.

Funding, source, dates

Funding= F Pending Funding=PF

ESF/MARINERA - ReDEco - Regional Drivers of Ecosystem Change and its Influence on Deep-Sea Populations in the Mediterranean. 2009-2012. [F: € 109 860; PF: € 109 860].

FP6-IST/2005/035223: GREX – Coordination and control of cooperating heterogeneous unmanned systems in uncertain environments (STEP): 2006-2009. [F: € 234 200; PF: € 87 194].

FP6 RTN/2006/2/036186-2: FREESUBNET-A European Research Training Network on Key technologies for Intervention Autonomous Underwater Vehicles: 2007-2010. [F: € 187 941; PF: € 156 553].

FP7 KBBE/2007/1/210496: MADE – Mitigating Adverse Ecological Impacts of Open Ocean Fisheries: 2008-2012. [F: € 345 168; PF: € 345 168].

FP7 ENV/2007/1/213144: CORALFISH - Assessment of the interaction between corals, fish and fisheries, in order to develop monitoring and predictive modelling tools for ecosystem based management in the deep waters of Europe and beyond: 2008-2012. [F: € 452 930; PF: € 452 930]

FP7 ENV/2008/1/226354: HERMIONE - Hotspot Ecosystem Research and Man's Impact on European Seas: 2009-2012 [F: € 123 762; PF: € 123 762]

FCT PTDC/MAR/74071/2006:TRACE 2008-2011 [F: € 154 926; PF: € 154 926]

FCT PTDC/MAR/72169/2006:CORAZON-. [F: € 187 967; PF: € 187 967]

FCT PTDC/MAR/65991/2006: IMUNOVENT: 2008-2011 [F € 192 652; PF: € 192,652]

EEA Financial Mechanism PT0040/2008: CONDOR - Observatory for long-term study and monitoring of Azorean seamount ecosystems: 2008-2011 [F: € 716198; PF: € 716,198]

ESF/EUROCORES-Proposal 06-EuroDEEP-FP-008 & FCT: EURODEEP/0002/2007 - DEECON - Unraveling population connectivity for sustainable fisheries in the deep sea. 2007-2010. [F: €182 043; PF: € 150 000]

FCT: EURODEEP/0001/2007 CHEMECO- [IMAR F €49,279]

Group Description	
Title of Research Group:	(RG-LVT-Lisboa-750009-3438) DSORL - Dynamical Systems and Ocean Robotics Laboratory
Principal Investigator:	António Manuel dos Santos Pascoal
Main Scientific Domain:	Engenharia Electrotécnica e Informática
Group Host Institution:	Instituto Superior Técnico - Universidade Técnica de Lisboa

Funding, source, dates
Funding, source, dates
Source Project Reference DSORL Approved Funding 2008
National
FCT RUMOS 2006-2009 PDCT/MAR/55609/2004 10813
FCT DENO 2007-2010 PTDC/EEA-ACR/67020/2006 30000
FCT HELICIM 2007-2010 PTDC/EEA-ACR/72853/2006 10000
FCT OBSERVFLY 2008-2011 PTDC/MAR/64546/2006 1000
FCT NAV 2007-2010 PTDC/EEA-ACR/65996/2006 22542
European
EC GREX- 2006-2009 FP6-EU-IST-035223 168500
EC VENUS - 2006 - 2009 FP6-EU-IST-034924 100000
EC FREEsubNET - 2006-2010 MRTN-CT-2006-036186 23794
Total 366649 Euro

Objectives & Achievements
Objectives
<p>One of the key objectives of the DSORL is to meet some of the challenges in advanced robotic vehicle systems design and control contributing to the development of faster, cheaper, and far more efficient methods for ocean exploration and exploitation. This motivated the definition of a research and development program addressing theoretical and practical engineering issues, as well as issues related to the interplay between marine sciences and marine technology that fall in the scope of Thematic Area A. Two main lines of action were set:</p> <ol style="list-style-type: none"> 1. Contributing to furthering the knowledge in the general area of dynamical system theory. 2. Developing new analysis and design tools in the areas of navigation, guidance, and control (NGC) and applying them to the development of advanced systems enabling the operation of multiple networked autonomous marine and aerial vehicles. <p>Theoretical Objectives:</p> <p>A. Linear and nonlinear systems theory: study and development of theoretical tools for the analysis and design of linear and nonlinear control / filtering systems.</p> <p>B. Robust Multiple Model Adaptive Control (RMMAC): Development of new methodologies for the design of robust adaptive controllers for plants with structured and unstructured uncertainty.</p> <p>C. Design of Navigation Systems for autonomous vehicles. Study of advanced solutions focusing on the: i) development of highly performing, moderate cost heading and attitude reference units; ii) study and practical evaluation of acoustics-based systems for underwater vehicle positioning; iii) development of geophysical-based navigation algorithms.</p> <p>D. Motion Control of single and multiple vehicles under stringent communication constraints, including those imposed by a very special medium: the ocean. Problems addressed: i) Motion control of autonomous vehicles; ii) Visual servoing control; iii) Path Following; iv) Terrain Contour Tracking; v) Coordinated/cooperative control of groups of autonomous vehicles; vi) Networked control over faulty communication links.</p> <p>Practical Objectives:</p> <p>A. Design and development of AUVs, ASCs and UAVs and on-board integration of scientific sensor suites and data acquisition / logging systems.</p> <p>B. Distributed hardware and software architectures for coordinated navigation and motion control of multiple vehicles as well as mission control.</p> <p>C. Tests and scientific missions with the robots developed in cooperation with the scientific partners in Thematic Area A and other international institutions.</p>

Main Achievements
Theoretical achievements
<ol style="list-style-type: none"> 1. Advances on the formulation of a Robust Multiple-Model Adaptive Control (RMMAC) architecture for linear time-invariant and time-varying systems subjected to structured and unstructured uncertainty. New theoretical results were obtained on Identification and Convergence Analysis of a Class of Continuous-Time Multiple-Model Adaptive Estimators [J3, C4]. 2. Study of linear and nonlinear control algorithms for motion control of fully and underactuated autonomous robotic vehicles in three-

Objectives & Achievements

dimensional space, including control algorithms for terrain avoidance and rotorcraft landing [C6, C7, C12, C17]. New results on performance limitations in reference-tracking and path-following for nonlinear systems [J1, J4].

3. Design of a novel family of nonlinear kinematic observer for pose estimation in SE(3). An almost globally exponentially stable attitude and position observer was obtained [J2]

4. Further development and experimental evaluation, using the Catamaran DELFIMx, of a low cost Inertial navigation System (INS) based on asymptotically stable discrete-time nonlinear complementary filters that merge inertial measurements with Earth's magnetic field observations and GPS data.

5 Study of filtering structures for USBL tightly-coupled inertial navigation. Development of nonlinear GPS/IMU based observers for rigid body attitude and position estimation. Study of estimators on SE(3) using range-only measurements Development and practical evaluation of acoustics-based systems for underwater vehicle positioning and tracking. Estimation algorithms were derived and their performance tested during real missions at sea [C8, C9, C10, C14, C16, C18, C21, C22].

6. Study and assessment in simulation of algorithms aimed at steering fleets of mobile robots along a set of given spatial paths, while keeping a desired inter-vehicle formation pattern. Decentralized algorithms that explicitly address the dynamics of the cooperating vehicles and the constraints imposed by the nature of the inter-vehicle time-varying communications network were derived. Study of algorithms for multiple vehicle path planning ensuring spatial or temporal deconfliction (non-collision) [C1, C2, C5, C20, C24].

7. Study of feature based navigation algorithms for the execution of long range missions with marine vehicles in unstructured environments. Integrated navigation solutions based on bathymetric and geomagnetic data were derived [C11, C19].

Practical Achievements

8. Full system development, implementation, and demonstration of the operational capabilities of the DELFIMx robotic ocean vehicle and a prototype Autonomous Helicopter.

9. Demonstration of coordinated vehicle motion control with the DELFIMx and a manned vessel at sea in the Azores, in cooperation with the IMAR/DOP/Univ. Azores and the partners of the EU GREX project. This entailed the implementation of algorithms for cooperative control and full development of a middleware architecture for mission planning and mission control.

10. Acoustic and navigation system integration, followed by the execution of high resolution multibeam surveys in cooperation with the IMAR/DOP/Univ. Azores. The system developed afforded the partners in Thematic Area A a state-of-the-art tool for bathymetric mapping.

Group Productivity

Publications in peer review Journals

[J1] A. Pedro Aguiar, João P. Hespanha, and Petar Kokotović, Performance Limitations in Reference-Tracking and Path-Following for Nonlinear Systems. IFAC Automatica, Vol. 44, No. 3, pp. 598-610, Mar. 2008.

[J2] Rita Cunha, Carlos Silvestre, João Hespanha, Output-feedback control for stabilization on SE(3), Elsevier Systems and Control Letters, Volume 57, Issue 12, pp. 1013-1022, December 2008.

[J3] José Vasconcelos, Michael Athans, Sahjad Fekriasl, Carlos Silvestre, Paulo Oliveira, Stability-and Performance-Robustness Tradeoffs: MIMO Mixed-mu vs Complex-mu Designs, International Journal of Robust and Nonlinear Control, February 2008, DOI: 10.1002/rnc.1299.

[J4] Aguiar, A. P., João P. Hespanha, and Petar V. Kokotović, Zero Dynamics and Tracking Performance Limits in Nonlinear Feedback Systems. In "Analysis and Design of Nonlinear Control Systems", Astolfi, Alessandro; Marconi, Lorenzo (Eds.), Springer Verlag Berlin, 2008.

Other publications International

[C1] Aguiar, A. P., I. Kaminer, R. Ghabcheloo, A. M. Pascoal, E. Xargay, N. Hovakimyan, C. Cao, V. Dobrokhodov, Time-Coordinated Path Following for Multiple UAVs using Dynamic Networking and L1 Adaptation, in Proc. of GN&C'08 - AIAA Guidance, Navigation and Control Conference, Honolulu, HI, Aug. 2008.

[C2] Aguiar, A., I. Kaminer, R. Ghabcheloo, A. M. Pascoal, E. Xargay, N. Hovakimyan, C. Cao, V. Dobrokhodov, Coordinated Path Following of Multiple UAVs for Time-Critical Missions in the Presence of Time-Varying Communication Topologies, in Proc. of the 17th IFAC World Congress, Seoul, Korea, Jul. 2008.

[C3] Aguiar, A., Vahid Hassani, António M. Pascoal, and Michael Athans, Identification and Convergence Analysis of a Class of Continuous-Time Multiple-Model Adaptive Estimators, in Proc. of the 17th IFAC World Congress, Seoul, Korea, Jul. 2008.

[C4] Almeida, J., Silvestre, C., Pascoal, A., Compliant coordination and control of multiple vehicles with discrete-time periodic communications, 17th IFAC World Congress, Seoul, South Korea, July 2008.

[C5] Antunes, Duarte, Hespanha, Joao P., Silvestre, Carlos, Kataria, Nitin, Brewer, Forrest, Computationally Efficient Methods for Digital Control, Proc. 47th IEEE Conference on Decision and Control, Cancun, Mexico, December 2008.

[C6] Antunes, D., Silvestre, C., Cunha, R., Linear Parameter Varying Control for Sampled-Data Multi-Rate Systems, 17th IFAC World Congress, Seoul, South Korea, July 2008.

[C7] Batista, P., Silvestre, C., Oliveira, P., Kalman and H Infinity Optimal Filtering for a Class of Kinematic Systems, 17th IFAC World Congress, Seoul, South Korea, July 2008.

[C8] Batista, P., Silvestre, C., Oliveira, P., Optimal Position and Velocity Navigation Filters with Discrete-Time Delayed Measurements, Proc. 47th IEEE Conference on Decision and Control, Cancun, Mexico, December 2008.

[C9] Batista, P., Silvestre, C., Oliveira, P., Position and Velocity Navigation Filters for Marine Vehicles, 17th IFAC World Congress, Seoul, South Korea, July 2008.

[C10] Gomes, L., Paulo Oliveira, Bathymetric Data Fusion: PCA based Interpolation and Regularization, Sea Tests, and Implementation, MTS/IEEE

Group Productivity

OCEANS Conference, Quebec, Canada, September 2008.

[C11] Guerreiro, B., Silvestre, C., Cunha, R., Terrain Avoidance Model Predictive Control for Autonomous Rotorcraft, 17th IFAC World Congress, Seoul, South Korea, July 2008.

[C12] ISEM and IST Teams, Underwater vehicle technology in the VENUS project, UUV Showcase Conference, Southampton, UK, 23-24 Sept. 08.

[C13] Morgado, M., Oliveira, P., Silvestre, C., Vasconcelos, J., Improving Aiding Techniques for USBL Tightly-Coupled Inertial Navigation System, 17th IFAC World Congress, Seoul, South Korea, July 2008.

[C14] Palomeras, N., Ridao, P., Carreras, M., Silvestre, C., Towards a Mission Control Language for AUVs, 17th IFAC World Congress, Seoul, South Korea, July 2008.

[C15] Peñas, A. Oliveira, P., Pascoal, A., Cunha, R., Silvestre, C., A Dynamic Estimator on SE(3) Using Range-Only Measurements, Proc. 47th IEEE Conference on Decision and Control, Cancun, Mexico, December 2008.

[C16] Serra, P., Cunha, R., Silvestre, C., On the Design of Rotorcraft Landing Controllers, Proc. 16th Mediterranean Conference on Control and Automation, Ajaccio, Corsica, França, 25-27 July 2008.

[C17] Sousa, R., Alex Alcocer, Paulo Oliveira, Reza Ghabcheloo, António Pascoal, Joint Positioning and Navigation Aiding System for Underwater Robots, MTS/IEEE OCEANS Conference, Quebec, Canada, September 2008.

[C18] Teixeira, F. and A. Pascoal, Geophysical Navigation of Autonomous Underwater Vehicles Using Geomagnetic Information, Proc. NGCUV'08 - IFAC Workshop on Navigation, Guidance and Control of Underwater Vehicles, Killaloe, Ireland, Apr. 2008.

[C19] Vanni, F., Aguiar, A. P., Pascoal, A., Cooperative Path-Following of Underactuated Autonomous Marine Vehicles with Logic-based Communication, Proc. NGCUV'08 - IFAC Workshop on Navigation, Guidance and Control of Underwater Vehicles, Killaloe, Ireland, Apr. 2008.

[C20] Vasconcelos, J.F., Elkaim, Gabriel H., Silvestre, C., Oliveira, P., Cardeira, B., A Geometric Approach to Strapdown Magnetometer Calibration in Sensor Frame, IFAC Workshop on Navigation, Guidance & Control of Underwater Vehicles 2008, Killaloe, Ireland, April 2008.

[C21] Vasconcelos, J., Silvestre, C., Oliveira, P., A Nonlinear Observer for Rigid Body Attitude Estimation Using Vector Observations, 17th IFAC World Congress, Seoul, South Korea, July 2008.

[C22] Vasconcelos, J. F., Silvestre, C., Oliveira, P., A Nonlinear GPS/IMU Based Observer for Rigid Body Attitude and Position Estimation, Proc. 47th IEEE Conference on Decision and Control, Cancun, Mexico, December 2008.

[C23] Vanni, F., A. Pedro Aguiar, and Antonio M. Pascoal, Cooperative Path-Following of Underactuated Autonomous Marine Vehicles with Logic-based Communication, in Proc. of NGCUV'08 - IFAC Workshop on Navigation, Guidance and Control of Underwater Vehicles, Killaloe, Ireland, Apr. 2008.

Other publications National

Mohammadreza Bayat, Vahid Hassani, and A. Pedro Aguiar, Nonlinear Kalman Based Filtering for Pose Estimation of a Robotic Vehicle from Discrete Asynchronous Range Measurements, in Proc. of CONTROLO'08 - 8th Portuguese Conference on Automatic Control, Jul. 2008.

Valverde, Pedro M. S., Oliveira, Paulo, Silvestre, Carlos, Underwater Vehicle Tracking Systems: Motion Models and performance analysis, 8th Portuguese Conference in Automatic Control Controlo 2008, Vila Real, Portugal, July 2008.

Master and Ph.D. thesis completed

MSc Theses (Before Bolonha)

Research Area: Preview Guidance and Control

Title: Coastline-following Preview Controller for the Delfimx Vehicle

Student: Pedro Gomes

Concluded 2008.

MSc Theses (Bolonha)

Research Area: Nonlinear observers

Title: Pose Observers for Unmanned Air Vehicles,

Student: Sérgio Brás,

Concluded 2008.

Research Area: Nonlinear Control

Title: Nonlinear Flight Control: Dynamic Inversion Based Control of Aircraft Pitch Student: Miguel Leitão,

Concluded 2008.

Research Area: Tracking Systems

Title: Multiple model underwater tracking systems,

Student: Joana Gomes,

Concluded 2008.

Research Area: Nonlinear control

Title: Robust Nonlinear Motion Control for Multiple Autonomous Robotic Vehicles,

Student: Emílio Pereira,

Concluded 2008.

Group Productivity

Research Area: Tracking Systems

Title: Indoor Target Tracking Vision Systems,

Student: Tiago Gaspar,

Concluded 2008.

Research Area: Tracking Systems

Title: Advanced Marine Vehicles Target Trackers,

Student: Renato Sousa,

Concluded 2008.

Research Area: Signal Processing

Title: Advanced Signal Processing Techniques for Integrated Navigation Systems,

Student: Luís Gomes,

Concluded 2008.

Master of Engineering, Imperial College of London

Research Area: Positioning Systems

Title: Advanced NAVSTAR-GPS Positioning Techniques for UAVs,

Student: CHAN Chun-Ning (Johnny),

Concluded 2008.

Patents/propotypes

- DELFIM and DELFIM_X Autonomous Surface Vehicles (ASCs) – designed and built by ISR/IST to carry out experimental research in the area of ocean robotics and to perform scientific missions at sea. DELFIM Length: 3.5m, Width: 2m, Weight: 320 Kg. DELFIMx Length: 4.5 m, Width: 2.4 m, Weight: 300 Kg. Propulsion by electric motors. These vehicles have been used to acquire marine data in the Azores, in cooperation with the partner IMAR/DOP and to carry out experiments on single and multiple vehicle cooperative control.

- INFANTE Autonomous Underwater Vehicle (AUV) – designed and built by ISR/IST and the company RINAVE to carry out experimental research in the area of ocean robotics and to perform scientific missions at sea. The vehicle is 4:5m long, 1:1m wide and 0:6m high. It is equipped with two main thrusters (propellers and nozzles) for cruising and fully moving surfaces (rudders, bow planes and stern planes) for vehicle steering and diving in the horizontal and vertical planes, respectively.

- MAYA AUV – designed and built by a Luso-Indian consortium consisting of NIO (Goa, India), ISR/IST, IMAR/DOP/UAzores, and RINAVE. A small, modular, autonomous underwater vehicle (AUV) for scientific and commercial applications. Missions include geological and oceanographic surveys, marine habitat mapping, inspection of harbours and estuaries. The first prototype has been tested and used extensively in Goa, India.

- CARAVELA 2000 Autonomous Research Vessel – designed and built by IMAR/DOP/UAzores, ISR/IST, and the companies RINAVE. and CONAFI Prototype of an autonomous surface craft for long range missions at sea (co-owned by IST/ISR, IMAR/Dept. Oceanography and Fisheries of the Univ. Azores, RINAVE, and CONAFI).

- Autonomous Helicopter (Bergen Industrial Twin) - a small-scale industrial helicopter. This is a transformed radio-controlled helicopter, about 1.6m long (including the rotor diameter), with a payload capability of 10 kg, and a top speed of 70 Km per hour.

- IRIS TOOL – designed and built by ISR/IST. A high accuracy surveying tool for both the above water and submerged parts of semi-submerged structures. IRIS is equipped with an accurate Laser Scanner, a profiler sonar, a high end motion reference unit, and a surveying class GPS.

- Medusa I – designed and built by ISR/IST. First prototype of a class of semi-submerged vehicles of small size for underwater target positioning. A set of vehicles acting cooperatively will be used in the scope of the EU COGAUVs (Cognitive marine robotics) project for assisted diving operations.

Organization of conferences

Associated Editor of the MSC-CCA 2008, IEEE Multi-conference on Systems and Control, IEEE International Conference on Control Applications (CCA), September 3-5, 2008, San Antonio, Texas (USA).

Co-Chair of the session "Low Altitude Flight and Landing Control", 2008 IFAC World Congress, Seoul, Korea, July 2008.

Chair of the session "Marine System I", 2008 IFAC World Congress, Seoul, Korea, July 2008.

Chair of the session "Marine System II", 2008 IFAC World Congress, Seoul, Korea, July 2008.

Chair of the session "Nonlinear Observers II", 2008 IFAC World Congress, Seoul, Korea, July 2008.

Organizer of the workshop on "Cooperative Control of Multiple Autonomous Vehicles" for the 17th IFAC World Congress, Seoul, Korea, July 2008. Cooperative Control of Multiple Autonomous Vehicles. This workshop focused on the theme of Cooperative Control of Multiple Autonomous Vehicles, with applications to underwater vehicles, surface craft, wheeled mobile robots, and aircraft.

Organizer of the special session on "Cooperative Motion Control of Multiple Autonomous Vehicles" for the 17th IFAC World Congress, Seoul, Korea, July 2008.

Chair of the session "Cooperative Motion Control of Multiple Autonomous Vehicles", 2008 IFAC World Congress, Seoul, Korea, July 2008.

Co-Chair of the session "Kalman Filtering", 2008 IFAC World Congress, Seoul, Korea, July 2008.

Member of the Technical Committee of the 8th Conference on Mobile Robots and Competitions, Castelo Branco, April 2008.

Group Productivity

Member of the Technical Program Committee, The 18th International Offshore (Ocean) and Polar Engineering Conference & Exhibition, Vancouver, British Columbia, Canada, July 6-11, 2008.

Member of the Technical Program Committee, V Jornadas Argentinas de Robótica JAR'08 (The 5th Argentine Robotics Workshop), Bahía Blanca, Argentina, 12-14 November, 2008.

Member of the Technical Program Committee, NGCUV'08 - IFAC Workshop on Navigation, Guidance and Control of Underwater Vehicles, Killaloe, Ireland, Apr. 2008.

Internationalization

Cooperation with international institutions:

[1] Department of Mechanical Engineering and Aeronautics, Naval Postgraduate School, Monterey, CA (USA) – a long standing collaborative research program on AUV and UAV NGC, as well as multiple vehicle control.

[2] Center for Control, Dynamical Systems, and Computation (CCDC) at University of California, Santa Barbara, CA (USA) – joint work on control, estimation theory, and networked control systems.

[3] National Institute of Oceanography (NIO), Goa (India) – an intensive research and development program was initiated in 1999, leading to the development of the MAYA AUV.

[4] Department of Engineering Cybernetics, Norwegian University of Science and Technology (NTNU), Trondheim (Norway) - exchange of students and research personnel; joint work on cooperative path following control.

[5] University of Girona, Institute of Informatics and Applications, Escola Politècnica Superior, Girona (Spain) – joint theoretical and practical work on Mission Control Systems for autonomous underwater vehicles.

[6] Dept. Electrical and Computer Engineering, University of Maryland (USA) – exchange of research personnel and joint initiatives on Networked Control Systems.

[7] Dept. Mechanical Engineering, John Hopkins University, Baltimore (USA) – exchange of research personnel and joint initiatives on Underwater Navigation Systems.

European Training Networks (ETN): FREEsubNET (2006-2010)- A European research network on key technologies for intervention autonomous underwater vehicles (Marie Curie Research Training Network).

Participation in International Technical Committees:

Member of the IFAC TC on Aerospace

Member of the IEEE TC on Aerospace Control

Member of the IFAC TC on Intelligent Autonomous Vehicles.

Chair and Member of the IFAC TC on Marine Systems.

Associate Editor of the IEEE Journal of Oceanic Engineering

Invited Talks:

UAV developments under the HELICIM and OBSERVFLY Projects, French Research Group in Robotics, GDR-Robotique, ENSAM Paris, Oct. 2008.

Mission and Vehicle Control of Aerial and Marine Vehicles, UCSB – CCDC, Spring 2008 Seminar Series, UCSB USA, May 2008.

Multiple Vehicle Path Generation and Cooperative Path Following with Spatial and Temporal Constraints, NTNU, Trondheim, Norway, October 2008.

Minimum Energy and H-infinity Estimation: Application to Systems with Implicit Outputs, NTNU, Trondheim, Norway, November 2008.

Future Research

Objectives

Future work will continue to be guided by the goal of bringing together dynamical systems theory and engineering practice, with applications to the development and operation of ocean robotic platforms and associated enabling systems, including those needed to observe the ocean from the air. Great emphasis will also be placed on solidifying cooperation links with research groups worldwide, and participating in European projects in areas that require an adequate balance between theoretical and practical issues. In line with previous work plans, the following tasks warrant special consideration.

1- Study of joint positioning and navigation aiding systems for autonomous underwater robots with explicit inclusion of disturbances observed during field operations. This work will build upon previous design and analysis results derived for tracking and integrated navigation systems through the use of non-linear time-varying filters. New computationally efficient signal processing techniques will be used to overcome the occurrence of dropouts and delays experienced by the acoustic signals used. The challenging theoretical problem of optimal multi autonomous surface vehicle maneuvering to aid in the positioning of multiple underwater targets will also be addressed.

2- Cooperative path planning, navigation, and motion control for multi autonomous air and marine vehicles. Considerable effort is now being placed on the deployment of groups of networked autonomous robotic vehicles that can interact autonomously with the environment and other vehicles to perform, in the presence of uncertainty and adversity, tasks beyond the ability of individual vehicles. This entails the development of advanced systems for coordinated motion control and navigation in the presence of severe underwater communication constraints together with the respective software and hardware architectures. The work will build on the results described in [F1, F2, F3, F6].

3- Study of non-conventional, geophysical-based navigation (GN) methods that hold great potential for the development of a new generation

Future Research

of navigation systems that rely on bathymetric, magnetic, and gravimetric data. The key idea is to use conspicuous, well mapped local characteristics of the medium in which the vehicle moves (digital terrain maps, maps of gravimetric and/or magnetic anomalies, etc.) to help in the navigation process.

