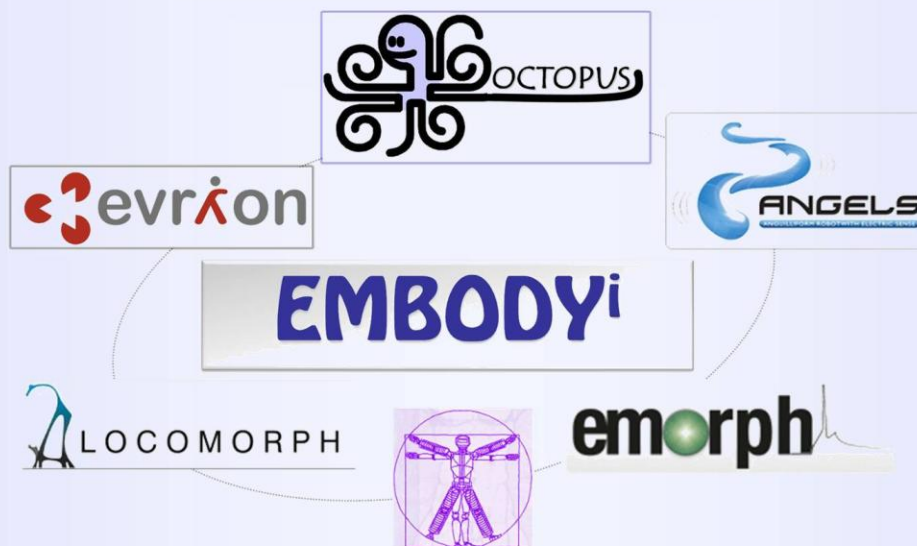




September, 20-24 2010

L.E.M. Livorno Euro Mediterranea - Livorno, Italy

Embodied Intelligence Summer School



**"The nature of the human mind is largely
determined by the form of the human body."**

Rodney A. Brooks, 1999

**"Artificial intelligence can only be achieved by machines
that have sensory and motor skills and are connected to
the world through a body."**

R. Pfeifer and J. C. Bongard, 2007

*How the Body Shapes the Way We Think
a new view of intelligence*

***The Embodied Intelligence Summer School will cover the
concepts of the Embodied Intelligence theory through
the integration of many disciplines viewpoint, as
robotics, biology, neuroscience, medicine, physiology,
psychology, as well as sociology and ethics.***



EMBODYi

Embodied

Intelligence

Summer School

School Program

Monday 20 September

- 9.00-9.45 Registration and Opening
- 9.45-10.30 Lecture 1: Rolf Pfeifer
- 10.30-11.00 Coffee Break
- 11.00-11.30 EMBODYi Projects Students Presentation
- 11.30-12.30 EMBODYi Projects Group Discussion
- 12.30-13.00 Students Poster Session
- 13.00-14.30 Lunch Break
- 14.30-15.00 Assignment of Group Work
- 15.00-19.30 Technical Tour to SSSA Labs
- 19.30-20.30 Welcome Party



Tuesday 21 September

- 9.00-9.45 Lecture 2: Auke Jan Ijspeert
- 9.45-10.30 Lecture 3: Benny Hochner
- 10.30-11.00 Coffee Break
- 11.00-11.45 Lecture 4: Barbara Webb
- 11.45-13.00 Students Poster Session
- 13.00-14.30 Lunch Break
- 14.30-16.00 Group Work
- 16.00-16.30 Coffee Break
- 16.30-19.30 Group Work



Thursday 23 September

- 9.00-9.45 Lecture 6: Paolo Dario
- 9.45-10.30 Lecture 7: Tamar Flash
- 10.30-11.00 Coffee Break
- 11.00-12.00 Group Work
- 12.00-13.00 Students Poster Session
- 13.00-14.30 Lunch Break
- 14.30-16.00 Group Work
- 16.00-16.30 Coffee Break
- 16.30-20.00 Group Work
- 20.30-23.00 Farewell Party



@ Fortezza Vecchia

Wednesday 22 September

- 9.00-9.45 Group Work
- 9.45-10.30 Group Work
- 10.30-11.00 Coffee Break
- 11.00-12.00 Students Poster Session
- 12.00-12.45 Lecture 5: Eugenio Guglielmelli
- 13.00- Lunch Break and
--23.00 Social Activity: Tour to Florence



Friday 24 September

- 9.00-10.30 Group Work Students Presentations
- 10.30-11.00 Coffee Break
- 11.00-12.00 Group Work Students Presentations
- 12.00-13.30 Closing

LECTURES LOCATION: L.E.M.

Livorno Euro Mediterranea
Piazza del Piamigione 1/2
Livorno, Italy



Livorno Euro Mediterranea



The EMBODYⁱ Projects

The "Embodied Intelligence" projects of the EMBODYⁱ initiative (a FET Proactive Initiative Funded by EU Framework 7 ICT- 2007.8.5) attend to explore new forms of sensing and interacting, employing new design approaches and ICT with the address to the relationship between shape, function and the physical and social environment for the development of new intelligent physical artefacts. The projects stress the role of interaction of agents with the environment for adaptation process and open-ended learning (changes in morphology, shape, cognition, perception, cooperation), study new design principles for new robot architectures based on the deeper understanding of the role of form and material properties in shaping behaviour or develop smart components and techniques for purposive agents where behaviour is not strictly program but robustly emerges from the interaction of the various components, or with the environment.

FET Proactive Initiative for the Embodied Intelligence Projects Target outcome:

The **research objectives** of the "Embodied Intelligence" initiative address new technologies and design approaches for building **physically embodied intelligent agents and artefacts**, with emphasis on the **relationship** between **shape, function** and the physical and social **environment**, and addressing one or several of the following:

Mind-body co-development and co-evolution: through permanent and extended multimodal interaction of agents with the physical and social environment. Projects will develop a better understanding of the role of such **interaction** in open-ended learning and **adaptation** processes, including morphological change for shaping perception, cognition, cooperation and social intelligence. They will demonstrate qualitative and quantitative improvements in agent capabilities and characteristics.

Morphology and behaviour: new design principles for sensing, actuation and locomotion components and for robot architectures that are based on a deeper understanding of the **role of form and material properties in shaping behaviour**, and of the ways in which these afford relationships and **interactions** with the

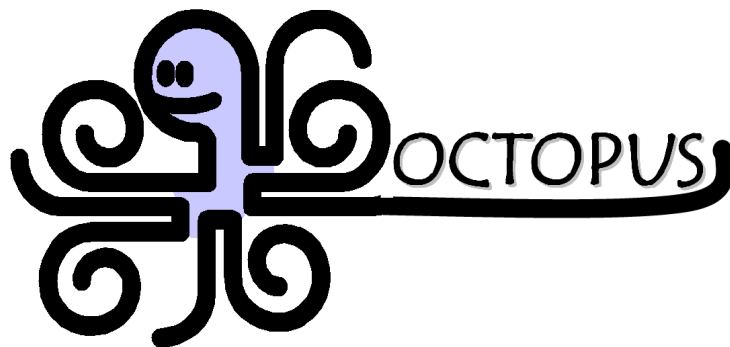
environment and with other agents. Projects will aim to demonstrate advantages in physical and performance characteristics of the robot e.g. in terms of control, weight, flexibility, resilience, or other characteristics.

Design for emergence: design paradigms and techniques for purposive agents where **behaviour** is not strictly programmed but robustly **emerges from the interaction of the various components** (each with local intelligence), **the environment and its ubiquitous information resources**. Projects will develop smart components and techniques for the design of ambitious classes of scalable robotic systems, incorporating where possible prior knowledge on tasks or environments, while leaving the necessary room for emergence and adaptation.

OCTOPUS

Novel Design Principles and Technologies for a New Generation of High Dexterity Soft-bodied Robots Inspired by the Morphology and Behaviour of the Octopus
COORD: Scuola Superiore Sant'Anna, Pisa, Italy

<http://www.octopus-project.eu/>



The OCTOPUS Integrating Project (IP) aims at investigating and understanding the principles that give rise to the octopus sensory-motor capabilities and at incorporating them in new design approaches and technologies for building physically embodied, soft-bodied, hyper-redundant, dextrous artefacts. To this purpose, a robotic artefact will be built in OCTOPUS that can locomote in water over a variety of terrains, explore narrow spaces, grasp objects and manipulate them effectively. The grand challenge that this IP will pursue is the design and development of the ICT and robotics technologies allowing the building of an embodied artefact, based broadly on the anatomy of an octopus, and with similar performance in water, in terms of dexterity, speed, control, flexibility, and applicability.

ANGELS

ANGuilliform robot with ELectric Sense

COORD: Ecole Nationale Supérieure de Nantes, France

<http://www.theangelsproject.eu/>



ANGELS (STREP) will design and build a prototype of a reconfigurable Anguilliform swimming robot able to split into smaller agents (and vice-versa), each equipped with a bio-inspired “electric sense” used both for recognition of objects and communication between agents. The robot will exploit both “mechanical re-configurability”, by changing body form or splitting into component agents, and a new concept of “electric re-configurability” that will allow the robots to self-adapt their perception to their environment by changing the location of emitters and receptors on the robot boundaries. The electric field generated around the robots can be considered as a prolongation of their material body in the surrounding water. This prolongation, that is named electric-body, can then be shaped through electric reconfigurations. ANGELS will explore the range of abilities conferred by different mechanical and electric morphologies, from the shaping of the common electric body shared by the agents navigating in formation, to design of behavioural cooperative rules inspired by fish for improving multiagent perception through emergent collective behaviours.

