## ROB: Summary Table

| **Institute** | ENEA Casaccia Research Center  
| | Via Anguillarese 301, Rome |
| **Year of foundation** | 1961 |
| **Reference person** | Claudio Moriconi  
| | claudio.moriconi@enea.it |
| **Website** | [http://robotica.casaccia.enea.it/](http://robotica.casaccia.enea.it/) |
| **Scientific Areas** | Man-machine interface  
| | Artificial intelligence  
| | Distributed Robotic Systems  
| | Underwater Robotics  
| | Sensors and perception  
| | Biorobotics  
| | Mechatronics |
| **Robotic Applications** | Assistive Robotics  
| | Robotics for hostile environments  
| | Service robotics |
| **Scientific Expertise** | Mechanical Design  
| | Systems engineering and electronic design  
| | Informatics  
| | Signal processing  
| | Control theory |
| **Team size** | 20 |
| **Senior researchers** | 12 |
**Introduction**

ENEA (Italian National Agency for New Technologies, Energy and Sustainable Economic Development) is a public organization operating in the fields of energy, the environment and new technologies. It has currently more than 2700 staff members distributed all over Italy, from Rome headquarters to 12 main research centers mostly dedicated to Research and Technology Development, transfer and dissemination.

ENEA involvement in Robotics dates back to the early years of the Italian nuclear program and is closely connected to the need for telemanipulation of highly radioactive substances. The Robotics Laboratory of ENEA, located in Casaccia (Rome) is active since 1961, with the design and realization of the first tele-operator in Europe for Nuclear Fuel management (Mascot 1). (See Fig. 54 and Fig. 55).

This makes ENEA the first Italian operator in robotics field.

Within the years, the laboratory widened its activity by developing control systems and sensing equipment for many robot systems including mobile surveillance robots, industrial special robots, advanced sensing devices (see Fig. 56 and Fig. 58).

Since 1996 the Laboratory started up an activity line on underwater robotics and developed, together with the Italian firm Tecnomare, the robot SARA (see Fig. 57), a large underwater robot tested in the Antarctica waters and intended especially for the monitoring of the sea bottom around the Italian base of Terranova (now Mario Zucchelli base).

Many other robotics applications have been developed since then including, as reported in the following, buoys, MMI for underwater vehicles, special vehicles.
In 2008, the Laboratory launched the innovative concept of the “self-organising complex creatures”, based on the swarm paradigm, but aimed at overcoming the most serious AUV problem, the very limited capability of communication with a human supervisor from underwater. Harness project, funded by the IIT (Italian Institute of Technology), is the first result of this concept and the VENUS parallel project, entirely funded by ENEA, is the direct investment of the RTO on this line. Together with ENEA, University of Tor Vergata and University of Perugia joined into the development of the complex project that has achieved the interest of many national end-users and many large industries.

**Educational activity**

The mission of ENEA does not include direct educational aspects, like lessons at the Universities. However, the robotics group was active since the beginning with traditional exploitation of master thesis supported by unit projects, and external grant. Postdoc courses on robotics have also been held during the development of the projects. Moreover, ENEA, as part of its institutional role, promotes the dissemination of knowledge acquired through its research activities. It can boast many and positive contact experiences with schools, like the ‘initiative “EneaScuola” born to support the dissemination of scientific and technological culture; this was achieved by seminars on various scientific topics for pupils in schools. On the same way also the project “Educarci al futuro.” was concerning the pupils training to the scientific research. An agreement with the Institute ITIS Fermi in Rome, based on the main topics of Robotics and Energy, was signed with the aim to introduce these themes in the world of secondary school, in order to train the younger generation. ENEA is also a member of the association Italian network of robotics (ref. to the Mondo Digitale always in the Rome Area) and appointed in the board direction of the association.

**Research**

The Robotics Unit of ENEA has moved its interest towards the technologies of advanced control and intelligent perception. The technological and scientific interests actually follow four main tracks whose latest results are in the following summarized.

**Land mobile robotics**

Many research projects have been carried out in the field of autonomous land mobile robots for surveillance and security goals, cultural heritage preservation and elderly people care (RAS, PRASSI projects, see Fig. 56 and Fig. 58, TECSIS project). In this frame have been developed algorithms for autonomous navigation, artificial vision pattern recognition and robot cooperation.

**Underwater and aerial mobile robotics**

A swarm of autonomous underwater vehicles targeted to communications and security applications is currently under development (Harness project and the parallel activity of the VENUS vehicle development, see Fig. 59 - The VENUS AUV). The key points are: a distributed
control system, new communication strategies and the design of a submarine prototype. The simultaneous control of several independent UAV’s concurring in the same aerial space in order to avoid possible conflicts among themselves and with commercial aircrafts is the subject of the Eurostars ARCA project. The subject is tackled using Cooperative Game Theory.

**Teleoperation and telemanipulation and Human-machine interfaces**

WiRo6.3 is a new control device for the interaction with virtual reality environments and for telemanipulation tasks, with force feedback capabilities. It is a six DoF mechanical device characterized by the actuation of a mobile platform by nine wires. Recently it has also been employed as a stabilized carrier for precision measurements apparatus.