4- Study of optimal continuous-time filters with discrete-time delayed measurements for a classes of nonlinear time-varying systems (such as kinematic systems) with application to the estimation of linear motion quantities (position, linear velocity, and acceleration of gravity), in three dimensions. Preliminary results are included in [F5, F6, F7] and constitute a promising alternative to standard navigation filters used nowadays in autonomous vehicles.

5- Development and implementation of discrete time nonlinear kinematic observers for pose estimation, with application to Marine and Air Vehicles equipped with different sensor suites. Based on recent theoretical results on the synthesis and analysis of nonlinear observers on SE(3) [F4] a new class of filters will be proposed validated and tested on the DSORL platforms.

6- Study of new decision and identification algorithms towards the design of a new Robust Multiple-Model Adaptive Control (RMMAC) architecture for linear time-invariant and time/varying systems subject to structured and unstructured uncertainty.

7- Development of a network of small Autonomous Marine Robotic Vehicles and human machine interfaces (HMI) to perform cooperative tasks involving human underwater divers in the loop (work to be done in the scope of a EC funded program due to start in 2009)

8- Development of an autonomous helicopter specially tailored for critical infrastructure monitoring under the HELICIM and AIRTICI projects.

9- Development of a versatile fixed wing unmanned aircraft specially tailored for marine science applications under the OBSERVFLY project.

[F1] P. Batista, C. Silvestre, P. Oliveira, A Sensor Based Controller for Homing of Underactuated AUVs, to appear in the IEEE Transactions on Robotics, 2009.

[F2] R. Ghabcheloo, A. P. Aguiar, A. Pascoal, C. Silvestre, I. Kaminer, and J. Hespanha. Coordinated path-following in the presence of communication losses and time delays. To appear in the SIAM - Journal on Control and Optimization, 2009.

[F3] Carlos Silvestre, Rita Cunha, Nuno Paulino, and Antonio Pascoal, A Bottom-Following Preview Controller for Autonomous Underwater Vehicles, to appear in the IEEE Transaction on Control Systems Technology, 2009.

[F4] J. F. Vasconcelos, B. Carneira, C. Silvestre, P. Oliveira, P. Batista, Discrete-Time Complementary Filters for Attitude and Position Estimation: Design, Analysis and Experimental Validation, Provisionally accepted, pending minor revision, IEEE Transactions on Control Systems Technology, 2009.

[F5] P. Batista, C. Silvestre, P. Oliveira, Position and Velocity Optimal Sensor-based Navigation Filters for UAVs, to be published in the Proc. 2009 American Control Conference - ACC2009, St. Louis, Missouri, USA, June 2009.

[F6] A. Hausler, R. Ghabcheloo, A. Pascoal, A. Aguiar, I. Kaminer, V. Dobrokhodov, Temporally and Spatially Deconflicted Path Planning for Multiple Autonomous Marine Vehicles, to be published in the Proc. MCMC 09, Brazil, Sept. 2009.

[F7] A. Pedro Aguiar and João P. Hespanha, Robust Filtering for Deterministic Systems with Implicit Outputs. Systems & Control Letters, Vol. 58, No. 4, pp. 263-270, Apr. 2009.

[F8] A. Pedro Aguiar and João P. Hespanha, H-infinity Estimation of Continuous-Time Systems with Implicit Outputs from Discrete Noisy Time-Delayed Measurements. Submitted for publication.

Funding, source, dates

Source Project Reference DSORL Approved Funding after 2008

National

FCT RUMOS 2006-2009 PDCT/MAR/55609/2004 10000

FCT DENO 2007-2010 PTDC/EEA-ACR/67020/2006 69120

FCT HELICIM 2007-2010 PTDC/EEA-ACR/72853/2006 36400

FCT OBSERVFLY 2008-2011 PTDC/MAR/64546/2006 162954

FCT NAV 2007-2010 PTDC/EEA-ACR/65996/2006 80000

AdI AIRTICI 2009-2012 QREN 546000

European

EC GREX- 2006-2009 FP6-EU-IST-035223 168500

EC VENUS - 2006 - 2009 FP6-EU-IST-034924 30000

EC FREEsubNET - 2006-2010 MRTN-CT-2006-036186 100000

EC CO3AUVs 2009-2012 FP720073 ICT2007.2.1 498000

Total 1700974 Euro

Group Description	
Title of Research Group:	(RG-LVT-Lisboa-750009-3447) Signal and Image Processing Group
Principal Investigator:	Isabel Maria Gonçalves Lourtie
Main Scientific Domain:	Engenharia Electrotécnica e Informática
Group Host Institution:	Instituto Superior Técnico - Universidade Técnica de Lisboa

Funding, source, dates

Funding, source, dates
European Projects:
- ESONET (FP6-SUSTDEV SUSTDEV-3), Mar 2007- Feb 2011, 7.5 M€
- UAN – Underwater Acoustic Networks (EU-FP7, ICT/Security), Oct 2008 – Sept 2011, 2.95 M€
- SIMBAD (FT7-ICT-2007-C, grant 213250), Apr 2008 - Mar 2011, 100 K€
FCT Projects:
- PHITOM (PTDC/EEA-TEL/71263/2006), Dec 2007 - Nov 2010, 172 K€
- WEAM (PTDC/ENR/70452/2006), Nov 2007 - Oct 2010, 182.4 K€
- U-BOAT (PTDC/EEA-TEL/67066/2006), Oct 2007 - Sept 2010, 97 K€
- SIPM (PTDC/EEA-ACR/73749/2006), Oct 2007 - Sept 2010, 116 K€
- NCOR (PTDC/PSI/67381/2006), Oct 2007 - Sept 2010, 100 K€
- SmartVision (PTDC/EIA/73633/2006), Jan 2008 - Nov 2010, 166 K€
- MODI (PTDC/EEA-ACR/72201/2006), Jan 2008 - Dec 2010, 130 K€
- DELKETI (PTDC/EEA-TEL/72572/2006), Jan 2008 - Dec 2010, 4 K€

Objectives & Achievements

Objectives

SIPG at IST
The research of SIPG at IST is organized along four areas: a horizontal area that deals with fundamental problems of signal and image processing and three other areas that build the path to more application-driven research (Wireless Communications, Image and Video Analysis, and Medical Image Analysis), where results emerging from the area of Fundamentals may be applied.
Fundamentals
Matrix completion problems lie at the heart of numerous applications in signal and image processing, e.g., minimal rank completion for structure-from-motion techniques in computer vision for video sequences with occlusions. The goal is to apply linear-algebraic tools to solve special instances, with practical relevance.
Wireless Communications
Study of the fundamental limits of multiple-antenna receiver/transmitter fading wireless channels and design of coding schemes which exploit the diversity available across the space, time and frequency domains of the signal space.
Image and Video Analysis
The goal is to develop fundamental tools for inferring high level content from image sequences. For example, in digital video, content-based representations, i.e., representations based on high-level content, rather than on pixels and images, enable powerful video editing and visualization, as well as efficient data compression. Also, for surveillance applications, an automatic analysis in terms of human activity recognition, e.g., tracking pedestrians or recognizing human activities, is nowadays fundamental.
Medical Image Analysis
This is an emerging area which tries to capitalize previous experience in image and video analysis. The goal is to develop semi-automatic tools to improve medical diagnosis using several imaging modalities (ultrasound, CT, MRI, fMRI). The work is focused in three goals: estimation of data volumes from ultrasound data (3D ultrasound), image pre-processing (noise reduction), and development of 2D and 3D models of organs using deformable models.
SIPG at UALG
The underwater acoustic signal processing group aimed at reinforcing its position in the areas of underwater acoustic coherent communications and active target detection. The work initiated several years ago on oceanographic and acoustic data assimilation for sonar performance prediction was terminated.

Main Achievements

SIPG at IST
Fundamentals
We developed a finite step algorithm which completes a given partial matrix whilst minimizing a prescribed singular value. The missing pattern is assumed to follow a Young pattern. This finds direct application in computer vision techniques.

Objectives & Achievements

Wireless Communications

The single-user MIMO channel in the low signal-to-noise regime was investigated from both the capacity and probability of error viewpoints. We addressed the challenging scenario of no channel information at the receiver, and allowed an arbitrary correlation structure for the observation noise. The theoretical analysis led to new criteria for designing space-time codebooks which compared favourably to state-of-art solutions.

Image and Video Analysis

Current approaches to the inference of 3D from video use the factorization of a large matrix that is highly rank deficient. However, since this matrix is only partially observed, its decomposition can not be computed by standard methods, and only suboptimal methods were known. In contrast, we developed a globally optimal algorithm to solve the problem. In shape analysis, we developed a maximally invariant representation and algorithms that use deformable models. For surveillance, we developed a tracker that deals with multiple pedestrians and algorithms for the recognition of human activities.

Medical Image Analysis

We developed a volume reconstruction system based on ultrasound images (3D ultrasound) as well as algorithms for the reconstruction of the carotid atherosclerotic plaque. We have also developed denoising algorithms using a novel approach (Lyapunov equation) and diagnosis methods using MRI images of the liver, heart, and brain and diagnosis methods for genetic diseases using cytogenic techniques. This was done in collaboration with the Institute of Molecular Medicine and St. Mary Hospital.

SIPG at UALG

The underwater acoustic signal processing group has pursued its work into the development of the frequency shift passive time-reversal channel equalizer and in its application to the optimal combining of communication signals received in a sparse distribution of receiving arrays. Interesting results were obtained on the Radar'07 data set and presented at the conference papers in 2009.

Group Productivity

Publications in peer review Journals

N. Martins, C. Soares, S. Jesus. Environmental and Acoustic Assessment: the AOB concept. *Journal of Marine Systems*, vol 69, pp. 114-125, Jan. 2008

J. Nascimento, M. Figueiredo, J. Marques. Independent Increment Processes for Human Motion Recognition. *Computer Vision and Image Understanding*, ELSEVIER, 109, 126-138, Feb. 2008.

J. Nascimento, J. Marques. Robust Shape Tracking with Multiple Models in Ultrasound Images. *IEEE Transactions on Image Processing*, vol. 17, 392-406, March 2008.

P. Silva, R. Dinis. A Turbo SDMA Receiver for Strongly Nonlinearly Distorted MC-CDMA Signals. *Canadian Journal of Electrical and Computer Engineering*, vol. 33, 39-44, 2008.

R. Dinis, A. Gusmão. Nonlinear Signal Processing Schemes for OFDM Modulations within Conventional or LINC Transmitter Structures. *European Transactions on Telecommunications*, vol. 19, 257-271, Apr. 2008.

M. Beko, J. Xavier, V. Barroso. Further results on the capacity and error probability analysis of non-coherent MIMO systems in the low SNR regime. *IEEE Transactions on Signal Processing*, vol. 56, no. 7, 2915 - 2930, Jul. 2008.

J. Gomes, A. Silva, S. Jesus. Adaptive spatial combining for passive time-reversed communications. *Journal of the Acoustical Society of America*, vol. 124, no. 2, 1038-1053, Aug. 2008.

J. Gomes, V. Barroso. Array-based QR-RLS multichannel lattice filtering. *IEEE Transactions on Signal Processing*, vol. 56, no. 2, pt. 1, 3510-3522, Aug. 2008.

J. Sanches, J. Nascimento, J. Marques. Medical Image Noise Reduction using the Sylvester-Lyapunov Equation. *IEEE Transactions on Image Processing*, vol. 17, 1522-1539, Sept. 2008.

P. Aguiar, M. Stosic, J. Xavier. On Singular Values of Partially Prescribed Matrices. *Linear Algebra and its Applications*, ELSEVIER, vol. 429, 8-9, Oct. 2008.

M. Silva, A. Correia, R. Dinis. Interference Suppression Consisting of Pre-distortion Filtering and Selective Transmit Diversity. *Wireless Personal Communications*, Springer, vol. 47, 219-233, Oct. 2008.

J. Rodrigues, J. du Buf. Multi-scale lines and edges in V1 and beyond: brightness, object categorization and recognition, and consciousness. *BioSystems*, ELSEVIER, vol. 95, pp. 206-226, 2008.

Other publications International

J. Marques, J. Nascimento, A. Abrantes, M. Silveira. Robust Shape Estimation with Deformable Models. *Adv. Comp. Vision and Medical Image Proc.* Springer, 2008

D. Almeida, S. Nunes, J. Carvalho, V. Brito, J. Rodrigues, J. du Buf. Fine arts edutainment: the amateur painter. GRAPP

D. Afonso, J. Sanches, M. Lauterbach. Joint Bayesian Detection of Brain Activated Regions and HRF Estimation in Functional MRI. ICASSP

N. Souto, A. Correia, R. Dinis, J. Silva, L. Abreu. Multiresolution MBMS Transmissions for MIMO UTRA LTE systems. BMSB

R. Dinis, C. Lam, D. Falconer. Joint Frequency-Domain Equalization and Channel Estimation using Superimposed Pilots. WCNC

T. Araújo, R. Dinis. Analytical Evaluation of Nonlinear Distortion Effects on OFDMA Uplink Signals. VTC-spring

M. Silveira, J. Marques. Level set segmentation of dermoscopy images. ISBI

P. Figueiredo, J. Sanches. Sampling Strategy for Perfusion Quantification using PASL-MRI. ISBI

Group Productivity

- J. Rodrigues, P. Aguiar, J. Xavier. ANSIG — an analytic signature for permutation-invariant two-dimensional shape representation. CVPR
- P. Aguiar, M. Stosic, J. Xavier. Spectrally optimal factorization of incomplete matrices. CVPR
- A. Del Bue. A Factorization Approach to Structure from Motion with Shape Priors. CVPR
- S. Jesus, C. Soares, N. Martins. Water column tomographic inversion with a network of drifting buoys. ACOUSTICS
- J. Legac, J-P. Hermand, S. Jesus. Medium frequency (800-1600Hz) geoacoustic inversions with drifting sparse arrays during the MREA/BP'07 experiment. ACOUSTICS
- M. Beko, J. Xavier, V. Barroso. Low SNR analysis of the non-coherent MIMO channel under arbitrary channel and noise correlation structures. SPAWC
- M. Silveira, P. Aguiar. Simultaneous Registration and Intensity Normalization of SPECT Perfusion Images. EMBC
- I. Rodrigues, J. Sanches. Temporal 2D Reconstruction of Cell Nucleus from Fluorescence Confocal Microscopy Images with Anisotropic Filtering. EMBC
- J. Seabra, J. Xavier, J. Sanches. Convex Ultrasound Image Reconstruction with Log-Euclidean Priors. EMBC
- I. Rodrigues, J. Xavier, J. Sanches. Fluorescence Confocal Microscopy Imaging Denoising with Photobleaching. EMBC
- J. Nascimento, J. Sanches. Total Variation with automatic hyper-parameter estimation. EMBC
- N. Monteiro, J. Gomes, J. Xavier. Detection of statistical periodicities in DNA by conflict and entropy minimization methods. EUSIPCO
- J. du Buf, J. Rodrigues. Brightness perception: one simple model explains most if not all effects. ECVF
- J. Rodrigues, D. Almeida, J. Martins, R. Lam, J. du Buf. An integrated framework for combining gist vision with object segregation, categorisation and recognition. ECVF
- J. Gomes, A. Silva, S. Jesus. OFDM Demodulation in Underwater Time-Reversed Shortened Channels. OCEANS
- S. Jesus, O. Rodríguez. A time-reversal suboptimal detector for underwater acoustic barriers. OCEANS
- M. Silva, A. Correia, R. Dinis. On Pre-Processing for MIMO W-CDMA. WPMC
- J. Nascimento, J. Sanches. Ultrasound Imaging LV tracking with adaptive window size and automatic hyper-parameter estimation. ICIP
- J. Rodrigues, J. Xavier, P. Aguiar. Classification of unlabeled point sets using ANSIG. ICIP
- P. Aguiar, J. Xavier, M. Stosic. Globally optimal solution to exploit rigidity when recovering structure from motion under occlusion. ICIP
- N. Silva, J. Costeira. Subspace Segmentation with Outliers: a Grassmannian approach to the maximum consensus subspace. CVPR
- A. Martins, M. Figueiredo, P. Aguiar, N. Smith, E. Xing. Nonextensive entropic kernels. ICML
- R. Oliveira, L. Bernardo, P. Pinto, R. Dinis. A Load-adaptive Timeout for Beaconing-based Link Protocols in Ad Hoc Networks. EW
- R. Dinis, P. Montezuma, J. Martins. Soft Combining ARQ Techniques for Wireless Systems Employing SC-FDE Schemes. ICCCN
- P. Carvalho, J. Martins, L. Bernardo, R. Dinis. Effective Power Control in UWB Systems Using Spreading Code's Spatial Resolution Properties. ISWCS
- M. Silveira, S. Heleno. Water/Land Segmentation in SAR Images using Level Sets. ICIP
- M. Silveira, J. Nascimento, J. Marques. Level Set Segmentation with Outlier Rejection. ICIP
- B. Pires, J. Moura, J. Xavier. LASIC: a model invariant framework for correspondence. ICIP
- M. Taiana, J. Santos, J. Gaspar, J. Nascimento, A. Bernardino, P. Lima. Color 3D model-based tracking with arbitrary projection models. WORV, SIMPAR
- X. Llado, A. Del Bue, L. Agapito. Recovering Euclidean Deformable Models from Stereo-motion. ICPR
- D. Afonso, J. Sanches, M. Lauterbach. fMRI Brain Activity and Underlying Hemodynamics Estimation in a New Bayesian Framework. ISBI
- L. Caldeira, J. Sanches. Liver Tumor Assessment with DCE-MRI. ISBI
- A. Khmelinskii, R. Ventura, J. Sanches. Chromosome Pairing for Karyotyping Purposes using Mutual Information. ISBI
- J. Sanches, D. Afonso, K. Bartnykas, M. Lauterbach. Comparison of Two Different Approaches for Brain Activity Detection in fMRI: SPM-Bayesian and SPM-GLM. ISBI
- L. Caldeira, J. Sanches. Pharmacokinetic Perfusion Curves Estimation for Liver Tumor Diagnosis from DCE-MRI. ICIAR
- J. Coelho, J. Sanches, M. Lauterbach. fMRI Binary Detection of Brain Activated Regions with Graph-Cuts. EMBC
- A. Khmelinskii, R. Ventura, J. Sanches, "Automatic Chromosome Pairing Using Mutual Information", EMBC
- J. Seabra, J. Sanches. Three-dimensional labeling of vulnerable regions in carotid plaques using Graph-Cuts. EMBC
- J. Seabra, J. Sanches. Modeling Log-Compressed Ultrasound Images for Radio Frequency Signal Recovery. EMBC
- I. Rodrigues, J. Sanches, J. Bioucas-Dias, "Denoising of Medical Images Corrupted by Poisson Noise", ICIP
- L. Caldeira, I. Silva, J. Sanches. Automatic Liver Tumor Diagnosis with Dynamic-contrast Enhanced MRI. ICIP

Group Productivity

- D. Afonso, J. Sanches, M. Lauterbach. Robust Brain Activation Detection in Functional MRI. ICIP
- N. Souto, R. Dinis, J. Silva, P. Carvalho. A High Throughput Technique for OFDM Systems. WCNC
- J. Gomes, A. Silva, S. Jesus. Experimental assessment of time-reversed OFDM underwater communications. ACOUSTICS
- T. Araújo, R. Dinis. Analytical Evaluation of Nonlinear Distortion Effects on OFDMA Signals used in the Downlink Transmission. ISWCS
- P. Pedrosa, R. Dinis, F. Nunes. Performance Evaluation of Decision-Directed Carrier Synchronization for SC-FDE Schemes". ISWCS
- J. Fayad, A. Del Bue, P. Aguiar. Articulated motion analysis from motion capture data. CMBBE
- A. Martins, P. Aguiar, M. Figueiredo. Tsallis kernels on measures. ITW
- M. Taiana, J. Nascimento, J. Gaspar, A. Bernardino. Sample-Based 3D Tracking of Colored Objects: A Flexible Architecture. BMVC
- J. Buenaposada, A. Del Bue, E. Muñoz, L. Baumela. A Model of Brightness Variations due to Illumination Changes and Non-rigid Motion using Spherical Harmonics. BMVC
- J. Nascimento, M. Figueiredo, J. Marques. Learning of Motion patterns using Generative Models. ICIP
- N. Delgado, F. Nunes, J. Xavier. A geometrical approach for maximum likelihood estimation of multipath. ION GNSS
- N. Delgado, F. Nunes, J. Xavier. GNSS satellite selection for multiple-constellations using convex geometry. NAVITEC

Other publications National

- J. Seabra, L.M. Pedro, J. Sanches, F. Viola, A.C. Dinis, J. Mendanha, P. Brogueira and M.T. Peña. Investigação no Ensino de Engenharia Biomédica: dois casos de estudo. Saúde & Tecnologia, pp. 7-19, May 2008.
- Mariana S. C. Almeida, Joao Sanches, Luis B. Almeida. Blind Adaptive Deblurring of Chromosome images. First Portuguese Forum on Computational Biology (FPBC'08), Gulbenkian Institute of Science, Oeiras, July 2008.
- Artem Khmelinskii, Rodrigo Ventura, Carmo-Fonseca, M. and Joao Sanches. Automatic Pairing of Metaphase Chromosomes with Mutual Information for Karyotyping Purposes (Poster). FPBC'08, Oeiras, July 2008.
- Isabel Rodrigues and João Sanches. Spation-temporal 3D reconstruction from fluorescent microscopy images with anisotropic filtering (Poster). FPBC'08, Oeiras, July 2008.
- Isabel Rodrigues and João Sanches. Cell nucleus GFP flow analysis from sequences of LSCFM images (Poster). Portugal-UT Austin CFD 2008 1st Workshop on Computational Engineering: Fluid Dynamics (WCE'08), IST, Lisbon, July 2008.
- José Santos, João Sanches and Silva Carvalho. Autonomic Nervous System Control Model of the Blood Pressure and Heart Rate Physiological Variables (Poster). WCE'08, IST, Lisbon, July 2008.
- Isabela Silva, João Sanches and Ana G. Almeida. Alignment-by-Reconstruction in Cardiac MRI. 14ª Conferência Portuguesa de Reconhecimento de Padrões (RecPad'08), Coimbra, Oct. 2008.
- Isabel Rodrigues and João Sanches. Fluorescence Confocal Imaging Noise Removal: A Bayesian Approach. RecPad'08, Coimbra, Oct. 2008.
- José Santos, João Sanches and Silva Carvalho. Autonomic Nervous System Control Model of the Blood Pressure and Heart Rate Physiological Variables. RecPad'08, Coimbra, Oct. 2008.
- Joana Coelho, João Sanches and Martin H. Lauterbach. fMRI Binary Detection. RecPad'08, Coimbra, Oct. 2008.
- Ricardo Ribeiro, José Seabra and João Sanches. Fatty Liver Automatic Diagnosis from Ultrasound Images. RecPad'08, Coimbra, Oct. 2008.
- José Seabra and João Sanches. Labeling of the Echo-Morphology of Atherosclerotic Plaques using Graph-Cuts. RecPad'08, Coimbra, Oct. 2008.
- J. A. Martins, J. Rodrigues, J.M.H. du Buf. Region segregation and saliency using colour information. RecPad'08, Coimbra, Oct. 2008.
- José Santos, João Sanches and Silva Carvalho. Autonomic Nervous System Control Model of the Blood Pressure and Heart Rate Physiological Variables. Workshop Physics of Biological Systems: From Genes to Societies (WPBS'08), Lisbon, Oct. 2008.
- Pedro Pires, João Sanches and Teresa Paiva. Activity Characterization from Actimetry Sensor Data for Sleep Disorders Diagnosis. WPBS'08, Lisbon, Oct. 2008.

Master and Ph.D. thesis completed

- Pedro Daniel Correia Pires. Activity Characterization from Actimetry Sensor Data for Sleep Disorders Diagnosis. M. Sc. Thesis, Instituto Superior Técnico, Lisbon, Portugal, Sept. 2008.
- Isabela Maria Montenegro da Silva. Toward a fully automatic left ventricle segmentation using cine-MR images. M. Sc. Thesis, Instituto Superior Técnico, Lisbon, Portugal, Sept. 2008.
- José Santos. A Baroreflex Control Model Using Head-Up Tilt Test. M. Sc. Thesis, Instituto Superior Técnico, Lisbon, Portugal, Sept. 2008.
- Joana Coelho. Joint Detection-Estimation of Brain Activity in fMRI using Graph Cuts. M. Sc. Thesis, Instituto Superior Técnico, Lisbon, Portugal, Sept. 2008.
- José J. Rodrigues. ANSIG - an Analytic Signature for Permutation Invariant Shape Representation. M. Sc. Thesis, Instituto Superior Técnico, Lisbon, Portugal, Sept. 2008.
- Augusto Santos. SUBSPACE SEGMENTATION. M. Sc. Thesis, Instituto Superior Técnico, Lisbon, Portugal, 2008.

Group Productivity

Pedro Guerreiro. LINEAR DISCRIMINANT ANALYSIS ALGORITHMS. M. Sc. Thesis, Instituto Superior Técnico, Lisbon, Portugal, 2008.

João Mota. DISTRIBUTED ALGORITHMS FOR SPARSE RECONSTRUCTION. M. Sc. Thesis, Instituto Superior Técnico, Lisbon, Portugal, 2008.

João Fayad. Articulated three-dimensional Human Modeling from Motion Capture Systems. M. Sc. Thesis, Instituto Superior Técnico, Lisbon, Portugal, October 2008.

Marko Beko. Non-Coherent Communication in Multiple-Antenna Systems: Receiver Design, Codebook Construction and Capacity Analysis. Ph.D. Thesis, Instituto Superior Técnico, Lisboa, Portugal, Feb. 2008.

João Rodrigues. Integrated multi-scale architecture of the cortex with application to computer vision. Ph.D. Thesis, University of Algarve, Faro, Portugal, Feb. 2008.

Patents/propotypes

José J. Rodrigues, Pedro M. Q. Aguiar, and João M. F. Xavier, System and Method for Shape Recognition, Patent filed with Portuguese Patent Office, PT 104003, March 2008.