EMORPH

Event-Driven Morphological Computation for Embodied Systems

COORD: *Italian Institute of Technology, Genova, Italy*

<http://emorph.eu/>



EMORPH (STREP) proposes to overcome the limitations of ICT, which despite its dramatic progress has not yet been able to design and build artificial systems that can compete with biological ones, on many aspects. There are limitations both at the technological level, and at the theoretical/computational level. EMORPH proposes to explore the concepts of embodied intelligence, by combining the design of novel data-driven biologically inspired sensory devices with the development of new asynchronous event-driven computational paradigms, with structure and morphology that are matched to the requirements of the robot's body and its application domain. The project will design asynchronous vision sensors with non-uniform morphology, using analogue VLSI neuromorphic circuits, develop supporting data-driven asynchronous computational paradigms for machine-vision methodologies that are radically different from conventional ones, and test embodied intelligence on advanced humanoid robotic platforms.

EVERYON

**Wearable robots for functional restoration, substitution,
rehabilitation, augmentation**

COORD: University Campus Biomedico, Rome, Italy

<http://www.evryon.eu/>



EVERYON (STREP) will develop a novel design approach for the development of wearable robots, such as active orthoses, prostheses and exoskeletons for functional restoration, functional substitution, rehabilitation and human augmentation. The proposed approach is based on the coevolution of morphology and control, where the design of the artificial system takes into account the dynamics of the biological counterpart so that the human body and the robot symbiotically benefit from each other, exhibiting emergent dynamic behaviours. The selected robot is an actuated bilateral orthosis for the lower limbs destined to restore proper walking capabilities in chronic impaired subjects. Experiments will be performed on volunteer elderly subjects. The approach and methodology to be developed within the project will have a deep potential impact in the field of wearable robotics, biorobotics, rehabilitation and functional restoring.

LOCOMORPH

Locomotion and movement in robots, with enhanced manoeuvrability, self-stabilization, energy efficiency and adaptation, thanks to morphology and morphosis

COORD: University of Zurich, Switzerland

<http://www.locomorph.eu/>



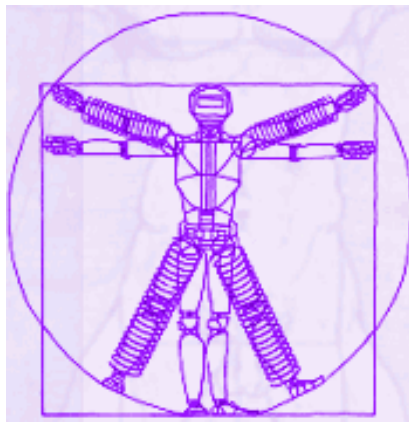
LOCOMORPH (STREP) will push beyond the state of the art in robotic locomotion and movements, by increasing efficiency, robustness, and thus usability in unknown environments. As robotic research and industry are competing to increase robots usability towards the highly-indemand service robotics, advancements in robotic locomotion today would give Europe a significant competitive advantage. Locomorph combines multidisciplinary approaches from biology, biomechanics, neuroscience, robotics, and embodied intelligence to investigate locomotion and movements in animals and robots, focusing on two concepts: morphology and morphosis. Through an exploration of morphology and morphosis, the consortium will develop robots with increased manoeuvrability, self-stabilization, energy efficiency, and adaptation to unknown environments. These advances will bring us closer to service robotics, as a large part of these robots must be able to locomote safely, regardless of surfaces, layouts, or terrains.

VIATORS

Safe, energy-efficient and highly dynamic variable impedance actuators

COORD: DLR, Germany

<http://www.viactors.org/>



VIATORS (STREP) addresses the development and use of safe, energy-efficient and highly dynamic variable impedance actuation systems, which will permit the embodiment of natural characteristics found in biological systems, into the structures of a new generation of mechatronic systems. This advance in technology will pave the way towards new application fields, such as industrial co-workers, household robots, advanced prostheses and rehabilitation devices, and autonomous robots for exploration of remote planets. Therefore, this project will deeply impact applications where successful task completion requires people and robots to collaborate directly in a shared workspace or robots to move autonomously and safely.

Scientific Committee

Prof. Rolf Pfeifer



Prof. Rolf Pfeifer received his masters degree in physics and mathematics and his Ph.D. in computer science from the Swiss Federal Institute of Technology (ETH) in Zurich, Switzerland. He spent three years as a post-doctoral fellow at Carnegie-Mellon University and at Yale University in the US. Since 1987 he has been a professor of computer science at the Department of Informatics, University of Zurich. He is the director Artificial Intelligence Laboratory at University of Zurich. He has organized a number of conferences and research projects such as "The 50th Anniversary World Summit of Artificial Intelligence" in Switzerland, 2006. He is also on the evaluation and consulting board of the "Mobilligence" project in Japan. His research interests are in the areas of embodiment, biorobotics, artificial evolution and morphogenesis, self-reconfiguration and self-repair, and educational technology. He is the author of the book "Understanding Intelligence" (with C. Scheier). A popular science book, entitled "How the body shapes the way we think: a new view of intelligence," has recently been published by MIT Press (with Josh Bongard). Rolf Pfeifer is currently setting up the "The ShanghAI Lectures", a mixed-reality lecture series which was broadcast from Jiao Tong University in Shanghai in 2009, and will be broadcast from Zurich in 2010. On-line interactive videoconferencing will be mixed with 3-D virtual collaborative environments. The project has the goal to build a world-wide cross-cultural community and knowledge source in embodied intelligence and related areas.

Prof. Paolo Dario



Paolo Dario received his Dr. Eng. Degree in Mechanical Engineering from the University of Pisa, Italy, in 1977. He is currently Professor of Biomedical Robotics at the Scuola Superiore Sant'Anna in Pisa. He has been Visiting Professor at Brown University, Providence, RI, USA, at the Ecole Polytechnique Federale de Lausanne (EPFL), Lausanne, Switzerland, at Waseda University, Tokyo, Japan, at the College de France, Paris, at the Ecole Normale Supérieure de Cachan, France, and at Zhejiang University, China. He was the founder of the ARTS (Advanced Robotics Technologies and Systems) Laboratory and is currently the Co-ordinator of the CRIM (Center for the Research in Microengineering) Laboratory of the Scuola Superiore Sant'Anna, where he supervises a team

of about 70 researchers and Ph.D. students. He is also the Director of the Polo Sant'Anna Valdera of the Scuola Superiore Sant'Anna.

His main research interests are in the fields of medical robotics, bio-robotics, mechatronics and micro/nanoengineering, and specifically in sensors and actuators for the above applications, and in robotics for rehabilitation. He is the coordinator of many national and European projects, the editor of two books on robotics, and the author of more than 250 scientific papers (more than 150 on ISI journals). He is Editor-in-Chief, Associate Editor and member of the Editorial Board of many international journals. He has been a plenary invited speaker in many international conferences.

Prof. Dario has served as President of the IEEE Robotics and Automation Society in the years 2002-2003. He has been the General Chair of the BioRob'06 Conference (The First IEEE/RAS-EMBS International Conference on Biomedical Robotics and Biomechatronics), of ICRA 2007 (International Conference on Robotics and Automation), ISG 2008 (the 6th Conference of the International Society for Gerontechnology) and of the First National Congress of Bioengineering (GNB 2008).

Prof. Dario is an IEEE Fellow, a Fellow of the European Society on Medical and Biological Engineering, and a recipient of many honors and awards, such as the Joseph Engelberger Award. He is also a member of the Board of the International Foundation of Robotics Research (IFRR). In 2009 He has been appointed Fellow of the School of Engineering of the University of Tokyo.

Prof. Cecilia Laschi



Prof. Cecilia Laschi is Associate Professor of Biomedical Engineering at the Scuola Superiore Sant'Anna in Pisa, Italy. She graduated in Computer Science at the University of Pisa in 1993 and received the Ph. D. in Robotics from the University of Genoa in 1998. Since 1992 she is with the ARTS Lab (Advanced Robotics Technology and Systems Laboratory) of the Scuola Superiore Sant'Anna in Pisa, Italy. From July 2001 to June 2002 she was visiting researcher at the Humanoid Robotics Institute of the Waseda University in Tokyo, as JSPS (Japan Society for the Promotion of Science) Fellow. Her research interests are in the field of biorobotics. Starting from basic robotics research, she has been investigated bioinspired solutions for personal robotics and bionics. She has been working in neuro-robotics, that is the application of robotics in neuroscience research. She is currently working on biomimetics, investigating animal and vegetal systems from an engineering point of view and with engineering tools, and designing robotic replicas that can fully explain the biological working principles and mechanisms. In the field of Service Robotics, she is working in the development of networked robots for applications in urban hygiene and in water monitoring. She is carrying out research activities in the field on neurodevelopmental engineering, by designing and developing instrumented toys for monitoring sensory-motor capabilities in infants. She has been and currently is involved in

many National and EU-funded projects, in the field of biorobotics. She has authored/co-authored more than 90 papers, appeared in international journals and conference proceedings. She is Guest Co-Editor of a Special Issue of the journal *Autonomous Robots on Bioinspired Sensory-Motor Coordination* and of a Special Issue of the *IEEE Transactions of Robotics on Human-Robot Interaction*. She is member of the IEEE, of the Engineering in Medicine and Biology Society, and of the Robotics & Automation Society, in which she co-chairs the Technical Committee on Human-Robot Interaction and Coordination. She is the Coordinator of the OCTOPUS Integrating Project.

