ASSOCIATE LABORATORY
INSTITUTE FOR SYSTEMS AND ROBOTICS - LISBON

ACTIVITIES REPORT - 2010

ISR-LISBON
IMAR-DOP/UAç
IN+
CREMINER

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General Information

Name of Research Unit: (LA-LVT-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 Mar/Instituição da Faculdade de Ciências - Faculdade de Ciências da Universidade de Lisboa/Instituto Superior Técnico - Universidade Técnica de Lisboa

Objectives & Achievements

Unit Description

The Associate Laboratory has the following organization structure:

Coordinating board
Executive board
Managers of thematic area
Advisory board

Coordinating Board

The Coordinating Board has as functions to supervise and to guide in general lines the cooperation activities of the four participant research units and to decide in cases of doubt resultant of divergent interpretations of the terms of the signed protocol.

The Coordinating Board is composed by the scientific coordinators of the involved units and by the managers of the thematic areas, and is presided over by the President of the Executive Board of the Laboratory that will assure that the Coordinating Board will meet at least once a year. The meetings of the Coordinating Board can be convoked by any one of its members.

Executive Board

The Executive Board is composed by the coordinators of the involved units and presided over by the scientific coordinator of the ISR-Lx. The Executive Board has as functions to assure the current management of the activities resulting from the collaboration among the participant units and to guarantee its accurate fulfillment.

Managers of Thematic Area

Each thematic area has a manager elected by the researchers involved in that particular area, for a period of 3 years. He has not responsibilities of executive management, but rather tasks like:

- to plan the activities to carry through in the thematic area and to promote its strategic orientation;
- to obtain the necessary human resources;
- to guarantee the cooperation and integration of the activities of the various groups;
- to prepare, in cooperation with the area researchers, project proposals and find financing sources for these projects (FCT, European Union, others);
- to prepare annual activities plans and reports in the domain of the thematic area to submit to the consideration of the Coordinating Board.

Advisory Board

The activities of the associate laboratory is followed by an Advisory Board, consisting of national and international experts, nominated by decision of the Coordinating Board. The Advisory Board is requested to give his judgment whenever the Coordinating Board considers it opportune and under proposal of the Executive Board.

General Objectives

The strategic plan for the AL aims at: i) consolidating successful research lines and increasing the level of interaction among them, ii) opening new lines of research that show considerable promise, and iii) fostering interaction with stakeholders and establishing common joint ventures with commercial agents on issues with societal and economic relevance. As such, the plan embodies in its structure a threefold strategy that hinges upon three main lines of action: science, technology, and interaction with the society and the industry, all sharing a systems approach to research rooted in solid mathematical methods. This tripartite structure is a fertile ground for cross-fertilization of ideas, motivates challenging problems for engineers and mathematicians, and affords scientists advanced methods and new tools for their research activity. In what concerns application themes with potential societal and economic impact we have elected, due to their increasing importance and the sheer magnitude of the scientific and technological problems that they pose, the open oceans and the deep sea, sustainable urban systems, and sustainable energy, environment, and economic development.

The key thrust of the AL activity will be threefold: research, training, and public service. In both research and training, the AL will complement its
Objectives & Achievements

internal multidisciplinarity with external cooperation by networking with highly reputed research and academic institutions and industrial partners worldwide. To this effect, impetus will be given to the exchange of scientific personnel, participation in international projects, and hiring of exceptional PhD students and senior researchers.

Public service is foreseen as one of the most important missions of the AL. This can take the form of consultancy services to public administration bodies, including governmental departments and local administrations.

We will reinforce outreach activities, in particular by taking initiatives to disseminate scientific knowledge and culture to the public at large, with special attention being given to the organization of summer schools and internships.

Advanced training initiatives will continue to be a major objective. The AL is presently involved in several international partnerships: (i) Carnegie Mellon-Portugal Program: Dual Doctoral Programs with Instituto Superior Técnico in Electrical and Computer Engineering, Engineering and Public Policy, and Technological Change and Entrepreneurship; (ii) MIT-Portugal Program: Doctoral Program at Instituto Superior Técnico with the Massachusetts Institute of Technology, in Sustainable Energy Systems, and (iii) Joint Doctoral Initiative in the area of Distributed and Cognitive Robotics involving Instituto Superior Técnico and École Polytechnique Federal de Lausanne (EPFL).

The programs with Carnegie Mellon and MIT merge several Portuguese research units and AL’s, in close collaboration with Universities and Industrial Partners.

Main Achievements during the year of 2010

With respect to 2009, the funding for research projects increased in 2010 approximately 17% (national, FCT mainly) and 23% (international, EU mainly) for a total of 70 and 27 projects, respectively. 19 is the number of patents/prototypes produced. The AL researchers published 118 articles in international peer review journals and more than 200 communications in the proceedings of international conferences and workshops. 16 journal papers and 23 conference communications are collaborative publications involving researchers from different groups and thematic areas of the AL and, in some cases, from international research institutions or universities. 17 PhD thesis were completed. Our researchers have organized or participated in organizing committees of 18 international conferences, workshops or working groups meetings.

Scientific and Engineering Achievements

Robotic Monitoring and Surveillance: Search and rescue, field and urban robotics ((Muti-)robot task plan, decentralized planning under uncertainty); Surveillance (Gesture and activity understanding from video, Representation of complex activities with bank of visual motion fields); Cognitive robotic assistant (iCub robot fully operational [Vislab]).

Sustainable Technologies and Environmental Systems: Development of a set of advanced energy systems models (energy use in buildings, interaction with electric vehicles); Development of major methodologies and tools in the assessment and the design of new products and new policies; Support to entrepreneurial initiatives in Industrial Ecology in Portugal; Support to Portuguese public policy on the use of natural carbon sinks (including geological carbon sequestration).

Technologies for Ocean Exploration: Development of new methodologies and software/hardware for: a) multiple vehicle cooperative motion planning, navigation, and control, b) optimal networked sensor placement for underwater target positioning, and c) sensor-based control for unmanned air vehicles. IMAR has become the world leading research center on the study of the deep-sea chemo-synthetic mussel Bathymodiolus and the 10th Web of Knowledge ranked institution on the study of hydrothermal vent extreme ecosystems (2006-2010); IMAR came to the fore with the installation of a new laboratory (CoralLab). Creminer is completing a major study on Arctic hydrothermal systems, with great emphasis on the deep biosphere and on comparison with the Azores hydrothermal fields. Showcase of Science and Technology in the Azores in the scope of the FRESUBNET Workshop, co-organized by IMAR and ISR –advanced robots and marine equipment were used intensively at sea by a large group of European researchers to: i) map the habitat around a newly found of a hydrothermal vent field, and ii) to perform acoustic telemetry and tracking of fish carrying acoustic emitters.

Signal Processing for Communicatio Networks and Multimedia: Breakthroughs that produced theorems/procedures for some relevant problems (Minimization of a Quadratic function on Smooth Manifolds, Minimization of a singular value of a partially prescribed matrix, Integer 0-1 problems). Main contributions at the enabling methodologies (Reconstruction of non-rigid objects from video sequences, Image matching for object recognition, Distributed consensus and detection in Sensor Networks, Localization and tracking in sensor Networks). Cutting-edge technological developments with impact on society at the industrial, services, cultural and policy levels (Pollution monitoring using a bus fleet, Image retrieval in large scale databases (internet) for images of art).

Activities

Integrative/multidisciplinary activities during the year of 2010

Final Fressubnet Workshop during which more than 30 scientists from 13 countries got together. The week-long event focused on the interplay between marine science and technology and consisted of a series of talks by experts and practical work at sea and in the laboratory. A previously unknown hydrothermal vent field in about 30m depth off Espalamaca, Faial Island, was described and mapped, an AUV built by students was tested in its first sea trial and a positioning system for biotelemetric studies was tested in cooperation with VEMCO (Canada). [Horta, 18-24 July 2010]

Science and Technology for the Deep-Sea: Session 1: Biodiversity and Ecosystem Functioning – Technology and Monitoring (6 July: 09:30 – 11:00); Session 2: Resources and Opportunities (6 July: 11:00 – 13:00). Ciência 2010 - 4- 7 July 2010. Fundação Calouste Gulbenkian, Lisbon.

PRINTART workshop “Where Computer Vision Meets Art”, that gathered researchers from the areas of computer vision and art history, Museu Nacional do Azulejo, Lisboa, Portugal.

“Towards Closing the Loop: Active Learning for Robotics”, Full day workshop at Robotics: Science and Systems 2010, University of Zaragoza, Spain.

### Activities

**Outreach activities during the year of 2010**

Oficina de Robótica, in collaboration with Ciência Viva, July 2010.

### Research Groups

<table>
<thead>
<tr>
<th>Reference</th>
<th>Title / Principal Investigator</th>
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</thead>
<tbody>
<tr>
<td>RG-LVT-50009-3422</td>
<td>Evolutionary Systems and Biomedical Engineering (Agostinho Claudio da Rosa)</td>
</tr>
<tr>
<td>RG-Centro-50009-3433</td>
<td>Centre of IMAR of the University of the Azores/ Department of Oceanography and Fisheries (IMAR-DOP/UAz) (Ricardo Piedade Abreu Serrão Santos)</td>
</tr>
<tr>
<td>RG-LVT-50009-3438</td>
<td>DSORL - Dynamical Systems and Ocean Robotics Laboratory (Carlos Jorge Ferreira Silvestre)</td>
</tr>
<tr>
<td>RG-LVT-50009-3447</td>
<td>Signal and Image Processing Group (Isabel Maria Gonçalves Lourtie)</td>
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<tbody>
<tr>
<td>RG-LVT-50009-3508</td>
<td>VisLab - Computer and Robot Vision Laboratory (Jose Alberto Rosado Santos Victor)</td>
</tr>
<tr>
<td>RG-LVT-50009-3583</td>
<td>Laboratory for Energy and Environmental Studies at IN+ Center for Innovation, Technology and Policy Research (Paulo Manuel Cadete Ferrao)</td>
</tr>
<tr>
<td>RG-LVT-50009-3584</td>
<td>Laboratory of Thermofluids, Combustion and Energy Systems, at IN+ Center for Innovation, Technology and Policy Research (Antonio Luis Nobre Moreira)</td>
</tr>
<tr>
<td>RG-LVT-50009-3585</td>
<td>Laboratory of Technology Policy and Management of Technology, at IN+ Center for Innovation, Technology and Policy Research (Rui Miguel Loureiro Nobre Baptista)</td>
</tr>
<tr>
<td>RG-LVT-50009-3589</td>
<td>Centre of Mineral Resources, Mineralogy and Crystalography of the Faculty of Science of Lisbon University (CREMINER) (Fernando José Arraiano de Sousa Barriga)</td>
</tr>
<tr>
<td>RG-LVT-50009-3853</td>
<td>Intelligent Robots and Systems (Pedro Manuel Urbano de Almeida Lima)</td>
</tr>
<tr>
<td>RG-T-LVT-50009-3503</td>
<td>Mobile Robotics Laboratory - MRLab (Maria Isabel Lobato de Faria Ribeiro)</td>
</tr>
<tr>
<td>RG-T-LVT-50009-3505</td>
<td>Intelligent Systems Laboratory (Pedro Manuel Urbano de Almeida Lima)</td>
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### Research Lines

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<tr>
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</thead>
<tbody>
<tr>
<td>RL-EEI-LA09-133</td>
<td>Robotic Monitoring and Surveillance (Jose Alberto Rosado Santos Victor)</td>
</tr>
<tr>
<td>RL-EME-LA09-137</td>
<td>Sustainable Technologies and Environmental Systems (Paulo Manuel Cadete Ferrao)</td>
</tr>
<tr>
<td>RL-EEI-LA09-145</td>
<td>Signal Processing for Communication Networks and Multimedia (João Paulo Salgado Arriscado Costeira)</td>
</tr>
<tr>
<td>RL-EEI-LA09-151</td>
<td>Technologies for Ocean Exploration (António Manuel dos Santos Pascoal)</td>
</tr>
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## Other Activities

### External Services and Resources


Involvement in the implementation of the Condor Seamount Observatory, on the Monitoring, Control and Eradication of the Invasive seaweed Caulerpa.


Involvement in significant activities of assessment of the government and local authorities on mineral resources, environmental protection and land use. Also, work in shale resources of Northern Portugal; Lithium resources; resources of Marco de Canavezes and Mondim de Basto; special clays of Meirinhas (Pombal).

### Training Activities

Strong involvement in the doctoral programs in the framework of the international partnerships with american and european universities (promoted by the portuguese government), in particular with MIT, Carnegie Mellon and EPFL.

### Organization of International Events

Final Freesubnet Workshop during which more than 30 scientists from 13 countries got together. The week-long event focused on the interplay between marine science and technology and consisted of a series of talks by experts and practical work at sea and in the laboratory. A previously unknown hydrothermal vent field in about 30m depth off Espalamaca, Faial Island, was described and mapped, an AUV built by students was tested in its first sea trial and a positioning system for biotelemetric studies was tested in cooperation with VEMCO (Canada). [Horta, 18-24 July 2010]

## Other Activities


2nd Annual MIT-Portugal Conference: Creating Values through Systems Thinking. FEUP, Porto, 28 de Setembro de 2010

15th International Symposium on Applications of Laser techniques to Fluid Mechanics, 05-08 July 2010, Lisbon, Portugal

## Internal Evaluations

### Summary of internal evaluations during 2010

During 2010, we made a deep analysis of the future of the AL. This resulted in a proposal of reorganization of the AL, including the integration of other groups/research units and the redefinition of the scientific and management organization. This proposal was submitted to FCT in July 2010.

### Future internal Evaluations plan for 2011

This year (2011) we will nominate a new advisory board. We will promote a visit of the board to take place at the end of the year or as soon as possible in 2012.
Group Description

Title of Research Group: (RG-LVT-50009-3422) 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

Objectives & Achievements

Objectives

The long term objective of LaSEEB group is to develop model-based real-time detection and classification of brain states using the multichannel 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.

Modelling and Classification of Brain States during awake and sleep for Neurocognitive training using Self-Organized Swarm Intelligence techniques.