Organization of conferences

Researchers from SIPG participated, as Program Committee Members, in the organization of several international meetings:

- 2nd International Conference on Sensor Technologies and Applications (SENSORCOMM), Cap Esterel, France, Aug 2008
- International Workshop on Underwater Networks (WUWNET), San Francisco, California, USA, Sept 2008
- OCEANS 2008 MTS/IEEE, Quebec City, Canada, Sept 2008
- IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP) 2008
- Iberoamerican Conference on Pattern Recognition (CIARP), September 9-12, Havana, Cuba, 2008
- Conference of the IEEE Engineering in Medicine and Biology Society - EMBC 2008
- International Conference on Image Analysis and Recognition - ICIAR 2008
- IBERAMIA 2008, Lisbon, Oct 2008
- VIIP'08 Visualization, Imaging and Image Processing, Palma de Maiorca, September, Spain, 2008
- IEEE Int. Conf on Image Processing, San Diego CA, USA, Oct 2008
- Wireless Communications Symposium of IEEE ICC'08 (International Conference on Communications)
- Wireless Communications Symposium of IEEE GLOBECOM'08 (Global Telecommunications Conference)
- IEEE Int. Conf on Image Processing, San Diego CA, USA, Oct 2008

Internationalization

Participation in projects

- ESONET, which represents an European Network of Excellence involving over 50 european institutions during 4 years
- UAN, which involves the collaboration of: CINTAL, SELEX, SINTEF, ISME, FOI, KM
- SIMBAD, which involves the collaboration of: Univ. Cà Foscari di Venezia, York Univ., Techn. Univ. Delft, Univ. degli Studi di Verona, Eidgenoessische Techn. Hochschule Zuerich

Supervision of students

- Tatjana Wunderlich, TU Muchen, Germany, Sept/Dec 08
- Marco Paladini, QMUL, London, UK, May/July 08
- Julien Huillery, France, Sept 08/Aug 09 (postdoc)
- Barbara Nicholas, France, Sept 08/Aug 09 (researcher - sabattical leave from CNRS, Grenoble)

PhD Thesis Committees

- Fitsum Admasu, Stochastic geometric methods for Automated 3D seismic image analysis, Univ. Magdeburg, Germany, 2008
- Ma. Carme Julià Ferré, Missing Data Matrix Factorization Addressing the Structure from Motion Problem, Univ. Autònoma de Barcelona, Spain, Feb 08

Visiting professor at

- Univ. Autònoma and Computer Vision Center, Barcelona.

Lecturing of

- Signal and Systems module of 6 hours to circa 20 students from 10 countries at the Summer School in Underwater Acoustics, organized by FORTH (Greece) under EU project DAMOCLES in the period 26-28 June 08
- Image Motion Analysis. Ph.D. Course, Univ. Autònoma de Barcelona, Spain

Invited lectures at

- Computer Vision Center, Univ. Autònoma de Barcelona, Spain, Feb 08

Associate Member of

- Bio Imaging and Signal Processing Technical Committee of the IEEE Signal Processing Society

Associate Editor of

- Statistics and Computing Journal, Springer

Group Productivity

- Intern. J. of Pattern Recogn. and Artif. Intellig.

Reviewers for international journals, such as

- IEEE T. Biomedical Eng.
- IEEE T. Pattern Analysis and Machine Intelligence
- IEEE T. Systems, Man and Cybernetics
- IEEE T. Signal Processing
- IEEE T. Circuits and Systems for Video Techn.
- IEEE T. Image Processing
- IEEE J. Oceanic Eng.
- Pattern Recognition
- Pattern Recognition Lett.
- Kluwer Int. J. Computer Vision
- ELSEVIER Computer Vision and Image Understanding
- J. the Acoust. Soc. of America
- IEE/IET Electronics Lett.

And for international meetings, such as

- IEEE International Symposium on Personal
- Indoor and Mobile Radio Communications (PIMRC'08)
- Third ACM International Workshop on UnderWater Networks (WUWNet'08)
- MTS/IEEE Oceans'08

Future Research

Objectives

SIPG at IST

The future research of SIPG at IST will also be organized along four areas: the horizontal area Fundamentals and three other areas that build the path to more application-driven research (Sensor Networks, Image and Video Analysis, and Biomedical Engineering).

Fundamentals

Signal processing on curved spaces (manifolds): the goal is to develop low-complexity algorithms for centroid computation with superlinear/quadratic convergence. Generalization of PCA is envisaged.

Nonconvex optimization: video analysis of articulated and deformable objects pose fundamental nonconvex quadratically constrained optimization problems. The goal is to find tight (if not, exact) convex relaxations.

Sensor Networks

In wireless sensor networks, communication links are subject to fading. Current distributed-based consensus algorithms fail to exploit the link failures statistics. We plan to incorporate this knowledge to achieve faster solutions. Other research topics to pursue are: sensor selection in large-scale networks for detection hypothesis and distributed algorithms for compressed sensing applications. This research is to be conducted within the CMU-PT program in which ISR participates.

Image and Video Analysis

Research on image and video analysis will continue to be motivated by fundamental limitations of current methods. In what respects to the inference of 3D content from image sequences, we plan to overcome limitations like the need to compute pointwise correspondences between different views. Also, since the majority of approaches deal only with rigid scenes, we seek methods to recover deformable objects. Other fundamental problems in image analysis concern the recognition of objects from their shape. We plan to address fundamental issues like shape representation and recognition. In what respects to human activity recognition, we plan to develop new representations for human motion, aiming to combine a stochastic description of motion with easily interpretable models. The model should be able to explain what kind of motions are present in a scene.

Biomedical Engineering

Current activities in medical image analysis using ultrasound and MRI images will continue.

Three new directions will be followed at three distinct levels:

- Brain and nervous system: diagnosis of Alzheimer's disease and mild cognitive impairment using PET images; identification of sleep disorders and development of models for the autonomic nervous system using control theory.
- Cell analysis: cell analysis based on confocal microscopy in collaboration with Institute of Molecular Medicine
- Genomic signal processing: ISR is committed to expanding this area of research. Work is already being conducted on problems of DNA sequencing and spectral analysis.

SIPG at UALG

The underwater acoustic signal processing group is investing mainly in three areas: environmental adaptive underwater coherent communications, vector sensor array processing for geoacoustic estimation and active target detection.

Funding, source, dates

Future Research

New funding can be expected to be kept based on financing from national and european research programs. Additional sources of financing can be expected from public and private contracts as the expertise of the group, both in IST and UALG, becomes more and more acknowledged within and outside Portugal.

It is also expected that ongoing FCT projects will lead to new FCT project proposals.

Ongoing projects:

- ESONET (FP6-SUSTDEV SUSTDEV-3), Mar 2007- Feb 2011, 7.5 M€
- PHITOM (PTDC/EEA-TEL/71263/2006), Dec 2007 - Nov 2010, 172 K€
- WEAM (PTDC/ENR/70452/2006), Nov 2007 - Oct 2010, 182.4 K€
- U-BOAT (PTDC/EEA-TEL/67066/2006), Oct 2007 - Sept 2010, 97 K€
- SIPM (PTDC/EEA-ACR/73749/2006), Oct 2007 - Sept 2010, 116 K€
- SmartVision (PTDC/EIA/73633/2006), Jan 2008 - Nov 2010, 166 K€
- NCOR (PTDC/PSI/67381/2006), Oct 2007 - Sept 2010, 100 K€
- UAN – Underwater Acoustic Networks (EU-FP7, ICT/Security), Oct 2008 – Sept 2011, 2.95 M€
- SIMBAD (FT7-ICT-2007-C, grant 213250), Apr 2008 - Mar 2011, 100 K€
- MODI (PTDC/EEA-ACR/72201/2006), Jan 2008 - Dec 2010, 130 K€
- DELKETI (PTDC/EEA-TEL/72572/2006), Jan 2008 - Dec 2010, 4 K€

Starting projects:

- OAEEx – Ocean Acoustic Exploration (FP7-PEOPLE-IRSES-2008), Jan 2009 – Dec 2011, 182 K€

Group Description	
Title of Research Group:	(RG-LVT-Lisboa-750009-3503) Mobile Robotics Laboratory - MRLab
Principal Investigator:	Maria Isabel Lobato de Faria Ribeiro
Main Scientific Domain:	Engenharia Electrotécnica e Informática
Group Host Institution:	Instituto Superior Técnico - Universidade Técnica de Lisboa

Funding, source, dates	
Funding, source, dates	
<ul style="list-style-type: none"> • €237.043,37, URUS - Ubiquitous Networking Robotics in Urban Settings, FP6-EU-IST-045062, Dec/2006 – Nov/2009 [together with VisLab and ISLab] • €56.181 RIOL-Robotic Inspection over Power Lines, FCT POSC/EEA-SRI/60775/2004, Set/2005-Aug/2008 • €10.000 Power Line Modeling and Inspection, LAbELEC-Electricity of Portugal (EDP), Oct/2007-Mar/2008 • €9.000 - FCT Base component of the pluriannual funding 	

Objectives & Achievements	
Objectives	
<p>The objective is to undertake research in the area of mobile robotics, with emphasis on the navigation of single and multi-robot systems, robot design, and human-robot interaction. Our research is often driven by a broad range of applications, and combines theoretical and implementation issues with the design and assembly of real robots.</p> <p>The navigation of mobile robots is addressed in structured and unstructured environments. Surveillance and transport applications provide the context and motivation in both single and multiple robot scenarios. These are problems requiring the integration of multiple techniques, ranging from path planning and trajectory following, environment localization and mapping to high level supervision and decision making and architectures to integrate different components. Standard EKF techniques are used to localization and mapping. Robot control is addressed using inclusion systems to model behaviours. High level supervision is supported on market based systems.</p> <p>Human-Robot Interaction is the external layer that encapsulates all other subsystems in a robot. It is likely that using human-based models, with formal descriptions of concepts that have been intensively studied in social sciences, will foster the development of social robots. The focus of our research is the mathematical modelling of human interactions and the extensions to the modelling of human-robot and robot-robot interactions. Semantics is extensively used by humans and provides a typical example of such key concepts as it contains the mechanism for robots to engage socially with non-expert humans. Hybrid systems and non-smooth calculus provide the main tools for modelling and analysis.</p> <p>Applications, with robot or product development, include monitoring in hazardous/remote environments with a tele-operated robot, power line inspection and Air Transfer System path planning and path following definition for ITER-International Thermonuclear Experimental Reactor.</p> <p>MRLab collaborates with the ISLab and VisLab within the framework of the Associate Laboratory Theme B, including the participation in the EU project URUS on networked robotics.</p>	

Main Achievements	
<ul style="list-style-type: none"> • Networked Robotic Systems integrate most activities and achievements in multi-robot systems. Within the URUS project MRLab and ISLab have been developing a service-oriented architecture to integrate generic components in a networked, decentralized, robotic system. This architecture encompasses network communications and middleware. It integrates information from a network of fixed cameras, generic sensors, distributed processing, and robots. High level decision strategies are being addressed using economic market models (ongoing PhD). This line of work seems particularly important in multiple robot applications to yield a team behaviour as natural as that of a team of humans. • The measurement of motion expressiveness in robots, a key feature for natural human-robot interaction, has been addressed using Elman neural networks. This work is intended to be the basis for the recognition of emotions expressed through motion by robots without anthropomorphic features. • Based on previous works with LAbELEC (a company from the EDP – Electricity of Portugal group) and Albatroz Eng, MRLab acted as a scientific consultant to certify the quality of a product developed by Albatroz Eng to LAbELEC. The product measures power line obstacle clearance based on laser scanning and performs on-line fault detection and classification during helicopter based normal inspections of EDP power lines. • Implementation of methodologies that yield the set of optimal paths for the Air Transfer System (a large mobile robot 2.6 × 3.7 × 8.5 m (w × h × l) carrying a maximum weight of 100 tonnes) that will be installed in ITER-International Thermonuclear Experimental Reactor, France. This work was done in collaboration with IPFN-Instituto de Plasmas e Fusão Nuclear of IST. • As a follow up of previous activities for ITER, MRLab submitted to Fusion for Energy (F4E) (The European Joint Undertaking for ITER and the Development of Fusion Energy), a project to the call "Activities related to the development of an Air Transfer System prototype and Cask Transfer System Virtual Mock-up". Our proposal was chosen among the three presented. Activities under the project will start March 2009. 	

Group Productivity	
Other publications International	
<ul style="list-style-type: none"> • Francisco Melo, Isabel Ribeiro, Sean P.Meyn, "An analysis of reinforcement learning with function approximation" Proceedings of the 2008 International Conference on Machine Learning, ICML2008, Helsinki, CA, Finland, July 5-9 2008. • Francisco Melo, Isabel Ribeiro, "Reinforcement learning with function approximation for cooperative navigation tasks", Proceedings of the 2008 IEEE International Conference on Robotics and Automation, ICRA2008, Pasadena, CA, USA, May 19-23 2008. 	

Group Productivity

- Francisco Melo, Isabel Ribeiro, "Emerging coordination in infinite team Markov games" Proceedings of the 7th International Conference on Autonomous Agents and Multi-agent Systems, AAMAS'08, Estoril, Portugal, May 12-16, 2008.
- Nelson Gonçalves, João Sequeira, "Modeling Robot Behaviors With Hybrid Automata", Proceedings of the 8th Portuguese Conference on Automatic Control, Controlo 2008, Vila Real, Portugal, July 21-23, 2008.
- João Sequeira, "The URUS Project", Proceedings of the 2nd European Workshop on European Research towards Trusted Ambient intelligence, EuroTRUSTAmI'08, Sophia-Antipolis, France, September 16-18, 2008.
- João Sequeira, "Measuring motion expressiveness in wheeled mobile robots" Proceedings of the European Robotics Symposium 2008, EUROS 2008, Prague, Czech Republic, March 26-27, 2008.
- N. M. Hagenfeldt, A. Karlsson, J. Sequeira, "An Alternative Metrology Concept: Ray Trace Ranging" Proceedings of the 3rd International Symposium on Formation Flying, Missions and Technologies, ESA/ESTEC, Noordwijk, The Netherlands April 23-25, 2008.
- João Sequeira, "Architectural Aspects of Networked Robotic Systems", Proceedings of the 2008 IEEE International Workshop on Safety, Security, and Rescue Robotics, SSR'08, Sendai, Japan October 21-24, 2008.

Other publications National

- José Rodrigues, Dario Figueiro, Carlos Neves, Isabel Ribeiro, "Leader-Following Graph-Based Distributed Formation Control", Proceedings do Encontro Científico do 8º Festival Nacional de Robótica, ROBOTICA2008, Aveiro, Abril de 2008, pp.71-77.
- Nuno Lucas, José Gaspar, João Sequeira, "EKIT – Tool For Learning Signals, Circuits and Electronic Systems", Proceedings of the 4th Workshop in Electronics, Telecommunications, and Computers, JETC'08, Lisbon, Portugal, November 20-21, 2008.

Patents/propotypes

RIOL (prototype+patent): Robot able to move on suspended cables monitoring a variety of aspects, e.g., faulty insulators in electric power lines, wildlife, and environmental variables. Suspended cables, namely electric power lines, are a common infrastructure in most developed regions and provide a structured media that crosses all sorts of terrains. The specific task of electric power lines inspection is commonly executed using helicopters. The inspection requirements, namely the close distance the helicopters have to fly from the line, make this task highly dangerous and economically costly. A prototype able to illustrate the locomotion was developed under this project. The complete robot will be able to carry a generic payload and will be fully autonomous. A long term goal for this project is to deploy a number of robots over the electric power line infrastructure that would autonomously act as a cooperating team in a wide range of missions. A patent request was submitted to the national authorities, INPI, by Oct. 2007 and was granted May 2008.

Organization of conferences

MRLab researchers were co-organizers of the following workshop:

- Workshop on "Formal Models and Methods for Multi-Robot Systems" at AAMAS 2008, in Estoril, Portugal.

MRLab researchers were IPC members of the following conferences:

- IROS2008 – International Conference on Intelligent Robots
- IFAC World Congress, Seoul, Korea, July 2008
- 2008 Robotics: Science and Systems Conference, Zurich, Switzerland, June 2008
- Scientific Meeting of the Portuguese Robotics festival, Aveiro, Portugal, 2008
- 2008 IEEE International Workshop on Safety, Security, and Rescue Robotics, Sendai, Japan, October 2008
- 5th International Conference on Informatics in Control, Automation and Robotics, ICINCO 2008, Madeira, Portugal, May 2008

Industry contract research

Company: LABELEC –Group EDP (Electricity of Portugal)

Consultancy of the project: INFRANET II – Power Line Maintenance Inspection

Duration: 6 months, from Oct 2007 to March 2008

ISR/IST received funds = 10.000€

After INFRANET I, Gomes-Mota established his own company (Albatroz Eng.) and LABELEC contracted it to extend the results obtained so far into a ready-to-use product to be used by REN (National Electric Network) in the normal inspection and maintenance missions carried out in helicopters where obstacle clearance was visually carried out. This was INFRANET II project.

The product features a video-camera, a GPS-based geo-reference and a low-cost laser scanner with a one-dimension angle sweep, all installed in helicopter. The motion of the vehicle while the laser scans sweeps a three-dimensional volume around the overhead line, generating a cloud of 3D points that represent, the line, the poles and the nearest object to the laser on any scanned direction. The project developed an acquisition interface, a display interface, an algorithm to identify the line, the line supports and remaining obstacles from raw-range data and a procedure to detect abnormal situations (e.g., obstacles closer to the line than a given threshold).

In INFRANET II, ISR/IST was asked by LABELEC to provide scientific consultancy on the assessment of the developed product.

Internationalization

- Collaboration with Universidad Politecnica de Catalonia, University of Seville, University of Zaragoza and LAAS, under the framework of the EU FP6 URUS project
- MRLab researchers were reviewers of the following journals:
 - a. IEEE Transactions on Robotics, 2008
- Isabel Ribeiro acted as an consultant/observer for Fusion for Energy of on-going projects of ITER-International Thermonuclear Reactor in the area of Remote Handling, namely in transportation of reactor components by autonomous vehicles.

Group Productivity

Government/Organization contract research

Isabel Ribeiro, acting as adviser for the Executive Board of FCT (Portuguese Foundation for Science and Technology), was co-responsible for the preparation of the Call for Proposals for Scientific Research and Technological Development Projects in all Scientific Domains launched by FCT. The call opened in November 2008 and received around 5800 proposals. She was responsible for the design of a new proposal form, authored the "Guide for preparation and submission of R&D projects" and the "Guide for Peer Review of R&D projects".

Future Research

Objectives

MRLab and ISLab have a past experience of collaboration in research projects, and graduate students supervision. Research staff in both labs share common scientific interests, and tackle complementary aspects in the area of intelligent mobile robots. The two groups will merge into a single one, the IRSLab (Intelligent Robots and Systems Lab), starting 2009, with the goal of fostering their collaboration and increasing the critical mass. The Future Research herein presented corresponds to the objectives of this new research group.

The new IRSLab will reinforce the research focus on some of the topics currently studied by ISLab and MRLab:

- i) the development of decentralized sequential decision making methods based on POMDP models (worldwide cited work, with considerable number of publications already in 2008);
- ii) using DES for multi-robot plan representation, analysis and synthesis, namely Petri nets based task modeling and temporal logic based multi-robot task specifications;
- iii) active cooperative perception and cooperative navigation in multi-robot teams using probabilistic approaches, where we expect to introduce novel methods and demonstrate results in unstructured scenarios;
- iv) systems integration, middleware and robot architecture for networked robot systems;
- v) exploring models of social behavior in human societies, inspired on semiotics, to devise alternative, human-like, strategies for interaction among robots and between humans and robots.

We are also exploring multidisciplinary, thought-provocative research topics, which have demonstrated potential for introducing breakthrough concepts in areas such as coordination of robot collectives based on concepts borrowed from the social and natural sciences, namely Economy and Biology. In the upcoming 3 years, it is our goal to strengthen those areas by increasing the collaboration with experts in related fields, and by increasing our critical mass in fields lying in the intersection of the contributing disciplines through recruitment of post-docs. Major ideas in these directions concern:

- o exploiting the concept of institutional economy to further develop our awarded Institutional Robotics concept, namely its potential for interaction between robot collectives and humans;
- o exploiting the immune system ability to detect anomalous situations and to trigger adequate responses, replicating its operation principles in teams of several robots with a large number of virtual sensors that can be reproduced, mutated or eliminated;
- o addressing the problem of how a single robot can cope with an unstructured, unpredictable, and dynamic environment, by using bio-inspired cognitive architectures, such as ego-centered spatial representations of the environment, and motivational systems aiming at the sociability of the robot.

Regarding applications, we will extend our work in search and rescue to field robotics activities and applications, notwithstanding their relevance for public policies, and potential for innovative results on unstructured environments blending sound theory and technological developments. In addition, generic robotics applications, namely those including networked robot systems, will extend the contributions to the area of integration of complex systems that is being addressed in the URUS project.

The involvement in ITER Remote Handling activities will continue, extending the past contributions of the group, among them the design of the current reference model for ITER cask transportation systems. In 2009, this participation in ITER's activities will take place in the frame of the execution of the project Air Transfer System prototype and Cask Transfer System Virtual Mockup - EURATOM F4E-2008-GRT-016 (MS-RH).

Funding, source, dates

- €237.043,37, URUS - Ubiquitous Networking Robotics in Urban Settings, FP6-EU-IST-045062, Dec/2006 – Nov/2009 [together with VisLab and ISLab]
- €172.060,00 - Activities related to the development of an Air Transfer System prototype and Cask Transfer System Virtual Mockup - EURATOM F4E-2008-GRT-016 (MS-RH), Mar/2009-Jun/2010 [together with ISLab]

Group Description	
Title of Research Group:	(RG-LVT-Lisboa-750009-3505) Intelligent Systems Laboratory
Principal Investigator:	Pedro Manuel Urbano de Almeida Lima
Main Scientific Domain:	Engenharia Electrotécnica e Informática
Group Host Institution:	Instituto Superior Técnico - Universidade Técnica de Lisboa

Funding, source, dates	
Funding, source, dates	
33.852,00 EUR – FCT project DecPUCS: Decentralized Planning Under Uncertainty for Cooperative Systems (PTDC/EEA-ACR/73266/200) €237.043,37, URUS - Ubiquitous Networking Robotics in Urban Settings, FP6-EU-IST-045062, Dec/2006 – Nov/2009 [together with IRS' VisLab and MRLab]	

Objectives & Achievements	
Objectives	
<p>The driving theme of the Intelligent Systems Laboratory is the R&D on decentralized decision-making and control for multi-robot (networked, cooperative) systems (main focus), cognitive robots, human-robot interaction, and management systems. Decentralization is a key issue, as the overwhelming amount of information that must be handled in modern systems, composed of a massive number of embedded sensors, actuators, processors, and wireless communication devices, together with the well-known weaknesses of centralized systems, call for novel approaches to decentralized decision-making at different levels of abstraction, using the "think local, act global" principle. Our research is often driven by practical applications, and the applications include monitoring and decision-making in hazardous/remote environments (e.g., space, contaminated areas, post-disaster scenarios), and services (e.g., ambient assisted living, helping people in public spaces, energy consumption in buildings).</p> <p>Our distinctive feature is that we bring together people with a common background on systems theory, but different approaches to modelling, analysis and synthesis of intelligent systems, mainly coming from:</p> <ul style="list-style-type: none"> • artificial intelligence, with a focus on decentralized and distributed methods, and specific interest in planning under uncertainty, organizational issues, neurosciences-, biology- and social sciences-inspired robot architectures and methods; • systems and control, with a focus on complex systems consisting of a large number of interconnected embedded systems, e.g., sensor and robot networks, institutional management systems, or biological systems, and specific interest on modelling, analysis and synthesis methods. 	

Main Achievements	
<ul style="list-style-type: none"> • We used Linear-Time Temporal Logic (LTL), to specify the performance objectives for a given Discrete Event System (DES) in a more natural language, and build a supervisor that restricts the DES' behaviour to those objectives by construction. • Petri nets (PN) to program individual and relational behaviors for cooperative multirobots (soccer robots), with synchronization and commitment. • Robotic task performance analysis is carried out over a PN-based closed loop model of the robot situated in its environment, using both PN qualitative (formal verification) and quantitative (stochastic performance) analysis tools. • We have introduced a Q-value theory for Dec-POMDPs, which has been useful for planning in single-agent models like MDPs and POMDPs. • We have introduced a model for stochastically delayed communication, which unifies and extends several existing communication models for Dec-POMDPs. • We applied planning-under-uncertainty methodologies, such as POMDPs, to networks of (visual) sensors and robots. We studied the problem of dynamically selecting a subset of sensors that can be active at any point in time, to optimize a user-defined objective. We have demonstrated our techniques on the ISRobotNet network of 10 cameras. • We explored decision-theoretical methods for active cooperative perception, i.e., active perception involving multiple sensors and multiple cooperating decision makers. • A general formulation for low-communication decentralized estimation of the 6 DoF full-order state vector of a N-vehicle formation was introduced. • We introduced agent programming based on preference elicitation under evaluations over observed behaviours using the MDP framework • Institutional Robotics (IR) is a new strategy to conceptualize multi-robot systems, which takes institutions as the main tool of social life of robots with bounded rationality and bounded autonomy. In this period we introduced the first applications of IR concepts to real e-Puck robots. • Research on adjustable autonomy for robot remote operation was carried out using the RAPOSA platform, namely regarding autonomous docking to the robot cable, autonomous stair climbing, and 3D remote operation using a Head Mounted Display and the robot camera pairs to feed stereo video. • We have endowed the iCub humanoid robot cognitive architecture with a spatial model of the environment. iCub is now capable of learning new objects, once they are shown to it close to his "eyes". Whenever learnt objects are found on the environment, iCub gazes at them, sequentially. 	