Organizers

Cecilia Laschi - [OCTOPUS IP Coordinator](#)

Chiara Bartolozzi - [ANGELS Coordinator](#)

Frederic Boyer - [EMORPH Coordinator](#)

Eugenio Guglielmelli - [EVRON Coordinator](#)

Lijin Aryananda - [LOCOMORPH Coordinator](#)

Alin Albu-Schaeffer - [VIATORS Coordinator](#)

Local Organizing Committee

Laura Margheri - [PhD Student Biorobotics](#)

Federica Radici - [Administrative Assistant](#)



**Scuola Superiore
Sant'Anna**

di Studi Universitari e di Perfezionamento



FUNDING OPPORTUNITIES from the

FUTURE & EMERGING TECHNOLOGIES scheme



Invited Speakers

Prof. Rolf Pfeifer



Prof. Rolf Pfeifer received his masters degree in physics and mathematics and his Ph.D. in computer science from the Swiss Federal Institute of Technology (ETH) in Zurich, Switzerland. He spent three years as a post-doctoral fellow at Carnegie-Mellon University and at Yale University in the US. Since 1987 he has been a professor of computer science at the Department of Informatics, University of Zurich. He is the director Artificial Intelligence Laboratory at University of Zurich. He has organized a number of conferences and research projects such as "The 50th Anniversary World Summit of Artificial Intelligence" in Switzerland, 2006. He is also on the evaluation and consulting board of the "Mobilligence" project in Japan. His research interests are in the areas of embodiment, biorobotics, artificial evolution and morphogenesis, self-reconfiguration and self-repair, and educational technology. He is the author of the book "Understanding Intelligence" (with C. Scheier). A popular science book, entitled "How the body shapes the way we think: a new view of intelligence," has recently been published by MIT Press (with Josh Bongard). Rolf Pfeifer is currently setting up the "The Shanghai Lectures 1.1", a mixed-reality lecture series which was broadcast from Jiao Tong University in Shanghai in 2009, and will be broadcast from Zurich in 2010. On-line interactive videoconferencing will be mixed with 3-D virtual collaborative environments. The project has the goal to build a world-wide cross-cultural community and knowledge source in embodied intelligence and related areas.

Prof. Auke Jan Ijspeert



Prof. Auke Jan Ijspeert is Associate Professor at the EPFL (the Swiss Federal Institute of Technology at Lausanne), and head of the Biorobotics Laboratory (BioRob), previously the Biologically Inspired Robotics Group (BIRG). He has a BSc/MSc in Physics from the EPFL, and a PhD in Artificial Intelligence from the University of Edinburgh (with John Hallam and David Willshaw as advisors). He carried out postdocs at IDSIA and EPFL (LAMI) with Jean-Daniel Nicoud and Luca Gambardella, and at the University of Southern California (USC), with Michael Arbib and Stefan Schaal. He then became a research assistant professor at USC, and an external collaborator at ATR (Advanced Telecommunications Research institute) in Japan. In 2002, he came back to the EPFL first as a SNF assistant professor, and since October 2009 as an associate professor (with tenure). His research interests are at the intersection

between robotics, computational neuroscience, nonlinear dynamical systems, and applied machine learning. He is interested in using numerical simulations and robots to get a better understanding of animal locomotion and movement control, and in using inspiration from biology to design novel types of robots and locomotion controllers (Ijspeert et al, Science, Vol. 315. no. 5817, pp. 1416 - 1420, 2007). With his colleagues, he has received the Best Paper Award at ICRA2002, the Industrial Robot Highly Commended Award at CLAWAR2005, and the Best Paper Award at the IEEE-RAS Humanoids 2007 conference. He is an associate editor for the IEEE Transactions on Robotics, and has acted as guest editor for the IEEE Transactions on Biomedical Engineering, Autonomous Robots, and Biological Cybernetics. He is/was the Technical Program Chair of 5 international conferences (BioADIT2004, SAB2004, AMAM2005, BioADIT2006, LATSIS2006), and has been a program committee member of over 40 conferences. For more information, publications, courses, books and contacts see the Biorobotics Laboratory page.

Prof. Benny Hochner



Prof. Benny Hochner Studied Neurobiology at the Hebrew University of Jerusalem (PhD 1983). Did his postdoctoral training with Prof. Eric Kandel (Nobel Laureate for Medicine, 2000) at Columbia University. Returned to the Hebrew University of Jerusalem as a Research Fellow at Otto Loewi Center and later became Independent researcher at the department of Neurobiology. Currently he is an Associate Professor of Neurobiology at the Department of Neurobiology, Institute of Life Sciences and a Member of the Interdisciplinary Center for Neural Computation of the Hebrew University. He is the Principal Investigator of the Octopus Group of the Hebrew University of Jerusalem. Prof. Hochner is involved in octopus arms research as inspiration for robotics since 1994. His research was supported by the US Navy and DARPA until 2006 and by the Israel Science Foundation. In parallel, Prof. Hochner studies the neurobiology of learning and memory in the octopus. During this time Prof. Hochner published, as a senior author, 20 papers on these subjects in high ranking journals including Nature, Science, Current Biology Journal of Neuroscience, etc. He is now involved in the OCTOPUS Integrating Project for the study of the neuromuscular system of the octopus arm, the octopus central and peripheral motor control, the arm biomechanics.

Prof. Barbara Webb



Prof. Barbara Webb is a reader at the University of Edinburgh, Member of Informatics Life-Sciences Institute Associate, Member of Institute for Adaptive and Neural Computation, Member of Institute of Perception, Action and Behaviour and the head of the Cricket Lab. She joined the School of Informatics at the University of Edinburgh in May 2003. Previously she has lectured at the University of Stirling (1999-2003), the University of Nottingham (1995-1998) and the University of Edinburgh (1993-1995). She received her Ph.D. (in Artificial Intelligence) from the University of Edinburgh in 1993, and her B.Sc. (in Psychology) from the University of Sydney in 1988. She is a pioneer in the new research area of Biorobotics, studying how to make robots that emulate or simulate biological organisms computationally and physically. She has co-edited the first book on the topic together with Thomas Consi and she is the author of numerous articles that show how a robot can serve as a tool for biologists. Her main research interests are perceptual systems for the control of behavior. The work is largely concerned with building computational and physical models of these mechanisms to explicate and evaluate hypotheses. In particular she focuses on insect behaviours, as their smaller nervous systems may be easier to elucidate. Recent work has focussed on some of the more complex capabilities of insects, including multimodal intergration, navigation and learning. She also have an interest in theoretical issues of methodology; in particular the problems of measurement, modeling and simulation.

Prof. Eugenio Guglielmelli



Prof. Eugenio Guglielmelli received the Laurea degree in Electronics Engineering and the PhD in Biomedical Robotics from the University of Pisa, Italy, in 1991 and in 1995. He is currently Associate Professor of Bioengineering at Campus Bio-Medico University (Roma, Italy) where he serves as the Head of the Laboratory of Biomedical Robotics and Biomicrosystems, that he founded in 2004. He teaches Biomechatronics and Rehabilitation Bioengineering at UNICAMPUS. His main current research interests are in the fields of novel theoretical and experimental approaches to human-centered robotics and to biomorphic control of mechatronic systems, and in their application to basic neuroscience, behavioural analysis, robot-mediated motor therapy, assistive robotics, neuro-robotics and neuro-developmental engineering. He is author/co-author of more than 170 publications appeared on peer-reviewed international journals, books and procs. of international conferences. He is also co-author of three international patents, and founding member of four academic spin-off companies.

Prof. Paolo Dario



Paolo Dario received his Dr. Eng. Degree in Mechanical Engineering from the University of Pisa, Italy, in 1977. He is currently Professor of Biomedical Robotics at the Scuola Superiore Sant'Anna in Pisa. He has been Visiting Professor at Brown University, Providence, RI, USA, at the Ecole Polytechnique Federale de Lausanne (EPFL), Lausanne, Switzerland, at Waseda University, Tokyo, Japan, at the College de France, Paris, at the Ecole Normale Supérieure de Cachan, France, and at Zhejiang University, China. He was the founder of the ARTS (Advanced Robotics Technologies and Systems) Laboratory and is currently the Co-ordinator of the CRIM (Center for the Research in Microengineering) Laboratory of the Scuola Superiore Sant'Anna, where he supervises a team of about 70 researchers and Ph.D. students. He is also the Director of the Polo Sant'Anna Valdera of the Scuola Superiore Sant'Anna.

His main research interests are in the fields of medical robotics, bio-robotics, mechatronics and micro/nanoengineering, and specifically in sensors and actuators for the above applications, and in robotics for rehabilitation. He is the coordinator of many national and European projects, the editor of two books on robotics, and the author of more than 250 scientific papers (more than 150 on ISI journals). He is Editor-in-Chief, Associate Editor and member of the Editorial Board of many international journals. He has been a plenary invited speaker in many international conferences. Prof. Dario has served as President of the IEEE Robotics and Automation Society in the years 2002-2003. He has been the General Chair of the BioRob'06 Conference (The First IEEE/RAS-EMBS International Conference on Biomedical Robotics and Biomechatronics), of ICRA 2007 (International Conference on Robotics and Automation), ISG 2008 (the 6th Conference of the International Society for Gerontechnology) and of the First National Congress of Bioengineering (GNB 2008). Prof. Dario is an IEEE Fellow, a Fellow of the European Society on Medical and Biological Engineering, and a recipient of many honors and awards, such as the Joseph Engelberger Award. He is also a member of the Board of the International Foundation of Robotics Research (IFRR). In 2009 He has been appointed Fellow of the School of Engineering of the University of Tokyo.

Prof. Tamar Flash



Prof. Tamar Flash received her PhD in Medical Physics from the Harvard-MIT division of Health Science and Technology. She conducted her Post-Doc training in the department of Brain and Cognitive Science and the Artificial Intelligence laboratory at MIT. Since 1985 she has been working at the Dept of CS and Applied Math at the Weizmann Institute of Science. She has been involved in octopus movement control research as an inspiration

for robotics since 1994. Her research was supported by the US Navy, DARPA and by the Israel Science Foundation. The main focus of her research is on motor control in humans and robotic systems. This research combines experimental work in human subjects with the development of mathematical models that formulate alternative hypotheses concerning motion planning and control strategies by the brain. This combined research helps in gaining insight into human motor control and subserves the development of motion planning and control algorithms for artificial robotic systems. In particular, together with colleagues she studies the principles that underlie the selection and planning of human 2D and 3D arm movements during reaching, drawing and grasping tasks. The comparison of motor performance in neurologically healthy human subjects with that of patients suffering from various movement disorders contributes to the understanding of the pathophysiological processes underlying such disorders. One of her current interests is in the topic of motor learning in humans and in the development of learning capabilities for robotic systems. Another current interest is in developing mathematical formalisms based on differential geometry and Lie Algebra to investigate motion planning strategies and the resolution of task and kinematic redundancy problems associated with multi-degrees of freedom moments in biological and robotic systems. An additional current interest is in investigating the neural control of flexible hyper-redundant arms as in the Octopus.