**Sensorial systems**

“Artificial skin” is a sensorial system able to transmit to the operator human skin sensation. TESSA is a Hi resolution stereoscopic underwater visual sensorial system aimed at 3D visual reconstruction of submerged objects.

**Funded projects**

TINA, Telepresence Interface Architecture, funded by Ministry of Research - development of a multimedial architecture for robot supervision.

TECSS: Diagnostic technologies and intelligent systems for the development of the archaeological sites of Southern Italy - funded by the Ministry of research on the PON and leaded by ENEA allowed the development of a number of technologies for the diagnostics, the maintenance and the fruition of the cultural heritage. Many developments, including underwater robotics and sensing technologies have been addressed and realized: in Fig. 61 experimental equipment for an ultrasonic underwater camera and in Fig. 60 it is shown a stereoscopic camera for undersea archeological goods.
For the exploration of remote sites forms of cooperation of more robots have been also studied (Fig. 62).

PRASSI: Autonomous robotic platform for security and surveillance of industrial plants - funded by Ministry of Research, Study and Development of a fully autonomous terrestrial mobile surveyor.

MIAO: Microsystems for hostile environments; Funded by MIUR was aimed at the development of microtechnologies for hostile environments among these the study of intelligent functions for feeling classification from the perception of an artificial skin.

Projects more specifically oriented to the field of underwater Robotics:

SARA, Antarctica Robotized Autonomous Submarine (see annexed picture) - design, realisation, control and demonstration of a large underwater vehicle torpedo shaped for the exploration and monitoring of Antarctica underwater basement – funded by the he University and Research Ministry.

PANDORA, Ice drilling and navigation for Antarctica sub ice lakes - conceived and carried out as a preliminary investigation to allow a submersible vehicle to navigate in the Antarctica lakes encapsulated under thousands of meters of ices in centre of the Plateau it has been funded mainly by ENEA’s funds (Fig. 63).

ARAMIS - MAS3 (Marine Science and technology) European project aimed at the development of submersible compact intelligent sensing units.

BOMA, automated buoy for environmental monitoring; ENEA has been involved especially for the aspects of intelligent control of the underwater asset.

MELBA, Automated buoy for environmental monitoring along sea currents; ENEA has been involved especially for the aspects of intelligent control of the underwater asset.

SAM, autonomous submarine for the Mediterranean sea - Study, design and realisation of AUV for deep areas of Mediterranean Sea. Funded by the Ministry of Research.

STSS-500, underwater acoustic camera. Development of a smart interface to allow a human operator to effectively perceive acoustical images in shallow water also in condition of fuzzy images. Special care has been devoted to the aspects of human factors trying to present the information flow to the brain in order to exploit at best its peculiar abilities together with artificial recognition (moving objects recognition, artificial classification of sounding patterns). Funded by Ministry of Research.
HARNESS (Human telecontrolled Adaptive Robotic NEtwork of SensorS) deals with a multipurpose underwater robotic swarm, the HARNESS project (Human telecontrolled Adaptive Robotic Network of SensorS) currently in progress in our laboratory. This system is based on cheap autonomous underwater vehicles (AUV) organized with swarm rules and conceived to perform tasks, ranging from environmental monitoring to terrorism attack surveillance (Fig. 64).

Fig. 64 - Venus during test in pool

Available facilities

- **Laboratory Pool** for submersible swarm test, 6 by 8 meters with limited depth (1.4 mt) has been realized to test algorithms and devices.
- **Brasimone lake** – A big facility located not far from Bologna and managed by ENEL that has the property of the lake itself: Brasimone is a closed lake with one of the greater ENEA’s centers disposed around it. An agreement to perform robotic campaigns with demanding features has been already consolidated with the Centre authorities and the final campaign of the recent STSS-500 project has been carried out in that site.
- **Tigershark swarm** (6 elements) - a simple and cheap underwater vehicle to test the behavior of small - medium size underwater swarms.
- **Simulation platform** for basic skull navigators. A simple simulation platform realized during a self-funded preparation phase of the project.
- **SARA** (Submarine for Antarctica Robot Autonomous) a 5 meter. long AUV torpedo shaped designed and realized by an Italian team headed by ENEA, able to navigate down to 1000 m from the surface
- **Falcon** - ROV for test campaign assistance in lakes or seas. It is a very powerful, easy to use underwater skull able to survey, deploy, recover other underwater devices. It could be endowed also with manipulating capabilities.
- **UGV** of various dimensions.
- **Inflatable boat** for underwater test campaigns. Especially useful for lake operation.
Publications


C. Moriconi, “Human and artificial intelligent beings: reasoning on a cultural approach”, IARP International Tsukuba Workshop, 8 December 2002

Stefano Chiesa, Sergio Taraglio – “A Novel Genetic Approach To Epipolar Geometry Estimation” - 376-381, IPCIPVC V IPVC 2010: Las Vegas, Nevada, USA


C. Moriconi, R. dell’Erba, - Harness: A robotic swarm for environmental surveillance ENEA 6th IARP RISE2012 the 11-13 of September in Warsaw

Claudio Moriconi e Ramiro dell’Erba – “The Localization Problem for Harness: a Multipurpose Robotic Swarm” The Sixth International Conference on Sensor Technologies and Applications SENSORCOMM 2012 August 19 - 24, 2012 - Rome, Italy