Main Achievements

The main achievements during 2010 are the first steps toward the new proposal of Linguistic Modelling through Rhythm Segmentation of the Electroencephalographic (EEG) signals of Human Sleep and on further development, implementation and application of Neurofeedback (NF) based Brain Training and Neurophysiologic Therapy. The potential application of the advances have been demonstrated namely on the definition of Peripheral Vision (PV) Indexes for Team Sports or Driving/Steering Machines and currently on the development of PV enhancement through NF. The topic of biologically inspired new algorithms and paradigms for search and optimization has been extended. Current focus is on Evolutionary Algorithms for Dynamic Environments and Artificial Life Modelling and Simulations of Bio-systems and its application to Exams Timetabling. Advantages of using multiprocessor or multicell architectures have been investigated as workhorse for Agent Based Modelling and Simulations Systems.

Group Productivity

Publications in peer review Journals


Other international publications

Group Productivity


Other national publications


Organization of conferences

ACM SAC 2010 – Computational Intelligence Image Analysis track, Crans-Montana, Switzerland.
INSTICC – IJCCI - International Conference on Evolutionary Computation 2010 – Programme Chair, Valencia, Spain.

Internationalization

Federal University of Sao Paulo, Brazil
Alves GR, Rosa AC, Brito M, Pradella-Hallinam M, Tufik S. Cyclic Alternating Pattern (CAP) in normal children from 12 to 24 months. Arq NeuroPsiquiatr 2010,68(5),689-693,
University Of Granada, Spain.
Carlos M Fernandes, Agostinho C Rosa, Juan Julian Merelo. Investigation Replacement Strategies for the Adaptive Dissortative Mating Genetic


COST, European Cooperation in Science and Technology
Participation in the Arterial spin labelling Initiative in Dementia (AID) European Cooperation in Science and Technology (COST) Action (P. Figueiredo).
### Title Description

**Title of Research Group:** *(RG-Centro-50009-3433)*
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

- **FCT**
- **TRACE-PTDC/MAR/74071/2006**
- **CORAZON-PTDC/MAR/72169/2006**
- **IMUNOVENT-PTDC/MAR/65991/2006**
- **CHEMICO-EURODEEP/0001/2007**
- **REDECO ESF/MARINERA/Mr/003/2008**
- **BIOMOUNT-PTDC/MAR/105486/2008**
- **METHAFISHCODE -PTDC/MAR/101795/2008**
- **Rish&Shine-PTDC/BIA-BEC/103734/2008**
- **DEECON -EURODEEP/0002/2007**
- **SEAMOV-PTDC/MAR/108232/200/8**
- **CARCASE-PTDC/MAR/099656/2008**
- **DIMBIO PTDC BIA/BDE/67286/2006**
- **EC & OTHER INTERNATIONAL FUNDING**
  - **MESH-Atlantic (Atlantic Area 2009-1/110).**
  - **HERMIONE-FP7 ENV/2008/1/226354**
  - **CORALFISH -FP7 ENV/2007/1/213144**
  - **MADE FP7 KBBE/2007/1/210496**
  - **ESONET**
  - **MEFEPO- FP7 KBBE-2007-1-4-19**
  - **FREESUBNET**
  - **CONDOR EEA PT0040/2008**
  - **CORALCHANGE-FP7-MC-IRG**
  - **Bangen -PTC/MAC/1/C070**
  - **Marprof/MAC/2/M065**
- **Agreement nº 58-0210-7F135**
- **Sustainable Fisheries in Azores**

### 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 and biotechnology, eco-toxicology, satellite oceanography, fisheries dynamics, behavioral 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 centers and institutes, enterprises and professional associations. IMAR-DOP/UAz
also carries out services for industry and public administration. It is also involved in activities of promotion and divulgence of research activities in media, museums, at the primary and high school system and through the internet. In IMAR-DOP/UAz will continue involved and given emphasis in deep-sea research.

Portugal holds jurisdiction, and exclusive economic rights, over a very large area of the seabed. One of the main national objectives, at the present time, is to increase the knowledge that exists on the resources and ecosystem functioning.

Our research aims key issues of ecosystem functioning in a time of changes, climate change and anthropogenic exploration of Open Ocean and deep-sea biotic resources. We are focused 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 these is a need to accomplish the ecosystems approach for management. Focus is given to bio-telemetry studies of top predators together with habitat mapping at the level of seafloor and water column. These studies 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, are 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.

Main Achievements

IMAR-DOP/UAz, has effectively become a leading research center for integrated studies on seamounts and hydrothermal vents, involved in 8 projects of the FP6 and 4 of the FP7, it is also the world leading research center on the study of the deep-sea chemo-synthetic mussel Bathymodiolus and the 10th Web of Knowledge ranked institution on the study of hydrothermal vent extreme ecosystems (2006-2010); the implementation of LabHorta (a new international laboratory for the study of hydrothermal vents) was a major milestone, for it opened a new window on the studies of extreme ecosystems of the deep-sea. More recently we came out with the installation of new laboratory (CoralLab), dedicated to the husbandry and experimentation with cold-water corals, making possible the study of certain aspects of the biology and physiological processes of cold-water corals and associated fauna, which are difficult in situ. For example, in CoralLab seawater temperature and pH can be independently controlled in different aquaria, enabling the simulation of seawater temperature and acidity increases predicted as consequences of climate change, and the study of physiological responses.

Ongoing experiments at CoralLab include studies on: (i) physiological responses of scleractinian and corals to increased seawater carbon dioxide partial pressure (pCO2) and temperature; (ii) the sensitivity/resilience of gorgonians to mechanical injury under different temperature conditions; (iii) gene expression analysis of relevant genes known to be directly involved in immune and stress responses to the presence of pathogens and or environmental stressors.

Current status

Projects and research lines have been developed to address several biotechnological related issues at DOP:

1. Marine enzymes from environmental microbes (Deep-sea vents and shallow water vents): mostly through a DNA-based approach using metagenomic analyzes, i.e. the sequencing of all the genomes present in microbial communities. Some of the enzymes we are targeting have a direct implication in industry: proteases; amylases, pullulanase, glucocoolylylases, glucosidases, cellulases, xylanases, Lipases, esterases. 2. Enzymatic activities detected by screening methods using bulk extracts from microalgae, fungi, bacteria and marine invertebrates collected in the Azores. We have given special emphasis to the detection of antibacterial activities and we are setting new protocols for the purification of natural antibiotics of marine origin. 3. The establishment of global gene expression analyses or transcriptome analyses using state-of-the-art technologies such as the 454-sequencing to generate several thousands of DNA sequences corresponding to new genes whose putative biological functions may be biotechnology relevant.

Another achievement was the understanding the Trophodynamic of the CONDOR seamount (Azores, Portugal, North Atlantic). Stable carbon and nitrogen isotopic signatures were determined on these species and compared to other samples from the Mid-Atlantic Ridge (South and North of the Azores). The energetic content of each group was established through their biochemical composition (total proteins; lipids and sugars). We establish the trophic structure of the colonizing modules through stable isotope and fatty acid approach from hydrothermal sites (Lucky Strike and Rainbow) on the Mid-Atlantic Ridge and on the mud volcanoes in the Gulf of Cadiz.

Group Productivity

Publications in peer review Journals


Other international publications


Other international publications


Other international publications


Group Productivity


Patents/propotypes

None

Organization of conferences

- Final Freesubnet Workshop during which more than 30 scientists from 13 countries got together. The week-long event focused on the interplay between marine science and technology and consisted of a series of talks by experts and practical work at sea and in the laboratory. A previously unknown hydrothermal vent field in about 30m depth off Espalamaca, Faial Island, was described and mapped, an AUV built by students was tested in its first sea trial and a positioning system for biotelemetric studies was tested in cooperation with VEMCO (Canada). (Horta, 18-24 July 2010)
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  Session 2: Resources and Opportunities (6 July: 11:00 – 13:00). Ciência 2010 - 4- 7 July 2010. Fundação Calouste Gulbenkian, Lisbon.
- Workshop on “Environmental Management of Deep-Sea Chemosynthetic Ecosystems: Justification of and Considerations for a Spatially Based Approach”, 31 May through 4 June 2010, CRESCO, Dinard, France (Steering Committee).

Industry contract research

POPA - The Observers Program of the Fisheries of the Azores (Tuna component):

The Programme results from an agreement between Regional Administration, Earth Island Institute, the Tuna Canning Industry Association (Pão do Mar), the Fishing Boat Owners Association (APASA) and IMAR – Instituto do Mar - through the University of The Azores Center (IMAR-DOP/UAç), which carries out the programme.

In 1999, the Regional Secretary has implemented a regional law (portaria regional 31/99) which recognizes POPA as a Program with full capacity for monitoring any kind of fishery. The POPA Program worked with several fisheries. under contract with the fisheries industry, such as:

1) black scabbard fishery with drift bottom long line, 2) experimental king crab fishery with bottom traps, 3) pole and line fishery for tuna in Angola. 4) Shrimp fisheries in the Mediterranean.

Certification of canned tuna. Contracts with the tuna canned industry in view to certify the product in terms of safety for health (heavy metals and histamines).

Internationalization

- Member of the Pelagic Working Group under the Global Ocean Biodiversity Initiative. Meeting a moving target, Realizing global objectives for conservation of the pelagic realm.
- Member of the International Working group for the Conservation of the Northwest Atlantic Loggerhead Nesting Population
- Collaborative research with the Oceanic Fisheries Programme of the Secretariat of the Pacific Community (SPC), Noumea, New Caledonia to analyses tuna fishing on west and central Pacific Ocean seamounts.
- Supervision of four MSc thesis students (Norway, Italy, Serbia, South Africa) of the Erasmus Mundus Master of Science in Marine Biodiversity and Conservation (EMBC).
- Member of the International Scientific Committee of OCOSS’10”Ocean & Coastal Observation”
- Co-chair of the Interridge group “Monitoring and Observatories; Member of the ESONET Scientific Council; Member of the ESONET Scientific Council;
Group Productivity

- Collaborative research on sperm whale socio-ecology with the Woods Hole Oceanographic Institution (USA), the University of Southern Denmark (USD) and the University of Århus (UA), Denmark.

Scientific international cruises: 1) RRS James Cook with the ROV Isis to the Mid-Atlantic-Ridge, project ECOMAR – ‘Ecosystems of the Mid-Atlantic Ridge at the sub-polar front and Charlie-Gibbs Fracture Zone’; 2) MoMARSAT on board the RV PourquoiPas? with the ROV Victor-6000 to install an observatory at Lucky Strike; 3) MenezMAR on board the RV Meteor with the ROV Quest.

Government/Organization contract research

The Research Group (RG) has been involved in contracts with Government Bodies concerning, e.g. the following Public Policies and governance bodies: 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, and the International Council for the Exploration of the Seas, the Marine Strategy Framework Directive, the Azores Marine Park.

Additionally the Group has been involved in the implementation of the Condor Seamount Observatory, on the Monitoring, Control and Eradication of the Invasive seaweed Caulerpa.

Contracts:

1 - CAULERPA - Monitoring, Control and Eradication of the Invasive seaweed Caulerpa.
2 - POPA - Fisheries Observer Program of the Azores
3 - CETPESCA - Monitoring interactions of cetaceans and the squid fishery. Contract Research with the Regional Secretariat for the Environment and the Sea
4 - DEMERSAIS - Monitoring deep-sea fisheries cruises
5 - Ships - Management and operation of RV Arquipélo and LI Águas-Vivas

- some reports:


Title of Research Group:
DSORL - Dynamical Systems and Ocean Robotics Laboratory

Principal Investigator:
Carlos Jorge Ferreira Silvestre

Main Scientific Domain:
Engenharia Electrotécnica e Informática

Group Host Institution:
Instituto Superior Técnico - Universidade Técnica de Lisboa

Funding, source, dates

Source Project Reference DSORL Funding in 2010

National
AdI AIRTICI 2009-2012 QREN

European
EC FREESubNET - 2006-2010 MRTN-CT-2006-036186
EC CO3AUVs 2009-2012 FP720073 ICT-2007.2.1
EC TRIDENT 2010-2013 FP7248497 ICT-2009.2.1

Objectives & Achievements

Objectives

The key objectives of the R&D work carried out at the DSORL are twofold: i) to study a number of challenging theoretical problems in the areas of advanced robotic vehicle systems design, navigation, and control, and ii) exploit the theoretical methodologies developed to yield faster, cheaper, and far more efficient tools for ocean exploration and exploitation as well as critical infrastructure monitoring, than those available today. The tools include surface and underwater robots, as well as aerial vehicles working as communication relays or re-directing the operations of marine vehicles upon detection of relevant episodic events. These goals have motivated the definition of a research and development program addressing theoretical and practical engineering topics, as well as issues that are at the crossroads of marine science and technology, the main focus of the cooperative research and development work set forth under Thematic Area A. Two main lines of action underpin the work carried out at the DSORL:

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.

- Theoretical Objectives:

A. Linear and nonlinear systems theory: study and development of theoretical tools for the analysis and design of linear and nonlinear control / filtering systems.

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.


D. Motion Control of single and multiple vehicles under stringent communication constraints, including those imposed by a very special medium: the ocean, with its plethora of phenomena that include multiple path effects, ray bending, and fading. Problems addressed: i) Motion control of autonomous vehicles with inner-outer loop control loops; ii) Visual servoing control; iii) Path Following; iv) Terrain Contour Tracking; v) Coordinated/cooperative control and navigation of groups of autonomous vehicles; vi) Diver assisted control by resorting to robot companions; vii) Networked control over faulty communication links.

E. Development of advanced methods for Cooperative Multiple Vehicle Mission Planning and Execution under energy and temporal constraints, in the presence of stationary and moving obstacles.

- Practical Objectives:
Objectives & Achievements

A. Design and development of Autonomous Underwater Vehicles (AUVs), Autonomous Surface Crafts (ASCs), and Unmanned Air Vehicles (UAVs); with on-board integration of scientific sensor suites and data acquisition / logging systems.

B. Distributed hardware and software architectures for coordinated navigation and motion control of multiple vehicles as well as mission control of heterogeneous platforms.

C. Tests and scientific missions with the robots developed in cooperation with the scientific partners in Thematic Area A and other international institutions.

D. Dissemination actions for young students and the general public with the objective of bringing visibility to the challenging area of advanced marine / aerial robotics systems and their application to demanding scientific, surveillance, and security mission scenarios.