Student Participants

- ◆ *Arienti Andrea* (a.arianti@sssup.it)
- ◆ *Ascrizzi Antonio* (a.ascrizzi@sssup.it)
- ◆ *Bonsignori Gabriella* (g.bonsignori@sssup.it)
- ◆ *Botvinnik Alexander* (alexande.botvinnik@mail.huji.ac.il)
- ◆ *Calisti Marcello* (m.calisti@sssup.it)
- ◆ *Carpino Giorgio* (g.carpino@unicampus.it)
- ◆ *Casanova Flurin* (flurincasanova@access.uzh.ch)
- ◆ *Cempini Marco* (m.cempini@sssup.it)
- ◆ *Cianchetti Matteo* (m.cianchetti@sssup.it)
- ◆ *Clercq Charles* (charles.clercq@iit.it)
- ◆ *De Rossi Stefano* (s.derossi@sssup.it)
- ◆ *Follador Maurizio* (m.follador@sssup.it)
- ◆ *Fornai Francesco* (f.fornai@sssup.it)
- ◆ *Fossati Sara Maria* (sara.fossati@iit.it)
- ◆ *Giorelli Michele* (m.giorelli@sssup.it)
- ◆ *Godage Isuru* (Isuru.Godage@iit.it)
- ◆ *Hanassy Shlomi* (shlomi.hanassy@mail.huji.ac.il)
- ◆ *Hung Vu Quy* (vqhung@ifi.uzh.ch)
- ◆ *Iqbal Sheikh Farrukh* (fsheikh@ifi.uzh.ch)
- ◆ *Jawad Brahim* (brahim.jawad@emn.fr)
- ◆ *Kuppuswami Naveen* (naveenoid@ifi.uzh.ch)
- ◆ *Lenzi Tommaso* (t.lenzi@sssup.it)
- ◆ *Levy Guy* (Guy.Levy@mail.huji.ac.il)
- ◆ *Li Tao* (taoli@ifi.uzh.ch)
- ◆ *Margheri Laura* (l.margheri@sssup.it)
- ◆ *Marrazza Stefano* (s.marrazza@sssup.it)
- ◆ *Marazzato Laura* (l.marazzato@sssup.it)
- ◆ *Muscolo Giovanni* (g.muscolo@sssup.it)
- ◆ *Mattioli Fabio* (f.mattioli@sssup.it)
- ◆ *Orofino Stefano* (s.orofino@sssup.it)
- ◆ *Pereira Carolina* (carolina@iibce.edu.uy)
- ◆ *Pateromichelakis Nikos* (nikospat@ics.forth.gr)
- ◆ *Pouya Soha* (soha.pouya@epfl.ch)
- ◆ *Rea Francesco* (francesco.rea@iit.it)
- ◆ *Renda Federico* (f.renda@sssup.it)
- ◆ *Sadeghi Ali* (a.sadeghi@sssup.it)
- ◆ *Shaukat Ali* (Shaukat.ALI@emn.fr)
- ◆ *Tagliamonte Nevio* (n.tagliamonte@unicampus.it)
- ◆ *Tapia Cecilia* (Cecilia.Tapia@iit.it)
- ◆ *Tramacere Francesca* (f.tramacere@sssup.it)
- ◆ *Van den Kieboom Jesse* (jesse.vandenkieboom@epfl.ch)
- ◆ *Vespignani Massimo* (m.vespignani@unicampus.it)
- ◆ *Zheng Tianjiang* (Tianjiang.Zheng@iit.it)



Andrea Arienti (a.arienti@sssup.it)

is an undergraduate student in Mechanical Engineering from the University of Pisa and he is working on his thesis at the ARTS Lab of the Scuola Superiore Sant'Anna as part of the OCTOPUS Integrating Project (FP7, ICT 2007.8.5 Embodied Intelligence). The *Octopus vulgaris* is a marine invertebrate with amazing motor capabilities and intelligent behaviours. Its body has no rigid structures and has interesting characteristics of dexterity. Starting from the study of the anatomy and the observation of the performance of the octopus arm, it is possible to take inspiration from nature to design and build several

mock-ups made of different materials and actuated by different cables arrangements. These mock-ups allow verifying biological hypothesis and define specifications for the design of the octopus-like artifact. For this purpose, a versatile platform was designed and developed to control a very complex mock-up made by silicone and actuated by some cable, which are capable of mimicking both the longitudinal and transverse muscles of the octopus arm. Topics of research are bioinspired and soft robotics, underactuated structures and design of smart actuations systems.

Contact Information: Research Centre on Sea Technologies and Marine Robotics

Viale Italia, 6 - 57126 Livorno, Italy

Ph. +39 050 883395; Fax: +39 050 883399



Antonio Ascrizzi (a.ascrizi@sssup.it)

Main topic: Robots Plants

Objectives: Design and development of the robotic plant behavioural architecture (tropisms and collective roots behaviour)

Contributions: Each root of the plantoid robot has a highly sensorized apex and has a local processing unit for determining the steering direction, based on the sensory input. The way the steering direction chosen by each root is strongly based on the explanation of the *tropism mechanisms* in plants. From a robotics perspective, tropisms can be seen as reactive behaviours. However, plants show an interesting capability to manage

large amounts of sensory data and to fuse them at a very low level, with limited computing resources. Tropisms in plants are performed at the low level of the root apex, and they probably implement simple mechanisms, from a computational point of view. This task aims at taking advantage of the findings on the plant tropisms for developing new *low-cost* (computationally) techniques and for implementing *sensor fusion* and tropisms in the plantoid robot roots.

Contact Information: Center for Micro-BioRobotics, IIT@SSSA

Italian Institute of Technology - Viale Rinaldo Piaggio 34 - 56025, Pontedera (Pisa) - Italy



Gabriella Bonsignori (g.bonsignori@sssup.it)

MSc in Biological Science, PhD Student in Biorobotics at Scuola Superiore Sant'Anna.

Main topic: Insect and Robot jumping locomotion.

Objectives: To investigate scales effects in animal and robot locomotion for the design of an autonomous robot of small dimensions. To analyze insects jumping locomotion in order to better understand, by an engineering point of view, the embodied optimization mechanism used

by insects and to apply it to the robots' design.

Contributions: Qualitative analysis of literature on animal and insect jumping locomotion; evaluation of criteria for the choice of a group of insects that use jumping locomotion as their preferred locomotion strategy; elaboration of an experimental protocol for the analysis of insects jumping locomotion by using a high speed video camera; mathematical and statistical data analysis; kinematic and dynamic modelling of motion.

Contacts: CRIM Lab Polo Sant'Anna Valdera - Scuola Superiore Sant'Anna - Viale Rinaldo Piaggio, 34 - 56025 - Pontedera (PI) – Italy

Scuola Superiore Sant'Anna - Piazza Martiri della Libertà, 33 - 56127 – Pisa

Phone: +39 050 883 412; Fax: +39 050 883 497



Alexander Botvinnik (alexande.botvinnik@mail.huji.ac.il)

I'm PhD student from Neurobiology Department of Hebrew University of Jerusalem (Prof. Benny Hochner lab.).

My main research: The motor primitives of *Octopus vulgaris* and relationships between arm elongation and bend propagation during arm extension movements.

My contact details: mail: alexande.botvinnik@mail.huji.ac.il; ph. 972-23714205.



Marcello Calisti (m.calisti@sssup.it)

Marcello Calisti has a degree in Mechanical Engineering and a MS degree in Biomedical Engineering. He has a PhD Student position at Scuola Superiore Sant'Anna di Pisa, working in the Octopus Project, ICT-FET Proactive Initiative EMBODYi (2009-2013). His work is related to bioinspiration and embodied intelligence, and in particular to the behavioural architecture related to the octopus artefact. His work entails the implementation of multiple arms coordination and the

autonomous behaviour selection by the robot. He is currently developing a simulation environment where it is possible to test soft robot movements, taking into account collision

detection to investigate the interaction between the robot structure and the environment. He is also working on designing and building various mock-ups to test specific biological hypothesis on certain behaviours of the octopus, such as crawling and reaching.

Contact Information: Research Centre on Sea Technologies and Marine Robotics
Viale Italia, 6 - 57126 Livorno, Italy
Ph. +39 050 883395; Fax: +39 050 883399



Giorgio Carpino (g.carpino@unicampus.it)

(BS 2005, MS 2008) is currently a PhD Student at Campus Bio-Medico University, where he started working in the Laboratory of Biomedical Robotics and Biomicrosystems in January 2009, under the supervision of Prof. Eugenio Guglielmelli. His research programme is focused on the development of novel robotic devices for human assistance and rehabilitation, with a special focus on the relation between morphology and control. The objective is to exploit structural intelligence as ability of the mechanical structure of producing useful emergent dynamic behaviors and of adapting itself to external perturbations through reflexes. Such research is being applied to lower limbs exoskeletal robots for assisting human walking. He is currently involved in the EC-funded Evryon Project, contributing to mechanical design via 3D CAD-based techniques for improving ergonomics and the pHRI.



Flurin Casanova (casanova@ifi.uzh.ch)

I'm a PhD student at the Artificial Intelligence Lab at the University of Zurich and work on the Locomorph project. That's why my research interests are focused on legged locomotion and corresponding fields.

My contact details are: Flurin Casanova, Artificial Intelligence Laboratory, Department of Informatics, University of Zurich, Andreasstrasse 15 8050 Zurich, Switzerland. E-mail: casanova@ifi.uzh.ch

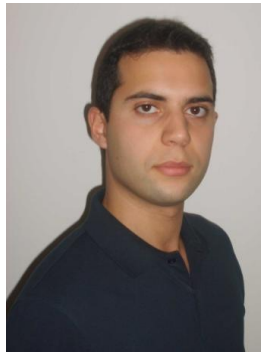


Marco Cempini (m.cempini@sssup.it)

will start his PhD course at the ARTSLab on November 2010. He is actually collaborating with the laboratory in the study, modelling and design of mechanical components for robotic platforms, within the Evryon project. His research interests aim to analyze and study the limitations of the current robotic exoskeletons device for neuroscientific applications, from the mechanical and structural point of view: particularly, the optimization (especially in terms of comfort, adaptability and security towards the human user, in a view of a

full symbiotic human-machine physical interface) of the structural design, including the use of non-linear materials and analysis is the main core of his research project, whose goal is to classify the requirements and define a robust and versatile architecture for a perfectly-fitted wearable exoskeleton assistive devices.