Group Productivity	
Publications in peer review Journals	
<ul style="list-style-type: none"> • F. Oliehoek, Matthijs Spaan, N. Vlassis, Optimal and Approximate Q-value Functions for Decentralized POMDPs, Journal of Artificial Intelligence Research, Vol. 32, pp. 289-353, 2008 	

Group Productivity

- Bruno Lacerda, Pedro Lima, Linear-Time Temporal Logic Control of Discrete Event Models of Cooperative Robots, Journal of Physical Agents, Vol. 2, No. 1, Special Issue on Multi-Robot Systems , 2008

Other publications International

- Nuno Lopes, Pedro Lima, OpenSDK - An Open-source Implementation of OPEN-R, Proc. of AAMAS 2008 - 7th International Joint Conference on Autonomous Agents and Multi-Agent Systems, Estoril, Portugal, 2008
- Hugo Costelha, Pedro Lima, Modelling, Analysis and Execution of Multi-Robot Tasks using Petri Nets, Proc. of AAMAS 2008 - 7th International Joint Conference on Autonomous Agents and Multi-Agent Systems, Estoril, Portugal, 2008
- V. Ziparo, L. Iocchi, P. Palamara, Hugo Costelha, D. Nardi, PNP: A Formal Model for Representation and Execution of Multi-Robot Plans, Proc. of AAMAS 2008 - 7th International Joint Conference on Autonomous Agents and Multi-Agent Systems, Estoril, Portugal, 2008
- F. Oliehoek, Matthijs Spaan, S. Whiteson, N. Vlassis, Exploiting Locality of Interaction in Factored Dec-POMDPs, Proc. of AAMAS 2008 - the 7th International Conference on Autonomous Agents and Multiagent Systems, Estoril, Portugal, 2008
- Matthijs Spaan, Francisco Melo, Interaction-Driven Markov Games for Decentralized Multiagent Planning under Uncertainty, Proc. of AAMAS 2008 - the 7th International Conference on Autonomous Agents and Multiagent Systems, Estoril, Portugal, 2008
- Porfírio Silva, Rodrigo Ventura, Pedro Lima, Institutional Environments, Proc. of Workshop AT2AI: From agent theory to agent implementation, AAMAS 2008 - 7th International Conference on Autonomous Agents and Multiagent Systems, Estoril, Portugal, 2008
- Gonçalo Neto, Pedro Lima, Combining Supervisory Control of Discrete Event Systems and Reinforcement Learning to Control Multi-Robot Systems, Proc. of Workshop Formal models and methods for multi-robot systems, AAMAS 2008 - the 7th International Conference on Autonomous Agents and Multiagent Systems, Estoril, Portugal, 2008
- Artem Khmelinskii, Rodrigo Ventura, João Sanches, Chromosome Pairing for Karyotyping Purposes using Mutual Information, Proc. of ISBI 2008 - 5th IEEE International Symposium on Biomedical Imaging: From Nano to Macro, Paris, France, 2008
- P. F. Palamara, V. A. Ziparo, L. Iocchi, D. Nardi, Pedro Lima, Teamwork Design Based on Petri Net Plans, Proc. of RoboCup International Symposium 2008, Suzhou, China, 2008
- Matthijs Spaan, F. Oliehoek, N. Vlassis, Multiagent Planning under Uncertainty with Stochastic Communication Delays, Proc. of ICAPS 2008 - 18th International Conference on Automated Planning and Scheduling, Sydney, Australia, 2008
- Artem Khmelinskii, Rodrigo Ventura, João Sanches, Automatic Chromosome Pairing Using Mutual Information, Proc. of EMBC 2008 - 30th Annual International Conference of the IEEE Engineering in Medicine and Biology Society, Vancouver, British Columbia, Canada, 2008
- Matteo Taiana, J. Santos, José Gaspar, Jacinto Nascimento, Alexandre Bernardino, Pedro Lima, Color 3D Model-Based Tracking with Arbitrary Projection Models, Proc. of SIMPAR 2008 - International Conference on Simulation, Modeling and Programming for Autonomous Robots, Workshop on Omnidirectional Robot Vision, Venice, Italy, 2008
- Matthijs Spaan, Cooperative Active Perception using POMDPs, Proc. of AAI 2008 Workshop on Advancements in POMDP Solvers, Chicago, USA, 2008
- Aamir Ahmad, Probabilistic Roadmap Method and Real Time Gait Changing Technique Implementation for Travel Time Optimization on a Designed Six-legged Robot, Proc. of ISR 2008 - 39th International Symposium on Robotics, Seoul, South Korea, 2008
- Rodrigo Ventura, Action and Adaptation: Lessons from Neurobiology and Challenges for Robot Cognitive Architectures, AAI Fall Symposium: Biologically Inspired Cognitive Architectures, AAI, Washington DC, 2008

Other publications National

- Monte Carlo Localization Based on Gyrodometry and Line-Detection , J. Messias, João Santos, João Antunes, Pedro Lima, Proc. of ROBÓTICA2008 - 8th Conference on Mobile Robots and Competitions, Aveiro, Portugal, 2008
- B. Dias, Rodrigo Ventura, José Gaspar, Automatic Transcription of Musical-Whistling: Comparing Pitch Detection Methods, Proc. of JETC 20078 - IV Jornadas de Engenharia Electrónica e Telecomunicações e de Computadores, Lisbon, Portugal, 2008

Master and Ph.D. thesis completed

PhD

- Rodrigo Ventura, "Emotion-based Mechanisms for Decision Making in Autonomous Agents", Ph.D. Thesis, Instituto Superior Técnico, Universidade Técnica de Lisboa, Jan 2008.

MSc

- Pedro Fazenda, "Non-Holonomic Robot Formations with Obstacle Compliant Geometry", Master Thesis, Instituto Superior Técnico, Universidade Técnica de Lisboa, Jan 2008.
- André Bianchi de Aguiar Araújo Figueiredo, "Sistema de Controlo de um Veículo Autónomo Aéreo", MSc. Thesis, Instituto Superior Técnico, Lisbon, Portugal, Jan 2008.
- David Jerónimo, "Passarola: Dirigível Autónomo para Operações de Salvamento (Electrónica)", MSc. Thesis, Instituto Superior Técnico, Lisbon, Portugal, Sep 2008.
- Ricardo Alcácer, "Passarola: Dirigível Autónomo para Operações de Salvamento (Robótica)", MSc. Thesis, Instituto Superior Técnico, Lisbon, Portugal, Sep 2008.
- João Messias, "Task Specific Motion Control of Omnidirectional Robots", MSc. Thesis, Instituto Superior Técnico, Lisbon, Portugal, Sep 2008.
- Francisco Mendonça, "Smooth Priorities", Master Thesis, Instituto Superior Técnico, Lisbon, Portugal, Oct 2008.
- Pedro Afonso, "Railway Traffic Management", MSc. Thesis, Instituto Superior Técnico, Lisbon, Portugal, Oct 2008.
- Artur Prego, "Desenvolvimento e Análise de Comportamentos Relacionais em Robots Futebolistas", MSc. Thesis, Instituto Superior Técnico, Lisbon, Portugal, Oct 2008.
- Fausto Ferreira, "RAPOSA: Robot Autónomo Para Operações de Salvamento", MSc. Thesis, Instituto Superior Técnico, Lisbon, Portugal, Oct 2008.

Group Productivity

- Dario Bacellar, "From Pixels to Objects - Enabling a spatial model for humanoid social robots", MSc. Thesis, Instituto Superior Técnico, Lisbon, Portugal, Oct 2008.
- Cristina Aleixo, "A receptionist robot: navigation and image processing", MSc. Thesis, Instituto Superior Técnico, Lisbon, Portugal, Oct 2008.
- Manuel Malhado, "A receptionist robot: interface and coordination", MSc. Thesis, Instituto Superior Técnico, Lisbon, Portugal, Oct 2008.
- Bruno Filipe Simão Dias, "Automatic Music Transcription", MSc. Thesis, Instituto Superior Técnico, Lisbon, Portugal, Nov 2008.
- João Santos, "Multi-Robot Cooperative Object Localization: Decentralized Bayesian Approach", MSc. Thesis, Instituto Superior Técnico, Lisbon, Portugal, Dec 2008.

Patents/prototypes

PASSAROLA: an autonomous aerial blimp testbed. The robot has onboard vision and computation capabilities, based on a digital signal processor, and was developed together with a realistic hardware-in-the-loop simulator developed over USARSim. This development environment enabled fast prototyping and implementation of navigation primitives for the blimp, namely vision-based line following and ground vehicle tracking.

Organization of conferences

ISLab researchers were co-organizers of the following workshops:

- Workshop "Teaching with Robots", within Robotics: Science and Systems 2008
- Workshop on "Formal Models and Methods for Multi-Robot Systems" at AAMAS 2008, in Estoril, Portugal.
- Multiagent Planning Workshop at ICAPS 2008, Sydney, Australia, in September 2008.

ISLab researchers were IPC members of the following conferences:

- European Conference on Artificial intelligence (ECAI'08)
- IROS 2008
- RoboCup Symposium 2008
- International Conference on Simulation, Modeling, and Programming for Autonomous Robots (SIMPACT 2008)
- 18th Int. Conf. on Automated Planning and Scheduling (ICAPS'08)
- 24th Conf. on Uncertainty in Artificial Intelligence (UAI'08)
- 23rd Conf. on Artificial Intelligence (AAAI'08)
- 7th Int. Conf. on Autonomous Agents and Multi-Agent Systems (AAMAS'08)

Internationalization

- See collaborative publications in the publications' list
- Collaboration with Universidad Politecnica de Catalonia, University of Seville, University of Zaragoza and LAAS, under the framework of the EU FP6 URUS project
- Collaboration with the University of Amsterdam
- Co-supervision of PhD student with Alcherio Martinoli at EPFL, Switzerland, under the IST-EPFL Dual Degree program
- ISLab researchers were members of the editorial board of the following journals:
 - o Journal of Advanced Robotic Systems, published by ARS Publishing, Vienna
 - o Portuguese Magazine Robótica
- ISLab researchers were reviewers of the following journals:
 - o IEEE Transactions on Systems, Man and Cybernetics, part B
 - o IEEE Transactions on Robotics
 - o Journal of Artificial Intelligence Research
 - o Autonomous Agents and Multi-Agent Systems
 - o Neurocomputing
 - o European Journal of Operational Research
- Pedro Lima was the Supervisor of Valdeinei Silva, Ph.D. Student from Universidade Politécnica de São Paulo, Brasil
- Pedro Lima is a Trustee of the RoboCup Federation
- Invited Talks:
 - o A Multidisciplinary Approach to Cooperative Robotics, invited talk, DISALab at EPFL, Lausanne, Switzerland, 20 November 2008, by Pedro Lima
 - o A Systems Theory Approach to Cooperative Robotics and Sensor Networks, invited talk o IROS2008 Network Robot Systems Workshop, Nice, France, 26 September 2008, by Pedro Lima

Future Research

Objectives

ISR's ISLab and MRLab have a past experience of collaboration in research projects, and graduate students supervision. Research staff in both labs share common scientific interests, and tackle complementary aspects in the area of intelligent mobile robots. The two groups will merge into a single one, the IRSLab (Intelligent Robots and Systems Lab), starting 2009, with the goal of fostering their collaboration and increasing the

Future Research

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The involvement in ITER Remote Handling activities will continue, extending the past contributions of the group, among them the design of the current reference model for ITER cask transportation systems.

Funding, source, dates

- €107.916,00, DecPUCS: Decentralized Planning Under Uncertainty for Cooperative Systems, FCT PTDC/EEA-ACR/73266/2006, Oct/2007 – Sep/2010
- €237.043,37, URUS - Ubiquitous Networking Robotics in Urban Settings, FP6-EU-IST-045062, Dec/2006 – Nov/2009 [together with IRS' VisLab and MRLab]
- €172.060,00 - Activities related to the development of an Air Transfer System prototype and Cask Transfer System Virtual Mockup - EURATOM F4E-2008-GRT-016 (MS-RH), Mar/2009-Jun/2010 [together with IRS' MRLab]

Group Description	
Title of Research Group:	(RG-LVT-Lisboa-750009-3508) VisLab - Computer and Robot Vision Laboratory
Principal Investigator:	Jose Alberto Rosado Santos Victor
Main Scientific Domain:	Engenharia Electrotécnica e Informática
Group Host Institution:	Instituto Superior Técnico - Universidade Técnica de Lisboa

Funding, source, dates	
Funding, source, dates	
237K€, URUS - Ubiquitous Networking Robotics in Urban Settings, FP6-EU-IST-045062, Dec06– Nov09 [+ ISLab and MRL]	
594K€, ROBOT-CUB - ROBotic Open-architecture Technology for Cognition, Understanding, and Behaviour, EU- IST-2004-004370, Sep04 – Aug09.	
380K€, CONTACT - Learning and Development of Contextual Action, EU- NEST-5010, Sep05–Feb09.	
89K€, BIOLOOK: Biomimetic Oculomotor Control for Humanoid Robots, FCT - PTDC/EEA-ACR/71032/2006, Oct.2007-Sept.2010.	
80K€, MMCACC: Advanced Monte Carlo Algorithms for Computational Control, FCT - PTDC/EEA-ACR/ 70174/2006, Sep.2007–Aug 2010	
31K€, GESTINTERACT: Gesture Interpretation for the Analysis of Interactions Humans/Robots/Humans, FCT - POSI/EEA-SRI/61911/2004, Sept 2005–Aug 2008.	
25K€, VEMUCARV: Spatial validation of complex urban grids in virtual immersive environments, POCTI/AUR/48123/2002, May 2005–June 2008.	

Objectives & Achievements

Objectives

Vision is an extremely powerful sensing modality that allows many species to perceive the surrounding world (color, texture, motion, shape, contrast, etc.) and act accordingly, offering large spatial resolution and reasonable temporal dynamics.

The research at the Vislab aims at (i) the development of new methodologies and tools for computer and robot vision and to (ii) demonstrate such methodologies in challenging applications. The research is organized in two main lines:

- Vision Based Control and Navigation
- 3D Reconstruction, Motion Analysis and Surveillance

a) Vision Based Control and Navigation

We address the problem of understanding how to use visual information to control an artificial system (robot) in order to perform a given task. Our research is often inspired on biological systems and aims at designing more flexible and robust artificial vision systems and to improve the understanding of biology. The following topics are being pursued:

- Visual Geometries
- Vision based control, active vision and navigation
- Feature learning and object recognition
- Learning and cognition for human(oid) robots

b) 3D Reconstruction, Motion Analysis and surveillance

Vision allows us to retrieve information about the scene structure (geometry) or camera motion from video sequences. By imposing physical constraints such as rigidity, the reconstruction process was reformulated to cope both with partial views of the object and degenerate surfaces (such as planar or piecewise planar objects). This approach lead to an innovative algorithm with diverse applications:

- Reconstruction of an object with quite diverse images (different scale, partial views)
- A new biometric algorithm which identifies people by measuring the compliance of an acquired image of a face with a rigid transformation of a known model.

Another line of research is the development of video surveillance systems able to learn to understand human activities as required by the increasing number of cameras deployed in public spaces. We apply similar approaches for human-robot, non-verbal (gesture) interaction.

Main Achievements

The work at VisLab is characterized both by the development of new methodologies for computer and robot vision as well as by addressing several applications with societal impact. The approach followed is strongly multidisciplinary with close links to biology, neuroscience or psychology. The lab has been involved in large-scale, ambitious projects with international partners (e.g. EU). As before, the group has hosted several international post-doc, doctoral or visiting students during 2008.

Some of the main achievements are listed below:

Human activity analysis

We have continued the development of computer vision methods able to provide an interpretation of the observed scenes. We developed learning approaches for recognizing human activity from video in different scenarios, in particular for surveillance or human robot interface.

Feature selection and object recognition

We have developed models for feature detection and selection based on Gabor filters, with responses similar to the human visual system. We further adopted boosting techniques to improve the recognition rates as well as for feature selection.

Objectives & Achievements

Camera design and camera networks

We developed methods for the calibration of novel camera geometries and networks of cameras from extended observation of video streams.

Humanoid robotic platforms

We have completed the design of the iCub face and body covers. The iCub is the most sophisticated humanoid robot currently under development and will hopefully be used by a large community world wide. We have continued the development of another mobile platform (Vizzy) combining a humanoid torso and a mobile base.

Visuomotor coordination, learning and grasping

We have developed methods for vision (e.g. tracking, attention) and motor coordination in humanoid robots, including learning about affordances and grasping strategies.

Participation in EU Projects and International Partnerships

In addition to key contributions to our major EU Projects (Robotcub, Contact and Urus), we have won another EU Project proposal (Handle) on the topic of in-hand manipulation that will start in the beginning of 2009. We have also actively participated in the IST-EPFL Joint PhD Initiative with two students involved in the joint doctoral studies between IST and EPFL

Group Productivity

Publications in peer review Journals

- Plinio Moreno, Alexandre Bernardino and José Santos-Victor, Improving the SIFT descriptor with smooth derivative filters, Pattern Recognition Letters, Vol. 30 (1) 2008.
- Modeling Dynamic Scenarios for Local Sensor-Based Motion Planning, L. Montesano, J. Minguéz, L. Montano, Autonomous Robots, Vol. 25(3) 2008.
- Learning Object Affordances: From Sensory Motor Maps to Imitation, Luis Montesano, Manuel Lopes, Alexandre Bernardino, Jose Santos-Victor, IEEE Transactions on Robotics, Special Issue on Bio-Robotics, Vol. 24(1) Feb 2008.

Other publications International

- Color 3D Model-Based Tracking with Arbitrary Projection Models, Matteo Taiana, J. Santos, José Gaspar, Jacinto Nascimento, Alexandre Bernardino, Pedro Lima, Proc. of SIMPAR 2008 - International Conference on Simulation, Modeling and Programming for Autonomous Robots, Workshop on Omnidirectional Robot Vision, Venice, Italy, 2008.
- Calibration from statistical properties of the visual world, Etienne Grossmann, José Gaspar and Francesco Orabona, European Conference on Computer Vision, Marseille, France, October 2008.
- Modeling Speech imitation, Jonas Hörnstein, Lisa Gustavsson, José Santos-Victor and Francisco Lacerda, IROS-2008 Workshop - From motor to interaction learning in robots, Nice, France, September 2008.
- Fitted natural actor-critic: A new algorithm for continuous state-action MDPs, Francisco S. Melo and Manuel Lopes, European Conference on Machine Learning(ECML/PKDD) Antwerp, Belgium, September 2008.
- Associating word descriptions to learned manipulation task models, Verica Krunić, Giampiero Salvi, Alexandre Bernardino, Luis Montesano, José Santos-Victor, IROS-2008 WORKSHOP on Grasp and Task Learning by Imitation, Nice, France, September 2008.
- A computational model for social learning mechanisms, Manuel Lopes, Francisco S. Melo, Ben Kenward and José Santos-Victor, IROS-2008 Workshop - From motor to interaction learning in robots, Nice, France, September 2008.
- Pose Estimation for Grasping Preparation from Stereo Ellipses, Giovanni Saponaro, Alexandre Bernardino Proc. of the Workshop on Humanoid Robotics at CLAWAR 2008, Coimbra, Portugal, 8-10 Sept. 2008.
- Sample-Based 3D Tracking of Colored Objects: A Flexible Architecture, Matteo Taiana, Jacinto Nascimento, José Gaspar and Alexandre Bernardino, Proc. of the British Machine Vision Conference, BMVC2008, Leeds, UK, 1-4 Sept. 2008.
- Multimodal Saliency-Based Bottom-Up Attention A Framework for the Humanoid Robot iCub, Jonas Ruesch, Manuel Lopes, Alexandre Bernardino, Jonas Hornstein, José Santos-Victor, Rolf Pfeifer, 2008 IEEE International Conference on Robotics and Automation Pasadena, CA, USA, May 19-23, 2008.
- A Benchmark on Stereo Disparity Estimation for Humanoid Robots, Jurgen Leitner, Alexandre Bernardino and José Santos-Victor, Proc. of Robotica 2008, 8th Conference on Autonomous Robot Systems and Competitions, Aveiro, Portugal, April 2008.
- Visual Self-Calibration of Pan-Tilt Kinematic Structures, Bartosz Tworek, Alexandre Bernardino, José Santos-Victor, Proc. of Robotica 2008, 8th Conference on Autonomous Robot Systems and Competitions, Aveiro, Portugal, April 2008.
- Reconstruction of Isometrically Deformable Flat Surfaces in 3D from Multiple Camera Images, Ricardo Ferreira, João Xavier, João Paulo Costeira, Proc. of ICASSP 2009 - IEEE International Conference on Acoustics, Speech, and Signal Processing, Taipei, Taiwan, 2009
- 3D face recognition from multiple images: a shape-from-motion approach, Manuel Marques, João Paulo Costeira, Proc. of FG 2008 - 8th IEEE International Conference on Automatic Face and Gesture Recognition, Amsterdam, The Netherlands, 2008. BEST STUDENT PRESENTATION AWARD.
-
- Subspace Segmentation with Outliers: a Grassmannian approach to the maximum consensus subspace, Nuno Pinho da Silva, João Paulo Costeira, Proc. of CVPR 2008 - IEEE Computer Society Conference on Computer Vision and Pattern Recognition, Anchorage, Alaska, USA, 2008
- Optimal shape from motion estimation with missing and degenerate data, Manuel Marques, João Paulo Costeira, Proc. of WACV 2008 - IEEE Workshop on Application of Computer Vision, Copper Mountain, CO, USA, 2008

Other publications National

- Calibrating a Network of Cameras Based on Visual Odometry, Nuno Leite, Alessio Del Bue, José Gaspar, in Proc. of IV Jornadas de Engenharia Electrónica e Telecomunicações e de Computadores, pp174-179, November 2008, Lisbon, Portugal.
- Control of Unicycle Type Robots: Tracking, Path Following and Point Stabilization, Ricardo Carona, A. Pedro Aguiar, José Gaspar, in Proc. of IV

Group Productivity

Jornadas de Engenharia Electrónica e Telecomunicações e de Computadores, pp180-185, November 2008, Lisbon, Portugal.

- Experiments on Vision Based Control of and Indoors RF Blimp, Marco Neves, João Marques, Alexandre Bernardino, José Santos-Victor, Proc. of Controlo 2008, 8th Portuguese Conference on Automatic Control, Vila Real, Portugal, 21-23 July 2008.

- Predictive Reaching control with Multiple motion Models, Paulo Carreiras, Alexandre Bernardino, José Santos-Victor, Proc. of Controlo 2008, 8th Portuguese Conference on Automatic Control, Vila Real, Portugal, 21-23 July 2008.

Master and Ph.D. thesis completed

Samuel António Tojal Ferreira, "Predtrack - Predição de Alvos Móveis: Aplicação ao Controlo de uma Cabeça Robótica," M.Sc.Thesis, Instituto Superior Técnico, Lisbon, Portugal, November 2008.

Daniela Filipa Gonçalves Pamplona, "Gaussian Foveation," M.Sc. Thesis, Instituto Superior Técnico, Nov. 2008.

Nuno Filipe Maia Lucas, "Ekit - Kit de Apoio à Aprendizagem de Sinais, Circuitos e Sistemas Electrónicos," M.Sc. Thesis, Instituto Superior Técnico, Nov. 2008

Bruno Filipe Simão Dias, "Automatic Transcription of Musical Whistling," M.Sc. Thesis, Instituto Superior Técnico, Nov. 2008

Dario Bacellar, "From Pixels to Objects - Enabling a spatial model for humanoid social robots", MSc. Thesis, Instituto Superior Técnico, Lisbon, Portugal, Oct 2008.

Ricardo Daniel Rita Beira, "Mechanical Design of an Anthropomorphic Robot Head," M.Sc. Thesis, Instituto Superior Técnico, Jan. 2008

Plinio Moreno López, "Object component models using Gabor filters for visual recognition," Ph.D. Thesis, Instituto Superior Técnico, Lisbon, Portugal, September 2008.

Luís Guilherme, "Controlo de um Gerador de Ondas Hidráulicas em Canal com Absorção Activa", MSc. Thesis, Instituto Superior Técnico - LNEC, Lisbon, Portugal, Dec 2008.

Hugo Silva, "Sistema de Visão em Tempo Real para Aplicações Robóticas em Sistemas Autónomos", " , MSc. Thesis, Instituto Superior Técnico – ISEP, Lisbon, Portugal, Mar 2008.

Patents/protopypes

- Baltazar Humanoid Torso: composed of a high-speed 4 degrees of freedom binocular head, an articulated arm and hand, for research in learning by imitation.

- Vizzy – another humanoid platform that is mounted on a segway mobile base. Construction is planned to be finished in 2009.

- Two robotic heads designed for the iCub, each with 6 degrees of freedom, an inertial sensor, audio and ability to perform facial expressions (see pictures below)

- TRC LabMate mobile platform.

- One Pioneer mobile platform equipped with a manipulator.

- Two Nomad Superscout mobile platforms, equipped with vision and an on-board computer.

- One Tobii system for gaze tracking

- One data glove and magnetic tracker

Organization of conferences

VisLab members were involved in the Program Committee of the following conferences:

- IEEE International Conference on Robotics and Automation, ICRA.

- IEEE Computer Society Conference on Computer Vision and Pattern Recognition, CVPR.

- IEEE International Conference on Intelligent Robots and Systems, IROS.

- Robotics Systems and Science, RSS.

- International Workshop on Epigenetic Robotics, EPIROB.

- International Conference on Image Analysis and Recognition, ICIAR.

- British Machine Vision Conference, BMVC.

- Iberian Conference on Pattern Recognition and Image Analysis, IBPRIA.

- European Conference on Computer Vision, ECCV.

- International Joint Conference on Artificial Intelligence, IJCAI.

Internationalization

The group consists of an international team of 9 doctoral researchers including where only 5 are Portuguese. About one third of the PhD students are not of Portuguese nationality. Most of the core activities are carried out in the context of large international projects.

International Projects and partnerships

- EU Proj. ROBOTCUB - ROBotic Open-architecture Technology for Cognition, Understanding & Behavior

- EU Proj. URUS - Ubiquitous Networking Robotics in Urban Settings

- EU Proj. CONTACT - Learning and Development of Contextual Action, EU- NEST-5010, Sep05–Feb09.

- Involvement in the IST-EPFL Joint Doctoral Initiative

Group Productivity

National projects with international partners

- FCT Proj. BIOLOOK – with participation of the Uppsala University
- FCT Proj. MCMCAC – with participation of the University of Vancouver.

Participation in theses committees abroad

- Ph.D. Thesis, Micha Hersch, “Adaptive sensorimotor peripersonal space representation and motor learning for a humanoid robot”, EPFL Dec. 2008.
- Ph.D Thesis, Sandra Nope, “Sistema Bioinspirado de Reconocimiento e Imitación de Gestos Aplicado en Robótica”, Universidad del Valle, Cali, Colombia, Sept 2008.
- PhD Thesis reviewer, Andrew Dankers, “Real-Time Synthetic Primate Vision”, Australian National University, August. 2008
- Ph.D Thesis reviewer, Adolfo Martínez Usó, “Unsupervised Band Selection and Segmentation in Hyper/Multispectral Images”, Universitat Jaume I, Castellon, Espanha, Sept 2008.