Main Achievements

THEORETICAL ACHIEVEMENTS

1. Further advances in the formulation of a Multiple-Model Adaptive Control (MMAC) architecture for linear time-invariant and time-varying plants subjected to structured and unstructured uncertainty, and sensor noise. The techniques yield - under certain conditions - closed loop robust stability and performance guarantees.

2. Study of new algorithms for control and state estimation on SE(3) to: i) extend the LQR problem to non-compact Lie Groups and ii) solve the state estimation problem of left-invariant dynamical system evolving on the special Euclidean group SE(3) with implicit output functions. These techniques have wide ranging applications in control and estimation of autonomous robotic vehicles equipped with vision systems.

3. Further developments on multiple model adaptive estimation (MMAE) and model identification (MMAI) methods that rely on a minimum energy criterion.

4. Further developments on a new methodology for multiple vehicle cooperative path planning to meet desired temporal and energy expenditure objectives, with due account for temporal or spatial deconfliction as well as communication and geophysical-based navigational requirements.

5. Further studies and assessment in simulation of the efficacy of a set of algorithms for cooperative motion control of multiple autonomous marine vehicles in the presence of communication failures, with due account for collision avoidance in dynamic environments.

6. Study and assessment (in simulation and through field tests) of the performance achievable with time-coordinated path following systems for multiple UAVs over time-varying networks using L1 adaptation (work done in cooperation with the Naval Postgraduate School. Monterey, CA and the Univ. Illinois, Urbana, USA).

7. Development of Lyapunov-based adaptive nonlinear control systems with application to the design of depth tracking and attitude controllers for underwater towed vehicles with parametric uncertainty.

8. Further development of new algorithms for AUV single beacon acoustic navigation in the presence of unknown ocean currents.

9. Improvement of the capabilities of “NetMarSyS: A Networked Marine Systems Simulator for Hardware-In-The-Loop Testing of Cooperative Multiple Vehicle Control and Navigation Systems” developed at the ISR/IST to assess the performance of advanced cooperative and navigation control algorithms prior to system implementation and testing at sea.

10. Study of nonlinear filtering structures for USBL tightly coupled inertial navigation and development of nonlinear GPS/IMU based observers for rigid body attitude and position estimation.

11. Derivation of a Rotorcraft image based controllers for extended flight envelope coverage. The proposed solution consists of a nonlinear state feedback controller for thrust and torque actuations that uses directly in the control loop the image features.

12. Further development of new methods to prove almost input-to-state stability (ISS) and almost global stability of nonlinear “rotational motion” systems by exploiting the combined use of Lyapunov Functions and Density Functions.

13. Development of algorithms for Nonlinear Attitude Estimation Systems Using Active Vision and Inertial Measurements, as applied to the problem of estimating the attitude of a rigid body equipped with a triad of rate gyros and a pan and tilt camera.

14. Further results on Networked Control Systems. New developments were obtained for a class of systems that is especially suited to model networked control systems utilizing CSMA-type protocols, with stochastic intervals between transmissions and packet drops.

15. Development of a new methodology for optimal placement of networked acoustic sensors to track multiple underwater targets by resorting to tools from estimation theory and multiple-objective optimization.

PRACTICAL ACHIEVEMENTS

1. Design, development, and test of an autonomous quadrotor for the inspection of critical infrastructures. This aerial vehicle, developed under the AIRTICI project, is equipped with video cameras and lasers that together with advanced control and navigation algorithms will allow the robot to operate close to walls or under bridges without GPS.

2. Design, development, and test of an integrated Ultra Short Baseline (USBL) and Inertial Navigation System (INS) to be used as a low cost cooperative navigation system for underwater robotic vehicles. Preliminary sea tests were conducted in Sesimbra in the scope of the TRIDENT project.

3. Further development and testing of MEDUSA, an autonomous semi-submersible vehicle (SSB) that is being used in the scope of the EU
Objectives & Achievements

CO3AUVs project. The vehicle is equipped with acoustic devices for underwater target tracking and complementary terrain-based / single beacon navigation experiments.

Group Productivity

Publications in peer review Journals


Other international publications


Paulo Rosa, Carlos Silvestre, Jeff S. Shamma, Michael Athans, Fault Detection and Isolation of an Aircraft Using Set-Valued Observers, 18th IFAC Symposium on Automatic Control in Aerospace ACA2010, Nara, Japan, September 2010.


### Other national publications


### Ph.D. thesis completed


Group Productivity

<table>
<thead>
<tr>
<th>Title: Sensor-based Navigation and Control of Autonomous Vehicles.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student: Pedro Batista</td>
</tr>
<tr>
<td>Thesis reviewers: Prof. Claude Samson (INRIA Sophia Antipolis, France), Prof. Robert Mahoney (Australian National University, Canberra, Australia).</td>
</tr>
<tr>
<td>Concluded 2010.</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Title: Nonlinear Navigation System Design with Application to Autonomous Vehicles.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student: José Maria Vasconcelos.</td>
</tr>
<tr>
<td>Thesis reviewers: Prof. Anders Rantzer (University of Lund, Sweden), Prof. Jorge Miranda Dias (Universidade de Coimbra, Portugal).</td>
</tr>
<tr>
<td>Concluded 2010.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Title: Positioning and Navigation Systems for Robotic Underwater Vehicles.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student: Alex Alcocer Penas.</td>
</tr>
<tr>
<td>Thesis reviewers: Prof. Jérôme Jouffroy, (University of Southern Denmark), Prof. Aníbal Castilho Coimbra de Matos (Faculdade de Engenharia da Universidade do Porto, Portugal).</td>
</tr>
<tr>
<td>Concluded 2010.</td>
</tr>
</tbody>
</table>

Patents/prototypes

1. 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. 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.

2. 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.

3. 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.

4. 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).

5. 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.

6. Autonomous Quadrotor– designed and built by ISR/IST. A quadrotor helicopter with payload capability of about one kg. Design in the scope of the AIRTICI project for aerial vehicle hardware and software architectures test and evaluation. This prototype will be used in bridge inspection tasks.

7. Medusa – 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 up to 4 vehicles acting cooperatively will be used in the scope of the EU COGAUVs (Cognitive marine robotics) project for assisted diving operations.

Organization of conferences

<table>
<thead>
<tr>
<th>Member of the Technical Committee of the 18th European Signal Processing Conference - EUSIPCO 2010, Aalborg, Denmark, 2010.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Member of the Technical Committee of the 9th Portuguese Conference on Automatic Control-CONTROLO2010, Coimbra, September 2010.</td>
</tr>
</tbody>
</table>
Group Productivity

Member of the Technical Committee of the 7th IFAC Symposium on Intelligent Autonomous Vehicles, Lecce, Italy, September 2010.

Chairman of the session: Fault Diagnosis II, 49th IEEE Conference on Decision and Control (CDC 2010), Atlanta, Geórgia, USA, December 2010.

Chairman of the session: Networked Control Systems IV, 49th IEEE Conference on Decision and Control (CDC 2010), Atlanta, Geórgia, USA, December 2010.

Chairman of the session: Modeling III, 49th IEEE Conference on Decision and Control (CDC 2010), Atlanta, Geórgia, USA, December 2010.

Member of the Technical Committee of the 49th IEEE Conference on Decision and Control (CDC 2010), Atlanta, Georgia, USA, December 2010.

Member of the Technical Committee of the International Conference on Emerging Technologies and Factory Automation, ETFA’2010, Bilbao, Spain, September 2010.

Member of the Technical Committee of the 7th IFAC Symposium on Intelligent Autonomous Vehicles, IAV 2010, Lecce, Italy, September 2010.

Chairman of the session: Navigation and Path Planning, American Control Conference (ACC 2010), Baltimore, Maryland, USA, July 2010.

Industry contract research


Internationalization

[1] Naval Postgraduate School, Monterey, CA (USA) – a long standing collaborative research program on AUV and UAV Navigation, Guidance, and Control (NGC) as well as cooperative multiple vehicle path planning and control with temporal and spatial deconfliction.

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


[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.


[6] School of Electrical and Computer Engineering, Georgia Institute of Technology (USA) – exchange of research personnel and joint initiatives on development of decision systems based on Set Valued Observers.


* Participation in International Technical Committees

Chair and Member of the IFAC Technical Committee on Marine Systems.

Member of the IFAC Technical Committee on Aerospace

Member of the IEEE Technical Committee on Aerospace Control

Member of the IFAC Technical Committee on Intelligent Autonomous Vehicles.

Associate Editor, IEEE Oceanic Engineering.

Vice-President of EurOcean, the European Portal for Marine Science and Technology.
**Group Description**

**Title of Research Group:** (RG-LVT-50009-3447) 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**

- Source Project Reference Funding in 2010
  - FCT SIPM PTDC/EEA-ACR/73749/2006
  - FCT MODI PTDC/EEA-ACR/72201/2006
  - FCT SMARTVISION PTDC/EIA/73633/2006
  - FCT WEAM PTDC/ENR/70452/2006
  - FCT PHITOM PTDC/EEA-TEL/71263/2006
  - FCT U-BOAT PTDC/EEA-CRO/67066/2006
  - FCT ADDI PTDC/SAU-BEB/103471/2008
  - FCT ARGUS PTDC/EEA-CRO/098550/2008
  - FCT VISTA PTDC/EIA-EIA/105062/2008
  - FCT HEARTACK PTDC/EEA-CRO/103462/2008
  - FCT SENSOCEAN PTDC/EEA-ELC/104561/2008
  - FCT URBISNET PTDC/EEA-CRO/104243/2008
  - FCT PRINTART PTDC/EEA-CRO/098822/2008
  - FCT Fibromyalgia PTDC/SAU-BEB/104948/2008
  - FCT ADCOD PTDC/EEA-TEL/099973/2008
  - EU UAN FP7, ICT/Security
  - EU OAEx FP7, IRSES, PEOPLE
  - EU IMASEG3D PIIF-GA-2009-236173
  - EU SIMBAD FT7-ICT-2007-C

**Objectives & Achievements**

### Objectives

**Fundamentals.**

Fitting bilinear models to given data with missing measurements is a core problem in many applications stemming from computer vision, wireless communications, machine learning, etc. This translates into difficult constrained nonconvex optimization problems which are commonly addressed on a case-by-case basis. The goal is to develop a novel optimization framework to enable an unified and modular treatment of this class of inference problems.

**Sensor Networks.**

Consensus is an iterative distributed algorithm that computes the global average of data distributed among a network of agents using only local communications. It arises in many different areas, e.g., distributed data fusion and coordination of mobile autonomous agents. The speed of consensus algorithms depends critically on the choice of the weights with which neighboring nodes mix their states. Design of optimal weights is well-understood for networks with fixed topologies. However, in practice, networks usually exhibit random time-varying topologies either because the underlying wireless channels supporting the network links experience random fading or the network protocol itself is randomized, e.g., link states along time are controlled by a randomized protocol like standard gossip. The goal is to design the mixing weights for consensus algorithms so that the convergence towards consensus is the fastest possible, for the challenging scenario of networks with random topologies.

Many applications of sensor networks require some form of surveillance or tracking, and thus critically rely on the availability of spatial information, e.g., knowing the location of a detected target, or the positions of sensing nodes. Due to economic constraints conventional solutions for localization based on GPS are usually unfeasible, and calibration of sensor positions is often not practical when a very large number of nodes must be deployed. One of the research goals is to obtain estimates for the positions/parameters of point-like or diffusive sources from unreliable measurements of range, received signal strength, or concentrations of some types of gases obtained at the sensors.

**Underwater Acoustics**
Objectives & Achievements

Taking advantage of the spatial diversity of multi-sensor arrays and the inherent physical media variablity, the emphasis of this group is to provide enhanced methods for underwater acoustic channel distortion mitigation. Areas of application include: mobile and fixed node underwater acoustic networks, target detection in port protection activities and remote environmental monitoring. This group counts with 4 permanent staff professors, 3 postdoc, 4 PhD students, 2 undergraduate students and 2 engineers.

Image and Video Analysis

In what respects to Image and Video Analysis Several, our group addresses several fundamental problems, guided by key applications. In general, our objectives concern the development of fundamental tools for inferring high level content from image sequences, with applications that range from image recognition to medical image analysis. Examples are the representation and estimation of non-rigid (i.e., deformable) 3D shape of objects from video sequences; the development of representations suitable for image recognition tasks such as image database indexing, information retrieval and object recognition; the recognition of human activity in surveillance applications; the detection of skin lesions in dermoscopic images; and the automatic segmentation of the left ventricle of the heart in ultrasound images.

Main Achievements

Fundamentals.

We developed a novel unified approach to handle seamlessly several bilinear factorization problems in which one of the factors is constrained to lie on a manifold. Also, missing data in the measurements is allowed. We introduced an equivalent problem decoupling the core bilinear aspect from the manifold specificity. We then tackle the resulting constrained optimization problem with Bilinear factorization via Augmented Lagrange Multipliers (BALM). The mechanics of our algorithm are such that only a projector onto the manifold constraint is needed. This work originated an ECCV’10 publication and a journal submission to IEEE-PAMI.

Sensor Networks.

We have developed a method to design optimal weights (i.e., ensuring the fastest speed of convergence) for distributed consensus algorithms running over networks with random topologies. Our results are applicable to networks with correlated random link failures and to networks with randomized protocols. The key was to prove that, for symmetric random links, optimizing the mean-square-error convergence rate can be cast as a convex optimization problem, and, for asymmetric links, optimizing the mean-square deviation from the current average state is also a convex optimization problem. One IEEE-TSP journal paper and one ICASSP’10 conference paper were published. This research was conducted within the Carnegie Mellon-Portugal program in which ISR participates.

We developed centralized algorithms that jointly estimate sensor and target positions from range measurements. These are based on convex semidefinite relaxations of likelihood functions, and as such require very little prior information on sensor positions. This makes them particularly useful for application scenarios where pre calibration is unfeasible. Our methods achieve robustness to outlier measurements by adopting (non-differentiable) cost functions where l1 norms replace the usual squared distances. One conference paper was published, and one IEEE-TSP journal paper was submitted and accepted.