Contact Information: ph.+39 349 0502500



Matteo Cianchetti (m.cianchetti@sssup.it)

The octopus arm is composed of muscles arranged in a special structure named HYDROSTAT, whose main characteristic is that its volume remains constant during contractions and it serves as a modifiable skeleton allowing the transformation of force into motion. The main aim of the study is to reproduce this structure in order to obtain similar performances: relative small decrease of the diameter obtained by contractions of transverse artificial muscles lead a large increase of the arm length. To obtain this structure soft actuators (as contracting elements) and suitable materials have been investigated. The study aimed at overcoming technological problems related to the development of mechanisms and actuators for a soft-bodied robot. Several different kinds of technologies were explored, among which EAP (ElectroActive Polymers) and SMA (Shape Memory Alloys). Materials represent another very important part of the work since the passive properties of the arm are a key factor in reproducing octopus-like movements, so on the base of observations, experimental measures and bibliographic references, a comparative analysis on suitable materials and geometries was carried out.

Contact Information: Research Centre on Sea Technologies and Marine Robotics

Viale Italia, 6 - 57126 Livorno, Italy

Ph. +39 050 883395; Mobile: +39 340 7219306; Fax: +39 050 883399



Charles Clercq (charles.clercq@iit.it)

I am working in the eMorph project, for which my aim is to provide some adapted solutions which take advantage of the dynamic of the events-driven sensor. Indeed, the conventional visual sensors impose some major bottlenecks, for which, despite the number of solutions brought, the "vision community" did not find any general approach to deal with. The events-based paradigm has the advantage to avoid these bottlenecks by taking care of the dynamic of the scene, but impose to rethink the way to deal with the informations. I am actually working on the computation of the optical-flow, which is an interesting problem to show the intrinsic differences between the mainstream frames-based and the promising events-based paradigms, because of its dependency on the motion, and so, on the dynamic of the scene. The optical-flow has several applications in robotic as the obstacles avoidance, the attention attraction and so on, which make it interesting in autonomous contexts.



Stefano De Rossi (s.derossi@sssup.it)

MSc Control Engineering; PhD Student in Biorobotics; Project: EVRYON

Activity: Design and development of a fully integrated multiple sensing technology for a lower limb exoskeleton In the framework of the EVRYON project, which aims, at the end, at developing a lower limb assistive exoskeleton, a fully-integrated, multiple sensing technology should be developed. Its main objective is to correctly identify the intention of the user, his/her residual motion capability, its physiological gait movement, and to exploit this information to tune a central impedance control of the joints to give assistance to the user. Crucial to this is the sensorization equipment, which will involve an interaction force measurement unit, a

sensorized insole for the detection of the gait phase, a joint torque/velocity/position estimation algorithm, and a set of inertial measurement units for the monitoring of the user's limbs status. This data will be then fused to extract all the relevant information required by the adaptive control of the robot.

Contact Information: ARTS Lab, Polo Sant'Anna Valdera - Scuola Superiore Sant'Anna - Viale Rinaldo Piaggio, 34 - 56025 - Pontedera (PI) - Italy

Scuola Superiore Sant'Anna - Piazza Martiri della Libertà, 33 - 56127 - Pisa

Phone: +39 050 883 472



Maurizio Follador (m.follador@sssup.it)

Maurizio Follador (Torino, 1984) received his master's degree in Biomedical Engineering at Polytechnic of Turin in 2009, with a thesis on a simulator for knee testing, developed at the European Centre for Knee Research in Leuven (Belgium). In May 2009 won a research fellowship to work in the OCTOPUS Project, focusing on the design and realization of the actuation method of the robotic arm. Main challenge in this part of the project is the realization of an artefact with characteristic of dexterity, which can manipulate objects and

perform locomotion of the robot. Research has been focused on material and technology selection and characterization. Main field of research is Shape Memory Alloy (SMA) technology. Working on SMA involves material characterization, optimization of construction parameters, realization of the actuators and validation of the models used for designing, modelling electro-thermal interaction with FE models.

Contact Information: Research Centre on Sea Technologies and Marine Robotics

Viale Italia, 6 - 57126 Livorno, Italy

Ph. +39 050 883395; Mobile: +39 338 2247306; Fax: +39 050 883399



Francesco Fornai (f.fornai@sssup.it)

My name is Francesco Fornai, I achieved a M.Sc. degree in Mechanical Engineer and I am currently a Ph.D. student in Biorobotics. My research is focused on the development of a new bio-inspired robotic platform for water monitoring. The research aims at investigating an innovative method for monitoring water quality adopting passive, bio-inspired, and low cost robots. The passive feature enables long endurance missions, with no or very few batteries onboard with the energy required for payload sensors provided by energy scavenging techniques. The low cost feature permits to use a big number of robots monitoring large areas, and the bio-inspired feature exploits the energy-efficient solutions developed by Nature. The robots move on the water surface following sea currents and winds monitoring some water parameters with the electric power provided by green energy solutions (solar cells and a system based on the thermocouple principle). A system able to move the robots up and down along the water column is under investigation. A good source of inspiration to develop this kind of robot is represented by the jellyfish.

Contact Information: Research Centre on Sea Technologies and Marine Robotics

Viale Italia, 6 - 57126 Livorno, Italy

Ph. +39 050 883395; Mobile: +39 328 66 25 739; Fax: +39 050 883399; Skype: francesco_fornai



Sara Maria Fossati (sara.fossati@iit.it)

The morphological characterization of the octopus arm is of great importance for obtaining a comprehensive view on functional organization of the muscular hydrostat and to define mechanical constraints of the arm muscular hydrostat.

My activity in the OCTOPUS project is focused on the anatomical and histological analysis of the octopus arm in order to observe and characterize possible structural advantage for a robotic viewpoint. To do that, I analyzed both in transverse and longitudinal serial sections, the morphology of segments from basal, central, and apical portion of the arm using classical histochemical and immunohistochemical reactions. These techniques allowed me for evaluating muscle and nerve cell density and their orientation, and for estimating the ratio between the volumes occupied by nerve, ganglia and muscle along the arm, in order to help building an 'efficient' mechanical arm prototype.

Contacts: Email sara.fossati@iit.it; Mobile phone +39 347 57 52 235



Michele Giorelli (m.giorelli@sssup.it)

Michele Giorelli received his Bachelor and Master degree in Control System Engineering respectively in 2006 and 2009 from the Polytechnic University of Bari. He won a European fellowship at the robotics laboratory of the Polytechnic University of Catalonia in 2009 to work in the field of laparoscopy surgery. From March 2010 he is working in the Octopus-IP Project at the Research Centre on Sea Technologies and Marine Robotics of the Scuola Superiore Sant'Anna (SSSA). He has obtained a three year PhD fellowship at SSSA with the project "Control strategy for soft-robot". His main research interest

is in the field of robot control, with particular emphasis on the techniques for controlling soft-robots, which entail, for instance, the need for dealing with a large number of degrees of freedom. He thinks that Embodied Intelligence offers a good and smart solution to control this kind of robots.

Contact Information: Research Centre on Sea Technologies and Marine Robotics

Viale Italia, 6 - 57126 Livorno, Italy

Ph. +39 050 883395; Fax: +39 050 883399



Isuru Godage (Isuru.Godage@iit.it)

Isuru Godage is a PhD research student in Italian Institute of Technology, Genova, Italy. His main interests include biomimetics and modeling of deformable bodies. He currently works in OCTOPUS project on designing and modeling a robotic arm inspired by the octopus.



Shlomi Hanassy (shlomi.hanassy@mail.huji.ac.il)

I am a PhD student in the Neurobiology department of the Hebrew University, working in the laboratory of Prof. Benny Hochner. My work, which is on the field of motor control, deals with those following issues:

- Octopus Arms biomechanics and neurobiology
- Automatic System for reconstruction and analysis 3d movements of octopus arm (including kinematic parameters like: Lengthening,

Width, Velocities, Volumes, angular velocities and which are changing dynamically during the movement)

- Analytic and non-Analytic online systems for controlling non-linear biomechanical and artificial (robotic) dynamic models, including hyper redundant structures.

Contact information: The department of Physiology -Hebrew University, Hadassa Ein Carem Medicine School, Jerusalem 91904, ISRAEL - Phone: Lab. (HUJI) 02-675804; cellular. 0544-831088.



Farrukh Iqbal Sheikh (fsheikh@ifi.uzh.ch)

I am a research student pursuing my PHD at the Artificial Intelligence laboratory, University of Zurich. I have been assigned to the Locomorph project where my focus of research is to build bio-inspired, self-stable, maneuverable and controllable morphing legged robot. These robots intend to exhibit robust locomotion not only by having various gait but also through varying morphologies. We are building various shapes of robots and testing them in real environment to get the better insight of robot performance. This will help us to understand, how various morphologies could affect the performance of robot locomotion.