Supervision international students

- Giovanni Saponaro, Università di Roma La Sapienza, Italy, (March September 2008), M.Sc, ERASMUS.
- M.Sc. students Davide Zambrano and Egidio Falotico, Scuola Superiore Sant’Anna, Italy.
- M.Sc. student Mohit Khurana, IIT Guwahati, India.
- Nicolas Greggio, visiting PhD student, Scuola Superiore Sant’Anna, Italy.

Membership of editorial boards

- IEEE Transactions on Robotics, José Santos-Victor

Reviewers for international journals

- Autonomous Robots, Springer Netherlands
- IEEE Transactions on Biomedical Engineering
- IEEE Transactions on Circuits and Systems for Video Technology
- IEEE Transactions on Image Processing,
- IEEE Transactions on Pattern analysis and Machine Intelligence
- IEEE Transactions on Robotics
- IEEE Transactions on System Man and Cybernetics
- International Journal on Humanoid Robot, World Scientific
- Journal of Robotics and Autonomous Systems

Government/Organization contract research

José Santos-Victor, National delegate to the European Space Agency, Mars Exploration Program (AURORA).

Future Research

Objectives

The goals for 2009 consist in the developing the main research lines of the Lab.

From the beginning of 2009 the lab will receive a complete copy of the iCub platform. We plan to use the lab and this platform as a training facility for researchers from other labs (national and international) who may wish to carry on their research work at the VisLab.

We will pursue an aggressive policy of participation in EU Projects. While this results from the international reputation of the group, it contributes to the international visibility and allows us to tackle ambitious projects in multidisciplinary consortia.

We have started the organization of the “Robot Learning Summer School – RLSS”, an official IEEE Robotics and Automation event with keynote speakers in different areas of learning and robotics.

In 2009 we will initialize the work on the new EU Project HANDLE where the concept of affordances and exploration of sensorimotor loops will be extended to in-hand manipulation.

Finally, we will need to hire more researchers since the new platforms and the range of research initiatives currently undertaken in the lab call for enlarging the research team with new people and competences.

Funding, source, dates

237K€, URUS - Ubiquitous Networking Robotics in Urban Settings, FP6-EU-IST-045062, Dec06– Nov09 [+ ISLab and MRL - Theme B]

594K€, ROBOT-CUB - ROBotic Open-architecture Technology for Cognition, Understanding, and Behaviour, EU- IST-2004-004370, Sep04 – Aug09.

380K€, CONTACT - Learning and Development of Contextual Action, EU- NEST-5010, Sep05–Feb09.

89K€, BIOLOOK: Biomimetic Oculomotor Control for Humanoid Robots, FCT - PTDC/EEA-ACR/71032/2006, Oct.2007-Sept.2010.

748K€, HANDLE: Developmental pathway towards autonomy and dexterity in robot in-hand manipulation, ICT –231640– HANDLE, Feb 2009-Jan 2013.

Group Description	
Title of Research Group:	(RG-LVT-Lisboa-750009-3583) Laboratory for Energy and Environmental Studies at IN+ Center for Innovation, Technology and Policy Research
Principal Investigator:	Paulo Manuel Cadete Ferrao
Main Scientific Domain:	Engenharia Mecânica
Group Host Institution:	Instituto Superior Técnico - Universidade Técnica de Lisboa

Funding, source, dates

Funding, source, dates
€ 119.901,00; Reitoria da UTL, Contract W/N, 2005/2008
€ 36.000,00; Ente per le Nuove Tecnologie, L'Energia e L'Ambiente, Contract N.º 037075, 2006/2008
€ 41.580,00; Agência Portuguesa do Ambiente, Contract N.º 76/2008, 2008/2009
€ 74.962,50; Agência Portuguesa do Ambiente, Contract N.º 164/2008, 2008/2010
€ 130.000,00; Agência Portuguesa do Ambiente, Contract W/N, 2007/2009
€ 192.905,00; Fundação para a Ciência e a Tecnologia, Contract N.º PTDC/70767/2006, 2007/2010
€ 194.761,00; Fundação para a Ciência e a Tecnologia, Contract N.º PTDC/AMB/67241/2006, 2007/2010
€ 327.335,41; Fundação para a Ciência e a Tecnologia, Contract N.º MIT-PT/SES/0008/2006, 2007/2011
€ 317.954,43; Fundação para a Ciência e a Tecnologia, Contract N.º MIT-PT/AP/0015/2006, 2006/2011
€ 30.000; EDP, 2007/2008
€ 52.600,00; Chamartin Imobiliária and Sustentare, 2008/2009
€ 25.781,00; Necton, 2008/2009
€ 37.000,00; Rural Development Program for Continental Portugal, 2008
€ 31.944,00; FCT, 2006/2008
€ 53.310,00; FCT, 2007/2010
€ 102.756,00; FCT, 2007/2010
€ 559.054,00; EC, 2003/2008
€ 810.202,00; FEDER, 2008/2011
€ 240.274,00; EEA Grants, 2008/2011
€ 228.000,00; EC,
€12.988; FCT, 2007/2010
€10.470; FCT, 2006/2008

Objectives & Achievements

Objectives

The objective is to undertake multidisciplinary research aiming at developing and evaluating emerging and alternative complex engineering systems promoting sustainability, namely in terms of the needs to secure socio-economic development and the quality of the environment, creating a more prosperous and sustainable society.

Enabling technologies will be developed and assessed under a systems view, comprising the use and environmental implications of materials, energy, and products in modern societies. To achieve these objectives, research and development activities include the analysis of advanced systems, but also the analysis of the global carbon bio-geochemical cycle and of material flows in the economy, including product and material life cycle management through reuse, remanufacturing, and recycling.

Main research areas include:

- Development of fundamental sustainability theory, linking thermodynamics, ecology and economics.
- Environmental modelling
- Carbon cycle
- Eco-design for sustainability in industrial, domestic and agricultural applications
- Total life-cycle energy chain and environmental impact assessment
- Develop new models for Urban climate
- Economic tools in environmental and sustainability assessment
- Flows of materials in the economy from raw-materials extraction to final integration in the natural environment
- Techno-economic assessment, technological change and systems integration.

Main Achievements

The activities developed within this topic were multidisciplinary, linking basic and applied research to technology development, and focused on the issues of sustainability, namely in terms of the needs to secure the quality of the environment, together with the management of energy resources and economic development.

In this context, the Laboratory of Environmental Systems has been able to:

Objectives & Achievements

- Develop major methodologies and tools that bring together economy and environment in the assessment and the design of new products (Eco-design tools) and new policies (e.g.: National Integrated framework for Residues Management, Hybrid Economic Input-Output-Life Cycle Assessment or Life Cycle Activity Analysis)
- Develop a far indicator of environmental pressure, combining consumer and producer responsibility (Rodrigues and Domingos, 2008).
- Support entrepreneurial initiatives in Industrial Ecology in Portugal, such as the design of a variety of new companies aimed at recycling and further processing end-of-life products or the design and implementation of an Eco-Industrial park at Chamusca.
- Create a network for sustainability in Portuguese agriculture, comprising close to 100 farmers, occupying 0.7% of Portugal, and close to 30 partners, including universities, NGOs and private firms.
- Provide support to Portuguese public policy on the use of natural carbon sinks.
- Develop a formalised theory for organisms (Sousa et al., 2008).

Group Productivity

Publications in peer review Journals

- Ferrão, P., Ribeiro, P. and Silva, P. (2008) "A management system for end-of-life tyres: the Portuguese case study". *Waste Management*, 28 (3), pp. 604-614.
- Luz, S. M. ; Deltio, J ; Rocha, G ; Goncalves, A ; Delarco Jr, A . (2008) "Cellulose and cellulignin from sugarcane bagasse reinforced polypropylene composites: Effect of acetylation on mechanical and thermal properties". *Composites. Part A, Applied Science and Manufacturing*, 39, p. 1362-1369.
- M J.N.O. Panão, H. J. P. Gonçalves, P. Ferrão (2008) "Optimization of the urban building efficiency potential for mid latitude climates using a genetic algorithm approach". *Renewable Energy*, 33(5), pp. 887-896.
- S.M. Luz, Gonçalves, A.R., del'arco A.P., Ferrão, P. (2008) "Composites from Brazilian natural fibers with polypropylene: mechanical and thermal properties". *Composite Interfaces*, 15, (7-9), pp. 841-850.
- Domingos, T. (2008). A discussion of the paper, Elshkaki et al., "Dynamic stock modeling: a method for the identification and estimation of future waste streams and emissions based on past production and product stock characteristics", *Energy* 2005, 30: 1353-63." *Energy* 33(5): 834.
- Rodrigues, J., T. Domingos (2008). Consumer and producer responsibility: Two approaches. *Ecological Economics* 66(2-3): 533-546.
- Rodrigues, J., T. Domingos (2008). Consumer and producer responsibility: Comments. *Ecological Economics* 66(2-3): 551.
- Sousa, T., T. Domingos, S. A. L. M. Kooijman (2008). From empirical patterns to theory: A formal metabolic theory of life. *Philosophical Transactions of the Royal Society of London B* 363: 2453-2464.
- Teixeira, R., T. Domingos, A. P. S. V. Costa, R. Oliveira, L. Farropas, F. Calouro, A. M. Barradas, J. P. B. G. Carneiro (2008). Soil organic matter dynamics in Portuguese natural and sown grasslands. *Options Méditerranéennes CIHEAM – Sustainable Mediterranean Grasslands and Their Multi-Functions*, A-79: 41-44.
- Teixeira, R., T. Domingos, P. Canaveira, T. Avelar, G. Basch, C. C. Belo, F. Calouro, D. Crespo, V. G. Ferreira, C. Martins (2008). Carbon sequestration in biodiverse sown grasslands. *Options Méditerranéennes CIHEAM – Sustainable Mediterranean Grasslands and Their Multi-Functions*, A-79: 123-126.
- Valada, T., R. Teixeira, T. Domingos (2008). Environmental and energetic assessment of sown irrigated pastures vs maize. *Options Méditerranéennes CIHEAM – Sustainable Mediterranean Grasslands and Their Multi-Functions*, A-79: 131-134.
- Göckede, M., [...], Pita, G., et al. (2008). Quality control of CarboEurope flux data –Part I: Footprint analyses to evaluate sites in forest ecosystems, *Biogeosciences* 5, 433-450.

Other publications International

- Abreu, J., Gonçalves, A. (2008). "Understanding consumer behavior for energy demand side management: A framework of research". *Smart Energy Strategies 2008 Conference*. 8-10 September, 2008, Zurich, Switzerland.
- Ferreira, J. G. B. ; Luz, S. M. ; Del'Arco Junior, A. P. (2008). "Interface e caracterização térmica de compósitos de polipropileno reforçados com fibras de carbono e poliácrlonitrila oxidada". In: *Anais do 18 ° Congresso Brasileiro de Engenharia e Ciência dos Materiais*, 2008. p. 3574-3585.
- Costa I, Ferrao P. (2008). "Developing a local approach to eco industrial parks: the case of Chamusca EIP". *14 Annual Sustainable Development Research Conference*, New Delhi, India, 21-23 September.
- Costa I, Massard G, Agarwal A. (2008). "The legislative framework on waste management in the European Union: a key issue of industrial symbiosis". *14th Annual Sustainable Development Research Conference*, New Delhi, India, 21-23 September.
- Langenegger, U., Starodumova, A. and D. Wiesmann. (2008). "Topological Reconstruction of Decays with Missing Particles". *Proceedings of the Hadron Collider Physics Symposium 2007. Nuclear Physics B - Proceedings Supplements. Volumes 177-178, March 2008, Pages 347-348*
- Luz, S ; Gonçalves, A. R. ; Del'Arco Junior, A. P. ; Ferrão, P. M. C. 2008. "Thermal and dynamic mechanical properties of polypropylene reinforced with sugarcane bagasse". *Proceedings of the 24th Polymer Progress Science*, 2008. Salerno.
- Luz, S. M. ; Ferrao, P. M. C. ; Del'Arco Junior, A. P. ; Gonçalves, A. R. Caracterização interfacial de compósitos reforçados com fibras de bagaço de cana. In: *18º Congresso Brasileiro de Engenharia e Ciência dos Materiais*, 2008, Porto de Galinhas. *Anais do 18º Congresso Brasileiro de Engenharia e Ciência dos Materiais*, 2008. p. 3503-3514.
- Niza, S.; Rosado, L. (2008). "Methodological advances in urban material flow accounting - the Lisbon case study". *ConAccount 2008: "Urban metabolism: measuring the ecological city"*. Prague, Czech Republic, 11-12 September 2008.
- Pereira, N. C. (2008). "Retrofit options for increasing energy efficiency in office buildings - methodology review". *Conference for Enhanced Building Operations (ICEBO)*, October 20-22, 2008, Berlin, Germany.
- Pina, A. (2008). "Going Electric: Flores Island case study on introduction of electric vehicles". *Young European Arena of Research, Transport Research Arena 2008*, 21 - 25 April, 2008, Ljubljana, Slovenia.
- Pina, A., Ioakimidis, C., Ferrão, P. (2008). "Economic modeling of a seawater pumped-storage system in the context of São Miguel". *IEEE International Conference on Sustainable Energy Technologies 2008*, 24-27 November, 2008, Singapore.
- Pina, A., Ioakimidis, C., Ferrão, P. (2008). "Introduction of electric vehicles in an island as a driver to increase renewable energy penetration". *IEEE International Conference on Sustainable Energy Technologies 2008*, 24-27 November, 2008, Singapore.

Group Productivity

- Pina, A., Suomalainen, K., Ferrão, P. (2008). "A greener island". Alliance for Global Sustainability Meeting, January, 2008, Cambridge, USA.
- Rosado, L., Ferrão, P. (2008). "Measuring the Embodied Energy in Household Goods: Application to the Lisbon City". ConAccount 2008: "Urban metabolism: measuring the ecological city". Prague, Czech Republic, 11-12 September 2008.
- Silva, C. A. ; Ferrão, P. ; Rodrigues, L. ; Alves, D.E. (2008). "Análise da aplicação de fibras de juta em produtos industriais". V Congresso Nacional de Engenharia Mecânica, 2008, Salvador.
- Domingos, T., T. Sousa (2008). DEB theory as a Paradigm for the Integration of Thermodynamics with the Natural and the Social Sciences. New Developments in DEB Theory and its Applications - NTVB Symposium, Free University of Amsterdam Amsterdam, The Netherlands, 24th January.
- Mota, R., T. Domingos, V. Martins (2008). Welfare Measures and Sustainability for Portugal 1992 - 2004. Monte Verità Conference on Sustainable Resource Use and Economic Dynamics – SURED 2008, 2-5 June, Ascona, Switzerland.
- Mota, R., T. Domingos, V. Martins (2008). Welfare measures and sustainability for Portugal, 1992 – 2004, 15th Ulvön Conference on Environmental Economics, 17-19 Junho, Ulvön, Sweden.
- Canaveira, P., R. Teixeira, T. Domingos (2008). Soil carbon sequestration from cropland and grassland management in Portugal. LULUCF Workshop .Montpellier, 7-9 July.
- Rodrigues, J., T. Domingos (2008). The estimation error in multi-regional input-output environmental models. International I-O Meeting on Managing the Environment, Sevilla, 9-11 Julho.
- Rodrigues, J., T. Domingos (2008). The estimation error in multi-regional input-output environmental models. International I-O Meeting on Managing the Environment, Sevilla, 9-11 Julho.
- Abreu, J., J. Gonçalves, T. Domingos (2008). Understanding consumer behavior for energy demand side management. A framework for research. Conferência "Smart Energy Strategies", Zürich, 8 e 10 de Setembro.
- Teixeira, R., C. Fiúza, T. Domingos (2008), Developing a methodology to integrate private and external costs and application to beef production. 6th International Conference on LCA in the Agri-Food Sector, Zürich, 12–14 Novembro.
- Valada, T., R. Teixeira, T. Domingos (2008), Maize production in Portugal for Bioethanol use: an Environmental and Energy Assessment, 6th International Conference on LCA in the Agri-Food Sector, Zürich, 12–14 Novembro.
- Marta-Pedroso, C., Marques, M. G, T. Domingos (2008) - Guaranteed Sustainability Label: is it a way of promoting sustainable agriculture? Paper presented at ACES, A Conference on Ecosystem Services, Naples, USA, 8-11 Dezembro.
- Mota, R., T. Domingos, V. Martins (2008). Welfare measures and sustainability for Portugal, 1992 – 2004, Proceedings of the Monte Verità Conference on Sustainable Resource Use and Economic Dynamics - SURED 2008, 2-5 Junho, Ascona, Switzerland.

Other publications National

- Costa I. (2008). "O conceito de Eco Parque Industrial: O caso da Chamusca". Segunda Conferência de Resíduos: novas políticas, novos negócios. Jornal Água e Ambiente, Lisboa, 1 - 2 Abril.
- Costa I. (2008). "Simbioses Industriais: Criar Ligações, Explorar Oportunidades". Conferência Ambiente Responsável e Saúde. Chamusca, 28 Outubro.
- Costa I. (2008). "ECOLivingLab@Chamusca". Conferência Da inovação à sociedade da imaginação – os Centros Living Labs em Portugal, IAPMEI, 27 de Junho.
- Silva, C. A. ; Ferrão, P. ; Freitas, M., Rodrigues, L. B.; Alves, D.E. (2008). "Using Life Cycle Assessment on environmental management projects: a case study of a Brazilian vehicle development". IEMC-Europe 2008: Internacional Engineering Management Conference, 2008, Estoril.
- Domingos, T. (2008). Dynamic Energy Budget Theory - A General Mathematical Theory in Biology, Empirically Tested for the Major Groups of Organisms. KDBIO Seminar, INESC-ID Lisbon, Portugal, 3rd April.
- Teixeira, R., T. Domingos, A. P. S. V. Costa, R. Oliveira, L. Farropas, F. Calouro, A. M. Barradas, J. P. B. G. Carneiro (2008). Soil organic matter dynamics in Portuguese natural and sown grasslands. 12th Meeting of the FAO-CIHEAM Sub-Network on Mediterranean Pastures and Fodder Crops "Sustainable Mediterranean Grasslands and their Multi-Functions", Elvas, 9-12 April.
- Teixeira, R., T. Domingos, Canaveira, P., Avelar, T., Basch, G., Belo, C.C., Calouro, F., Crespo, D., Ferreira, V.G., Martins, C. (2008). Carbon sequestration in biodiverse sown grasslands. 12th Meeting of the FAO-CIHEAM Sub-Network on Mediterranean Pastures and Fodder Crops – "Sustainable Mediterranean Grasslands and their Multi-Functions", 9-12 April, Elvas.
- Valada, T., R. F. M. Teixeira, T. Domingos (2008). Environmental, energetic and economic Assessment of land allocation to bioenergy crops. Bioenergy: Challenges and Opportunities, International Conference and Exhibition on Bioenergy, April 6th – 9th 2008. Universidade do Minho, Guimarães, Portugal.
- Valada, T., Teixeira, R., T. Domingos (2008). Environmental and energetic assessment of sown irrigated pastures vs maize. 12th Meeting of the FAO-CIHEAM Sub-Network on Mediterranean Pastures and Fodder Crops – "Sustainable Mediterranean Grasslands and their Multi-Functions", 9-12 April, Elvas.
- Domingos, T. (2008). Implicações energéticas e ambientais da utilização de biocombustíveis. Angola: Ensino, Investigação e Desenvolvimento. 1ª Conferência. Universidade do Minho, Instituto Politécnico de Bragança, Braga, 15-17 Maio.
- Fernandes, J. D., T. Sousa, S.A.L.M Kooijman, T. Domingos (2008). Scaling laws for entropy production within and across species: a mechanistic approach, Workshop Physics of Biological Systems: From Genes to Societies, Lisboa, 2-3 Outubro 2008

Master and Ph.D. thesis completed

- Cravo, S. (2008). "Estudo do Fabrico de um Componente para a Indústria Automóvel com Base na utilização de Curvas Limite de Estampagem". Dissertação para obtenção do grau de Mestre em Engenharia de Concepção. IST,Lisboa.
- Pinto, T. (2008). "Autoprodução - Quem, como e porquê?". Dissertação para obtenção do grau de Mestre em Engenharia de Concepção. IST,Lisboa.
- Pinto, T. (2008). "Aplicação da Avaliação de Ciclo de Vida à Análise Energética e Ambiental de Edifícios". Dissertação para obtenção do grau de Mestre em Engenharia de Concepção. IST,Lisboa.
- Fernandes, J. (2008) "The Potential for BIPV Product Development and Entrepreneurship in Portugal - Evidence from the International Design Competition Lisbon Ideas Challenge". Dissertação para obtenção do grau de Mestre em Engenharia e Gestão de Tecnologia. IST,Lisboa.
- Seródio, S. (2008) "Science and Technology Policies for the Development of Photovoltaic Technology in Portugal" Dissertação para obtenção do grau de Mestre em Engenharia e Gestão de Tecnologia. IST,Lisboa.

Group Productivity

- Teixeira, R (2008), Economic Incentives For Carbon Sequestration In Grassland Soils: An Offer You Cannot Refuse, Tese de Mestrado em Engenharia do Ambiente, IST, Lisboa.
- Mota, R. (2008), Welfare and Sustainability Measures in Dynamic Economies: Green Accounting for Portugal 1992 - 2004, Tese de Mestrado, ISEG, Lisboa.
- Serrenho, A. (2008).Desenvolvimentos no Formalismo de Gibbs-Tisza.Callen em Termodinâmica: Obtenção de Equações Fundamentais e Análise do Equilíbrio Químico. Dissertação para a obtenção do Grau de Mestre em Engenharia do Ambiente, IST,Lisboa. •Bernardo, J.(2008).Avaliação do Potencial de Biomassa de Portugal Continental. Dissertação para a obtenção do Grau de Mestre em Engenharia do Ambiente, IST,Lisboa.
- Fernandes, J. D.(2008). Mechanistic analysis of energy and entropy in biological and ecological systems. Dissertação para a obtenção do Grau de Mestre em Engenharia do Ambiente, IST,Lisboa.
- Rodrigues, N. (2008). A sustentabilidade de sistemas agrícolas extensivos - caso de estudo das explorações do projecto Extensity. Dissertação para a obtenção do Grau de Mestre em Engenharia do Ambiente, IST,Lisboa.
- Ribeiro, P. (2008). "A Ecologia Industrial e a Gestão de Resíduos em Portugal- Políticas e Ferramentas para o Fecho dos Ciclos dos Materiais". Dissertação para obtenção do grau de doutoramento em Engenharia do Ambiente. IST,Lisboa.
- Panão, M. (2008). "Simulação Térmica de Edifícios num Contexto Urbano: Contribuição para a Eficiência". Dissertação para obtenção do grau de doutoramento em Engenharia Mecânica. IST,Lisboa.
- Pinto, A. (2008). "Aplicação da Avaliação de Ciclo de Vida à Análise Energética e Ambiental de Edifícios". Dissertação para obtenção do grau de doutoramento em Engenharia Mecânica. IST,Lisboa.
- Soares, A. (2008). "Reciclagem e Políticas Públicas. O Caso da Reciclagem de Plásticas do Sector Automóvel". Dissertação para obtenção do grau de doutoramento em Engenharia do Ambiente. IST,Lisboa.
- Garcia, A. (2008) "Fine Sediments Resuspension Processes and Transport in Nazeré Submarine Canyon". ". Dissertação para obtenção do grau de doutoramento em Engenharia do Ambiente. IST,Lisboa.
- Henriques, A. (2008). Metodologia para cálculo das emissões de gases de efeito de estufa associadas a edifícios. Dissertação para obtenção do grau de Mestre em Engenharia do Ambiente. Instituto Superior Técnico, Lisboa.
- Lorena, A. (2008). Modelling microalgal growth and carbon capture with Dynamic Energy Budgets Theory. Dissertação para obtenção do grau de Mestre em Engenharia do Ambiente. Instituto Superior Técnico, Lisboa.

Internationalization

"Participation in the European Research Group AquaDEB (www.ifremer.fr/aquadeb)".

Future Research

Objectives

The future research activities will maintain the global objective of undertaking multidisciplinary research aiming at developing and evaluating emerging and alternative complex systems promoting sustainability, strengthening five major areas:

- 1) Fundamental Sustainability Theory
- 2) Industrial Ecology
- 3) Sustainable Energy Systems
- 4) Sustainable Agricultural Systems
- 5) Carbon Sinks in Natural Systems

The main objectives for the future development of these areas are as follows:

1) FUNDAMENTAL SUSTAINABILITY THEORY

Work on the development of the fundamental theoretical tools for sustainability will continue, thermodynamics (Gibbs-Tisza-Callen formalism, finite-time thermodynamics and non-equilibrium thermodynamics), ecology (based on DEB – Dynamic Energy and Mass Budgets theory) and economics (standard neo-classical microeconomics and behavioural economics).

2) INDUSTRIAL ECOLOGY

Industrial Ecology will be developed to promote a holistic view of engineering systems which requires the development of a set of tools to bridge different scales, from site or product specific analysis to the whole economy and from the economic to the socio-environmental dimension, thus resulting in a multi-disciplinary set of analytical tools, the "Industrial ecology toolbox", whose development and extension will be a continuous goal for the future. These tools will be used to design and promote new policy instruments that may contribute to improve the environmental performance of products and services through their life-cycles, as well as more efficient Economic Metabolisms at different scales.

3) SUSTAINABLE ENERGY SYSTEMS

The future activities in this scientific domain are intended to promote leadership in sustainable energy systems, by promoting high level international scientific and industrial partnerships, with emphasis on:

- Energy Planning Including Economics

This research area will build upon energy and environment values and economic domains, at the level of energy systems analysis and design. This will be based on a strong modelling framework capacity, including the analysis of the dynamics of energy demand (behavioural economics theory) and of local and regional renewable energy resources.

- Urban metabolism

Development of a spatially comprehensive and temporally broad physical accounting of resource consumption of urban centres, emphasising energy consumption in buildings and new and innovative solutions to promote the concept of "Sustainable Buildings".

4) SUSTAINABLE AGRICULTURAL SYSTEMS

Work on this area will continue the development of sustainability assessment in agriculture, and its application to public policy and farmer counselling.

5) CARBON SINKS IN NATURAL SYSTEMS

Future Research

Work on carbon sinks in natural system will continue, analysing carbon dynamics in forests and grassland. This will be based on experimental work using carbon flux measurements (eddy-covariance) and direct measurements of carbon pools, and modelling work, using conventional models and DEB-based models.