Underwater Acoustics

One of the high points of year 2010 was the organization of the UAN’10 sea trial in the vicinity of the Island of Pianosa (Italy) for testing an underwater acoustic network of sensors for exchanging information between bottom moored and AUV mounted nodes. This sea trial involved partners from the European project UAN plus the personnel and equipment from the NATO Undersea Research Centre in La Spezia (Italy), during the whole month of September. The other topic of interest is the ongoing collaboration with COPPE and IAEPM in Brazil, under the OAEEx Marie-Curie project, which provided the opportunity for setting up an experiment off the Island of Cabo Frio, for acoustic characterization of the upwelling regime in the area. Data analysis of these two sea trials is ongoing.

Image and Video Analysis

In what respects to the recovery of 3D structure from image sequences, we developed a new representation allowing a robust reconstruction of nonrigid paper-like surfaces (like a movie of a waving flag) and a large scale optimal algorithm for point matching. The latter hinges on a new theorem that states the uniqueness of a solution to this combinatorial problem in a convex setting (published on Linear Algebra and Applications). In image recognition, we designed a feature extractor methodology that is able to handle several types of matching problems for which the system has not been trained (oral presentation at CVPR2010) and proposed an efficient representation/normalization procedure for arbitrary 2D shapes and images (presented at ICIP2010). In surveillance, we addressed the characterization of human activities in outdoor scenes, using multiple motion fields, learned from the video data. The model selects the motion fields which best describe the trajectories of the objects of interest and recognizes different types of activities. Finally, in medical imaging, we developed two algorithms for the left ventricle segmentation problem; the first one showed that the use of deep belief networks produce the best results in the field in a public database (presented at ISBI2010 and ICIP2010); the second one, based the use of particle filtering and deep belief networks, demonstrated even better results and was published in CVPR2010 and ICPR2010.

Group Productivity

Publications in peer review Journals


Artem Khmelinskii, Rodrigo Ventura and João Sanches, A Novel Metric for Bone Marrow Cells Chromosome Pairing, Biomedical Engineering, IEEE Transactions on Biomedical Engineering, Vol. 57, No. 6, June 2010.


Other international publications

D. Jakovetic, J. Xavier, J. Moura, Consensus in correlated random topologies: weights for finite time horizon, ICASSP

P. Ekim, J. Gomes, J. Xavier, P. Oliveira, A convex relaxation for approximate maximum-likelihood 2D source localization from range measurements, ICASSP

G. Carneiro, J. Nascimento, A. Freitas, Robust left ventricle segmentation from ultrasound data using deep neural networks and efficient search methods, ISBI

J. Seabra, J. Sanches, On Estimating De-speckled and Speckle Components from B-mode Ultrasound Images, ISBI

J. Seabra, J. Sanches, F. Ciompi, P. Radeva, Ultrasonographic Plaque Characterization Using a Rayleigh Mixture Model, ISBI

I. Rodrigues, J. Sanches, Photobleaching/Photobleaching Differential Equation Model for Intensity Decay of Fluorescence Microscopy Images, ISBI

J. Sanches, J. Sousa, P. Figueiredo, Bayesian Fisher Information Criterion for Sampling Optimization in ASL-MRI, ISBI


D. Castells, J. Rodrigues, J. du Buf, Obstacle detection and avoidance on sidewalks, VISAPP

G. Carneiro, J. Nascimento, Multiple dynamic models for tracking the left ventricle of the heart from ultrasound data using particle filters and deep learning architectures, CVPR

G. Carneiro, The Automatic Design of Feature Spaces for Local Image Descriptors using an Ensemble of Non-linear Feature Extractors, CVPR


R. Sousa, J. Rodrigues, J. du Buf, Recognition of facial expressions by cortical multi-scale line and edge coding, ICIAR

J. Mota, P. Aguiar, Efficient Methods for Point Matching with Known Camera Orientation, Image Analysis and Recognition, ICIAR


R. Saruthirathanaworakun, J. Peha, Dynamic primary-secondary spectrum sharing with cellular systems, CrownCom

N. MARTINS, L. CALADO, A. PAULA, S. JESUS, Classification of three-dimensional ocean features using three-dimensional empirical orthogonal functions, ECUA

A. SILVA, O. RODRÍGUEZ, F. ZABEL, J. HUILLERY, S. JESUS, Underwater Acoustic simulations with a time variable acoustic propagation model, ECUA

O. RODRÍGUEZ, A. SILVA, F. ZABEL, S. JESUS, The TV-APM interface: a web service for collaborative modeling, ECUA

U. VILAPORNSAWAL, A. SILVA, S. JESUS, Combined adaptive time reversal and DFE technique for time-varying underwater communications, ECUA

E. Zamanizadeh, J. Gomes, J. Biocas-Dias, Identification of sparse time-varying underwater channels through basis pursuit methods, ECUA

O. Rodríguez, A. Silva, J. Gomes, S. Jesus, Modeling arrival scattering due to surface roughness, ECUA

P. FELIBERTO, P. SANTOS, S. JESUS, Tracking source azimuth using a single vector sensor, SENSORCOMM

M. Bicego, A. Martins, V. Murino, P. Aguiar, M. Figueiredo, 2D Shape Recognition using Information Theoretic Kernels ICPR

M. Silveira, J. Marques, Boosting Alzheimer Disease Diagnosis using PET images, ICPR

G. Carneiro, J. Nascimento, The fusion of deep learning architectures and particle filtering applied to lip tracking, ICPR

G. Carneiro, A Comparison Study on the Use of an Ensemble of Feature Extractors for the Automatic Design of Local Image Descriptors, ICPR

M. Silveira, J. Marques, Boosting Alzheimer’s Disease Diagnosis using PET images, ICPR


J. Nascimento. J. Marques, Improved Gradient Vector Flow for robust shape estimation in medical imaging, EMBC

R. Gafaniz, J. Sanches, ATP Consumption and Neural Electrical Activity: A Physiological Model for Brain Imaging, EMBC

I. Rodrigues, J. Sanches, Denoising of LSFCM images with compensation for the Photobleaching/Photobleaching effects, EMBC

N. Santos, J. Sanches, P. Figueiredo, Bayesian optimization of perfusion and transit time estimation in PASL-MRI, EMBC
### Group Productivity

<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>R. Ventura</td>
<td>Classifier-assisted metric for chromosome pairing, EMBC</td>
</tr>
<tr>
<td>J. Seabra</td>
<td>Ultrasonographic Characterization and Identification of Symptomatic Carotid Plaques, EMBC</td>
</tr>
<tr>
<td>A. Domingues</td>
<td>Automatic Annotation of Actigraphy Data for Sleep Disorders Diagnosis Purposes, EMBC</td>
</tr>
<tr>
<td>O. Adamec</td>
<td>Statistical characterization of actigraphy data during Sleep and Wakefulness States, EMBC</td>
</tr>
<tr>
<td>M. Silveira</td>
<td>Joint fMRI brain activation detection and segmentation using Level Sets, EMBC</td>
</tr>
<tr>
<td>J. Nascimento</td>
<td>Manifold learning for object tracking with multiple motion dynamics, ECCV</td>
</tr>
<tr>
<td>A. del Bue</td>
<td>Bilinear factorization via Augmented Lagrange Multipliers, ECCV</td>
</tr>
<tr>
<td>E. Zamanizadeh</td>
<td>Identification and matching of sparse delay-Doppler spread functions from high-frequency communications signals, OCEANS</td>
</tr>
<tr>
<td>J. Crespo</td>
<td>The 2D Orientation is Unique Through Principal Moments Analysis, ICIP</td>
</tr>
<tr>
<td>R. Guerreiro</td>
<td>Learning Simple Texture Discrimination Filters, ICIP</td>
</tr>
<tr>
<td>M. Bicego</td>
<td>Combining Free Energy Score Spaces with Information Theoretic Kernels: Application to Scene Classification, ICIP</td>
</tr>
<tr>
<td>J. Nascimento</td>
<td>Efficient search methods and Deep belief Networks with particle filtering for non-rigid tracking: Application to lip tracking, ICIP</td>
</tr>
<tr>
<td>J. Nascimento</td>
<td>Discriminative Model Selection for Object Motion Recognition, ICIP</td>
</tr>
<tr>
<td>J. Nascimento</td>
<td>Classification of Complex Pedestrian Activities from Trajectories, ICIP</td>
</tr>
<tr>
<td>J. Nascimento</td>
<td>Improving the Robustness of Gradient Vector Flow in Cluttered Images, ICIP</td>
</tr>
<tr>
<td>A. Domingues</td>
<td>Actigraphy Data Classification during Sleep and Wakefulness States, ESRS</td>
</tr>
<tr>
<td>O. Adamec</td>
<td>A Mixture Distribution Model to describe Actigraphy Data during Sleep and Wakefulness States, ESRS</td>
</tr>
<tr>
<td>J. Sanches</td>
<td>Cell Phone based Continuous Tympanic Temperature Measurement System, ESRS</td>
</tr>
<tr>
<td>J. Sanches</td>
<td>Cell Phone based Sleep electronic Diary (SeD), ESRS</td>
</tr>
<tr>
<td>D. Bajovic</td>
<td>Distributed detection over random networks: a large deviations analysis, ALLERTON</td>
</tr>
<tr>
<td>A. Martins</td>
<td>Turbo Parsers: Dependency Parsing by Approximate Variational Inference, EMNLP</td>
</tr>
<tr>
<td>A. Martins</td>
<td>Online MKL for Structured Prediction, NIPS-NDMKL</td>
</tr>
<tr>
<td>A. Martins</td>
<td>Augmenting Dual Decomposition for MAP Inference, NIPS-NDMKL</td>
</tr>
<tr>
<td>R. Belo</td>
<td>The impact of broadband on students’s performance, ICIS</td>
</tr>
</tbody>
</table>

### Other national publications


### Ph.D. thesis completed


### Patents/propotypes

- Prototypes: SmartVision: active vision aid for the blind.

### Organization of conferences

- Program committees:
  - IEEE International Conference on Image Processing (ICIP)
  - IEEE International Symposium on Biomedical Imaging (ISBI)
  - Conference of the IEEE Engineering in Medicine and Biology Society (EMBC).
Group Productivity

International Conference on Pattern Recognition (ICPR)
International Conference on Computer Vision Theory and Applications (VISAPP)
International Conference on Image and Signal Processing (ICISP)
International Conference on Image Analysis and Recognition (ICIAR).
Conference on Computer Vision and Pattern Recognition (CVPR)
Canadian Conference on Computer and Robot Vision (CRV)
Computational Modeling of Objects Presented in Images: Fundamentals, Methods and Applications (CompIMAGE).
Mexican International Conference on Artificial Intelligence (MACAI)
Mexican Conference on Pattern Recognition (MCPR).

Other Events:
João Paulo Costeira e Gustavo Carneiro organized, at Museu Nacional do Azulejo, Lisboa, Portugal, the PRINTART project workshop “Where Computer Vision Meets Art”, that gathered researchers from the areas of computer vision and art history (http://printart.isr.ist.utl.pt/workshops.htm).

Internationalization

D. Jakovetic, J. Xavier, J. Moura, Weight optimization for consensus algorithms with correlated switching topology, IEEE Trans. on Sig. Proc., vol. 58, no.7, pp. 3788-3801, July
M. Bicego, A. Martins, V. Murino, P. Aguiar, M. Figueiredo, 2D Shape Recognition using Information Theoretic Kernels, IAPR Int. Conf. on Pattern Recogn., Aug.
A. Martins, N. Smith, E. Xing, P. Aguiar, M. Figueiredo, Turbo Parsers: Dependency Parsing by Approximate Variational Inference, SIGDAT Conf. on Empirical Meth. in Natural Language, Oct..
A. Martins, N. Smith, E. Xing, P. Aguiar, M. Figueiredo, Online MKL for Structured Prediction. NIPS Workshop on New Directions in Multiple Kernel Learning, Dec.
D. Castells, J. Rodrigues, J. du Buf, Obstacle detection and avoidance on sidewalks, Int. Conf. on Computer Vision Theory and Applic., May.
A. del Bue, J. Xavier, L. Agapito, M. Paladini, Bilinear factorization via Augmented Lagrange Multipliers, European Conf. on Computer Vision, Sept.
D. Jakovetic, J. Xavier, J. Moura, Consensus in correlated random topologies: weights for finite time horizon, IEEE Int. Conf. on Acoust., Speech and Sign. Proc., March
R. Belo, P. Ferreira, R. Telang The impact of broadband on students’s performance, Int. Conf. on Information Syst., Dec.
J. Seabra, J. Sanches, F. Ciompi, P. Radeva, ULTRASONOGRAPHIC PLAQUE CHARACTERIZATION USING A RAYLEIGH MIXTURE MODEL, IEEE Int. Symp. on Biomedical Imaging
Group Description

Title of Research Group: (RG-LVT-50009-3508)
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

i) INTERNATIONAL


ii) NATIONAL

DCCAL: Discrete Cameras Calibration using Properties of Natural Scenes
BIOLOOK: Biomimetic Oculomotor Control for Humanoid Robots
MMCACC: Advanced Monte Carlo Algorithms for Computational Control

Objectives & Achievements

Objectives

One of the key objectives of the VisLab is to conduct research in computer and robot vision aiming at (i) the development of new methodologies and tools for computer and robot vision and the (ii) demonstration of such methodologies in challenging applications.

We can learn from biological systems how vision is an extremely powerful sensing modality to perceive the surrounding world (colour, texture, motion, shape, contrast, etc.) and act accordingly, offering large spatial resolution and reasonable temporal dynamics.

Our 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. Thanks to massive developments in computing power we can now employ powerful learning techniques in the context of vision and robotic problems. The following topics are currently addressed:

- Design of visual geometries and camera networks
- Vision based control, active vision and navigation
- Feature learning and object recognition
- Learning and cognition for (humanoid) 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. Amongst other topics,
Objectives & Achievements

we are currently investigating the following problems:

a. Video surveillance systems able to learn and understand patterns of human activity
b. Calibration of camera networks and nonconventional camera systems
c. Model based tracking and object recognition
d. Gesture analysis and recognition

Main Achievements

The work at VisLab aims to develop new methodologies for computer and robot vision as well as to address several applications with societal impact. The approach followed is strongly multidisciplinary with close links to biology, neuroscience or psychology. The group is regularly involved in large-scale, ambitious projects with international partners (e.g. EU).

