Training Opportunity for Portuguese Trainees

Reference	Title	Duty Station
PT-2017-TEC-MMA	**Space Automation and Robotics**	**ESTEC**

Overview of the unit's mission:

The section is located within the Mechatronics and Optics Division, which provides technical expertise and engineering support in the areas of automation and robotics, space mechanisms, life & physical sciences and environment control & life support (ECLS), optics and opto-electronics.
The division is structured in four sections:

- Automation and Robotics Section
- Life & Physical Sciences and ECLS Section
- Optics Section
- Opto-Electronics Section

The Automation and Robotics Section in particular is responsible for the creation and maintenance of an industrial technology base for the automation aspects of space based operations and their remote control.
As such, the domain of competence of the group includes the specification and control of space robotics systems (from manipulators to autonomous vehicles) and laboratory supporting automation and robotics in manned and unmanned missions.
The Automation and Robotics Section operates a series of laboratories, which provide the tools to support the section activities and in which prototyping and functional verification of Automation and Robotics systems take place.
For a more detailed description of the terms of reference, activities and assets of the section see http://www.esa.int/robotics.

Overview of the field of activity proposed:

The trainee will be supporting the Automation and Robotics section at ESTEC, and in particular the Automation and Robotics Laboratories (ARL).

This position is split between the areas of orbital robotics (in particular On-Orbit Servicing and Active Debris Removal), planetary robotics and human-robot interaction.

Our trainees are given a high degree of autonomy and responsibilities, and will be expected to take ownership of the laboratories, be responsible for tasks and help with the day-to-day maintenance.

The exact tasks will depend on the candidate's final qualifications, interests and the needs of the section and will be from among the following:

Orbital robotics

- Support and supervise industrial activities on the ARL flat floor in the area of on-orbit servicing and active debris removal

The ARL has recently acquired a flat floor and a number of air-bearing platforms. Currently the lab is undertaking or initiating a number of industrial activities that will use the lab. The candidate will in particular be supporting:

- One industrial activity to cross-validate the flat floor facility with an orbital robotics simulator in industry. An air-bearing floor provides excellent contact dynamics but is constrained to two dimensions (3 DOF). By constraining other Dynamics simulation facilities to the same 3DOF, we achieve rigorous cross-validation between the different facilities.
- Additionally the lab has recently taken delivery of software for dynamic simulation of space debris capture with nets. The candidate will be working on validating the software with the real contact dynamics available on the ARL flat floor.

- Research & Development on autonomy for space debris capture

The lab is currently supporting the e.Deorbit and d.Deorbit missions in which the question of autonomy has been identified as being of particular significance. The candidate will be presented with the opportunity to develop hardware and execute tests aimed at performing a detailed investigation of the difficulty vs. necessity of autonomy required for capturing un-cooperative targets with a robotic arm in a free-floating environment. The work will leverage previous developments within the section in the field of visual surveying and autonomy to investigate the capture operation.

• Research & Development on novel robotic systems using air bearings/cushions The ARL is evaluating novel air-bearing concepts in order to de-couple the inertia lof the air-bearing from the item under investigation. This will allow for further improvement in the quality of the simulated orbital environment. Typical tasks are: Finding requirements, concept development, evaluation of solutions and bread boarding of prototypes.

Planetary robotics

• Development and operational readiness of planetary rover platforms.

The ARL has several small scale planetary rovers and are currently developing another one. They serve as generic representative testbeds for both lab and field experiments, where payload and algorithms can be integrated. The candidate will be involved in aspects of the system development and integration (e.g. new algorithmic modules, sensor integration, ground control station, operational procedures, testing, etc.)

• Rover onboard software control architectures in open source Robotic Frameworks.

The integration of complete planetary robotic systems shows particular complexity in the software integration of different algorithms, control laws, and subsystem control modules. Currently ARL is involved in the process to choose a standard rover operating system. The candidate will have the opportunity to be involved in the evaluation process.

• Planetary robotic arm control and operations.

Two rover platforms in the ARL are foreseen to be equipped with custom-designed robotic arms (5 and 6 DoF respectively). The candidate will have the possibility to develop independent control modules for the arm ain integrate them in the overall rover onboard control software architecture in an optimised manner. In parallel the control approaches of industrial activities on the same field will be evaluated. Finally the rover-arm coordinated motion can be explored.

• Definition and development of new laboratory planetary robotics platforms and subsystem prototyping.

The ARL has a target to have a regular cycle of developing new platforms to be used as planetary robotics testbeds (e.g. rovers), where the lessons-learned and experiences of previous developments can be incorporated. The candidate will be involved in the definition of such systems in terms of mechatronic design, interfaces and resources and wherever needed implement subsystem prototyping activities.

Human Robot Interaction

• Definition, development and prototyping of new human-robot interaction means and subsystems.

The ARL has been developing means to command and control robots through immersive/haptics human-robot interfaces far various applications. The interfaces are used to implement human-in-the loop control of manipulation or driving. Such interfaces provide visual and mechanical feedback to the operator so that different degrees of telepresence are made possible. The interfaces are as matter of fact robots themselves whose design has to consider human factor and safety as well as robustness against delays/jitter in the communication with the controlled robot. The candidate will be involved in the definition of such systems in terms of mechatronic design, software design and implementation as well testing with human subjects in the lab or in field trials.

• Definition, development and prototyping of new robot based in-flight exercise countermeasures.

Long duration spaceflight causes Astronauts to lose muscoskeletal mass and elongate. Besides the potential detrimental effects on the health of the astronauts during re-entry and early stay on Earth, for very long missions (such as those to the Moon, Mars, and Near Earth Objects) there is a very increased risk of bone fracture and muscle strain. Losses are reduced with the use of exercise countermeasures. The ARL has a new line of research and development that aims at the use of exoskeleton as exercise countermeasures

The ARL has been developing space exoskeletons as human-robot interaction means. The same technology will be used for exoskeleton based exercise countermeasures. The candidate will be involved in the definition of such systems in terms of mechatronic design, software design and implementation as well testing with human subjects in the lab or in medical trials.

Other

• Collaboration with third parties companies in the frame of hardware development and procurement

The ARL has a constant need to upgrade and adjust its inventory in order to support new activities. The candidate will be intimately involved in this process by directly interacting with third parties to discuss concepts, negotiate prices, in order to procure equipment or software.

• Support relevant R&D activities or CDF studies when necessary.

The section staff supervises a number of industrial R&D activities in all fields related to space robotics. The candidate will have the opportunity to participate in reviews and otherwise support the activities as required. Some support to the e.deorbit, d.deorbit or Exomars missions may also be expected.

• Suppport to the operations of the Automation & Robotics Lab.

The ARL recently went through a complete reorganization and infrastructure upgrade, with the goal to optimise the operational resources and foster more parallel research activities. As certain final aspects of the upgrades

are on-going, particularly in the field of orbital robotics, the candidate shall work closely with the head of the ARL in the deployment and calibration of new robotic facilities (metrology, hardware research platforms, etc.) and in the definition of lab operational guidelines and procedures. Within this task the candidate will obtain experience in the complex organisation and operation of a high-tech lab facility as well as gain an overview of all the research activities performed in ESA in the field of Automation and Robotics.

Required education:

- Applicants should have just completed (conclusion not older than two years) or be in their final year of a university course at Master's level in a technical or scientific discipline.
- Candidates must be fluent in English or French, the official languages of the agency
- Recent graduate in the field of Robotics, Mechatronics, Mechanical, Space engineering, or Computer Science with significant software experience.
- Electronics experience is an asset
- Demonstrated experience in initiating and running practical projects.