Funding, source, dates

€ 194.761,00; Fundação para a Ciência e a Tecnologia, Contract N.º PTDC/AMB/67241/2006, 2007/2010

€ 192.905,00; Fundação para a Ciência e a Tecnologia, Contract N.º PTDC/70767/2006, 2007/2010

€ 310.826,98 Fundação para a Ciência e a Tecnologia, Contract N.º MIT-PT/SES/0008/2006, 2007/2011

€ 345.343,57; Fundação para a Ciência e a Tecnologia, Contract Nº MIT-PT/AP/0015/2006, 2006/2011

€ 253.421,51; Fundação para a Ciência e a Tecnologia; Acordo MIT-Coordenação

€ 246.000,00; REN, FCT, Valorpneu; Sogilub, AMB3E; Conferência ISIE 2009

€ 44.880,00; Protocolo EDP

€ 90.000,00; EDP, 2008/2010

€ 397.117,00; FEDER, 2010/2011

€ 805.00,00; FEDER, 2010/2013

€ 199.974,00; Interreg, 2009/2010

€195.815,00; Fundação para a Ciência e a Tecnologia,, 2010/2012

€125.390,00; Fundação para a Ciência e a Tecnologia,, 2009/2012

€191.202,00; Fundação para a Ciência e a Tecnologia,, 2010/2013

Group Description	
Title of Research Group:	(RG-LVT-Lisboa-750009-3584) Laboratory of Thermofluids, Combustion and Energy Systems, at IN+ Center for Innovation, Technology and Policy Research
Principal Investigator:	Antonio Luis Nobre Moreira
Main Scientific Domain:	Engenharia Mecânica
Group Host Institution:	Instituto Superior Técnico - Universidade Técnica de Lisboa

Funding, source, dates	
Funding, source, dates	
70000€, "Advanced Intermittent Spray Cooling Systems", Project PTDC/EME-MFE/69459/2006 sponsored by FCT (2007-2010).	
70000€, "Dynamic behaviour of cryogen spray cooling", Project POCTI/EME/57944/2004 sponsored by FCT (2005-2008).	
60000€, "Desenvolvimento da técnica de quimiluminiscência para a detecção directa da composição de misturas de combustíveis em chamas laminares.	
FCT- PDTC/EME/-MFE/68830/2006	
55000€, "Chamas incidentes-modelação matemática e experimental do seu comportamento instável", FCT-PDTC/EME-NFE/68829/2006	
198.649.35€, "Aether" Aero-acoustical and thermo-acoustical coupling in energy processes", Marie Curie Program MRTN-CT-2006-035713	
88500€, An innovative approach of integrated wildland fire management regulating the wildfire problem by the wise use of fire: solving the Fire Paradox - FP6-018505 (2006 2010)	

Objectives & Achievements	
Objectives	
<p>The core goal of fundamental research is the innovation of new engineering concepts and is addressed as a driving force for new technologies. Fundamental research builds the scientific knowledge necessary to give function a sustainable and human-oriented form, thus harmonizing technology with the environment, at the same time that application studies chase the functionality of advanced technologies and their results (products and services) from a user perspective. In this context, research at the Laboratory of Thermofluids, Combustion and Energy Systems Design is aimed at improving knowledge in advanced fields of strategic technologies with emphasis on principles of thermodynamic transport phenomena. The final goal is to bring together multidisciplinary knowledge to develop new procedures and technologies, as well as to carry out research to gain the fundamental knowledge needed to solve new problems in the topic of system conversion energy.</p> <p>The work essential covers the system optimization of input/output of energy and pollutant, ranging from large scale units to micro-systems with special emphasis on lean burning processes (for NOx control), ignition and instabilities aspects of flames, fundamentals of fluid atomization, enhanced heat transfer processes, and experimental and physical modelling of forest fire phenomena, covering interdisciplinary scientific fields, such as Thermal-fluid-dynamics, Combustion and Advanced Techniques for Flow Measurements, Control Engineering, Materials Engineering, Transport and Thermophysical Properties of Materials, Electronics and Microsystems.</p> <p>The activities are organized on the basis of projects which provide the necessary external funding, namely from national and international funding agencies and/or private companies from which research areas emerge.</p>	

Main Achievements	
<p>The work essential covered the system optimization of input/output of energy and pollutant, ranging from large scale units to more recently micro-systems with special emphasis on lean burning processes (for NOx control), ignition and instabilities aspects of flames, fundamentals of fluid atomization and enhanced heat transfer processes, covering interdisciplinary scientific fields. In general the main achievements can be resumed as</p> <ul style="list-style-type: none"> -International collaborative research – e.g. University of Rome, Belgrade, Imperial College of Science and Technology, Institute of Physics and Mathematics-Russia, and a large consortium (over 50 institutions) on forest fire research -Publications in high score ranking journals and book chapters -Active participation in large international symposia -Invitation for keynote lectures 	

Group Productivity	
Publications in peer review Journals	
<p>"A real-time assessment of measurement uncertainty in the experimental characterization of sprays", M. R. Panão, A. L. N. Moreira, Measurement Science and Technology, Volume 19, Number 9, 2008.</p> <p>"On the identification of helical instabilities in a reacting swirling flow", S.I. Shtork, N.F. Vieira, E.C. Fernandes, Fuel, Volume 87, Issues 10-11, August 2008, Pages 2314-2321</p>	
Other publications International	
<p>"Friction losses and heat transfer in laminar microchannel single-phase liquid flow", V. Silverio, A.L.N. Moreira, 6th International Conference on Nanochannels, Microchannels and Minichannels, Darmstadt, Germany, July 2008.</p> <p>"Pressure Drop and Heat Convection in Single-Phase Fully-Developed Laminar Flow in Microchannels of Diverse Cross-section", V. Silverio, A. L. N. Moreira, EUROTHERM 5th European Thermal-sciences Conference, Eindhoven, Netherlands, May 2008.</p>	

Group Productivity

"Secondary atomization characteristics in intermittent spray cooling", M. R. O. Panão, A. L. N. Moreira, 22nd Annual Conference on Liquid Atomization and Spray Systems, Como, Italy, 07th - 10th September 2008.

"Multijet atomization for spray cooling applications", M. R. O. Panão, J. L. C. V. Rosa, A. L. N. Moreira, 22nd Annual Conference on Liquid Atomization and Spray Systems, Como, Italy, 07th - 10th September 2008.

"Direct-Contact-Intermittent-Spray-Cooling for Thermal Management of a Computer Processor", Tiago H. Moita, Marcelino B. dos Santos and António L. N. Moreira, 22nd Annual Conference on Liquid Atomization and Spray Systems, Como, Italy, 07th - 10th September 2008.

"Simultaneous PDA and wall heat flux measurements to develop a dynamic heat transfer correlation for fuel-spray impingement in port-fuel injection systems", M.R.O. Panão, D. F. G. Durão, A.L.N. Moreira, 14th International Symposium on Applications of Laser Techniques to Fluid Mechanics, Lisbon 07-10 July, 2008.

"Development of an empirical correlation to predict secondary atomization of impacting boiling droplets", A. S. Moita, A. L. N. Moreira, 14th International Symposium on Applications of Laser Techniques to Fluid Mechanics, Lisbon 07-10 July, 2008.

"Boiling morphology and heat removal of impinging coolant droplets", A. S. Moita, A. L. N. Moreira, 22nd Annual Conference on Liquid Atomization and Spray Systems, Como, Italy, 07th - 10th September 2008.

"Experimental Study of a Double-Diffusive System: Application to Solar Ponds" Célia F. Tavares¹, David Castro Alves¹, João M.P Coelho¹, Manuel Abreu¹, António M. Joyce¹, Edgar C. Fernandes, , 14th Int. Symp on Appl. Laser Techniques to Fluid Mechanics, Lisbon, Portugal, July 07 – 10, 2008

"Acoustic transfer function of a group of laminar flames", Leitão, I. V., Fernandes, E.C., 14th Int. Symp on Appl. Laser Techniques to Fluid Mechanics, Lisbon, Portugal, July 07 – 10, 2008

Mendes-Lopes J M C , Ventura J M P, and N.M.G. Santos N M G: " Mutual influence between surface fire propagation and a tree trunk", Forest Fires 2008 - International Conference on Modelling, Monitoring and Management of Forest Fires, pp. 131 141, 17 19 September, 2008, Toledo, Spain

Master and Ph.D. thesis completed

Ph.D. thesis:

"Experiments on impinging intermittent sprays", M. R. O Panão.

Master thesis:

"Avaliação do desenvolvimento de sistemas avançados de arrefecimento para microelectrónica", Tiago H. Moita (co-supervision).

"Experimental study off the heat transfer phenomena during the impact of boiling droplets", Matteo Morais (co-supervision).

"Improvement of the stable limits and primary air entrainment in a single burner of a domestic water heater unit", Gonçalo Nuno de Oliveira Duarte, Master thesis in Mech Eng. IST-2008

"Spectrum analysis of flames chemiluminescence", Filipa Maria Sereno Ferro, master Thesis in Technological Physics, IST

"Resolving non-stationary flame propagation toward a wall using PIV for the determination of flame stretch correlations", Ilídio Silvestre Guerreiro, Master in Mech Eng, IST-2008

Organization of conferences

Organization of the 4th International Symposium on Applications of Laser Techniques to Fluid Mechanics, Lisbon 07-10 July, 2008.

Internationalization

THT – Thermo-Fluidmechanics and Heat Transfer Research Group from Bergamo University,

University of Rome Tor Vergata – Department of Enterprise Engineering

Technical University of Darmstadt - SLA (Fachgebiet Strömungslehre und Aerodynamik) and Center of Smart Interfaces.

"Aether" Aero-acoustical and thermo-acoustical coupling in energy processes", Marie Curie Program MRTN-CT-2006-035713

Future Research

Objectives

The present knowledge on thermodynamic transport phenomena, with special emphasis on thermoacoustic oscillations, of lean flames for low pollutant emission technology , liquid droplet formation (sprays technology) and heat transfer phenomena should now be directed towards the micro systems of distributed energy systems (mini-micro flames and combustion chambers with application for example in fuel cells), mini spray cooling technologies and heat transfer of micro devices with application to electronic devices cooling systems. The transfer of knowledge into these Microsystems is not a linear process, since fluid mechanic processes are changed, boundary conditions becomes of the same order of magnitude of the process itself and the size of the systems required a special adaptation of the laboratory non-intrusive techniques (specially based on light emission and sound waves) need to be made. The objective is to improve fundamental knowledge and establish/reinforce international collaborative work in these new areas while contributing to the Industry in these topics. In addition the topic of biomass combustion will be addressed with a collaborative research with the Technical University of Luella/Sweden.

Research on forest fire phenomena will continue mainly in two axes: creating a reliable database on flame propagation in forest fire fuel complexes, and physical modelling.

Funding, source, dates

Future Research

70000€, "Advanced Intermittent Spray Cooling Systems", Project PTDC/EME-MFE/69459/2006 sponsored by FCT (2007-2010).

60000€, "Desenvolvimento da técnica de quimiluminiscência para a detecção directa da composição de misturas de combustíveis em chamas laminares.

FCT- PDTC/EME/-MFE/68830/2006

55000€, "Chamas incidentes-modelação matemática e experimental do seu comportamento instável"

FCT-PDTC/EME-NFE/68829/2006

198649.35€, "Aether" Aero-acoustical and thermo-acoustical coupling in energy processes", Marie Curie Program MRTN-CT-2006-035713

88500€, An innovative approach of integrated wildland fire management regulating the wildfire problem by the wise use of fire: solving the Fire Paradox - FP6-018505 (2006 2010)

Pending funding:

"Fundamental Studies on MULTIJET Spray Technology – MUST", Project PTDC/EME-MFE/099040/2008.

"MICRA - Fenómenos de Transporte em Micro Tubos" (Transport Phenomena in Micro-Channels) - PTDC/EME-MFE/099749/2008.

"IDEAL_CS - Projecto Integrado de Sistemas Avançados de Arrefecimento a Líquido" (Integrated Design of Advanced Liquid Cooling Systems) - PTDC/EME-MFE/104005/2008.

19000€, Pilot burner ignition tests, Bosch/IST Research projects

16000€, LowNox Non-Premixed Flame, Bosch/IST Research projects

73000€, Non-Intrusive Detection of Equivalence Ratio in a Flame, Bosch/IST Research projects

Group Description	
Title of Research Group:	(RG-LVT-Lisboa-750009-3585) Laboratory of Technology Policy and Management of Technology, at IN+ Center for Innovation, Technology and Policy Research
Principal Investigator:	Rui Miguel Loureiro Nobre Baptista
Main Scientific Domain:	Economia e Gestão
Group Host Institution:	Instituto Superior Técnico - Universidade Técnica de Lisboa

Funding, source, dates	
Funding, source, dates	
€110.000-“Universidades e Criação de Empresas”, PTDC/ESC/71125/2006; FCT, 01/01/08.	
€ 199.074-“Diversificação”, PTDC/GES/71174/2006; FCT, 01/09/07.	
€ 510.715-“Mudança Tec. e Inovação”, CMU-PT/0014/2007; FCT, 01/01/07.	
€ 135.090-“VPE - VECTOR E”, 130/7.2/ADI/LVT; IST/AI, 01/01/07.	
€ 12.000 - “IECER” - 01/06/2008	

Objectives & Achievements

Objectives

The main objectives of the “Technology Policy and Management of Technology” Laboratory are:

- To develop and use advanced research methodologies for the analysis of techno-economic systems;
- To promote the exchange of knowledge in advanced technologies and the management of technology and innovation for the optimization of industrial

processes, as a way to promote competitive advantages at the corporate level;

- To derive science and technology policies, and innovation and entrepreneurship strategies leading to socio-economic development.

The emphasis on innovation and entrepreneurship draws on recent conceptual approaches to economic growth in which the accumulation of knowledge and entrepreneurial activity are the fundamental driving forces behind growth. This fact is reflected in the trend in developed economies towards an increasing investment in advanced technology and the development of entrepreneurial capabilities. Concepts such as learning ability, creativity, and entrepreneurial human capital gain greater importance as guiding principles for the conduct of individuals, institutions, nations and regions. The research carried out focuses on a variety of issues surrounding the creation and diffusion of knowledge as well as of human capital capable of learning and developing commercial applications for that knowledge. These issues include:

- Systems and Policies for Knowledge Creation, Diffusion and Usage;
- Higher Education Policy and Management;
- The Learning Economy;
- Technology and Economic Inequality;
- The impact of Entrepreneurship on Regional and National Economic Development;
- Innovation and Firm Productivity;
- Technology Management and Collaborative Innovation;
- Education, Human Capital and Entrepreneurship;
- Globalization, Diversification and Technology Capacity in the Auto Parts Sector;
- Mobilizing Information and Communication Technologies: Implications for Regional Development.

Main Achievements

The development of competencies in the areas of entrepreneurship, and science, technology and innovation policy has been carried out successfully according to the following main lines of development:

i) The promotion of master degree programs in “Engineering Policy and Management of Technology” (from 1998) and in “Engineering Design” (from 2002), with the aims of training young engineering graduates in new areas of education, and promote new links with Portuguese companies;

ii) The promotion of a new Ph.D. program in technological change and entrepreneurship (from 2007), developed jointly with Carnegie Mellon University (and leading to a dual degree by IST and CMU), with the aim of providing advanced training to young researchers, and developing international research projects

involving students and faculty across the Atlantic;

iii) Active participation by faculty and research students in international conferences and workshops, and the organization of the International Conferences on Technology Policy and Innovation, which were launched in July 1997 and are carried out in close collaboration with a number of leading research groups

worldwide.

iv) Activities promoting technology-based entrepreneurship through extra-mural programs of entrepreneurship education and new venture development, such as the VECTORE program, which has led to several technology-based start-ups.

The Laboratory has obtained funding for the development of research projects in a variety of fields related with its main objectives, including:

- Technological change and economic development;

Objectives & Achievements

- Education and Entrepreneurial Human Capital;
- Higher Education Policies;
- Universities and Technology-based Entrepreneurship;
- Innovation and Firm Productivity;
- Diversification and Entrepreneurial Entry by Small Firms.

Group Productivity

Publications in peer review Journals

Baptista, R., V. Escária, and P. Madruga "Entrepreneurship, Regional Development and Job Creation: the Case of Portugal", *Small Business Economics*, 30(1): 49-58, 2008. (online version 2007). (IF=1.168) (Nr. C=0).

Other publications International

Amaral, A.M., R. Baptista, and F. Lima (2008). Entrepreneurial Exit and Firm Performance. *Frontiers of Entrepreneurship Research*. Wellesley, MA: Babson College, pp. 123-137.

Baptista, R., F. Lima and M.T. Preto (2008). Is there a Labor Market 'Penalty' to Entrepreneurship?, in George T. Solomon (Ed.), *Proceedings of the Sixty-Seventh Annual Meeting of the Academy of Management*, ISSN 0896-7911.

Faria, P. and Sofka, W. "Formal and Strategic Appropriability Strategies of Multinational Firms – A Cross Country Comparison" ZEW Discussion Paper n°. 08-030 <http://www.zew.de/en/publikationen/publikation.php3?action=detail&nr=4387>.

Leitão, J. (2008). 'The Taylor Effect on the Performance of the Red Devils' Football Brand', In Helmut D.; E. Franck; and H. Kempf (Eds.), *Football – Economics of a Passion*. Hofmann-Verlag, Sportökonomie, 10: 289-307. ISBN: 978-3-7780-8370-3.

Leitão, J. (2008). 'Open Innovation Clusters: The Case of Cova da Beira Region (Portugal)', In Gopalakrishnan, P. (Ed.) *Open Innovation: The New Business Strategy*, ICAFI Books, ICAFI University Press, India: 173-187. ISBN: 978-81-314-2083-6.

Master and Ph.D. thesis completed

Pedro Faria (2008). "Knowledge Management and Innovation: Firm Level Evidence from Portugal" Ph.D. Thesis, Mimeo, Universidade Técnica de Lisboa - Instituto Superior Técnico.

Internationalization

REE - Europe, Roundtable on Entrepreneurship Education;

CLUSTER--Consortium Linking Universities of Science and Technology for Education and Research - Taskforce on Entrepreneurship & Innovation;

IPREG - Institute for Policy Research in Entrepreneurship and Growth;

UTEN - University Technology Enterprise Network, partnership UT-Austin-Portugal;

CINDA - Centro Interuniversitario de Desarrollo (Santiago de Chile), Research Project, with diverse European and South-American universities, aimed at designing a model for evaluating university-based start-ups.

Carnegie Mellon University / Portugal - Doctoral dual degree program in Technological Change and Innovation

Future Research

Objectives

The Laboratory of Technology Policy and Management of Technology at IN+ plans to pursue the development of the main research lines it has established and solidified over the last few years. In particular, two principal lines of development are to be pursued:

i) The development of research in entrepreneurship, technological change and higher education, leading to new insights for practitioners and policy makers in science, technology, industry and higher education, and aiming to contribute to economic development, competitiveness and employment growth.

ii) The development of activities promoting technology commercialization and technology-based entrepreneurship in a university environment, through entrepreneurship and technology transfer training, and new venture development.

Concerning the first line of development, research in a variety of topics, using diverse methodologies, is to be pursued. Some of the topics to be addressed are the continuation of already successful research streams, while other represent new challenges:

- Systems and Policies for Knowledge Creation, Diffusion and Usage;
- Higher Education Policy and Management;
- The Learning Economy;
- The impact of Entrepreneurship on Regional and National Economic Development;
- Innovation and Firm Productivity;
- Technology Management and Collaborative Innovation;
- Education, Human Capital and Entrepreneurship;
- Spin-offs and the Pre-history of Entrepreneurs: analysis of specific forms of entrepreneurial human capital;
- The Post-history of Entrepreneurs: entrepreneurial experience and the internal labor markets of the firm;
- Universities and New Firm Creation: geographical proximity and technology-based entrepreneurship;
- Entrepreneurial Exit and Habitual Entrepreneurship.

Concerning the second line of development, the VECTORE program will remain a cornerstone of entrepreneurship training and new venture development in Lisbon, and new programs will be developed focusing on specific technologies in energy, the environment, ICTs, and

Future Research

bio-engineering.

Funding, source, dates

€ 200.000,00 – “Capital Humano, Carreiras Empreendedoras e Novas Empresas de Base Tecnológica”, CMU-PT/Etech/0036/2008; Date 01/04/2009

Group Description	
Title of Research Group:	(RG-LVT-Lisboa-750009-3589) Centre of Mineral Resources, Mineralogy and Crystallography of the Faculty of Science of Lisbon University (CREMINER)
Principal Investigator:	Fernando José Arraiano de Sousa Barriga
Main Scientific Domain:	Ciências da Terra e do Espaço
Group Host Institution:	Fundação da Faculdade de Ciências - Faculdade de Ciências da Universidade de Lisboa

Funding, source, dates	
Funding, source, dates	
The main sources of funding for the RG (2008) have been provided by FCT, as i) Pluriannual funding (in the global amount of € 55000) ii) 2008 - 64 research projects (totalling € 54036) Contracts with industry, extremely significant as achievements, were another source of funding (€ 78811.30).	

Objectives & Achievements	
Objectives	
<p>Creminer is devoted to research and development in Earth and Space Sciences related to geochemical systems and to the genesis, evolution and use of crustal resources, from land and the ocean floors, with emphasis in fluid-rock interaction processes and Mineralogy and Crystallography and their applications, including environmental management. therefore Our RG will continue with the present objectives as very high priorities. Natural resources are presently subjected to extremely high demand, related mainly to expansion of emerging economies, namely those of the "sleeping giants". Studying the sea floor are growing, related to a large effort in re-equipment of the national research institutions, designed for marine studies. Among the infrastructures under the responsibility of Creminer RG we wish to mention the Stable Isotope Laboratory, the Mobile Lab and AmbiTerra. Other relevant facilities include a new electron microprobe microanalyser and reequipment of other units, both within and outside our Associate Laboratory. We will soon have access to ships equipped for earth science research, with multi-beam bathymetry, multi-channel seismics and specialised vehicles and samplers such as AUVs, ROV's and TV Grabs. Scientific subjects to be developed by the Creminer RG in the next few years include i) Geology of the Deep Biosphere, ii) The Carbon Cycle and CO2 Sequestration and iii) Forensic Geology like geoarchaeology, where the expertise of natural sciences can relate with social requirements to produce conclusive evidence, capable proving (or disproving) involvement and/or responsibility in crimes. Our expertise in soil science and our ability to analyse low temperature rocks and soils for nutrients and pollutants shall contribute to find essential links between the deep biosphere and rock evolution, from soft sediments to hard rock. The Carbon Cycle and CO2 Sequestration is self explanatory on the inevitability of widespread use of fossil fuels for decades to come. An efficient CO2 sequestration will imply the confinement of CO2 produced in large industrial facilities, the refinement of sequestration models and the identification of suitable geological formations in order to avoid an unbearable environmental cost</p>	

Main Achievements	
<p>The group has achieved internationally recognized success with its studies on ore-forming processes on land. These include different types of mineralization, with emphasis on the Iberian Pyrite Belt. The studies on the world-class Neves Corvo deposit, in particular, projected the name of the RG throughout the world as have led to several publications. The prominent and breakthrough activity in this research field, had won for this group the inclusion of two members among the co-proponents of IODP Proposal 584: TAG II, and attracted the interest for collaborative research of one of the world leading companies in oceanic exploration for metallic resources. achieved internationally recognized success with its studies on ore-forming processes on land. These include different types of mineralization, with emphasis on the Iberian Pyrite Belt. The studies on the world-class Neves Corvo deposit. We have also succeeded in terms of reaching recognition in experimental and geochemical modeling of low-temperature processes related with environmental impacts due to heavy metal contamination in landfills and old mining areas. A laboratory devoted to experiments of metal adsorption kinetics onto mineral surfaces was fully equipped and installed at FCUL. Some of these studies have led to management recommendations to national governmental organisms, and justified invited publications in international books and industries such as construction companies requested our consultants services and recruit our labs to perform analyses</p>	

Group Productivity	
Publications in peer review Journals	
<p>Dias Á S, Mills R A Taylor R N, Ferreira, P and Barriga, F J A S , (2008). Geochemistry of a sediment push-core from the Lucky Strike hydrothermal field, Mid-Atlantic Ridge. <i>Chemical Geology</i>, 247(3-4): 339-351. doi:10.1016/j.chemgeo.2007.10.015.</p> <p>Fonseca, R., Barriga, F.J.A.S., Conceição, P.– Clay minerals in sediments of Portuguese reservoirs and their significance as weathering products from over-eroded soils. Comparative study of the Maranhão, Monte Novo and Divor Reservoirs (South Portugal). Accepted for publication in <i>International Journal of Earth Sciences</i>.</p> <p>Gaspar M., Knaack C., Meinert L.D., and Moretti, R., 2008, REE in skarn systems: A LA-ICP-MS study of garnets from the Crown Jewel gold deposit: <i>Geochimica et Cosmochimica Acta</i>, v. 72, p. 185-205.</p> <p>Huston, D, Relvas, JMRS, Gemmell, B, Driberg, S (2008) The role of granites in volcanic-hosted massive sulphide ore-forming systems: an assessment of magmatic-hydrothermal contributions to the ores (invited paper; submitted to <i>Mineralium Deposita</i>)</p> <p>Inverno, C.M.C., Solomon, M., Barton, M., and Foden, J., 2008, The Cu-stockwork and massive sulfide ore of Feitais, Aljustrel, Iberian Pyrite Belt, Portugal: a mineralogical, fluid inclusion, and isotopic investigation: <i>Economic Geology</i>, v. 103(1), p. 241-267.</p> <p>López-Pérez, R.; Alvarez-Valero, A.M.; Nieto, J.M.; Sáez, R.; Matos, J.X. (in press) Use of sequential extraction procedure for assessing the environmental impact at regional scale of the São Domingos Mine (Iberian Pyrite Belt). <i>Applied Geochemistry</i>, Elsevier Ed., 12pp.</p> <p>Marques AFA, Scott SD, Gorton M, Barriga, FJAS, Fouquet, Y (2009). Pre-eruption history of enriched MORB basalts from the Lucky Strike and Menez Gwen areas, Mid-Atlantic Ridge (37°05'N). in press <i>LITHOS</i> a volume in tribute to Roger Hekinian, 10.1016/j.lithos. 2009.05.026</p> <p>Mateus, A.; Pinto, A.; Alves, L.C.; Matos, J.X.; Figueiras, J.; Neng, N. (in press) Roman and modern slag at S. Domingos mine (IPB, Portugal): compositional features and implications for their long-term stability and potential re-use. <i>International Journal of Environment and Waste Management</i> Inderscience Publishers Ltd, 39pp.</p>	

Group Productivity

Miranda, R. Valadares V., Terrinha P., Mata J., Azevedo M.R., Gaspar M., Kullberg JC, Ribeiro C, Age constraints on the Late Cretaceous alkaline magmatism on the West Iberian Margin, Cretaceous Research, In Press, DOI: 10.1016/j.cretres.2008.11.002.