Contact information: Artificial Intelligence Laboratory Department of

Informatics University of Zurich Andreasstrasse 15 (Office 2.25) 8050 Zurich Switzerland

Phone: +41 44 635 24 05 fax: + 41 44 635 45 07



Brahim Jawad (brahim.jawad@emn.fr)

Phd thesis on «the Electrolocation modelling for the Angels robot». Doctoral advisor: Frédéric BOYER, IRCCYN laboratory Robotic group, NANTES. Co-doctoral advisor: Pol-Bernard GOSSIAUX, SUBATECH laboratory, Theory group, NANTES. Goal and achieved works: ANGELS project which full description is given in the website «www.theangelsproject.eu/tiki-index.php» aims at building an eel-like robot equipped with the electric sense for the navigation and localization in dark waters. The

ANGELS robot would be capable to divide itself in several individual modules which could communicate each other informations about the explored environment. The ANGELS project has reached the level of an international collaboration, each partner having a well defined task in the project. In the Nantes group we work on electrolocation modelling. At the end of the first year we were able to propose an analytical model for the electric navigation and to test it successfully in our test bed. We now collaborate more with biologists to improve the electrolocation model so we can in the next months begin the implementation in the robot.



Naveen Kuppuswamy (naveenoid@ifi.uzh.ch)

With a background in Robot Control, my primary interests are in sensori-motor control techniques of embodied agents. In particular, I am interested in Adaptive and Dynamic Control strategies employed in nature. I am also interested in various aspects of robot mechanical and electronic design. I am a member of RobotDoc (EU Marie Curie Network project) and OCTOPUS project (EU FP7 Project). I am currently the following: 1. Mag-E Actuation : We are

trying to design an actuator for fin-based locomotion based on the principles of electromagnetism. This design will allow us to study energy efficient actuation using passive properties of the underlying magneto-mechanical system and develop simple control strategies exploiting the inherent nonlinearity of the system. This is a collaboration with Mr. Juan Pablo Carbajal. 2. Passive Silicone octopus-like arms and String Pullers : The first target in the Octopus Project is to come up with an effective design for actuation of soft-bodied arms which can replicate the prototypical behaviours of the natural octopus like reaching and grasping. We are trying to understand the passive properties of silicone and how this can aid us in the design and actuation of the string pulling arms, which are basically tendon driven silicone structures with inextensible strings simulating muscle contraction in longitudinal and transverse directions. This is a collaboration with Mr. Matteo Cianchetti of the ARTS Lab of Scuola Superiore Sant'Anna, Italy.

Contact Information: Artificial Intelligence Laboratory - Department of Informatics -University of Zurich - Andreasstrasse 15 (Office 2.22), 8050 Zurich, Switzerland
Ph.: +41 44 635 24 01; fax: +41 44 635 45 07



Tommaso Lenzi (t.lenzi@sssup.it)

Tommaso Lenzi was born in Prato, Italy, in 1983. He received the the BSc and the MSc in Biomedical Engineering, with honors, in 2005 and 2008 respectively, from University of Pisa. Since 2007, he is with ARTS Lab of Scuola Superiore Sant'Anna, where he is currently working as a PhD student in Biorobotics. His main research activities are in the field of neuro-robotics, with particular interest in wearable robotics for rehabilitation and assistive purposes.



Guy Levy (Guy.Levy@Mail.huji.ac.il)

I have completed my bachelor's degree in the Hebrew University of Jerusalem in the year 2000 in the fields of Computer-Science and Mathematics.

In the year 2003 I joined the Interdisciplinary Center for Neural Computation (ICNC) in the Hebrew University which is a direct program for Masters and PhD in the Neural-Computation field.

After I have completed my Masters in the ICNC I joined the laboratory of Prof' Benny Hochner in the Neurobiology department, and now I am a PhD student there, and also continue to belong to the ICNC.

Within my studies, in the present I am kinematically analyzing the arms movements of the Octopus Vulgaris while crawling on a two-dimensional surface. In this part of my research I aim to kinematics describe how each single arm is moving within the crawling movement and also how the different arms that are attending the movement are coordinated. This part of my research will

hopefully contribute to the octopus EMBODYi project, since it will help to understand how the octopus robot should use the arms when crawling and also how to coordinate between them.

Contact information: Guy.Levy@Mail.huji.ac.il; Cell phone: +972-528-753298



Tao Li (taoli@ifi.uzh.ch)

I have been working in OCTOPUS IP since Feb., 2009. Jointly with SSSA, a robot-arm octopus platform has been developed in 2009. By proper selection of material, silicone in this case, and appropriate design of mechanical structure, the control problem of a totally soft robot has been significantly decreased. My future research work would be in the area of soft robot design and control.

Contact information: Artificial Intelligence Laboratory, Department of Informatics, University of Zurich, Andreasstrasse 15 (Office 2.26) 8050 Zurich, Switzerland

Tel: + 41 44 635 43 15; Fax: + 41 44 635 45 07



Laura Margheri (l.margheri@sssup.it)

was born in Florence in 1982. She received her Master Degree in Biomedical Engineering (with Honors) from the University of Pisa in July 2008. In November 2008 she started her Ph.D. in Biorobotics at the ARTS Lab of the Scuola Superiore Sant'Anna. She is involved in the OCTOPUS Integrating Project with the main objectives of the study *in vivo*, the characterization and modeling of the *Octopus vulgaris* through the development of purpose-made sensorized instruments. The deep investigation and the characterization of the octopus arms from a bio-engineering viewpoint is fundamental to fully understand the unique features of this animal or to take inspiration for the design of new high-

dexterous robotic systems. Focused research on the octopus arms anatomy and biomechanics is carried out to extract new biological information and define specifications for the design of a biomimetic robot inspired to the form and morphology of the octopus. Research fields and interests include biorobotics and biomimetics, biomechanics, motion analysis and modeling, marine biology.

Contact Information: Research Centre on Sea Technologies and Marine Robotics

Viale Italia, 6 - 57126 Livorno, Italy

Ph. +39 050 883395; Mobile: +39 347 1329605; Fax: +39 050 883399



Stefano Marrazza (s.marrazza@sssup.it)

received his Master Degree in Biomedical Engineering at the University of Florence (Italy) in April 2009. In July 2009 he joined the CRIM Lab where he works on the development of innovative bio-robotics platform. His main research interests are: bio-inspired robotics, bio-inspired sensors, 3D microfabbrication processes, energy system storage for autonomous robot.



Laura Marazzato (l.marazzato@sssup.it)

She is actually at the end of the first year of her PhD in Biorobotics. Her research interests are in the fields of Humanoids Robotics and Motion Analysis. Her research activity aims to the specification of biomechanical models of human legs for the locomotion and movements involved during a swimming task. In particular her studies are focused on the temporal and spatial coordination of the whole-body and on relationships between body segments during natural human movements. Based on direct experiments on human beings, results are going to be used for the formulation of neurophysiological models in order to improve the knowledge on the control system in human beings. The Sabian robot, a humanoid platform for the study of human behavior in the real environment, will be used for the implementation and validation of models. Contact information: Phone: +39-050-883-094; Fax: +39-050-883-497



Giovanni Gerardo Muscolo (g.muscolo@sssup.it)

Ph.D. title: Design and Development of humanoid robot components based on the principle of embodied intelligence. Main Scientific Interests: Humanoid Robotics, Service Robotics, Bioengineering, Biomechanics, Robotics Locomotion, Mechanics of Robots; Mechatronics, Robotics, Industrial Automation; Machine Design, Rotor Dynamics, Applied Mechanics. Research activity: Collaboration in European research projects: NANOBIOACT, ROBOTCUB and ROBOSOM.

Contact Information: Giovanni Gerardo Muscolo, M.Sc. in Mech. Eng. at University of Pisa, Italy. Ph.D. Candidate in Mech. Eng. at University of Genova, Italy. Research Assistant at ROBOT-AN Lab, ARTS lab, Scuola Superiore Sant'Anna - Polo Sant'Anna Valdera. Viale Rinaldo Piaggio, 34 - 56025 Pontedera (PI) – Italy. Ph: +39 050883429.



Fabio Mattioli (f.mattioli@sssup.it)

Ph.D. Student. The aim of my research is to develop a novel class of actuators based on the osmotic principle, characterized by energy efficiency, robust design and ease of fabrication. This work takes inspiration from some of the faster natural processes acting on a miniature scale, i.e. in cnidocysts (the stinging cell of Cnidaria) and in the Venus Flytrap closure mechanism., The actuator design will be carried out by integrating biological research, also considering SoA academic and commercially available technologies (e.g. osmotic membranes developed

for desalination), so as to obtain optimal performance (e.g. regarding power/volume) and to explore scale effects when targeting the milli/micro domain.

Contact Information: Center for Micro-BioRobotics, IIT@SSSA

Italian Institute of Technology - Viale Rinaldo Piaggio 34 - 56025, Pontedera (Pisa) - Italy

Phone: +39 050 883459; Fax: +39 050 883101



Stefano Orofino (s.orofino@sssup.it)

received his Master Degree in Biomedical Engineering (with honors) at the University of Firenze (Italy) in July 2008. In September 2007 he joined the CRIM Lab where he is now Ph.D. student in Microsystem Engineering, in collaboration with the University of Roma “Tor Vergata”. His research interests are: Bio-inspired robotics, Biomaterials, Bio-inspired sensors, 3D Microfabbrication Processes.

Contacts: CRIM Lab Polo Sant'Anna Valdera - Scuola Superiore

Sant'Anna - Viale Rinaldo Piaggio, 34 - 56025 - Pontedera (PI) – Italy

Phone: +39 050 883 412; Fax: +39 050 883 497



Nikolaos Pateromichelakis (nikospat@ics.forth.gr)

was born in Chania, Crete in 1981. He completed his bachelor degree at the Technological Educational Institute of Crete in 2004 , at the Department of Mechanical Engineering, Faculty of Technological Applications, with a major in Mechatronics and Industrial applications. In 2006 he completed the Master of Science in Mechatronics at FH Aachen, Germany. Subsequently, he was selected for a nine-month intership with Kloker Nanotechnik, a company working in the area of microrobotics, and undertook work on the “Development and

Evaluation of Algorithms for the measurement of objects in nano-climax”. Since the end of his military service in 2007 he has been working as a technician at the laboratory of Computational Vision and Robotics at FORTH, participating in many research programs. He is specialized in Computer Aided Design; he is educated in operating systems of 3D printing, in the design of electronic circuits, in the programming of microprocessors as well as in the development of low-level control systems for robotic mechanisms. He is experienced and has developed various programs in the area of measurement technology.

