

**1st LERICI INTERNATIONAL WINTER SCHOOL
ON MARINE TECHNOLOGIES**

**AUTONOMOUS AND REMOTELY OPERATED
UNDERWATER VEHICLES**

Lerici (La Spezia), Italy, January 7-11 2002

Final Program

Each day of the school is organized in 7 hours of teaching, 4 of which in the morning. Lectures will start at 8.30, with a 15 minutes coffee break at 10.30. Lunch break will be between 12.30 and 14.00. Afternoon lectures will take place between 14.00 and 17.00. On Tuesday 8 lectures will end at 16.00, and on Friday 11, lectures will start at 9.30.

Monday January 7:

AUVs/ROVs dynamic models (8.30 - 11.30)

Lecturer: **Dr. Giovanni Indiveri**, Institute for Autonomous and Intelligent Systems, Fraunhofer Institute - Sankt Augustin - Bonn.

- Kinematics and dynamic equations for a floating rigid body.
- Fluid forces and moments.
- AUV, ROV and surface craft models.
- An introduction to thruster models.
- Model Identification issues and techniques.

Closed loop control of AUVs, ROVs, and Autonomous Surface Crafts (11.30-12.30, 14.00-17.00)

Lecturer: **Prof. Antonio M. Pascoal**, Institute for Systems and Robotics, Instituto Superior Tecnico, Lisbon.

- Review of key control concepts: stability and performance; robustness, limits of achievable performance.
- Linear control strategies: classical analysis and modern design tools.
- Nonlinear control strategies: gain scheduling, sliding mode theory, exact linearization; Lyapunov based designs; backstepping.
- Trajectory tracking and path following control.
- Applications to ROV, AUV, and surface craft control.

Tuesday, January 8:

Fundamentals of ocean acoustics (8.30-12.30)

Lecturer: **Prof. Henrik Schmidt**, Ocean Engineering Dept., Mass. Inst. Tech., Cambridge, MA

- Introduction to ocean acoustics: the ocean environment, sources, propagation paths, reflectivity, shallow/deep water, attenuation, scattering.
- Basic theory and modeling: wave equation, normal modes, ray-mode analogy.
- Demonstration of models: input and output and how to use them, intermodel comparisons, broadband modeling and results.

Acoustic instrumentation and imaging systems (14.00-16.00)

Lecturer: **Dr. Andrea Trucco**, ISME, c/o DIBE, University of Genova, Genova

- The beamforming concept.
- From beam signals to acoustic images.
- Typical sonar imaging systems.
- 3-D imaging challenges.

Wednesday, January 9:

Payload system integration and sensor data processing (8.30-10.30)

Lecturer: **Dr. Per Espen Hagen**, Norwegian Defense Research Establishment (FFI), Kjeller.

- Typical requirements for payload system integration.
- Real time payload sensor data processing.
- Post-mission processing.
- Example: The HUGIN Payload Processor system.
- Standardisation of AUV interfaces.

Acoustic communication in underwater applications (10.45-12.30, 14.00-15.00)

Lecturer: **Prof. Bryan Woodward**, Dept. Electronic and Electrical Engineering, Loughborough University, Loughborough.

- Underwater acoustic propagation.
- Communications techniques.
- Communications systems and applications.

Underwater manipulation systems (15.00-17.00)

Lecturer: **Prof. Giuseppe Casalino**, ISME, c/o DIST, Univ. of Genova, Genova

- Multilayer architecture for the control of multiarm systems.
- Interaction control during manipulation.
- Multifingered hand-arm coordination.
- Floating base multiarm systems.

Thursday January 10:

Video day – Examples from the field

Thursday has been allocated for presentation of experiences in AUVs/ROVs projects from the school lecturers and from other invited researchers. The presentations will serve the purpose of showing the audience how the theoretical material presented in the lectures is “put at work” in scientific experiments and industrial applications.

- 8.30 A. Pascoal
- 9.15 A. Bjerrum (Maridan, Hoersholm)
- 10.00 G. Conte (University of Ancona)
- 10.45 Coffe break
- 11.00 A. Caiti (ISME, c/o DSEA, University of Pisa, Pisa)
- 11.45 G. Lester (RDInstruments, San Diego)

- 14.00 E. Bovio (SACLANT Undersea Res. Ctr., La Spezia)
- 14.20 H. Schmidt
- 14.40 C. Von Alt (Woods Hole Oceaographic Institute)
- 15.00 M.J. Rendas (I3S, Informatique, Signaux et Systeme, CNRS-UNSA, Sophia Antipolis)
- 15.40 P.E. Hagen
- 16.20 J. Evans (Herriot-Watt Univ., Edinburgh)
- 16.40 I. Tena Ruiz (Herriot-Watt Univ., Edinburgh)
- 17.00 A. Cormack (Seebyte Ltd.)

Dinner (19.30, Doria Hotel, Lerici)

Participation open to all the school students and lecturers and to the “video day” invited researchers.

Friday January 11:

Navigation and localization (9.30-12.30)

Lecturer: ***Prof. Alex Leonessa***, Ocean Engineering Dept., Florida Atlantic University

- Background: Kalman Filter and Smoothing Algorithms.
- Complementary INS/GPS Integration.
- Filter Design.
- Conceptual Post-Processing Approach.
- A post-processing Kalman Smoother for Underwater Vehicles Navigation.
- Sea Trial Experiments and Results.

Virtual reality for underwater remote inspection (14.00-17.00)

Lecturer: ***Prof. Vittorio Murino***, ISME, c/o VIPS lab, Univ. of Verona, Verona

- Acoustic image processing.
- 3-D acoustic image segmentation and classification.
- 3-D acoustic scene reconstruction.
- Augmented and virtual reality applications.