Ribeiro da Costa I., Barriga F.J.A.S., Viti C., Mellini M., Wicks F.J. (2008) – Antigorite in deformed serpentinites from the Mid-Atlantic Ridge. *Eur. J. Mineral.*, 20: 563-572.

Ribeiro da Costa I., Barriga, F.J.A.S., Taylor, R.T. (2008) – Late seafloor carbonate precipitation in serpentinites from the Rainbow and Saldanha sites (Mid-Atlantic Ridge). *Eur. J. Mineral.*, 20: 173-181.

Rosa CJP, McPhie J, Relvas JMRS, Pereira, Z, Oliveiras, T., Pacheco, N, 2008. Volcanic facies architecture hosting the Neves Corvo VHMS deposit, Iberian Pyrite Belt, Portugal. *Mineralium Deposita*, 43: 449-466.

Rosa R.N., e Rosa D., 2008, “Exergy cost of the extraction of mineral resources”, *International Journal of Exergy*, 5, 532-555.

Rosa, CJP, McPhie, J, Relvas JMRS, Rosa DRN (2008) Type of volcanoes hosting the massive sulphide deposits of the Iberian Pyrite Belt (submitted to *Journal of Volcanology and Geothermal Research*)

Rosa, D.R.N., Finch, A.A., Andersen, T., and Inverno, C.M.C., 2008, U-Pb geochronology of felsic volcanic rocks hosted in the Gafo Formation, South Portuguese Zone: The relationship with Iberian Pyrite Belt magmatism: *Mineralogical Magazine*, v. 72(5), p. 1103-1118.

Rosa, D.R.N., Finch, A.A., Andersen, T., and Inverno, C.M.C., 2009 (online 2008) U-Pb geochronology and Hf isotope ratios of magmatic zircons from the Iberian Pyrite Belt: *Mineralogy and Petrology*, v. 95 (1-2), p. 47-69.

Silva, E.A.F.; Bobos, I.; Matos, J.X.; Patinha, C.; Reis, A.P.; Fonseca, E.C. (in press) Mineralogy and geochemistry of trace metals and REE in volcanic massive sulfide host rocks, stream sediments, stream waters and acid mine drainage from the Lousal mine area (Iberian Pyrite Belt, Portugal). *Applied Geochemistry*, Elsevier Ed., 18pp.

Theodoro, S.H.; Leonardos, O.H.; Rocha, E.; Macedo, I.; Fonseca, R. (in press) - Geochemistry of sediments, soil remineralization and agroforestry in Amazon: the way toward the reintegration of the natural sciences. *SciELO, Revista da Academia Brasileira de Ciências*. RJ (no prelo)

Other publications International

Barriga, F.J.A.S., Fonseca, R., Canário, T.; Morais, M. (2008) - Interações entre os sedimentos e a água na dinâmica de elementos metálicos nas albufeiras de Três Marias (Minas Gerais) e Tucuruí (Pará), Brasil. Livro de Resumos do IX Congresso de Geoquímica dos Países de Língua Portuguesa, Universidade de Cabo Verde/ Universidade de Aveiro, Praia (Cabo Verde), 15 a 20 de Março de 2008, pp.49.

Fernandes P, Jorge RCGS, Pereira Z & Oliveira JT (2008) Geochemistry of the Baixo Alentejo Flysch Group, South Portuguese Zone: Implications for provenance and palaeoweathering. *Geochimica et Cosmochimica Acta* 72 (12): A264, Suppl. 1

Fernandes P, Jorge RCGS, Pereira Z, Oliveira JT (2008) Caracterização geoquímica do Grupo do Flysch do Baixo Alentejo (Zona Sul Portuguesa): resultados preliminares, in IX Congresso de Geoquímica dos Países de Língua Portuguesa. Coord. Silva E, Azevedo M, Santos F, Patinha C, Reis A. Praia, Santiago, Cabo Verde: 103

Fonseca, R. & Barriga, F.J.A.S., Canário, T.; Morais, M. (2008) - Relações entre a geoquímica e mineralogia dos sedimentos e os fluxos de fósforo em albufeiras tropicais. Livro de Resumos do IX Congresso de Geoquímica dos Países de Língua Portuguesa, Universidade de Cabo Verde/ Universidade de Aveiro, Praia (Cabo Verde), 15 a 20 de Março de 2008, pp.48.

Fonseca, R., Barriga, F.J.A.S., Canário, T., Theodoro, S. (aceite para publicação em 2008). Mineralogy and geochemistry of Brazilian reservoir sediments: an approach to the green revolution in tropical environments. *Proceedings of the Second International Workshop “Rocks for Crops”*, Nairobi e Kisumu, Quênia.

Gaspar, M, Relvas, JMRS, Carvalho, J., Larson, P, Hart, G, Pinto, A, Pacheco, N, Noiva, PC, Barriga, G, Santos, P (2008). Cu isotopic variation in the Neves-Corvo deposit, Iberian Pyrite Belt. *Goldschmidt Conference Abstracts 2008*, A299.

Inverno, C. M.C., Ferraz, P., Moreira, M^a Eugénia, Argemela, a high-tonnage Sn-Li deposit in central Portugal: Resumo submetido ao Annual Meeting da Geological Society of America, em Portland, Oregon, EUA, em Out. 2009.

Leonardos, O.H.; Theodoro, S.; Oliveira, D.; Fonseca, R. & Barriga, F.J.A.S. (aceite para publicação em 2008). Nutrient assessment of dam sediments in the Amazon for using in local subsistence agriculture: the case of Tucuruí. *Proceedings do Second International Workshop “Rocks for Crops”*, Nairobi e Kisumu, Quênia

Luís, A.T.; Teixeira, P.; Almeida, S.F.P.; Ector, L.; Matos, J.X.; Silva, E.A.F. (2008) Impact of Acid Mine Drainage (AMD) on water quality, stream sediments and on periphytic diatom communities in the surrounding streams of Aljustrel mining area (Portugal). *Editorial Manager (tm) for Water, Air, & Soil Pollution*, DOI 10.1007/s11270-008-9900-z, 21pp.

Marques AFA, Scott, SD, Relvas, JMRS, Rosa, CJP, Barriga, FJAS (2008) Sn and Cu in melt inclusions of the Albernoa felsic volcanic centre, Iberian Pyrite Belt, Portugal: seeking the missing (magmatic) link. *Geophysical Research Abstracts*, Vol. 10, EGU2008-A-00000, 2008, EGU General Assembly 2008.

Matos, J.X.; Martins, L.P.; Oliveira, J.T.; Pereira, Z.; Batista, M.J.; Quental, L. (2008) Rota da pirite no sector português da Faixa Piritosa Ibérica, desafios para um desenvolvimento sustentado do turismo geológico e mineiro. *Projecto RUMYS, programa CYTED, Livro Rutas Minerales en Iberoamérica*, Ed. Paul Carrion, Esc. Sup. Politécnica del Litoral, Guayaquil, Equador, pp 136-155.

Relvas, JMRS, Povoas, L, Costa, T, Matos, J, Varela, T, Lopes, C, Barriga, FJAS, 2008. Project “Underground Visit to the Lousal Mine”: rehabilitation of a closed mine in the Iberian Pyrite Belt towards sustainable development and preservation of mining heritage. *PROGEO Special Volume* (submitted).

Rosa C., and Relvas JMRS. (2008c) Cartografia de fácies vulcânicas aplicada à prospecção de recursos minerais. In: Silva Gomes J.F. et al., (Eds.), *Proceedings CLME'2008/IICEM*, 12R009 (ISBN: 978-972-8826-20-8).

Rosa C., McPhie J., Relvas JMRS. (2008b). Lava-cryptodome-pumice cone volcanoes in the Iberian Pyrite Belt. In: *IAVCEI General assembly 2008*, Reykjavik, Iceland, Abstracts, p73.

Rosa C., Relvas JMRS., McPhie J., Pereira Z., Oliveira T., Pacheco N., Barriga F. (2008a). Volcanic facies architecture, hydrothermal alteration and subsea-floor replacement at the Neves Corvo deposit, Iberian Pyrite Belt. In: *GAC/MAC joint meeting 2008*, Quebec City, Canada, Abstracts 33, 147.

Salgueiro, R., Inverno, C., e Mateus, A., (aceite), Principais características e génese do skarn de Vale de Paês (Cuba-Vidigueira, Zona de Ossa Morena): Resumo Alargado submetido ao VII Congresso Ibérico/ X Congresso Nacional de Geoquímica, em Soria, Espanha, em Set. 2009.

Solomon, M., Inverno, C., Walshe, J., Pacheco, N., Noiva, P.C., Barriga, G., (aceite), Mantle (?) volatiles in the Lombador orebody, Neves Corvo, Portugal: Resumo Alargado submetido ao 10th Biennial SGA Meeting, em Townsville, Queensland, Austrália, em Ag. 2009.

Solomon, M., Inverno, C.M.C., Pacheco, N., Noiva, P.C., Barriga, G., Ferreira, A., and Gaspar, O.C., 2008, The Neves Corvo (Portugal) massive sulphide deposit: depositional instability in the Lombador lens, and the origin of sulphur: *Proceedings of 19th Australian Earth Science*

Group Productivity

Convention.

Other publications National

Mateus, A., Munhá, J., Inverno, C.M.C., Matos, J.X., Martins, L., Oliveira, D., Jesus, A., e Salgueiro, R., (submetido), Mineralizações na Zona de Ossa Morena (capítulo), in Dias, R., Araújo, A.A., Terrinha, P., e Kullberg, J.C., eds., Geologia de Portugal no contexto da Ibéria, 2ª edição: Évora, Universidade de Évora.

Salgueiro, R., Mateus, A., e Inverno, C., 2008, Origem e principais características da mineralização de magnetite e sulfuretos em Monges (Montemor-o-Novo, Zona de Ossa Morena): V Seminário de Recursos Geológicos, Ambiente e Ordenamento do Território, Vila Real, UTAD, Out. 2008, p. 161-169 (Resumo Alargado).

Master and Ph.D. thesis completed

Supervision of MSc and PhD Theses:

Marcus Manoel Fernandes, 2008, "Viabilidade económica do uso do rejeito do distrito gemológico de Arucaí, na agricultura regional", PhD thesis, Universidade Federal de Minas Gerais, Brasil (co-supervisor RMFF)

Cláudia Sofia Lola Simões, 2008, "Variabilidade temporal de nutrientes numa albufeira de clima tropical de savana (Albufeira de Três Marias, Minas Gerais, Brasil). MSc Thesis, Universidade de Évora (supervisor RMFF)

Additionally, during 2008 two PhD theses (Agata Dias, supervised by FJASB and Paulo Bravo Silva, co-supervised by JMFR) and one MSc thesis (Tiago Canario, supervised by RMFF) were in their final phases of preparation. Tiago Canario and Agata Dias defended their theses in April and July 2009, respectively.

Organization of conferences

10th Biennial Meeting of the Society for Geology Applied to Mineral Deposits (SGA), 17- 20 de Agosto de 2009, Townsville, Australia (Student Support Committee)

Congress "Minas de Além Tejo", organized by Fundação Frederic Velge, Lousal, Portugal; Junho, 2008.

Eccord Council Lisbon; June 2008

Industry contract research

SOMINCOR - MineTemp

Future Research

Objectives

This group aims to be one of the best in Marine Geology as well as geochemical systems and to the genesis, evolution and use of crustal resources, from land and the ocean floors, with emphasis in fluid-rock interaction processes and Mineralogy and Crystallography and their applications, including environmental management. It is also one of our goals to attract young researchers on Forensic Geology is another field, like geoarchaeology, where the expertise of natural sciences can relate with social requirements to produce conclusive evidence, capable proving (or disproving) involvement and/or responsibility in crimes, that's why we seeking for a post-doctoral researcher .

Exploring our past through the geoarchaeological record is a key example of how hard science can link with culture and contribute to evaluation of the anthropogenic impact on the geochemical cycle of elements and to improve remediation strategies promoting the development of green exploitation practices. The development of engineering systems can and should be rooted in the understanding of natural systems. Sustainable development systems will respect nature and will simultaneously be inspired in natural systems.

The RG has also been active in isotopic studies

Funding, source, dates

FCT- PTDC/CTE-GEX/65789/2001 - (01-01-2008) - €100.000.00 FCT - PTDC/GIN/67027/2006 - (01-09-2007) - €17.500.00 FCT - EUROMARC/0001/2007 - (01-09-2007) - €120.000.00 FCT - PTDC/ENR/70767/2006 - (21-12-2007) - €77.725.00 SOMINCOR - €38.000.00 - CVLOUSAL -€96.000,00

Group Description	
Title of Research Group:	(RL-COMP-750009-133) Robotic Monitoring and Surveillance
Principal Investigator:	Jose Alberto Rosado Santos Victor
Main Scientific Domain:	Engenharia Electrotécnica e Informática

Objectives & Achievements

General Objectives

This Thematic Area handles robotic monitoring & surveillance by autonomous, heterogeneous sensor and robot networks aiming to develop new models, methods, algorithms and systems and demonstrate their use in application scenarios.

These networks can be designed to meet, e.g., the spatial sampling requirements such as the dynamic properties of the observed phenomena, including human activity monitoring and classification. The components must be able to act and reconfigure the network to improve perception resolution and uncertainty, interact with humans or (re-) establish communication links. Autonomy allows for extended unsupervised operation and requires de-centralized decision-making.

Our approach encompasses a hierarchy of problems:

- Single robot navigation, cooperative formation control and decentralized decision making.
- Single sensors (e.g., vision-based activity recognition) vs. cooperative perception coordinated over a network of heterogeneous cameras and mobile robots.
- Sophisticated nodes (e.g. robot assistants) able to interact socially with humans as opposed to simple sensors dispersed in the environment.

Main Achievements

Theme B proposed to develop its research activities around 3 general application areas of public interest illustrating different hierarchical levels or scales when considering the general theme. The R&D achievements include both theoretical contributions and application-relevant results, developed in the context of large-scale international collaborative efforts:

- (i) Search and rescue, field and urban robotics: Theoretical developments on cooperative navigation and mapping using discrete event systems, cooperative perception and decentralized decision making; key contributions to EU Project URUS; development of an experimental platform and middleware (ISRobotNet).
- (ii) Surveillance of urban areas: Methodologies for recognizing human activity from video and calibration of distributed cameras, possibly with different geometries. Probabilistic models of sensor measurements, localization and fusion using POMDPs
- (iii) Cognitive robotic assistant: Study and development of biologically plausible models for modelling object affordances, bridging the gap between low-level sensorimotor loops and high level imitation or plan execution; development of humanoid platforms including the iCub, the most sophisticated humanoid robot worldwide.

An horizontal topic of increasing importance can be generally referred as Modelling of Biological Systems and Biomedical Engineering, which have for a long time been explored in different sub-topics (e.g. in computational neuroscience, modelling of the immune system with discrete even dynamic systems) and has recently been further developed in the domains of biomedical imaging and biomedical signal processing.

In the scope of this last field of research we developed a volume reconstruction system based on ultrasound images (3D ultrasound) as well as algorithms for the reconstruction of the carotid atherosclerotic plaque. We have also developed new denoising algorithms and diagnosis methods using MRI images of the liver, heart, and brain and diagnosis methods for genetic diseases using cytogenic techniques. This was done in collaboration with the Institute of Molecular Medicine and St. Mary Hospital.

Research Line Output

Collaborative Publications in peer review Journals

The research work carried by some of the groups involved in this thematic area is highly multidisciplinary, routinely involving teams from engineering and computer science, neuroscience, psychology, linguistics or social sciences. In spite of their strong multidisciplinary nature, these works are not listed here as formally they do not result from the collaboration of different groups.

Collaborative Other Publications

- International
- M. Spaan, F. Melo, Interaction-Driven Markov Games for Decentralized Multiagent Planning under Uncertainty, AAMAS - 7th Intl. Conf. on Autonomous Agents and Multiagent Systems, Estoril, Portugal, 2008. [VisLab + ISLab]
 - A. Khmelinskii, R. Ventura, J. Sanches, Chromosome Pairing for Karyotyping Purposes using Mutual Information, ISBI - 5th IEEE Intl. Symposium on Biomedical Imaging: From Nano to Macro, Paris, France, 2008. [ISLab + SPLab]
 - A. Khmelinskii, R. Ventura, J. Sanches, Automatic Chromosome Pairing Using Mutual Information, EMBC - 30th Annual Intl. Conf. of the IEEE Engineering in Medicine and Biology Society, Vancouver, Canada, 2008. [ISLab + SPLab]
 - M: Taiana, J. Santos, J. Gaspar, Jacinto Nascimento, A. Bernardino, P. Lima, Color 3D Model-Based Tracking with Arbitrary Projection Models, SIMPAR - Intl. Conf. on Simulation, Modeling and Programming for Autonomous Robots, Workshop on Omnidirectional Robot Vision, Venice, Italy, 2008. [VisLab + SPLab]
 - M. Taiana, J. Nascimento, J. Gaspar and A. Bernardino, Sample-Based 3D Tracking of Colored Objects: A Flexible Architecture, British Machine Vision Conf., BMVC, Leeds, UK, 1-4 Sept. 2008. [VisLab + SPLab]
 - R. Ferreira, J. Xavier, J. P. Costeira, Reconstruction of Isometrically Deformable Flat Surfaces in 3D from Multiple Camera Images, ICASSP - IEEE Intl. Conf. on Acoustics, Speech, and Signal Processing, Taiwan, 2009 [VisLab + SPLab]

Research Line Output

National

- B. Dias, R. Ventura, J. Gaspar, Automatic Transcription of Musical-Whistling: Comparing Pitch Detection Methods, JETC - IV Jornadas de Eng^o Electrónica e Telecomunicações e de Computadores, Lisbon, PT, 2008 [VisLab + ISLab]
- N.Leite, A. Del Bue, J. Gaspar, Calibrating a Network of Cameras Based on Visual Odometry, in JETC, Nov. 2008, Lisbon, PT. [VisLab + SPLab]
- R. Carona, A. Pedro Aguiar, J. Gaspar, Control of Unicycle Type Robots: Tracking, Path Following and Point Stabilization, JETC, Nov. 2008, Lisbon, PT. [VisLab + DSOR]
- A. Khmelinskii, R. Ventura, M. Carmo-Fonseca and J. Sanches, Automatic Pairing of Metaphase Chromosomes with Mutual Information for Karyotyping Purposes, (Poster), FPBC - First Portuguese Forum on Computational Biology, Oeiras, July 2008 [ISLab + SPLab].

Master and PhD thesis completed

- Dario Bacellar, "From Pixels to Objects - Enabling a spatial model for humanoid social robots", MSc. Thesis, Instituto Superior Técnico, Lisbon, Portugal, Oct 2008. [VisLab + ISLab]]

Future Research

Other Information

a) Joint Projects (EU/National)

We will continue the strong involvement of members of this Thematic Area in the European Project URUS - Ubiquitous networking Robotics in Urban Settings [VisLab, MRLab, ISLab], in the areas of distributed perception, distributed decision making, human robot interfaces and gesture recognition. The recently created ISRobotNet, infrastructure will be used as the main testbed for experiments with networked robots and sensors which has provided the basis for the development of novel approaches, algorithms and tests with real platforms, including its use by our international partners.

Under this thematic area we have pursued an active approach concerning the participation in EU Project proposal:

- One IP project on distributed robots and sensors with an emphasis on social learning has been submitted and selected amongst those invited for a hearing. [VisLab+ISLab+MRLab]
- Another proposal on the use of (robot) facial expressions and non verbal communication for the rehabilitation of stroke patients is also under evaluation. [VisLab+ISLab]
- A third proposal on the topic of Brain-computer interfaces based on learning technology inspired in biology and investigated in the context of humanoid robotics was submitted and is pending evaluation. [VisLab+SPLab]

Part of the work in networked robots and sensors has been developed together with the Energy group of IN+ and the Thematic Area C, in the context of a project with Galp Energia.

b) Joint organization of workshops

At the 7th Int. Conf. on Autonomous Agents and Multi-Agent Systems (AAMAS'08), a workshop on Formal Models and Methods for Multi-Robot Systems was organized by members of the Thematic Area [ISLab+MRLab]. Given that an increasing number of researchers worldwide are becoming interested in developing formal models and methods for multi-robot systems, the workshop provided a forum for exchanging ideas on multi-robot system analysis (e.g., formal verification, performance quantification) and design from specifications. Such formal techniques can benefit many problems in multi-robot systems, such as motion coordination, task planning, and sensor fusion. [VisLab+ISLab]

c) Restructuration of ISR Groups

The merge during 2009 of the ISLab and MRLab will consolidate the long lasting collaboration of those labs and the existence of common research topics. Amongst other reasons, this tighter collaboration has been strengthened over the years by the joint work and projects within this thematic area.

d) Future hiring needs

The possibility of hiring a new researcher, particularly in the domain of video surveillance, is hampering a stronger development of that area and has been dependent on the evaluation of the LA which has been postponed since 2006.

Future Plans

The plan for 2009 will focus on the development and continuation of the current research activities and a consolidation of the cross-fertilization between the research activities of the different groups. The involvement in large (international) projects has been found as a critical element not only to foster the collaborative work between different groups but also to target more ambitious problems and promote the visibility of the groups and of the Associated Lab.

We will extend the work in search and rescue to field robotics activities and applications, notwithstanding their relevance for society, and potential for innovative results on unstructured environments, blending sound theory and technological developments. The involvement in ITER Remote Handling activities will continue, extending the past contributions of the group, among them the design of the current reference model for ITER cask transportation systems

In what respects to human activity recognition for surveillance applications, we plan to develop new representations for human motion and activity recognition trying to overcome the limitations of current ones.

The existence of the iCub humanoid robot since the beginning of 2009 will open a new set of possibilities for work and collaboration since the platform allows multidisciplinary work in a variety of topics. Initiatives will be taken to promote the collaboration of the different groups in research initiatives to explore this platform.

We expect to consolidate the activities in the horizontal area of biological systems modelling and biomedical engineering, crossing as well this inspiration in the natural sciences with social sciences, namely psychology, linguistics or exploring the concepts of institutional economics and of the immune system in managing robot collectives and their interaction with humans. We will continue current activities in medical image analysis using ultrasound and MRI images and address two new directions:

Future Research

- Brain and nervous system: diagnosis of Alzheimer's disease and mild cognitive impairment using PET images; identification of sleep disorders and development of models for the autonomic nervous system using control theory.
- Cell analysis based on confocal microscopy in collaboration with Institute of Molecular Medicine.

Group Description	
Title of Research Group:	(RL-MECH-750009-137) Sustainable Technologies and Environmental Systems
Principal Investigator:	Paulo Manuel Cadete Ferrao
Main Scientific Domain:	Engenharia Mecânica
Objectives & Achievements	
General Objectives	
<p>The objective is to engage in multidisciplinary research, in order to develop and evaluate emerging/alternative complex engineering systems that promote sustainability: e.g. secure socio-economic development coupled with environmental quality. Enabling technologies will be developed and assessed under a systems view, covering the use and environmental implications of materials, energy, and products in modern societies. Fulfilling these objectives implies R&D activities such as the analysis of advanced systems, analysis of the global carbon bio-geochemical cycle and of materials flows in the economy, with product and material life cycle management through reuse, remanufacturing, and recycling.</p> <p>Main research areas include:</p> <ul style="list-style-type: none"> •Eco-design for sustainability in industry and domestic applications •Advanced integrated combustion and thermal systems •Total life-cycle energy chain and environmental impact assessment •Carbon cycle •Flows of materials in the economy from raw-materials extraction to final integration in the natural environment •Techno-economic assessment, technological change and systems integration 	
Main Achievements	
<p>The activities developed within this topic were multidisciplinary, linking basic and applied research to technology development, and focused on the issues of sustainability, namely in terms of the needs to secure the quality of the environment, together with the management of energy resources and economic development.</p> <p>In this context, the Laboratory of Environmental Systems has been able to:</p> <ul style="list-style-type: none"> •Promote the development a new PhD Program on Sustainable Energy Systems, in the context of the MIT-Portugal Program •Develop major methodologies and tools that bring together economy and environment in the assessment and the design of new products (Eco-design tools) and new policies (e.g.: National Integrated framework for Residues Management, Hybrid Economic Input-Output-Life Cycle Assessment or Life Cycle Activity Analysis). •Develop a far indicator of environmental pressure, combining consumer and producer responsibility (Rodrigues and Domingos, 2008). •Support entrepreneurial initiatives in Industrial Ecology in Portugal, such as the design of a variety of new companies aimed at recycling and further processing end-of-life products or the design and implementation of an Eco-Industrial park at Chamusca. •Create a network for sustainability in Portuguese agriculture, comprising close to 100 farmers, occupying 0.7% of Portugal, and close to 30 partners, including universities, NGOs and private firms. •Obtain significant results on carbon and water dynamics in forests and grasslands (Granier et al., 2007, Luyssaert, 2007, Pereira et al. 2007). •Provide support to Portuguese public policy on the use of natural carbon sinks. •Develop a formalised theory for organisms (Sousa et al., 2008). 	
Research Line Output	
Collaborative Publications in peer review Journals	
<p>The research conducted within some of the groups of this thematic area is intrinsically highly multidisciplinary, combining e.g. engineering disciplines with natural sciences, economy and management. During 2008 there were no publications formally resulting from the joint work of those groups. However, some of the new activities started during 2008 will reinforce the highly transdisciplinary work, particularly that involving the group of sustainable energy and the research team of CREMINER.</p>	
Collaborative Other Publications	
-	
Master and PhD thesis completed	
<p>As mentioned, while several highly multidisciplinary theses have been completed during 2008, they do not formally result from the joint work of different groups. However, some of the new activities started during 2008 will reinforce the highly transdisciplinary work.</p> <p>With respect to the recently started project involving the group of sustainable energy and the research team of CREMINER there is one new PhD student, Anna Gerbelova, enrolled in the PhD Program in Sustainable Energy systems.</p>	
Future Research	
Other Information	

Future Research

FCT Project on Carbon Capture and Sequestration: it combines the skills in environmental assessment of carbon capture technology with skills on geological survey for sequestration fields in Portugal. It involves researchers from IN+ and CREMINER.