Some of the main achievements are listed below:

Humanoid robotic platforms

The iCub humanoid platform hosted at the group is now fully functional and serving as a testbed for research in the broad areas of cognitive systems. We have actively contributed to the iCub community by developing both methodologies and software for perception, learning and control of the platform. During 2010, we have continued the development of another mobile platform (Vizzy) combining a humanoid torso and a mobile base.

Cognitive systems and vision

We have pursued efforts to develop methods for sensorimotor learning and coordination with complex humanoid platforms. The affordance model has been extended in the context of a collaboration with international partners to include relational learning tools that should allow for dealing with much larger datasets and complex tasks. This method follows closely findings in developmental psychology and neuroscience.

Human activity analysis

We have continued the development of computer vision methods able to provide an interpretation of the observed scenes. Some methods developed in the context of the URUS project have now been further developed in the context of a project integrated in the CMU-Portugal partnership.

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. This work is the core of a new national project (DCCAL)

Participation in EU Projects- In addition to key contributions to our major EU Projects (Robotcub and Handle), we have started two new EU Projects (Robosom and First-MM) on the topics of robotic sense of movement and mobile manipulation. The Robosom project was ranked first amongst all projects submitted to the IST-Call 4 on cognitive projects (~120 projects)

International Partnerships - We have also actively participated in the IST-EPFL Joint PhD Initiative with students involved in the joint doctoral studies between IST and EPFL as well as in the CMU-PT dual doctoral program.

Group Productivity

Publications in peer review Journals

• Tracking objects with generic calibrated sensors: an algorithm based on color and 3D shape features, Matteo Taiana, João Santos, José Gaspar, Jacinto Nascimento, Alexandre Bernardino, Pedro Lima, Robotics and Autonomous Systems, special issue on Omnidirectional Robot Vision, Vol. 58, Issue 6, 30 June, pp. 784-795, 2010
• Discrete camera calibration from pixel streams, Etienne Grossmann, José António Gaspar and Francesco Orabona, Computer Vision and Image Understanding (Special issue on Omnidirectional Vision, Camera Networks and Non-conventional Cameras), Volume 114, Issue 2, Pages 198-209, February 2010

Other international publications

BOOK CHAPTERS

CONFERENCES
- Sensor-Based Self Calibration of the iCub’s Head, José Santos, Alexandre Bernardino, José Santos-Victor, Proc. of IROS 2010 - IEEE/RSJ International Conference on Intelligent Robots and Systems, Taipei, Taiwan, October 2010
- Learning words and speech units through natural interactions, Jonas Hörnstein, José Santos-Victor, Proc. of Interspeech 2010 - International Conference on Spoken Language Processing, Makuhari, Japan, 2010
- Reconstruction Of Isometrically Embedded Flat Surfaces From Scaled Orthographic Image Data, Ricardo Ferreira, Ph.D. Thesis, Instituto Superior Técnico, Universidade Técnica de Lisboa, 2010
- TRC LabMate mobile platform, equipped different sorts of cameras, including panoramic ones if curved mirrors.
- 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. This robot was developed at VisLab since 2001 and was one of the most versatile humanoid robots in Portugal.
- Vizzy –humanoid platform mounted on a Segway mobile base. The first stage of integration was completed in 2010 and software development and integration will be done in 2011. This platform was developed within the lab and combines the flexibility and robustness of Baltazar with mobility. Some parts of the mechanical design were inspired after our design for the iCub.
- One robotic head designed for the iCub, each with 6 degrees of freedom, an inertial sensor, audio and ability to perform facial expressions.
- iCub humanoid platform: this humanoid platform was developed within the RobotCub project and, with 54 degrees of freedom, it is the most sophisticated humanoid platform worldwide.
Group Productivity

- One Pioneer mobile platform equipped with a Katana manipulator used for experiments in navigation, SLAM or mobile manipulation.
- 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
- The ISobotNet is a testbed for Networked Robot Systems developed by VisLab together with ISLab and MRLab, composed of an indoor area of around 160 m² with 10 webcams placed at the ceiling such that some of the fields of view do not overlap. Besides the camera sensors, four Pioneer AT and one ATRV-Jr robots are available. Each of the robots is equipped with sonars, onboard cameras, laser range finder and is Wi-Fi connected to the network.

Organization of conferences

Vislab members organized the following conferences / workshops / summer schools:

- “Towards Closing the Loop: Active Learning for Robotics”,
  Full day workshop at Robotics: Science and Systems 2010.
  Venue: University of Zaragoza, Spain.
  http://users.isr.ist.utl.pt/~rmcantin/pmwiki/pmwiki.php/RSS10/RSS10

- iCub and friends: a workshop for open source robotics",
  held with IEEE Humanoids 2010,
  http://eris.liralab.it/wiki/The_iCub_Humanoids_%2710_workshop

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

a. Robotics Science and Systems (RSS)
b. Emerging Technologies and Factory Automation, ETFA
c. International Conference on Computer Vision Systems, ICVS
d. International Conference on Image Analysis and Recognition, ICIAR
e. IEEE Intl. Conference on Robotics and Automation, ICRA
f. IEEE Computer Society Conf. Computer Vision and Pattern Recognition, CVPR
g. IEEE Intl. Conf. on Intelligent Robots and Systems, IROS
h. International Conference on Development and Learning, ICDL

Industry contract research

- One EU project started in 2011, includes a large Robotics Company (KUKA)
  -- Collaborative project with the company Ydreams

Internationalization

The group has more than 50% of international members and currently comprising 8 different nationalities. Most core activities are carried out in the context of large international projects.

EU PROJECTS AND PARTNERSHIPS
EU Proj:
+ ROBOTCUB
+ FIRST-MM
+ ROBOSOM
+ HANDLE
FCT-CMU/ MAIS-S

PARTNERSHIPS
IST-EPFL Joint Doctoral Initiative
CMU-Portugal Joint Doctoral Initiative

NATIONAL PROJECTS WITH INTL. PARTNERS
- FCT Proj. BIOLOOK – Uppsala Univ.
- FCT Proj. MCMCAC – Univ. of Vancouver.
Group Productivity

- FCT DCCAL - IDIAP.

PARTICIPATION IN THESE COMMITTEES ABROAD
- N. Greggio, "Unsupervised Object Segmentation, Representation, and Tracking for Humanoid Robots",
  Scuola Superiore Sant’Anna, Pisa, Italy.

SUPERVISION OF INTERNATIONAL STUDENTS
- Afshin Dehghan, BSc student, Univ. of Tehran, Iran
- Ashish Jain, BE student, Manipal Inst. of Technology, India
- Misel Batmendijn (IAESTE), BSc student, Tech. University of Kosice, Slovakia
- Urbain Prieur, UPMC, Paris, France. PhD co-tutela IST-UPMC.

INVITED TALKS/SEMINARS
José Santos-Victor,
- Reverse Engineering the Brain with Humanoid Robots, invited talk,
  (http://www.iciar.uwaterloo.ca/iciar10/talks.php)
- Bioinspired Robotics and Vision with Humanoid Robots," Keynote speaker,
  7th Intl. Conf. on Informatics in Control, Automation and Robotics (ICINCO), Madeira, June 2010.

A. Bernardino,
- Object Detection and Tracking on the iCub, Workshop iCub and Friends, IROS 2010, Taiwan.

Ruben M.-Cantin
- Towards Closing the Loop: Active Learning for Robotics, Univ. Seville, May 2010,
  - Active Learning for Developmental Robotics, Max-Planck Institute, Tuebingen, July.

REVIEWERS INTERNATIONAL JOURNALS
- Autonomous Robots
- EURASIP Journal on Advances in Signal Processing
- IEEE Transactions:
  + Autonomous Mental Development
  + Biomed Eng.
  + Circuits and Systems for Video Technology
  + Image Proc.
  + Neural Systems & Rehabilitation Engineering
  + PAMI
  + Robotics
  + System Man and Cybernetics
- Intl. J. of Humanoid Robotics
- Intl. Journal of Robotics Research
- J. of Robotics and Autonomous Systems
- J. of Intelligent and Robotic Systems
- J. of Real-Time Image Processing

Government/Organization contract research
- José Santos-Victor; IST Board Member, Vice-President for International Affairs
- José Santos-Victor; General Secretary of the CLUSTER network (www.cluster.org)
- José Santos-Victor; IST Director for the IST-EPFL Joint Doctoral Program
- Alexandre Bernardino, IST Dept of Electrical and Computer Engineering, Member of the Board
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
- 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
Objectives & 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:

- Promote the IST Design Studio, which aimed at strengthening research and education in engineering design to improve manufacturing competitiveness and innovation.
- 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) (Amaral and Ferrão, 2006, Behrens et al., 2007).
- 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.
- Obtain significant results on carbon and water dynamics in forests and grasslands (Granier et al., 2007, Luysaeraet, 2007, Pereira et al. 2007).
- Provide support to Portuguese public policy on the use of natural carbon sinks.
- Publish a special number of “Philosophical Transactions of the Royal Society of London B” with results on the DEB Theory, with two papers by ISR (Theme issue ‘Developments in dynamic energy budget theory and its applications’, compiled and edited by Tânia Sousa, Tiago Domingos, Jean-Christophe Poggiale and Bas Kooijman; 365 (1557) : 3413 - 3590).

Group Productivity

Publications in peer review Journals


Eight years of continuous carbon fluxes measurements in a Portuguese eucalypt stand under two main events: drought and felling. Agricultural and Forest Meteorology (aceite para publicação em 2010/12/16).


Group Productivity


Other international publications


Other national publications


Mota, R., T. Domingos (2010), Indicadores económicos de sustentabilidade e bem-estar, Revista CAIS.

Teixeira, C., T. Domingos (2010), A Biodiversidade e a Agricultura, Revista CAIS.

Teixeira, R., T. Domingos (2010). Sequestro de carbono em pastagens, Revista CAIS.


Valada, T., T. Domingos (2010). Biocombustíveis, Revista CAIS.

Serrenho, A., T. Domingos (2010), Energia na Economia, Revista CAIS.

Baptista P., Pina A., Lurdes Ferreira, ”No ambiente e nos incentivos está o ganho”, Artigo no Suplemento “Carro Eléctrico” do Jornal Público do dia 16 de Setembro de 2010


Ph.D. thesis completed


- Duarte Correia . Desenvolvimento e implementação de técnicas tomográficas para a análise de escoamentos com combustão. Doutoramento em Engenharia Mecânica, IST . Data de conclusão: Outubro de 2010

- Maria João Rodrigues . Building integrated photovoltaics (BiPV) technology diffusion into Portuguese urban areas . Doutoramento em Engenharia Mecânica, IST . Data de conclusão: 2010


Organization of conferences

Workshop Lançamento do Projecto ResiSt - Promoção da Resiliência Urbana através da gestão dos stocks de recursos urbanos Kick off Workshop of ResiSt – promoting urban resilience through the management of urban stock resources, 22 April 2010.http://lisboaenova.org /index.php?option=com_content&task=view&id=1299&Itemid=482

1st Workshop “Modelação e Planeamento de Sistemas Energéticos Sustentáveis”, 8 de Janeiro de 2010, IST

2nd Annual MIT-Portugal Conference: Creating Values through Systems Thinking. FEUP, Porto, 28 de Setembro de 2010

Industry contract research

Consulting services for the compensation of environmental impacts of printing and sending electricity invoices – contract with EDP – Energias de Portugal, S. A.

Consulting services for the evaluation of environmental services of the “Cascata da Serra da Estrela” – contract with EDP – Energias de Portugal, S. A. in consortium with two other organizations.

Consulting services for the evaluation, reporting, reduction and compensation of emissions of greenhouse gases – contract with Chamartin Imobiliária e Sustentare, Consultoria de Sustentabilidade, Lda.

Consulting services for the evaluation of sustainability of marine salt production - contract with Necton, S. A. .

Consulting services for the compensation of greenhouse gas emissions - contract with Ecoprogresso, S. A.

Internationalization


Government/Organization contract research

Group Description

Title of Research Group: 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

- "Desenvolvimento da técnica de quimiluminiscência para a detecção directa da composição de misturas de combustíveis em chamas laminares. FCT- PDTC/EME/-MFE/68830/2006-2010"
- "Chamas incidentes-modelação matematica e experimental do seu comportamento instável" FCT-PDTC/EME-NFE/68829/2006-2010

Objectives & Achievements

Objectives

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.

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.

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.

