UNIVERSITÀ DI PISA

DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE

Dottorato di Ricerca in Ingegneria dell'Informazione

Doctoral Course

"Maritime Autonomy with MOOS-IvP:

Introduction to Autonomous Marine Systems"

Dr. Michael Benjamin & Dr. Mohamed Saad Ibn Seddik

MIT- USA

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Short Abstract: This intensive one-week course provides a comprehensive introduction to maritime autonomy using the MOOS-IvP software framework, based on MIT's established 2.680 course curriculum. Participants will learn the fundamental principles of autonomous marine vehicle control, behavior-based autonomy architectures, and practical implementation of multi-objective optimization for marine robotics. The course is hands-on with coding and simulation exercises using the open-source MOOS-IvP middleware.

Course Contents in brief:

- Introduction to Maritime Autonomy and MOOS-IvP architecture.
- MOOS middleware and mission configuration.
- Development of a MOOS application.
- IvP Helm and Behavior-based control systems
- Development of a simple IvP behavior.
- Multi-vehicle coordination and communication

Total # of hours of lecture: 30 of hours (6hr/day)

References:

[1] Benjamin, Michael R., Henrik Schmidt, Paul M. Newman, and John J. Leonard. "Nested autonomy for unmanned marine vehicles with MOOS-IvP." *Journal of Field Robotics* 27, no. 6 (2010): 834-875.

[2] Benjamin, Michael R., John J. Leonard, Henrik Schmidt, and Paul M. Newman. "An overview of moos-ivp and a brief users guide to the ivp helm autonomy software." (2009).

[3] MOOS-IvP open source marine autonomy project documentation. Available at: https://oceanai.mit.edu/

[4] MIT Course 2.680 Materials: "Unmanned Marine Vehicle Autonomy, Sensing, and Communications". Massachusetts Institute of Technology https://oceanai.mit.edu/2.680/pmwiki/pmwiki.php

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CV of the Teacher

Dr. Michael Benjamin
Dr. Mike Benjamin is a Principal Research Scientist in the Center for Ocean Engineering at MIT's Department of Mechanical Engineering. He is a key member of MIT's Laboratory for Autonomous Marine Sensing Systems and the Marine Robotics Group within the Computer Science and Artificial Intelligence Laboratory (CSAIL). Dr. Benjamin specializes in algorithms and software for autonomous marine vehicles and is the founder of moos-ivp.org, which hosts the MOOS-IvP open-source project for marine autonomy software and is the world's largest open source project in marine autonomy. His pioneering work leverages a behavior-based architecture and multi-objective optimization through interval programming, enabling robust decision-making by reconciling competing objectives. Before joining MIT, Dr. Benjamin was with the Naval Undersea Warfare Center, where he earned the NAVSEA Scientist of the Year award. Dr. Benjamin's achievements include patents in autonomous navigation and NATO's 2017 Science Award for networked ASW systems.

Dr. Mohamed Saad Ibn Seddik

Mohamed Saad Ibn Seddik is a researcher and entrepreneur specializing in marine autonomy, robotics, and artificial intelligence. Over the past 12 years, he has developed intelligence systems for marine vehicles, leading and contributing to the design and deployment of tens of autonomous vessels. He is the Founder and CEO of blkSAIL, a startup dedicated to advancing autonomy and AI for maritime applications, and a Visiting Instructor at MIT, teaching maritime autonomy and robotics. He holds dual Master's degrees from ENSTA Bretagne (Computer Science and Automation for Embedded Systems) and the University of Angers (Signal Processing and Dynamic Systems) and a PhD from ENSTA Bretagne. He was also a Post-Doctoral Research Associate at MIT. His research interests span interval methods, autonomous systems, deep learning, AI-based decision-making, and robotics software architectures.

Final Exam: Practical project involving the design and implementation of a multi-objective autonomous mission using MOOS-IvP simulation environment. Students will demonstrate their understanding by developing, configuring, launching, and analyzing the performance of an autonomous marine vehicle with multiple competing objectives.

Room and Schedule

Room: *Aula Riunioni del Dipartimento di Ingegneria dell'Informazione, Via G. Caruso 16, Pisa – Ground Floor* e Aula Magna Ulisse Dini.

Schedule:

17 Nov 9.30-12.30 - 13.30-17.00

18 Nov 9.00-12.30 - 13.30-17.00

19 Nov 9.00-12.30 - 13.30-17.00

20 Nov 9.00-12.30 - 13.30-17.00

21 Nov 9.00-13.30

Prerequisites

- Basic C++ programming knowledge and git version control

- Fundamental understanding of robotics or control systems

- Familiarity with Linux/Unix command line interface

- Laptop with ability to run virtual machines or linux environment