Projects involving teams from the thematic area and thematic areas B and D, concerning energy efficiency in buildings relying on networks of sensors and/or robots able to sense comfort and environmental parameters that can then be used to optimally regulate the energy consumption levels. [IN+ + ISR]

Future Plans

A major line of research is, building on the strong interdisciplinarity of ISR-LA, the exploration of formal analogies between different fields in the natural, social and engineering sciences:

- The analogy between Thermodynamics, Microeconomics, Evolution and Engineering Optimisation, built on their common use of constrained optimization formalisms.
- The analogy between ecosystems and industrial systems, based on mass and energy flows, under the heading of Industrial Ecology.
- The analogy between organisms and industrial and urban systems, under the headings of Industrial Metabolism and Urban Metabolism.
- The analogy between coordination in (human and non-human) social systems and "societies" of autonomous robots, exploring the methods of game theory and institutional economics (ISR).

ISR-LA will aim at developing integrated models of environment-energy-economy interaction, at multiple spatial scales (cities, regions, countries), using the models such as input-output, computable general equilibrium modes, and economic growth.

This will be used to support government to promote new policies to promote sustainable energy systems in Portugal and regional and urban energy planning. The cooperation with industry should give rise to innovations in sustainable buildings technologies and on designing more efficient renewable energy based systems including intelligent transportation systems.

Based on these models, work will be carried out in the development of sustainability assessment tools and indicators, e.g. Green GDP, ecological footprint, human appropriation of net primary production.

Particular focus will also be given to the environmental themes of groundwater, solid waste and greenhouse gases, addressing technologies, models and policy tools for these themes. Sectorwise, particular attention will be given to the primary production and the energy sectors.

Group Description	
Title of Research Group:	(RL-COMP-750009-145) Signal Processing for Communicatio Networks and Multimedia
Principal Investigator:	Joao Paulo Salgado Arriscado Costeira
Main Scientific Domain:	Engenharia Electrotécnica e Informática

Objectives & Achievements

General Objectives

This thematic area has focused its attention on a set of theoretical developments with strong impact on classes of problems arising in a very diverse and multidisciplinary set of areas. This mathematical "tool development" cut-crosses application domains, mostly in communication technologies (wireless radio systems, acoustic, networking) and video processing technologies. These systems all share in common the need to handle large scale, usually nonlinear data representations and sometimes the need for distributed ways of processing data. Actions in this thematic area share the common goal of developing advanced signal processing algorithms with low computational complexity. To achieve this goal, we use new methodologies based on adequate mathematical disciplines, such as optimization theory, non-linear algebra, and differential geometry, leading to tools with a wide area of applications. On the technological side, these methods emerge in relevant contexts such as information processing in sensor networks (detection, estimation, localization, tracking), image and video reconstruction and recognition in large databases.

Main Achievements

Year 2008 was a particularly productive year, confirming and reinforcing some strategic decisions taken in the past, which had impact due to the scientific vision and a successful hiring policy which contemplated the admission of a mathematician together with an active grad student recruiting that leveraged our work to a new level . First a set of prizes, awarded during 2008:

- Pedro Aguiar, João Xavier, Marko Stosic – The DoCoMo USA Labs Innovative Paper Award for the best paper in ICIP08, the premier IEEE conference in Image Processing.
- Manuel Marques – "Best student presentation award" in FG2008, a top IEEE conference in face and gesture recognition.
- Marko Beko – Prémio Científico IBM 2008, the most prestigious Portuguese scientific prize for young researchers in engineering and computer science.
- José Jerónimo Rodrigues – Prémio Luís Vidigal for the best MSc thesis in IST 2008, advised by Pedro Aguiar and João Xavier.

Systematic publication in top conferences and journals: In 2008, four papers were published in one of the most selective conferences in computer vision and pattern recognition-CVPR2008 (17% acceptance rate).

The work on optimal design of codebooks for multi-antenna wireless communication systems had its "pinnacle" in 2008, with the publication of two IEEE-TSP, proving that it compared with advantage to the state of the art in the so called 4G systems.

Developments in convex analysis were applied in several areas which ranged from denoising in images of confocal microscopy to satellite selection or multiple motion detection in images. These applications share a common mathematical backbone in the sense that they can be framed (or well approximated) as convex optimization problems allowing efficient solutions

A new theoretical result in "matrix completion under rank constrained matrices" which fostered applications in computer vision and stands by itself as a very important result in mathematics. An adaptation of the original problem to biometrics, spun a new algorithm for face recognition with strong pose.

Research Line Output

Collaborative Publications in peer review Journals

Some of this work is clearly multidisciplinary involving researchers with quite different backgrounds (mathematics and engineering) which belong to the same group.

P. Aguiar, M. Stosic, J. Xavier. On Singular Values of Partially Prescribed Matrices. Linear Algebra and its Applications, ELSEVIER, vol. 429, 8-9, Oct. 2008.

J. Gomes, A. Silva, S. Jesus. Adaptive spatial combining for passive time-reversed communications. Journal of the Acoustical Society of America, vol. 124, no. 2, 1038-1053, Aug. 2008.

Collaborative Other Publications

Some of the publications are from members of the same (large) group but integrates a clearly multidisciplinary work involving people in very diverse areas

P. Aguiar, J. Xavier, M. Stosic. Globally optimal solution to exploit rigidity when recovering structure from motion under occlusion. IEEE International Conference on Image Processing ICIP'08, S. Diego CA, USA October 2008 - DoCoMo USA Labs Innovative Paper Award

Nuno Pinho da Silva, João Paulo Costeira Subspace Segmentation with Outliers: a Grassmannian approach to the maximum consensus subspace, Proc. of CVPR 2008 IEEE Computer Society Conference on Computer Vision and Pattern Recognition, Anchorage, Alaska, USA, 2008

P. Aguiar, M. Stosic, J. Xavier. Spectrally optimal factorization of incomplete matrices. Proc. of CVPR 2008 IEEE Computer Society Conference on Computer Vision and Pattern Recognition, Anchorage, Alaska, USA, 2008

J. Gomes, A. Silva, S. Jesus. OFDM Demodulation in Underwater Time-Reversed Shortened Channels. OCEANS'08

B. Pires, J. Moura, J. Xavier, "LASIC: a model invariant framework for correspondence", IEEE International Conference on Image Processing ICIP'08, S. Diego CA, USA October 2008

N. Monteiro, J. Gomes and J. Xavier, "Detection of statistical periodicities in DNA by conflict and entropy minimization methods", 16th European

Research Line Output

Signal Processing Conference - EUSIPCO 2008, Lausanne, Switzerland, August 2008

J. Seabra, J. Xavier and J. Sanches, "Convex ultrasound image reconstruction with log-Euclidean priors", 30th Annual International Conference of the IEEE Engineering in Medicine and Biology Society - EMBS'08, Vancouver, Canada, August 2008

I. Rodrigues, J. Xavier and J. Sanches, "Fluorescence confocal microscopy imaging denoising with photobleaching", 30th Annual International Conference of the IEEE Engineering in Medicine and Biology Society - EMBS'08, Vancouver, Canada, August 2008

N. Delgado, F. Nunes and J. Xavier, "GNSS satellite selection for multiple-constellations using convex geometry", 4th ESA Workshop on Satellite Navigation User Equipment Technologies, December 2008

N. Delgado, F. Nunes and J. Xavier, "A geometrical approach for maximum likelihood estimation of multipath", Proceedings of The Institute of Navigation - GNSS 2008, Savannah, September 2008

Master and PhD thesis completed

None

Future Research

Other Information

In cooperation with VISLAB, DSOR and Signal and Image Processing Group (SIPG), a prototype is being developed for automatic control of car assembly (smooth automatic docking of convertible tops using vision). The main contractor MDU (www.mdu.pt) is involved in a technology transfer process with ESA, and ISR-LA provides scientific consultancy and development of critical software parts. The concept was tested and development is taking place for real time operations. We estimate that tests in factory environment will take place in Aug 2009.

A cooperation between VISLAB and SIPG involving the Museu do Azulejo (Museum of Tiles) is developing a system to detect and classify missing tiles in very large panels as well as developing tools to help creating the image inventory of more than 30000 tiles. A scientific proposal was submitted for funding, based in this cooperation. We propose to search art databases (paintings) to help identify the original source of several tile panels.

In the framework of Carnegie Mellon-Portugal Program, a collaborative initiative was put forward into building a large heterogeneous sensor network (VISLAB, SPIG, ISLAB, DSOR). Besides basic aspects of sensing and actuation in massively distributed systems, joint supervision of PhD students are already in place to develop mechanisms for reliable positioning and tracking of targets in sensor networks and recognition in video.

Future Plans

This thematic area will keep the key strategic investment in basic methodologies which can spin new solutions to signal processing problems that lead, in general, to large-scale, nonlinear or distributed optimization problems.

In terms of areas of focus, a strong effort is being driven towards the area of information processing in sensor network, both in terms of applications as well as fundamental problems. In particular the following main topics are currently under development:

- Dimensionality reduction and sensor selection algorithms for efficient detection and decision in large scale wireless sensor networks.
- Fast generalized consensus algorithms for sensor networks with fading links and switching topology.
- Localization and tracking in sensor networks: Development of new algorithms for self localization and tracking (SLAT) that can deal with partial data, non-existence of anchor nodes and outliers.

We plan to deploy a small network based on firefly nodes, which were shared through the partnership with Carnegie Mellon and with which we intend to demonstrate some applications (energy management, occupancy profiling in buildings).

Video recognition technologies are a major field of application of these basic methodologies and also an application field of great interest. Object recognition, motion segmentation and search in large image databases fusing heterogeneous information are key areas to develop. We will keep leveraging our research through the active collaboration in the Carnegie Mellon program where many of the contributors to the thematic area participate.

Group Description	
Title of Research Group:	(RL-COMP-750009-151) Technologies for Ocean Exploration
Principal Investigator:	António Manuel dos Santos Pascoal
Main Scientific Domain:	Engenharia Electrotécnica e Informática

Objectives & Achievements

General Objectives

The main goal of thematic area A is to carry out research and development in marine science and technology for a better understanding of the oceans, and to use this knowledge for the sustainable benefit of society. The area brings to the core of its R&D activities research groups with different expertise and encompasses a wide spectrum of activities that touch upon theoretical and practical issues in marine science and technology. The program targets the Azores as a natural laboratory for the study of a number of challenging scientific issues in the fields of biological, chemical, geological, and physical oceanography.

At a technological level we aim to bring advances in robotics, communications, and systems and information theory to bear on the development of advanced marine platforms (including autonomous vehicles) and sensor systems that will afford marine scientists far more efficient tools than available today to study the ocean and its frontiers. Conversely, strong cooperation links established with marine scientists impact on the definition of new theoretical and technological problems that are motivated by challenging mission scenarios.

Main Achievements

The R&D activity addressed a vast number of issues that are at the crossroad of marine science and engineering.

Engineering:

The theoretical work developed led to novel navigation, guidance, and control systems for autonomous vehicles, including geophysical based navigation systems. New algorithms were also developed for multiple vehicle path planning and cooperative motion control in the presence of stringent acoustic communication constraints.

Science:

Through IMAR, the Associated Lab has become the world leading research center for the study of the deep-sea chemo-synthetic mussel *Bathymodiolus* and the 14th Web of Knowledge ranked institution (as University of the Azores) on the study of hydrothermal vent extreme ecosystems. The implementation and refurbishing in 2008 of LabHorta (a new international laboratory for the study of hydrothermal vents) were major milestones, for they opened a new window on the studies of extreme ecosystems of the deep-sea.

In parallel, noteworthy results were obtained towards the mapping of selected habitats and biodiversity in the Azores islands using a set of cross theme technologies and data/information collection systems.

In what concerns marine geology the areas of work included the Azores Sea, the Southwest Pacific, the North Atlantic, and the Arctic Ocean. Especially relevant was the discovery of a new, large hydrothermal field in the Arctic (Loki's Castle). A cruise in the Azores Sea, using an ROV, produced totally new observations on submarine lava eruptions. Public outreach through Creminer continued to be particularly noteworthy, with involvement in the National Museum of Natural History and in the setting-up of the Lousal "live science" center in Southern Portugal and the Quartz Museum in Viseu.

Bridging the gap between science and technology:

Representative milestones included:

i) Acoustic and navigation system integration, followed by the execution of high resolution multibeam surveys. The system developed is a state-of-the-art tool for bathymetric mapping.

ii) Full demonstration of coordinated vehicle motion control in the Azores in scope of the EU GREX project. This entailed the implementation of algorithms for cooperative control and full development of a middleware architecture for mission control.

Research Line Output

Collaborative Publications in peer review Journals

Multidisciplinary publications

Arrizabalaga H, Pereira JG, Royer F, Galuardi B, Goni N, Artetxe I, Arregi I, Lutcavage M (2008) Bigeye tuna (*Thunnus obesus*) vertical movements in the Azores Islands determined with pop-up satellite archival tags. *Fisheries Oceanography* 17:74-83

A. Pedro Aguiar, João P. Hespanha, and Petar Kokotović, Performance Limitations in Reference-Tracking and Path-Following for Nonlinear Systems. *IFAC Automatica*, Vol. 44, No. 3, pp. 598-610, Mar. 2008.

Khripounoff A, Vangriesheim A, Crassous P, Segonzac M, Lafon V, Waren A (2008) Temporal variation of currents, particulate flux and organism supply at two deep-sea hydrothermal fields of the Azores Triple Junction. *Deep-Sea Research Part I-Oceanographic Research Papers* 55:532-551

Mitchell NC, Beier C, Rosin PL, Quartau R, Tempera F (2008) Lava penetrating water: Submarine lava flows around the coasts of Pico Island, Azores. *Geochemistry Geophysics Geosystems* 9.

Morato T, Machete M, Kitchingman A, Tempera F, Lai S, Menezes G, Pitcher TJ, Santos RS (2008a) Abundance and distribution of seamounts in the Azores. *Marine Ecology-Progress Series* 357:17-21

Roncin N, Alban F, Charbonnel E, Crec'hriou R, Modino RD, Culioli JM, Dimech M, Goni R, Guala I, Higgins R, Lavisé E, Le Direach L, Luna B, Marcos C, Maynou F, Pascual J, Person J, Smith P, Stobart B, Szelienszky E, Valle C, Vaselli S, Boncoeur J (2008) Uses of ecosystem services

Research Line Output

provided by MPAs: How much do they impact the local economy? A southern Europe perspective. *Journal for Nature Conservation* 16:256-270

Sutton TT, Porteiro FM, Heino M, Byrkjedal I, Langhelle G, Anderson CIH, Horne J, Soiland H, Falkenhaus T, Godo OR, Bergstad OA (2008) Vertical structure, biomass and topographic association of deep-pelagic fishes in relation to a mid-ocean ridge system. *Deep-Sea Research Part II-Topical Studies in Oceanography* 55:161-184

Collaborative Other Publications

Multidisciplinary publications

Barriga FJAS, JMRS Relvas, AMS Pascoal (accepted in 2008). Exploration of Massive Sulphide Deposits on the Sea Floor. ICES International Symposium Issues Confronting the Deep Oceans, Horta, Azores Portugal, Gui Menezes and Robert Brock, eds, pp 38-39

Barriga FJAS, JMRS Relvas, AMS Pascoal (accepted in 2008). Some Thoughts on the Future of Exploration for Massive Sulfide Deposits in the Azores Sea. Deep-Sea Mining of Seafloor Massive Sulfides: A Reality for Science and Society in the 21st Century Science and Policy Workshop, April 1-2, 2009, Woods Hole, Massachusetts, USA

Gomes, L., Paulo Oliveira, Bathymetric Data Fusion: PCA based Interpolation and Regularization, Sea Tests, and Implementation, MTS/IEEE OCEANS Conference, Quebec, Canada, September 2008.

Person R, Beranzoli L, Berndt C, Dañobeitia JJ, Diepenbroecke M, Favali P, Gillooly M, Lykousis V, Miranda JM, Mienert J, Priede IE, Santos RS, Thomsen L, Van Weering T, Waldman C 2008 ESONET: An European sea observatory initiative. *Oceans 2008 - Mts/IEEE Kobe Techno-Ocean Vols 1-3:1215-1220* [ISIP:000257943100211].

Santos, R. S. & T. Morato 2008. Conservation and utilization of biodiversity in seamounts. Pp. 135-142. In: Sandlund, O. T. & L. Saksgård (Eds.) 2008. *Proceedings of the Norway/UN Conference on Ecosystems and People – Biodiversity for Development – The Road to 2010 and Beyond – Directorate for Nature Management, Trondheim. 179pp.* [ISBN: 978-82-7072-725-4]

Sousa, R., Alex Alcocer, Paulo Oliveira, Reza Ghabcheloo, António Pascoal, Joint Positioning and Navigation Aiding System for Underwater Robots, MTS/IEEE OCEANS Conference, Quebec, Canada, September 2008.

Teixeira, F. and A. Pascoal, Geophysical Navigation of Autonomous Underwater Vehicles Using Geomagnetic Information, Proc. NGCUV'08 - IFAC Workshop on Navigation, Guidance and Control of Underwater Vehicles, Killaloe, Ireland, Apr. 2008.

Vanni, F., A. Pedro Aguiar, and Antonio M. Pascoal, Cooperative Path-Following of Underactuated Autonomous Marine Vehicles with Logic-based Communication, in Proc. of NGCUV'08 - IFAC Workshop on Navigation, Guidance and Control of Underwater Vehicles, Killaloe, Ireland, Apr. 2008.

Master and PhD thesis completed

PhD Thesis

Marcus Manoel Fernandes, 2008 "Viabilidade económica do uso do rejeito do distrito gemológico de Arucaí na agricultura regional", PhD thesis, Universidade Federal de Minas Gerais, Brasil (co-supervisora Rita Fonseca) - concluded

Vera Domingues - SFRH/BD/13069/2003: Reconstruction of post-glacial colonization routes of fish with tropical and sub-tropical affinities in the Azores: A biogeographic and molecular approach. (University of the Azores - supervisor: Ricardo Serrão Santos) - concluded

Fernando Tempera - SFRH/BD/12885/2003: Classification and Mapping of Benthic Sublittoral Biotopes in the Faial-Pico Channel (Azores) (PhD awarded by the University of St Andrews, UK, co-supervisor Ricardo Serrão Santos) - concluded

Mirko De Girolamo - SFRH/BD/6916/2001: Genetic interpretation of the social mating system and larval dispersal in a fish with male parental care, the redlip blenny *Ophioblennius atlanticus atlanticus*. (University of the Azores, supervisor Ricardo Serrão Santos) - submitted

Jorge Fontes - SFRH/BD/12788/2003: Larval dispersal and recruitment patterns in Azorean coastal fishes (Implications for Marine Reserves). (University of the Azores, supervisor Ricardo Serrão Santos) - submitted

MSc Theses (Before Bolonha)

Research Area: Preview Guidance and Control

Title: Coastline-following Preview Controller for the Delfimx Vehicle

Student: Pedro Gomes

MSc Theses (Bolonha)

Research Area: Nonlinear observers

Title: Pose Observers for Unmanned Air Vehicles,

Student: Sérgio Brás

Research Area: Tracking Systems

Title: Multiple model underwater tracking systems,

Student: Joana Gomes

Research Area: Tracking Systems

Title: Indoor Target Tracking Vision Systems,

Student: Tiago Gaspar

Research Area: Tracking Systems

Title: Advanced Marine Vehicles Target Trackers,

Research Line Output

Student: Renato Sousa

Research Area: Signal Processing

Title: Advanced Signal Processing Techniques for Integrated Navigation Systems,

Student: Luís Gomes

Master of Engineering, Imperial College of London

Research Area: Positioning Systems

Title: Advanced NAVSTAR-GPS Positioning Techniques for UAVs

Student: CHAN Chun-Ning (Johnny)

Future Research

Other Information

MULTIDISCIPLINARY COOPERATIVE PROJECTS

GREX (EC Funding) - Coordination and Control of Cooperating Heterogeneous Unmanned Systems in Uncertain Environments. Objectives: study and development of advanced systems and sensor units enabling the concerted operation of fleets of marine vehicles (2006-2009)

FREEsubNET (EC Funding) - A European Research Network on Key Technologies for Intervention Autonomous Underwater Vehicles. Objectives: to provide a European-wide excellence in quality training to young and experienced researchers in the emerging field of Cooperative Autonomous Intervention Underwater Vehicles (I-AUV) (2006-10)

RUMOS (FCT Funding) - RUMOS: Robotic Underwater Vehicles and Marine Animals Tracking Systems. Objective: to develop a set of devices and methodologies for precise estimation of trajectories of underwater robotic vehicles (autonomous and remotely operated) and marine animals (2006-09)

NAV (FCT Funding): Development and Application of Advanced Nonlinear Control Techniques for the Coordination and Motion Control of a Network of Autonomous Vehicles. Objectives: to develop, implement and test advanced robust control strategies for the coordination and cooperative motion a network of autonomous vehicles (NAV) (2007-10)

EEA Financial Mechanism PT0040/2008: CONDOR - Observatory for long-term study and monitoring of Azorean seamount ecosystems: 2008-2011

Objectives: to established a permanent observatory in a seamount using traditional and advance observational equipments aiming to understand the biological, ecological, geological and oceanographic functioning of seamount ecosystems.

FP7 ENV/2007/1/213144: CORALFISH - Assessment of the interaction between corals, fish and fisheries, in order to develop monitoring and predictive modelling tools for ecosystem based management in the deep waters of Europe and beyond: 2008-2012.

FCT PTDC/MAR/72169/2006: CORAZON - Mid-depth benthic communities of conservation importance in the Azores: cold water coral ecosystems.

EEA Financial Mechanism PT0040/2008: CONDOR - Observatory for long-term study and monitoring of Azorean seamount ecosystems: 2008-2011

ESF/EUROCORES – Proposal 06-EuroDEEP-FP-008 & FCT: EURODEEP/0002/2007 - DEECON - Unraveling population connectivity for sustainable fisheries in the deep sea. 2007-2010.

We have submitted to FCT a collaborative project involving Creminer and ISR (BioGeoLakes) aimed at studying the Sobradinho dam lake in Central Brazil, one of the largest in the world. The study will bring together engineers and marine scientists and will make ample use of acoustic remote sensing techniques for lakebed characterization.

ORGANIZATION OF CONFERENCES (REPRESENTATIVE SELECTION)

ICES Working Group on Marine Habitat Mapping (WGMHM) Horta (Azores, Portugal). 31 March - 3 April 2008

Geographic Information Systems applied to Marine Sciences (Course). Horta. Permanent Forum for Sea Affairs. 7- 8 August, 2008, Horta

South Atlantic MAR-ECO Project Workshop. 14-15 June, 2008, Argentino Hotel Casino & Resort, Piriápolis, Uruguay.

Organization of the Workshop on “Cooperative Control of Multiple Autonomous Vehicles” for the 17th IFAC World Congress, Seoul, Korea, July 2008. Cooperative Control of Multiple Autonomous Vehicles. This workshop focused on the theme of Cooperative Control of Multiple Autonomous Vehicles, with applications to underwater vehicles, surface craft, wheeled mobile robots, and aircraft.

Member of the Technical Program Committee, The 18th International Offshore (Ocean) and Polar Engineering Conference & Exhibition, Vancouver, British Columbia, Canada, July 6th, 2008

Member of the Technical Program Committee, NGCUV'08 - IFAC Workshop on Navigation, Guidance and Control of Underwater Vehicles, Killaloe, Ireland, Apr. 2008.

PATENTS

There is a pending process for a patent for “FishMetrics” an automation method for the visual measurement and sampling of fish at the fish auctions. The project won the 4th Edition of the National BES Innovation Prize in 2008.

MAYA, a Miniaturized AUV for Scientific and Commercial Applications, submitted in India. The patent is the outcome of joint work done by the Associated Lab and the NIO, Goa, India

NEW PROTOTYPES

Future Research

- Medusa I - designed and built by ISR/IST. First prototype of a class of semi-submerged vehicles of small size for underwater target positioning. A set of vehicles acting cooperatively will be used in the scope of the EU COGAUVs (Cognitive marine robotics) project for assisted diving operations, to be started in 2009.

Future Plans

Future plans, similar to those presented in the quinquennial report (2003-2007), will further strengthen the symbiosis between science and technology.

A. Dam and coastal area surveying and monitoring using autonomous surface and underwater vehicles

Dams obstruct the normal flow of sediments from the continents to the ocean. There is great need to monitor sediment accumulation to then establish adequate policies. There is an ongoing cooperation program with Cape Verde aimed at determining sediment erosion rates under catastrophic climatic events. To meet these goals, it is planned to use autonomous marine robots.

B. Mapping and monitoring of hydrothermal sites using autonomous underwater vehicles.

Shallow water hydrothermalism / volcanism (Banco DJC and Serreta). We are interested in monitoring the young submarine volcanic systems in the Azores sea, such as the Serreta volcano and Banco D. João de Castro. This includes volcanic interpretation, hydrothermal activity and rapid response monitoring in case of new, shallow eruptions.

C. Observation and tracking of marine mammals and fish schools using aerial and oceanic autonomous vehicles. The objective is to greatly drastically improve the methods to do fish telemetry (this theme is strongly motivated by joint work of DSORL and IMAR in the scope of the EC projects FREEsubNET and GREX). This action will also witness, in the scope of the FCT OBSERFLY project, the development of a versatile UAV for location and tracking of marine mammals and commercially important or threatened pelagic species such as the Atlantic Tuna.

D. Ecosystem Studies. The research efforts will be focused on key issues of ecosystem functioning in a time of climate change and anthropogenic exploration of ocean biotic resources. Focus will be given to bio-telemetry studies of top predators together with habitat mapping.

New sensors and permanent stations, including landers, will be deployed. Together with the fixed observatory type studies of seamount and vents ecosystems, we will continue tagging several species with acoustic and satellite transmitters incorporating data-loggers for different types of environmental and physiological data acquisition. In many of the envisioned scenarios, the work at sea will be done with advanced sensor suites and robotic equipment.