Main Achievements

The work essentially 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 In general the main achievements can be resumed as

- International collaborative research – e.g. University of Lulea-Sweden, Institute of Physics and Mathematics-Russia, UCambridge, and a large consortium (over 50 institutions)
- Organization of a thematic workshop
- International collaboration at the student graduation level (Graduation-University of Lulea-Sweden)

Group Productivity

Publications in peer review Journals

Group Productivity


Other international publications


Simultaneous pressure and heat release measurements in a 150kW powder burner, Göktepe B. a*, Gebart R.b, Leitão N.c, Leitão I. V.c, Merícia J. G.c, Fernandes E. C., SPEIC10: Towards Sustainable Combustion – Tenerife (Spain) 16-18 June 2010

The influence of local stretch rate on flame C2*/CH* chemiluminescent ratio, T. Trindade*, E. C. Fernandes, SPEIC10: Towards Sustainable Combustion – Tenerife (Spain) 16-18 June 2010


The design of pressure probe sensor for combustion chambers, N. Leitão*, E. C. Fernandes, SPEIC10: Towards Sustainable Combustion – Tenerife (Spain) 16-18 June 2010

Detailed Analysis of Flame Chemiluminescence, Filipa Ferro, Edgar C. Fernandes, João Sanches, SPEIC10: Towards Sustainable Combustion – Tenerife (Spain) 16-18 June 2010

Characteristics of Unsteady Lean Premixed Impinging Laminar Flames, Merícia J. G., Fernandes E. C., SPEIC10: Towards Sustainable Combustion – Tenerife (Spain) 16-18 June 2010


The characterization of helical instabilities in swirl flows making use of acoustics probes and cross-correlation analysis, S.V. Alekseenko1, 2, E.C. Fernandes3, I.V. Litvinov2, S.I. Shtork1, 2, International Conference on Methods of Aerophysical Research, ICMAR 2010


Ventura, J M P, Mendes-Lopes, J M C, and Santos N M G: "Development of an instrumented tree trunk to work autonomously collecting temperature information in surface fire propagation", 6th Int. Conf. Forest Fire Research, paper 209, Coimbra, November 2010

Ph.D. thesis completed
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<tr>
<th>Group Productivity</th>
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<tr>
<td>“Influência recíproca de um tronco de árvore e de propagação de fogo em leito florestais”; Virgílio Manuel Ferreira Figueiredo, MEMec, IST, 2010 (supervisor JMC Mendes Lopes, co supervisor J Ventura)</td>
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<tr>
<th>Organization of conferences</th>
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<tr>
<td>15th International Symposium on Applications of Laser techniques to Fluid Mechanics, 05-08 July 2010, Lisbon, Portugal</td>
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<tr>
<td>Organization of Conferência Internacional SPEIC10: Towards Sustainable Combustion – Tenerife (Spain) 16-18 June 2010</td>
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<tr>
<th>Internationalization</th>
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<tr>
<td>‘Aether’ Aero-acoustical and thermo-acoustical coupling in energy processes”, Marie Curie Program MRTN-CT-2006-035713</td>
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FCT Relatório Científico 2010 [Instituto de Sistemas e Robótica - ISR - Lisboa]

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<tr>
<td><strong>Title of Research Group:</strong></td>
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<td><strong>Principal Investigator:</strong></td>
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<td><strong>Main Scientific Domain:</strong></td>
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<td><strong>Group Host Institution:</strong></td>
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<th>Funding, source, dates</th>
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<tr>
<td>“CORPORATE R&amp;D PRODUCTIVITY”, 151460-2009 AO8-PT; EUROPEAN COMMISSION, 29/09/2009</td>
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<td>“CAPITAL HUMANO, CARREIRAS EMPREENDEDORAS E NOVAS EMPRESAS DE BASE TECNOLÓGICA”, CMU-PT/ETECH/0036/2008; FCT, 01/04/2009</td>
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<tr>
<td>Universidades e Criação de Empresas”, PTDC/ESC/71125/2006; FCT, 01/01/08</td>
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<td>“Diversificação”, PTDC/GES/71174/2006; FCT, 01/09/07</td>
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<tr>
<td>“Mudança Tecnológica e Inovação”, CMU-PT/0014/2007; FCT, 01/07/07</td>
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<th>Objectives &amp; Achievements</th>
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<td><strong>Objectives</strong></td>
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<tr>
<td>The main objectives of the “Technology Policy and Management of Technology” Laboratory are:</td>
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<td>- To develop and use advanced research methodologies for the analysis of techno-economic systems;</td>
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<td>- 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;</td>
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<td>- To derive science and technology policies, and innovation and entrepreneurship strategies leading to socio-economic development.</td>
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<tr>
<td>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:</td>
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<tr>
<td>- Systems and Policies for Knowledge Creation, Diffusion and Usage;</td>
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<td>- Higher Education Policy and Management;</td>
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<td>- The Learning Economy;</td>
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<td>- Technology and Economic Inequality;</td>
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<td>- The impact of Entrepreneurship on Regional and National Economic Development;</td>
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<td>- Innovation and Firm Productivity;</td>
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<td>- Technology Management and Collaborative Innovation;</td>
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<td>- Education, Human Capital and Entrepreneurship;</td>
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<td>- Globalization, Diversification and Technology Capacity in the Auto Parts Sector;</td>
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<td>- Mobilizing Information and Communication Technologies: Implications for Regional Development.</td>
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<th>Main Achievements</th>
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<tr>
<td>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:</td>
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<td>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;</td>
</tr>
<tr>
<td>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;</td>
</tr>
<tr>
<td>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.</td>
</tr>
</tbody>
</table>
| iv) Activities promoting technology-based entrepreneurship through extra-mural programs of entrepreneurship education and new venture
Objectives & Achievements

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;
- 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


Other international publications


Other national publications


Internationalization

[Collaborative publication, Research, Graduate Training Networks or other forms of participation of the Research Group at the international level.]
Group Description

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<tr>
<th>Title of Research Group:</th>
<th>(RG-LVT-50009-3589) Centre of Mineral Resources, Mineralogy and Crystallography of the Faculty of Science of Lisbon University (CREMINER)</th>
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</thead>
<tbody>
<tr>
<td>Principal Investigator:</td>
<td>Fernando José Arraiano de Sousa Barriga</td>
</tr>
<tr>
<td>Main Scientific Domain:</td>
<td>Ciências da Terra e do Espaço</td>
</tr>
<tr>
<td>Group Host Institution:</td>
<td>Fundação da Faculdade de Ciências - Faculdade de Ciências da Universidade de Lisboa</td>
</tr>
</tbody>
</table>

Funding, source, dates

Funding from FCT, 2010:
Financiamento da Unidade (FCT-LA/Creminer)
PTDC/CTE_GEX/82678/2006
EUROMARC/00001/2007
PTDC/CTE_GIN/67027/2006
PTDC/CTE-GIX/097946/2008/

Objectives & Achievements

Objectives

Given the continuing extremely high demand for natural resources, and raising concerns on environmental impacts, Creminer continues 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. Creminer is starting a new, large research effort in uranium deposits, related not only to the strategic character of this energy resource but also to the uranium mining impacts.

Studying the sea floor continues dominant in Creminer. Among the infrastructures under the responsibility of Creminer there are the Stable Isotope Laboratory, AmbiTerra, and the Mobile Lab. We need easier 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 Creminer, in addition to current research, in the next few years, include i) Geology of the Deep Biosphere; ii) Geoarchaeology; iii) Uranium exploration and environmental issues. 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. We are applying this expertise to studies in the Azores Sea and in the Arctic near 74ºN.

Another strategic objective of Creminer is to contribute to strengthen the notion that Earth sciences and mineral resources are, more than ever, essential components of sustainable development.

The integration of researcher Ana Isabel Janeiro greatly expands our analytical capabilities, including in I&D activities to support the national industry including, for example, biodiesel research

In line with our expertise in erosion products and use of dam lake sediments, Project RECOVER - Reversing desertification in volcanic terrains, under a semiarid climate, through the reuse of erosion products was presented to, and is under consideration of the Government of Cape Verde.

READE will soon start new projects, on the characterization and environmental recovery of important areas of Minas Gerais (Paraopeba Basin and São Francisco River near Três Marias)

Creminer (and CCV Lousal) will lead the installation of the Lousal Laboratory of Metallogeny Applied to Exploration and Environmental Geochemistry (METALpro) with QREN funding

Other objectives are (a) strengthening the international relationships with the partners in the submitted projects in the areas of mineralogy of uranium minerals and kinetics of mineral dissolution; (b) perform synchrotron experiments with the materials used in Cu adsorption and validate the obtained theoretical models; and (c) undertake a research program on computational mineralogy and geochemistry supporting the existing experimental work, and develop models of metal adsorption onto clay edge surface sites, which are still unexplored by the scientific community.

Main Achievements

The group has achieved internationally recognized success with its studies on i) ore-forming processes and resource characterization on land, including metallic and non-metallic resources (with noteworthy involvement in publication of mineral resource maps); ii) submarine hydrothermal resources and the deep biosphere, and iii) experimental and geochemical modelling of low-temperature processes related with environmental impacts due to heavy metal contamination in landfills and old mining areas. Study the kinetics and mechanisms of adsorption of transition metals and radionuclides onto phyllosilicates and study the geochemical conditions and mineralogical controls in the formation of uranyl-bearing phosphates. There are already very significant (published) results. The main components of these studies are mineralogy and geochemistry, including isotopic geochemistry. Combination of i) and ii) led to original proposals for the exploration for submarine massive
sulphide deposits, ready to be tested in actual seafloor and subseafloor exploration campaigns. Our participation in the discovery of the Loki's Castle Arctic hydrothermal field (and study of Jan Mayen) speak eloquently for our level of involvement in sea floor studies. Work continues with comparisons with the Azores MoMAR examples, and more general studies including the behaviour of platinum group elements serpentinization and energy balance. The main limiting factor, for Creminer as for other research institutions in Portugal, is access to shiptime and submersible use.

Creminer led the Portuguese part of a new consortium with Brazil, for environmental studies, Rede Luso-Brasileira de Remediação e Reabilitação de Ambientes Degradados (READE), created in 2009. Great advances (including new members of the READE network, both in Portugal and in Brazil) will soon lead to active co-operative research and doctoral level education.

Public outreach efforts have strengthened further, largely related to the Centro Ciência Viva Mina de Ciência (Mine of Science Live Science Centre), part of the national network of science centres) already acclaimed as a landmark of capacity for the original production of scientific contents in hands-on exhibits. J Relvas and A Pinto are directors of the Centre.

Concerning the new experimental facilities, the Stable Isotope lab is now installed and, as of 2011, a highly qualified researcher (Ana Isabel Janeiro) was hired by FCUL and charged with running the isotope lab. She is integrated in Creminer. AmbiTerra (run by R Fonseca) gained expertise and general recognition as a top quality laboratory for soils and sediments, including marine sediments, for which AmbiTerra may already be a leading national laboratory. These labs are beginning to perform analyses not only for Creminer’s research but also in the framework of external contracts for applied studies and surveys.

The Mobile Lab has been used extensively for outreach activities, especially with the Cascais municipality, which has developed a close relationship with LA-ISR and Creminer.
Group Productivity

Discovery of a black smoker vent field and a novel vent fauna at the Arctic Mid-Ocean Ridges. Nature Comm 1:126:10.1038/ncomms1124


Other international publications


Barriga FJAS, Farias R, Dias AS, Cruz MI, Carvalho C, Relvas JM, Pedersen R (2010) Mineralogy and Acid-Extractable Geochemistry from the Loki’s Castle Hydrothermal Field, Norwegian Sea at 74 degrees N (South Knipovich Ridge). American Geophysical Union, Fall Meeting 2010, San Francisco

Barriga, F. J. A. S., Carvalho, I. M. Cruz, Á. S. Dias, R. Fonseca, J. M. R. Relvas, and R. B. Pedersen (2010), Mineralogy and geochemistry of Loki’s Castle Arctic vents and host sediments: preliminary results, paper presented at European Geosciences Union General Assembly (EGU), Vienna, Austria.


Carvalho J., Gaspar M., Archer C., 2010. Copper Isotopic Data from Ancient Copper Metallurgy in Ingadanais, (Vila Velha de Ródão) Portugal. 38th International Symposium on Archaeometry, 10-14 Maio, Tampa, Florida, USA.

Dias AS, I Cruz, R Fonseca, FJAS Barriga, RB Pedersen, 2010. Mineralogy and Geochemistry from Trollveggen Vent Field Chimneys and Metalliferous Sediments (Mohns Ridge, West Jan Mayen Fracture Zone at 71°N). AGU Fall Meeting, San Francisco

Fernandes V. A. S. M. and Fritz J. P. (2010). Need to re-evaluate the age of the Popigai Crater and the relevance for the Eocene/Oligocene boundary. The first Moscow Solar System Symposium (IM-S3), Splitter-meeting Popigai.


Gaspar, M. and Carvalho, J., 2010. Mineralogy and chemistry of copper ores and slags from Ingadanais mines: implications for ancient mining, 1º Congresso Internacional Povoamento e Exploração de Recursos Mineiros na Europa Atlântica Ocidental. 10-11 Dez, Braga


Group Productivity

(1M-S3), abstr.# 1M33-PS-46.


Noronha, F., Sousa, M., Carvalho, C., Mora, A.C., Moura, Ramos, J.M.F.(2010) - “Schistose rocks as a resource”- Actas Global Stone Congress – Alicante Sessão I Exploration and Quarry, Págs 1 a 5


Salgueiro, R., Inverno, C., and Mateus, A., 2010 (já on-line; em impressão), Main characteristics and genesis of the Vale de Pães iron skarn (Cuba-Vidigueira, Ossa Morena Zone): Estudos Geologicos (Spain), v. 66 (1), p. 65-74


Other national publications


Barriga FIAS, Roncada, A Dias, I Cruz, A Pinto, C Carvalho, J Relvas, 2010. The Role of Portugal in the Chacterization of Loki’s Castle, the northernmost hydrothermal field (74ºN). Second Portuguese Meeting on Polar Sciences. 26 April 2010, Lisbon Geography Society


Matos, J.X.; Pereira, Z.; Mata, A.; Oliveira, J.T. (2010) Iberian Pyrite Belt mining and geological heritage protection and valorization, the ATLANT Terra Project strategy. VII SIMPÓSIO MINERAÇÃO E METALURGIA SW EUROPEU, Vila Velha de Rodão


Group Productivity

VIII Congresso Nacional de Geologia, Vol.20, Nº17, 4 pág.


Rosa, D., Salgueiro, R., Inverno, C., and Oliveira, D., 2010. Occurrence and origin of alluvial xenotime from Central Eastern Portugal (Central Iberian Zone/ Ossa Morena Zone): Comunicações Geológicas, INETI/LNEG, 97:63-70


Ph.D. thesis completed


Industry contract research

Many studies for industry, on petrography, mineralogy and geochemistry, in Portugal and abroad, for resource evaluation, engineering geology and environmental protection. Creminer’s participation is noteworthy through READE (Minas Gerais, Brasil) and in Angola (contract with GeniusMineira Lda) the former devoted to environmental studies and the latter on mineral resources associated to West Congo Protorezoic belts, with emphasis on iron, IOCG-type (iron-oxide, Cu, Au) deposits, copper, rare-earth elements (including also the natural actinides uranium and thorium) and niobium-tantalum resources. Some quite interesting results have already been produced.

Internationalization

Nearly all of Creminer’s scientific activity is largely international, with co-operation with researchers and institutions from many countries.