Currently he is participating the OCTOPUS Project, developing a robotic tentacle. More specifically, he is developing the hardware, based on segments in the form of a parallel platform using SMAs as actuators, the SMAs control in order to accurately position each segment in space, the distributed electronics and control of each segment, and finally the control of the interconnected segments forming a tentacle in order to achieve some basic behaviors.



Carolina Pereira (carolina@iibce.edu.uy)

I am part of a team led by Dr. Angel Caputi that participate in the project ANGELS. In this group, my work is focused on two main aspects: i) the effects of the context on the image formation in the active electroreception of *Gymnotus omarorum* (a South American electric fish), ii) the consequences of the contextual effects on the spatial range of active electrolocation. The experimental approach to these problems includes physical, behavioral and electrophysiological measures.

This is important for the robot design because contribute to solve one of the most important problems of its construction: determine the effective reach that allows the control system to manoeuvre with acceptable precision at an appropriate navigation speed.

I work in the Department of Integrative and Computational Neurosciences in the Instituto de Investigaciones Biológicas Clemente Estable, Av. Italia 3318, C.P. 11600, Montevideo, Uruguay. Phone (598)24871616, Int.111



Soha Pouya (soha.pouya@epfl.ch)

Soha received her B.Sc. in Aerospace Engineering (2006) and M.Sc. in Flight Dynamics and Control (Jan. 2009) from Sharif University of Technology (SUT), Tehran, Iran. She worked on Autonomous operations of Aerial Robots with special focus on intelligent control during landing phase in her M.Sc. thesis. Meanwhile she worked as a part time assistant at Laboratoire d'Algorithmes et Systemes d'Apprentissage (LASA), EPFL from August 2008 to April 2009. She joined BIRG in April 2009 as a Research Assistant and

PhD candidate to work on reconfigurable robotics which is a part of LOCOMORPH, a European project (Future and Emerging Technologies program). For more details on Locomorph project and our current activities please see Locomorph page on our website: <http://biorob.epfl.ch/page38289.html>."



Francesco Rea (francesco.rea@iit.it)

The aim of my research is focused on one of the primary goals of robotics: the interaction between humans and robots. During my MSc course, I investigated several issues concerning how robots can categorize objects in the environment enhancing their knowledge. This is due to my belief that the interaction can take place only if human and robot do share the same multidimension space which means also sharing the same categorization of knowledge.

During my PhD course, I am addressing the issue on how cognitive information about objects can be embedded into robots. I tackle this problem taking inspiration from biological evidences in neuroscience and trying to build computational model able to simulate such aspects. The development of biological-plausible cognitive models progresses keeping in mind that the solution has to be applicable for robotics systems that sense and act in the real environment. It is accordingly to this motivation that I decided to develop my ideas on humanoid robot ICUB at the Italian Institute of Technology and within the EMORPH project.

Contact Information: Department of Robotics, Brain and Cognitive Science, Cognitive Humanoids Lab, Italian Institute of Technology, via Morego, 30, Genova, Italy
Phone: +39 010 71781-420; Fax: +39 010 71781-7



Federico Renda (f.renda@sssup.it)

Research activity: currently I'm working on the dynamic modeling of the octopus arm and its robotic counterpart. In my near future I hope to complete an octopus-like virtual agent for exploring embodied inspired sensory motor coordination logic. My major research focus involves the investigation of complex dynamic system analysis for developing new paradigms in robot design with special emphasis on biomimetic robotics, according to the principles

of embodied intelligence.

Contact Information: Research Centre on Sea Technologies and Marine Robotics
Viale Italia, 6 - 57126 Livorno, Italy
Ph. +39 050 883395; Mobile: +39 333 2128381; Fax: +39 050 883399



Ali Sadeghi (a.sadeghi@sssup.it)

was born in Tehran, Iran, on April 23, 1977. He received his B.Sc. and M.Sc., both in the Manufacturing and Production Engineering from Babol Noshirvani University of Technology (2001) and Faculty of Engineering of University of Tehran (2004). Now he is a Ph.D. student in Micro Bio-Robotics in Scuola Superiore Sant' Anna in Italy.

In 2001 he joined Almase saz Co. (a producer company, active in hard metal cutting tools & powder metallurgy) as a mold designer and head of die making department for three years. From 2004 till 2010 he worked as a lecturer in the Faculty of Electrical and Computer Engineering (ECE) of University of Tehran and as a research associate in Robotics and Artificial Intelligence Laboratory (RAIL) on that university.

He changed the traditional method of General Workshop course in the ECE faculty and now students make simple robots and mechatronics systems parallel to learn manufacturing

methods and work with machine tools. His main projects in RAIL consisted of vacuum cleaning robots, pole climbing robots and mobile Robots.

Sadeghi has received a best paper award for his design and work in climbing robots.

He passed a one year course for designing plastic injection molds in Iranian society of toolmakers.

Now he works on bio-inspired soft bodied robotics toward his Ph.D. dissertation.

His current research interest is in climbing robots, compliant and soft bodied robots and simple design robots.

Contact Information: Center for Micro-BioRobotics, IIT@SSSA

Italian Institute of Technology - Viale Rinaldo Piaggio 34 - 56025, Pontedera (Pisa) - Italy



Ali Shaukat (Shaukat.ali@mines-nantes.fr)

I am working as PhD researcher at Ecole des Mines de Nantes, France. I am preparing my PhD thesis on the following theme: “Dynamic modeling of locomotion robots through Newton-Euler approach”. This research work has two phases:

1. Inverse dynamic modeling of multi-body systems with joints and wheels: This model is based upon the Newton-Euler dynamics to calculate the inverse dynamics of mobile multi-body systems (discrete structures) e.g.

reorientation system of a satellite, snake-board, snake-like robot, mobile manipulator, etc.

2. Macro-continuous inverse dynamics of hyper-redundant robots:

This model is based upon the hyper-redundant robots bio-inspired by elongated animals e.g. snakes, caterpillars, worms, octopus etc. This model may be used in simulation, external force computation, design, and gait generation of hyper-redundant robots.



Nevio Luigi Tagliamonte (n.tagliamonte@unicampus.it)

BS 2006, MS 2008 is a PhD student in biomedical engineering at Università Campus Bio-Medico di Roma where he started working in the Laboratory of Biomedical Robotics and Biomicrosystems in January 2009. His research activity is focused on the design and development of novel robotic devices for rehabilitation and assistance, with special attention to the optimization of human-robot interaction. He is involved in the EVRYON FP7 FET project (n. 231451), which is about the development of a novel methodology for the design of wearable robots, based on a evolutionary concurrent design of morphology and control. Personal contribution is in the development of

the actuation system and control of a robot for gait assistance.

Contact information: Laboratory of Biomedical Robotics and Biomicrosystems

Università Campus Bio-Medico di Roma, Via Alvaro del Portillo, 21 - 00128 Roma, Italy

Tel.: +39 06 22 541 9610



Cecilia Tapia (cecilia.tapia@iit.it)

I am a Phd student in co-direction by Université Pierre et Marie Curie - Paris 6 and Istituto Italiano di Tecnologia –Università di Genova. My research is focused in neural based control for fish robot locomotion in turbulent flow, more specifically the “Karman Street”. Karman Street is a very well patterned sequence of vortices travelling in two parallel rows, generated by a bluff body inside a laminar flow. It has been observed that fish use these vortices in order to reduce energy consumption while they swim. With my work I try to obtain the most significant characteristics of this behavior in order to apply some of these concepts to a robot

fish. To do this I am using neural based controllers to control a (for the moment) simulated robot fish in inside a simplified model of a Karman Street, supported by CFD simulations.

Contact information: Email: cecilia.tapia@iit.it; Tel. +39 010 71781535; Address: IIT - Via Morego, 30 Genova, Italia



Francesca Tramacere (f.tramacere@iit.it)

My PhD activity is based on the investigation of octopus suckers suction mechanics in order to extract bioinspired design criteria for developing attachment mechanisms for microrobots. The research plan is structured so as to study sucker anatomy and to consider sucker sensing system as well, to understand how touch cues are used in sucker function. Experimental observation and development of *ad hoc* experimental biorobotic methodologies, including modelling, play a fundamental role.

During the first year of my PhD, I am investigating sucker anatomy with different techniques (namely imaging by histology, MRI, ecography and CryoSEM) aimed at extracting spatial information. The gathered details will be used for subsequent studies regarding biological aspects (sucker morphometry), modelling (3D geometry reconstruction and tissue modelling), paving the way for the robotic implementation phase.

Contact Information: Francesca Tramacere PhD Student Center for MicroBioRobotics IIT@SSSA Polo Sant'Anna Valdera - Scuola Superiore Sant'Anna - Viale Rinaldo Piaggio 34 - 56025 Pontedera (Pisa) – Italy – Ph.: +39 050 883104



Jesse van den Kieboom (jesse.vandenkieboom@epfl.ch)

Jesse van den Kieboom received his M.Sc. degree in Artificial Intelligence (cum laude) from the University of Groningen, in April 2009. He is currently Ph.D. student at the Biorob laboratory at EPFL, where he researches the co-design of mechanics and control using co-evolutionary algorithms, more specifically for lower limb exoskeletons targeting assistance and rehabilitation.



Massimo Vespignani (m.vespignani@unicampus.it)

Massimo Vespignani (MS in Biomedical Engineering, 2009) is a research assistant at Università Campus Bio-Medico di Roma, currently working in the Laboratory of Biomedical Robotics and Biomicrosystems (head: Prof. Eugenio Guglielmelli). His research activity, funded by the European Project IM-CLeVeR (FP7-ICT-IP-231722), focuses on the design and development of mechatronic platforms for behavioural

analysis of animal models (primates) and humans (children).