Some noteworthy leadership positions occupied by Creminer members are

- Portuguese delegate in the IODP Council and IWG+, Integrated Ocean Drilling Program (F Barriga)
- Portuguese delegate in ECORD Council, European Consortium for Ocean Research Drilling (F Barriga)
- Portuguese delegate in IMA, International Mineralogical Association (F Barriga)
- Member of the SGA Council, Society for Geology Applied to Mineral Deposits (J Relvas)
- Portuguese delegate in “InterRidge Steering Committee”, International Cooperation in Ridge-Crest Studies (P Ferreira)
- Member of InterRidge Working Group on Submarine Mineral Deposits (F Barriga)
- Portuguese co-ordinator of READE Rede Luso-Brasileira de Remediação e Reabilitação de Ambientes Degradados (R Fonseca)
- Co-ordinator of LNEG in project “PROMINE – Nano-particle products from new mineral resources in Europe” (C Inverno)
- Editor of Boletin Geologico y Minero, ITGE, Espanha (J Relvas)
- Rocks for Crops Association – IRCA (R Fonseca, F Barriga)
- European Science Foundation (program EuroMARC) project, “Ultraslow spreading and hydrogen-based deep biosphere: a site survey proposal for zero-age drilling of the Knipovich Ridge”. Individual Project (Portuguese team): Sulfide Petrology, Ore Genesis and the Deep
Creminer is involved in significant activities of assessment of the government and local authorities on mineral resources, environmental protection and land use. This includes participation in the Ciência 2010 FCT meeting as advisers for the announced program for assessment of the deep sea floor resources of the enlarged Portuguese continental Platform. Also, work in shale resources of Northern Portugal; Lithium resources; resources of Marco de Canavezes and Mondim de Basto; special clays of Meirinhas (Pombal).

A Creminer researcher (F Marques) has intense activity with EMAM (Estrutura de Missão para os Assuntos do Mar) as a Marine Geologist and ROV trainee.

Projects funded by FCT include:
- INCA (PTDC/CTE-GIN/67027/2006) Characterisation of crucial mineral resources for the development of renewable energy technologies: The Iberian Pyrite Belt ores as a source of indium and other high-technology elements (D Rosa, PI)
- MELT KP5 (PTDC/MAR/65197/2006) Mantle melting and crust production in the Mid-Atlantic Ridge under influence of Azores hotspot: a case study at KP-5 segment (~37.5ºN) P Ferreira, PI)

The following were selected for funding and will start in April 2011:
- ZHINC (PTDC/CTE-GIX/114208/2009) – Zinc Ores and High Tech Strategic Metals in the Neves-Corvo Deposit, starts in April 2011 (J Relvas, PI)
- TerRiftic (PTDC/MAR/111306/2009) Unraveling melting processes and volcanism on the Terceira Rift, Azores: a melt inclusion and vesicle study (F Marques, PI)
- METMOB (PTDC/CTE-GIX/116204/2009) Element and isotopic mobility and diffusion in metamorphic minerals from granite contact aureoles (starts in April 2011; Isabel R Costa, PI)
Title of Research Group: (RG-LVT-50009-3853)
Intelligent Robots and Systems

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

- ITER TCS/ATS - Activities related to the development of an Air Transfer System prototype and Cask Transfer System Virtual Mockup –F4E-2008-GRT-016 (MS-RH), funded by Fusion for Energy (F4E), Mar/2009-Jun/2010 [together with Instituto de Plasmas e Fusão Nuclear(IPFN)/IST].
- FCT Base component of the pluriannual funding (for 8 ETI).

Objectives & Achievements

Objectives

In 2010 this new group resulted from the merger of the previous Intelligent Systems Lab and Mobile Robotics Lab.

The driving theme of the Intelligent Robots and Systems Group is wide in scope. Its members approach complex systems from a holistic standpoint, rather than focusing on some of the subsystems. The topic of cooperation (among agents and/or robots, among robots and humans) arises naturally from this viewpoint. The historic background of the lab senior researchers has lead us to use Artificial Intelligence concepts (e.g., sequential decision making, learning, task planning, cognitive systems) driven by formal approaches that stem from Systems and Control Theory and from Operations Research (e.g., mathematical modeling, analysis and synthesis, optimization, path planning, navigation, localization, discrete-event systems, estimation theory, simulation, queuing theory, Markov systems). Our research is often driven by practical applications, as we strongly believe it is very important to apply our methodologies to practical domains, as challenging real-life problems provide richer sources of inspiration. Therefore, we have been exploring the application of our research on (cooperative) navigation, sensor fusion, planning under uncertainty, dynamic modeling, non-smooth systems, human-robot interaction, discrete event systems, bio-inspired approaches, cognitive architectures, to networked robot systems, remote handling systems, kinematically complex robots, field robots and soccer robots, humanoid robots, scheduling of queuing networks, and management of health systems, to name but a few.

Our distinctive feature is that we bring together people with a common background on systems theory, but different approaches to modeling, analysis and synthesis of intelligent systems, mainly coming from:

- artificial intelligence, with a focus on decentralized and distributed methods, and with 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., navigation of autonomous systems, sensor and robot networks, institutional management systems, biological systems, and specific interest on modeling, analysis and synthesis methods.

Main Achievements

In 2010, the group main achievements were:

- We formalized the representation of single and multi-robot plans by Petri nets, and used those models to design plans for real robots applied to the soccer domain. The model is based on a closed-loop between the Petri net plan and a Petri net model of the environment surrounding the robot(s), and its stochastic Petri net view enables studying quantitative properties of the system model in closed form, solving Markov chains. The parameters of the environment model Petri net are identified by an estimation algorithm.
- We have also developed a hybrid approach to robot task planning, learning and control under uncertainty that combines supervisory control of DES and Reinforcement Learning (RL). System models and supervisors are represented by finite state automata. RL is used to determine the optimal robot behavior (plan), within the subset of behaviors allowed by the supervisor, iteratively, online and along the robot course of action. Our approach reduces the size of the RL problem and speeds up the convergence to the optimal controller policy. Some events are unobservable by the supervisor and controller. We address this problem by building an environment observer that supports the decision-making process.
- We made significant progress in scaling up multiagent planning under uncertainty techniques, by speeding up the one-step decision problem
**Objectives & Achievements**

in Dec-POMDPs with up to 10 orders of magnitude on some benchmark problems (AAMAS2010). Furthermore, a key strength of the IRS group research team working on these topics is the focus on techniques that are applicable in real-world systems such as multi-robot systems. For instance, we explicitly take into account the limitations of intra-robot communication (ICRA 2010), designing techniques that allow robots to exploit communication when available, but not critically depend on it. Another key aspect of multi-robot systems is that they are embedded in physical environment, which means their interactions are often local only, which we take advantage of when planning their joint task.

- We devised an algorithm that handles Cooperative Perception problems under a common Bayesian framework, based on particle filters, for moving targets and observer sensors. We have also published work on cooperatively improving the localization of robots in a team by using information on the position of an object visually shared by the robots
- We published a paper comparing how Institutional Robotics principles and Swarm Robotics principles handle a problem of transportation between two sides of a scenario connected by a narrow corridor was published. The paper concludes that IR principles (in this case the robots create the traffic-controller institution) are superior to SR principles (simple behaviors and rules of interaction to avoid collisions in the corridor) when the number of robots and the length of the corridor increase.
- We have also started an FCT project joining biologists, philosophers, computer scientists and engineers on related topics.
- We started a research project in the CMU-Portugal program (MAIS-S), which addresses the problem of planning in decentralized multiagent systems in the context of intelligent surveillance networks. The project involves research teams at INESC-ID, IST/ISR, Carnegie Mellon University, and at Observit.
- In the project ITER TCS/ATS, complete studies on manoeuvres and parking of the TCS in the Tokamak and Hot Cell buildings of ITER (The International Thermonuclear Experimental reactor) were conducted. The specification of a test facility for a TCS (mobile vehicle) prototype was carried out, including the required area, and the building and equipment requirements. Update of the Trajectory and Evaluator Software tool (TES) aiming at providing, in CATIA format, the volume occupied by the TCS vehicle when following a 2D path.

**Group Productivity**

**Publications in peer review Journals**

5. A Novel Metric for Bone Marrow Cells Chromosome Pairing, Artem Khmelinskii, Rodrigo Ventura, João Sanches, IEEE Transactions on Biomedical Engineering (in press), 2010
10. Porfírio Silva, Javier Bustamante, "Sociedades Humanas, Sociedades Artificiais: Perspectivas da Convergência", in Trajectos, 16 (Primavera 2010), pp. 7-18

**Other international publications**

6. Multi-robot planning under uncertainty with communication: a case study, João Messias, Matthijs Spaan, Pedro Lima, AAMAS 2010 Workshop
Group Productivity

on Multi-Agent Sequential Decision Making in Uncertain Domains, Toronto, Canada, 2010


Ph.D. thesis completed


Organization of conferences

Matthijs Spaan:

- Organizing committee: AAMAS’10 workshop on “Multi-agent Sequential Decision Making in Uncertain Domains”

- Organizing committee (chair): “POMDP Practitioners Workshop: solving real-world POMDP problems”

Industry contract research

Grupo

- EU F4E-2008-GRT-016 ITER ATS: Activities Related to the Development of an Air Transfer System Prototype and Cask Transfer System Virtual Mock-up, Leader: ISR/IST, Other Partners: ASTRIUM (F), CIEMAT (S), IPFN/IST (P)

- QREN QuadMission: Desenvolvimento de um Sistema Automático e Inteligente para Aeronave Não Tripulada - Plataforma QuadCopter U4, Leader: UAVision

Internationalization

- Publications with foreign authors:


  - P. Silva, J. Bustamante, “Sociedades Humanas, Sociedades Artificiais: Perspectivas da Convergência”, in Trajectos, 16 (Primavera 2010), pp. 7-18
Group Productivity

- Heuristic Search for Identical Payoff Bayesian Games, F. Oliehoek, M. Spaan, J. S. Dibangoye, C. Amato, Proc. of AAMAS 2010 - 9th International Conference on Autonomous Agents and Multiagent Systems, Toronto, Canada, 2010

- Projects:
  - CMU-PT/SIA/0023/2009 MAIS-S: Multiagent Intelligent Surveillance System (with CS Department at CMU, Prof. Manuela Veloso, and INESC-ID)
  - EU F4E-2008-GRT-016 ITER ATS: Activities Related to the Development of an Air Transfer System Prototype and Cask Transfer System Virtual Mock-up, (with ASTRUM (F), CIEMAT (S), IPFN/IST (P))
  - P. Lima: member of the Board of Trustees of the RoboCup Federation
<table>
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<tr>
<th>Group Description</th>
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<tbody>
<tr>
<td><strong>Title of Research Group:</strong></td>
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<tr>
<td><strong>Principal Investigator:</strong></td>
</tr>
<tr>
<td><strong>Main Scientific Domain:</strong></td>
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### Objectives & Achievements

#### General Objectives

Our goal is to (i) develop new methods, algorithms and systems for robotic monitoring & surveillance by autonomous, heterogeneous sensor and robot networks and (ii) to demonstrate their use in realistic applications.

These networks can be used in multiple domains and adjust to the dynamic characteristics of the environment, observed phenomena or human activity. Each node can act or reconfigure the network to improve perception and uncertainty, interact with humans or re-establish communications. The desired autonomous, unsupervised operation requires de-centralized decision-making.

We consider 3 hierarchical levels:

- Cooperative/single robot navigation, formation control & decentralized decision making
- Vision-based activity recognition and cooperative perception in camera/robot networks
- Development of cognitive robot assistants (network nodes) that interact socially with humans

Finally, we nurture the emergent and strongly multidisciplinary area of biologically inspired systems and bioengineering, encompassing links to neuroscience, psychology or social sciences.

#### Main Achievements

Research activities are structured in 3 application areas of public interest, with networks of heterogeneous robots intervening at different hierarchical levels, and an emergent area in bioengineering. The achievements are both theoretical and application-driven, developed in the context of large international projects.

**General achievements**

- High internationalization and involvement in international Projs (FIRST-MM, ROBOSOM, ITER)
- Multidisciplinary research with neuroscience, psychology, biology, medicine and social sciences
- Coordination sessions to prepare proposals to FCT/EU calls

(i) **Search and rescue, field and urban robotics:**

- (Muti-)robot task plan using discrete event systems
- Decision-theoretic approach to decentralized planning under uncertainty
- Development of middleware and experimental test-bed for networked robot systems (ISRobotNet)
- New FCT projs
  + Perception-driven Formation control (PCMMC)
  + Social sciences/bio-inspired approaches to collective robotics (BioInstBots)

(ii) **Surveillance:**

- New CMU-PT project MAIS-S: Multiagent Intelligent Surveillance System [IRSGroup, VisLab, SPLab]
- New FCT proj. surveillance (ARGUS)
- Gesture and activity understanding from video
- Representation of complex activities with bank of visual motion fields
- Calibration of distributed cameras with different geometries

(iii) **Cognitive robotic assistant:**

- New EU Projs (ROBOSOM, FIRST-MM)
- Extend bio-inspired models of affordances w/ relational learning
- Grasp Learning with anthropomorphic hands
- iCub robot fully operational [Vislab]
- Tracking and software developments, deployed in the iCub repository.

(iv) **Bio-inspired methods, bioengineering**

- New FCT projs: ADDI (skin lesions); HEARTRACK; ADIAR (Alzheimer);
Objectives & Achievements

DYNIMAG (Neuroimaging, Epilepsy) [LAseeb, SPLab]
NEUROIMAGIOLOGY (Brain learning mechanisms) [LAseeb, SPLab]
- Collaborations: IMM, Hospitals Sta. Maria and Luz; Inst. Gulbenkian Ciência; Centre d’Imagerie Biomédicale, EPFL; Institute of Neurology, Univ College London.