Contact Information: Massimo Vespignani, Laboratory of Biomedical Robotics and Biomicrosystems; Università Campus Bio-Medico di Roma - Via Alvaro del Portillo, 21 - 00128 Roma, Italy Ph.: +39 06 22541 9610; +39 338 3826418



Zheng Tianjiang (Tianjiang.Zheng@iit.it)

I'm working on modeling and controlling the octopus arm. A kinematic/dynamic model of octopus arm was established. There are many segments in one arm and each segment consists of 4 longitudinal muscles and 4 radial muscles. It can easily mimic the movements of octopus arm such as: bending, reaching, feaching movements. Future work will include studying the control algorithm based on the kinematic and dynamic model. The CPG algorithm might be introduced to control this arm. Moreover, multi-arm control will be considered.

Contact Information: IIT Advanced Robotics - Via Morego,30 16163 GENOVA
Phone: +39 010 71781213; Mobile: +39 3450384095; Fax: +39 010 720321

VENUE, TRANSPORTATIONS AND ACCOMMODATION

VENUE

The Summer School will take place at L.E.M.Foundation, located in Piazza del Pamiglione 1/2, Livorno (<http://lem.comune.livorno.it/news.php>). It is located 10 minutes walking from the Hotel (see information below).

TRANSPORTATION

Livorno railway station is located on the railway connecting Pisa and Roma.

From Pisa the trip takes about 15 min; from Florence there are trains that go directly to Livorno; they take about 1h 25 min. Trains run frequently from Pisa and about each hour from Florence during all the day. See www.trenitalia.com <<http://www.trenitalia.com>> for a complete timetable.

If you arrive at Pisa Airport www.pisa-airport.com:

The Pisa airport terminal is directly linked to Pisa central station (Pisa Centrale) in 5 minutes.

A change in Pisa Centrale is necessary.

If you arrive at Florence Airport www.aeroporto.firenze.it:

Option 1: Take a taxi to Firenze Rifredi train station (15 min., 20 €).

Then take a train to Livorno, reaching Livorno in about 1h20 min.

Option 2: Take a taxi (20 to 30 min., 20 €) or bus (every 30 min., 20-min. trip, 4,50 €) to Florence main railway station, named Firenze SMN.

Then take a train to Livorno, reaching Livorno in about 1h25 min.

Taxi are available from Pisa Airport to Livorno, the run will take about 30' (depending on traffic) at a rate of about €35.00.

ACCOMMODATION

HOTEL GRANDUCA **** (www.granduca.it)

Piazza Giuseppe Micheli, 16-18 -57123 Livorno - Italy

Ph. +39-0586-891024/5/6

Fax +39-0586-891153

HOTEL BOSTON *** (www.bostonh.it)

Piazza Mazzini, 40 - 57126 Livorno - Italy

Ph. +39-0586-882333

Fax +39-0586-882044

MEALS

Lunches and dinners will be at own charge: the School venue, as well as the hotel are located in downtown Livorno (Venice Quarter) with a large choice of cafeterias, restaurants and shops.

EMBODYⁱ Summer School Locations

Lectures:

Fondazione L.E.M.
Piazza del Pamiglione, 1/2
Ph. +39-0586 826 427

Hotel Granduca ****

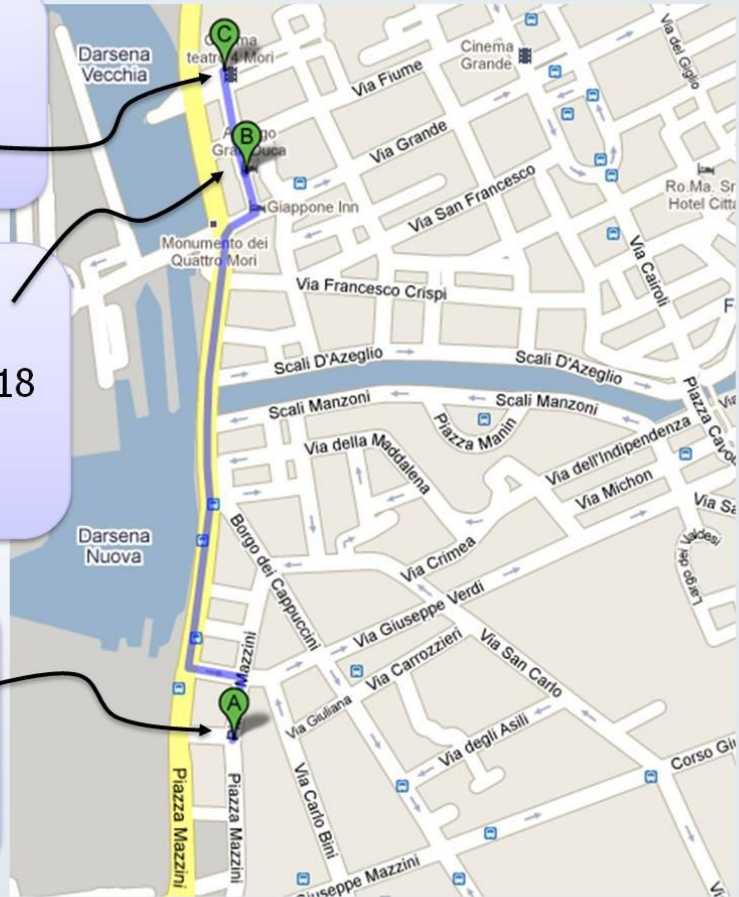
www.granduca.it

Piazza Giuseppe Micheli, 16-18
Ph. +39-0586 891 024/5/6
Fax +39-0586-891 153

Hotel Boston ***

www.bostonh.it

Piazza Mazzini, 40
Ph. +39-0586 882 333
Fax +39-0586 882 044



ABOUT LIVORNO

WHEATHER FORECAST

Livorno's coastal position means that, compared with areas of inland Tuscany, it enjoys a relatively mild climate during the winter months, and is usually a few degrees cooler during the summer.

Spring is yet to come but for next week we are waiting for better days and warmer temperatures.

We will have cloudy days and temperatures between 7C°min. and 18C°max

WHAT TO SEE IN LIVORNO

Livorno is situated along the coast of the Ligurian Sea, is one of Italy's most important ports, both as a commercial and touristic port of call, an industrial centre of national importance and, among all of the Tuscan cities, it is generally considered the youngest, even though its territory holds historical testimonies of remote times that have survived the mass bombings of the Second War World. The city, developed from the end of the XVI century upon request of the Medici family, is famous for being the birthplace of prestigious personalities such as Amedeo Modigliani, Pietro Mascagni and Carlo Azeglio Ciampi. In the past, until the first years of the 20th century it was also a tourist destination of international importance for the presence of important seaside and thermal establishments, that give the city its the name of Montecatini-on-the-sea. Livorno, which at the end of the XIX century counted around 100,000 inhabitants and was the 11th most populated city in Italy and the 2nd in Tuscany, in the last decades has had a notable decline in the number of inhabitants and now is the 3rd most populated city in Tuscany after Florence and Prato.

Among the important landmarks in the place is the prestigious Naval Academy that was built in 1881 to train officers of the Italian Navy. It stands out prominently amidst the several teaching institutions found in Livorno. An ancient observatory that dates back to the 19th century, many galleries that exhibit ancient samples of art and a museum with interesting Etruscan and Roman artifacts of great historical significance are a must for every tourist keen to learn about the culture of the local people.

Not to be missed is the 100 year-old race course, the Caprilli where racing seasons that matter, are often hosted. If you wish to have a wonderful birds eye view of some of the islands of the Tuscan region, then Terrazza Mascagni deserves a visit. One can feast on the beauty of distant Corsica, Elba, Capraia and Gorgona from there.

The imposing 16th century fort Fortezza Vecchia stands guard at the harbor. Also to be seen here is a piece of renaissance art in the statue of Quattro Mori in front of the crowded waterfront road at Piazza Micheli. A bronze statue of Ferdinando with four chained moors, sculpted by Pietro Tacca (1623) probably depicting the subordination



of African slaves under the Medici euphoria of victory over North African shipping also stands close by. Many have expressed shock at this aberration in a town so well known for its multiracial tolerance from the past.

The 16th century cathedral, Sanctuary of Montenero at Piazza di Montenero, dedicated to the patron of Tuscany, Madonna of the Graces was built where an oratory stood.

Several other ancient churches of great architectural beauty can also be visited in Livorno and appreciated from the historic and artistic point of view.

A very popular part of Livorno, is Venezia district where Fortezza Nuova stands surrounded by a network of canals. Dilapidated tenements dot the place and its difficult to believe this very is overnight transformed and place bubbles to life in August when the free street carnival of jazz and world music takes place!

From the hotel you can have a walk on the sea along the famous Terrazza Mascagni and, on a footpath starting from Cantieri Orlando you can reach Antignano area, passing along Accademia Navale. You can either explore the old town of Livorno, with a walk through the Venetian District.

For those who enjoys painting of the XIX/XX century a visit to the Museo Fattori is suggested, where you can find an interesting collection of Tuscan and Livorno art, in particular by Giovanni Fattori

<http://pegaso.comune.livorno.it/index/>.
For information on Tourism in Tuscany please visit the website <http://www.turismo.intoscana.it/intoscana2/export/TurismoRTen/>



WHERE TO EAT

If you stay in Livorno you do not have to miss the famous "Cacciucco" a Tuscan fish stew soup, made with "poor" but tasty fish, tomato, garlic and spices.

Here is a list with some nice restaurants in Livorno where you can taste it and other fish specialities:

RISTORANTE LA BARCAROLA****Viale Giosuè Carducci, 39, Tel +390586 40 21 26
www.labarcarola.it

RISTORANTE GRANDUCA*** Piazza Micheli 18, Tel +390586.891325
<http://www.ristorantegranduca.com/>

RISTORANTE LE VOLTE***Via Calafati, 4, Tel. +390586.896868

L'OSTRICAIO***, Viale Italia 100, Tel +390586.581345

TRATTORIA DA GALILEO***Via della Campana 20, Tel +0586.889009
<http://trattoriadagalileo.blogspot.com/>

NASO MANCINO**Piazza del Luogo Pio 8, Tel +390586.829172