Research Line Output

Collaborative Publications in peer review Journals

- A Novel Metric for Bone Marrow Cells Chromosome Pairing, Artem Khmelinskii, Rodrigo Ventura, João Sanches, IEEE Transactions on Biomedical Engineering (in press), 2010 [SigProcLab + IRSGroup]
- Robust band profile extraction using constrained nonparametric machine learning technique. Shadab Khan, João Sanches, Rodrigo Ventura. IEEE Transactions on Biomedical Engineering, 57(10):2587–2591, October 2010. [SigProcLab + IRSGroup]

Other highly multidisciplinary publications

Collaborative Other Publications

- Joint fMRI brain activation detection and segmentation using level sets, Silveira M, Figueiredo P. Proc. 32nd Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC 2010); Aug 31-Sept 4, Buenos Aires. [Laseeb + SigProcLab]
- Bayesian optimization of perfusion and transit time estimation in PASL-MRI, Santos N, Sanches JM, Figueiredo P Proc. 32nd Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC 2010); Buenos Aires, [Laseeb + SigProcLab]

PhD thesis completed

This Thematic Areas is highly involved in international projects concerning both research and advanced training. These activities are described below:

IST-EPFL Joint Doctoral Initiative – the thematic area is involved in two Focus Areas:
- Distributed and Cognitive Robotics, with about 6 students already enrolled
- Biomedical and Biological Imaging

Examples of ongoing theses
- José Nuno Pereira, "Institutional and Swarm Robotics", IST/EPFL Joint Doctoral Initiative
Research Line Output

- Bruno Nery, “Binding perception to action: a cognitive architecture for robots”
- Sébastien Gay, “The role of vision for locomotion control”
- Ricardo Beira, “Surgical robots”

CMU-Portugal Program
- One student supervised in the area of computer and robot vision

Dual Master Program with KTH – Stockholm
- An agreement on a dual master scheme in Systems, Decision and Control has been established for students active in the area of robotics.

Other multidisciplinary projects

EU Project ROBOTCUB - ROBotic Open-architecture Technology for Cognition, Understanding, and Behaviour, developed the iCub humanoid robot that is the most sophisticated Humanoid Robot worldwide, considering the number of degrees of freedom. The consortium included partners from Neurophysiology (University of Ferrara) and Developmental Psychology (Un. Uppsalla).

EU Project ROBOSOM – “Robotic Sense of Movement”, focusing on the role of vestibular information for locomotion control in humans and humanoids. This research project was evaluated as the best EU project proposal in the area of cognitive systems and involves partners from Neuroscience (Collège de France) and robotics from Europe (IST, Scuola superior Sant’Anna) and Japan (Waseda university).

EU Project HANDLE - “Developmental pathway towards autonomy and dexterity in robot in-hand manipulation”. This project aims to model the way how humans perform in-hand manipulation from experiments involving human subjects and instrumented objects. These models are used to transfer these skills to anthropomorphic articulated hands.

We have also been involved in the proposal of an EU-coordinated Action, “Coordination Action for the design and description of the FET Flagship candidate Robot Companions for Citizens” CA-RoboCom that was recently approved and will conduct preparatory work for a FET Flagship Project in this area to be proposed in 2012.
Title of Research Group: (RL-EME-LA09-137) Sustainable Technologies and Environmental Systems
Principal Investigator: Paulo Manuel Cadete Ferrao
Main Scientific Domain: Engenharia Mecânica

Objectives & Achievements

General Objectives

The objective is undertaking multidisciplinary research to develop and evaluate emerging and alternative complex engineering systems for sustainability. Technologies will be developed and assessed under a systems view, comprising the environmental implications of materials, energy, and products in modern societies. To achieve these objectives, research and development activities involve assessing advanced systems, but also analyzing the global carbon bio-geochemical cycle and materials flows in the economy.

Main research areas:
- Sustainable energy systems modeling and integration of energy technologies integrations making use of ICT
- Eco-design for sustainability
- Advanced integrated combustion and thermal systems
- Total life-cycle energy chain and environmental impact assessment
- Carbon cycle analysis
- Economy material flows
- Techno-economic assessment, technological change and systems integration
- Development of industrial ecology models applied to economic systems with emphasis on national and urban systems

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:
- Support a PhD Program on Sustainable Energy Systems, in the context of the MIT-Portugal Program
- Develop a set of advanced energy systems models, including energy use in buildings and its interaction with electric vehicles, national energy systems modeling including high time resolution or wind energy synthetic data models.
- 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.
- 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 (including geological carbon sequestration).
- Demonstrate the use of natural fiber based composites for auto-components
- Develop new urban metabolism models.

Research Line Output

Collaborative Publications in peer review Journals

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. Joint, trans-disciplinary collaboration is starting to appear. New work developed together with MIT is bringing the group of sustainable energy and the research team on artificial intelligence, for example through the PhD thesis of Pedro Janela.

Collaborative Other Publications


PhD thesis completed
Inês Costa (2010) "O Desafio das Simbioses Industriais: Um contributo científico para o desenvolvimento de simbioses industriai; caso de estudo Português" Doutoramento em Engenharia do Ambiente, IST-UTL.

**Group Description**

**Title of Research Group:** (RL-EEI-LA09-145) Signal Processing for Communication Networks and Multimedia

**Principal Investigator:** Joao Paulo Salgado Arriscado Costeira

**Main Scientific Domain:** Engenharia Electrotécnica e Informática

**Objectives & Achievements**

**General Objectives**

The main focus of thematic area D is on the development of computational methodologies for a set of fundamental problems in two major application contexts: a) Large Scale Distributed Sensing and b) Content Based Image and Video Understanding.

As a foundational assumption this research perspective looking at cross-cutting methodologies, imposes a clear multidisciplinary environment combining specific domain knowledge (e.g. Image Processing, wireless communications) with fundamental disciplines in Signal Processing (Estimation, Optimization) “down” to deep mathematics-rooted disciplines (Algebra, Differential Geometry, Probability Theory). Though artificial, these three levels will help interpreting today’s achievements as a result of strategic options taken many years ago. These decisions are reflected both in the recruiting policy (hiring a mathematician to be merged in an “engineering environment”) and in the formal/informal partnerships established over the years (Carnegie Mellon-Portugal program, joint projects, collaborative papers).

**Main Achievements**

Breakthroughs that produced theorems for some relevant problems:

A1 - Minimization of a Quadratic function on Smooth Manifolds – A unified framework to factorize matrices constrained to special manifolds (e.g. Stiefel)

A2 - Minimization of a singular value of a partially prescribed matrix – Optimal “filling” of missing entries of a low rank approximation of a given matrix.

A3 - Integer 0-1 problems: A unique solution of a 0-1 (permutation) problem over a convex set.

Main contributions for “enabling methodologies”:

B1 - Reconstruction of non-rigid objects from video sequences – Representations/frameworks and algorithms to obtain the 3D reconstruction of non-rigid and “flexible” objects from video sequences - direct consequence of A1.


B3 – Distributed consensus and detection in Sensor Networks – New methods to design optimal weights for distributed consensus algorithms running over networks with random topologies. Distributed hypothesis testing in SN with random links.

B4 - Localization and tracking in sensor Networks- A centralized algorithm that jointly estimates sensor and target positions from range measurements with resilience to outliers and little information on anchor position.

This downstream scientific flow disembogues in cutting-edge technological developments with impact on society at the industrial, services, cultural and policy levels. Main “themes”:

C1 Pollution monitoring using a bus fleet – New sensor platforms to measure 5 gases. Distributed event detection system for the pollution field. Pollution dynamics modelling and simulation of urban. A case study with Lisbon and Pittsburgh is under development.

C2 Image retrieval and recognition in large scale databases of images


Though the core of A1,A2,A3 are mostly SIPG/ISR’s all accomplishments are carried out withing partnerships (Carnegie Mellon-Portugal, CELC-FCUL) and involving SIPG, VISLAB,DSOR/ISR.

**Research Line Output**

**Collaborative Publications in peer review Journals**

As explained in the previous section, the ongoing activities within thematic area D stretch along a several “methodological” directions. This is made possible by the heterogeneous background of the researchers involved but also to the cooperative and “networked” environment under which research is done. Publications reflect the inter-group interactions and the intense co-development with external partners involved in tight working links through co-advisorship of PhD students and/or projects.


M. Stosic, M. Marques, J.P. Costeira: Convex solution of a permutation problem, Linear Algebra and its Applications 434 (Jan2011). Published online 2010-Key doc for A3.
Research Line Output

During 2010, 5 other submissions to major journals in Computer Vision and Signal Processing were done with 3 already accepted and 2 still under review (2 years average time until accepted).

Collaborative Other Publications


G. Carneiro, The Automatic Design of Feature Spaces for Local Image Descriptors using an Ensemble of Non-linear Feature Extractors, CVPR2010

A. del Bue, J. Xavier, L. Agapito and M. Paladini, Bilinear factorization via Augmented Lagrange Multipliers 11th European Conference on Computer Vision - ECCV'10, Crete, Greece, September 2010

D. Jakovetic, J. Xavier and J. M. F. Moura Consensus in correlated random topologies: weights for finite time horizon IEEE International Conference on Acoustics, Speech and Signal Processing - ICASSP’10, Dallas, Texas, USA, March 2010


PhD thesis completed

URBISNET – Real time monitoring of pollution gas field in large cities – Spun by an FCT funded project this “theme” became a central topic of research. Planned as a technological endeavour whereby data collected by a network of moving sensors (buses with sensors) is fused to produce a dense pollution map, became one instrument in a broader public-policy driven initiative. This reshaping resulted from joint co-advisorships of dual-degree PhD students from Carnegie Mellon’s ECE Department and Engineering and Public Policy Department and funded under the Carnegie Mellon-Portugal program. The objective is to model, simulate and measure pollution fields so that policy is done based on sound physical data. [SIGPLab, DSOR and Center for Atmospheric Particle Studies@CMU].

Novel information processing methodologies for intelligent sensor Networks - Started in late 2010 as a result of a CMU-Portugal project call, its broad objectives address key issues in large sensing and actuation infrastructures. Framed in the commonly known as Cyber Physical Systems domain, the goal is to study and innovate around the following main issues having Wireless Sensor Networks at its core: Sensor Selection, Secure Communications and Secure Control of Cyber Physical Systems. Industrial partners will deploy several testbeds with CMU’s Sensor Andrew as the main experimental leverage [SPIGLab, CENSCIR@CMU].

PRINTART (http://printart.isr.ist.utl.pt) Content and Ontology based Art Image Annotation and Retrieval – Image retrieval is a major issue on today’s networked world. Here we teamed up with Art Historians from University of Lisbon to frame a large scale retrieval system. We focused on the original Portuguese Tile Panels (Azulejo) which frequently result from compositions of famous paintings and prints. The objective is to trace the roots of the Azulejo and identify the original paintings it came from. The main challenges are quite coincident in the fundamental research proposals namely the huge data dimension, the nonlinear/combinatorial character and ultimately the need for distributed search [SIGP, Coral-Group@CMU and external partner Fac Letras UL].
The main goal of thematic area A is to carry out research and development in advanced marine science and technology to better understand ocean phenomena and to explore the deep mineral and biological deep seafloor resources. 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**

**Engineering:**
Development of new methodologies and software/hardware architectures for: a) multiple vehicle cooperative motion planning, navigation, and control, b) optimal networked sensor placement for underwater target positioning, and c) sensor-based control for unmanned air vehicles.

**Science:**
IMAR-DOP/UAz has become a leading research center for integrated studies on seamounts and hydrothermal vents, thorough its involvement in 8 projects of the FP6 and 4 of the FP7; IMAR has also become the world leading research center on the study of the deep-sea chemosynthetic mussel Bathymodiolus and the 10th Web of Knowledge ranked institution on the study of hydrothermal vent extreme ecosystems (2006-2010); recently, IMAR also came to the fore with the installation of a new laboratory (CoralLab), dedicated to the husbandry and experimentation with cold-water corals, making possible the study of certain aspects of the biology and physiological processes of cold-water corals and associated fauna, which are difficult in situ. Ongoing experiments at CoralLab include studies on gene expression analysis of relevant genes known to be directly involved in immune and stress responses to the presence of pathogens and or environmental stressors.

From an Earth Sciences point of view, Creminer is completing a major study on Arctic hydrothermal systems, with great emphasis on the deep biosphere and on comparison with the Azores hydrothermal fields. 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. Analytical facilities, including the new Stable Isotope Lab, the Soil and Sediment Lab AmbiTerra and the Mobile Lab are all equipped and starting to be extensively used.

**Bridging the gap between science and technology:**
A Showcase of Science and Technology in the Azores in the scope of the FREESUBNET Workshop, July 2010, Horta, Faial, co-organized by IMAR and ISR –advanced robots and marine equipment were used intensively at sea by a large group of European researchers to: i) map the habitat around a newly found of a hydrothermal vent field, and ii) to perform acoustic telemetry and tracking of fish carrying acoustic emitters.


Collaborative Other Publications

The following list of representative publications describes work that either involved different research groups or is the outcome of strong cooperative links with external co-authors.


PhD thesis completed

1. PhD Thesis that have an interdisciplinary character and are co-supervised by foreign experts

Virginie Riou - MoMARMENet (FP6-RTN/2003/505026) Marie Curie Fellowship 2005: Trophic ecology of the hydrothermal vent mussel Bathymodiolus azoricus. (co-tutela: PhD awarded by the University of the Azores, Portugal and by the Université Libre de Bruxelles, Belgium). (Approved 14 of January 2010) [supervised by Ricardo Serrão Santos and Ana Coelho]


2. The following multidisciplinary projects have fostered intensive cooperative work between the DSORL, IMAR, and the Signal and Image Processing Group at both National and European levels. All projects address issues that require a strong symbiosis between engineering and marine science.

[1] EU “FREESUBNET- Marie Curie Research Training Network”. 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 par excellence to carry out scientific and commercial missions at sea without tight human supervision.

Research Groups: DSORL, IMAR, Signal and Image Processing Group

URL: http://www.freesubnet.eu/

[2] “NAV-Development and Application of Advanced Nonlinear Control Techniques for the Coordination and Motion Control of a Network of Autonomous Vehicles”: the goal of this project is to develop, implement and test advanced robust control strategies for the coordination and cooperative motion a network of autonomous vehicles (NAV). The research work is driven by the high-impact field of marine robotics. It is expected that the methodologies and techniques developed in NAV-Control will contribute to the development of important tools for ocean exploration and exploitation.

Research Groups: DSORL and IMAR

URL: http://users.isr.ist.utl.pt/~pedro/NAV
“OBSERFLY-Uninhabited Aircraft for Marine Science Applications”: the project aims to develop a versatile UAV prototype that can take-off and land either on an opportunity airstrip (using the landing gear) or on a bay or harbor (as a seaplane). The aircraft will be designed for marine science applications with special emphasis on the location and tracking of marine mammals and commercially important or threatened pelagic species such as the Atlantic Tuna.

Research Groups: DSORL and IMAR