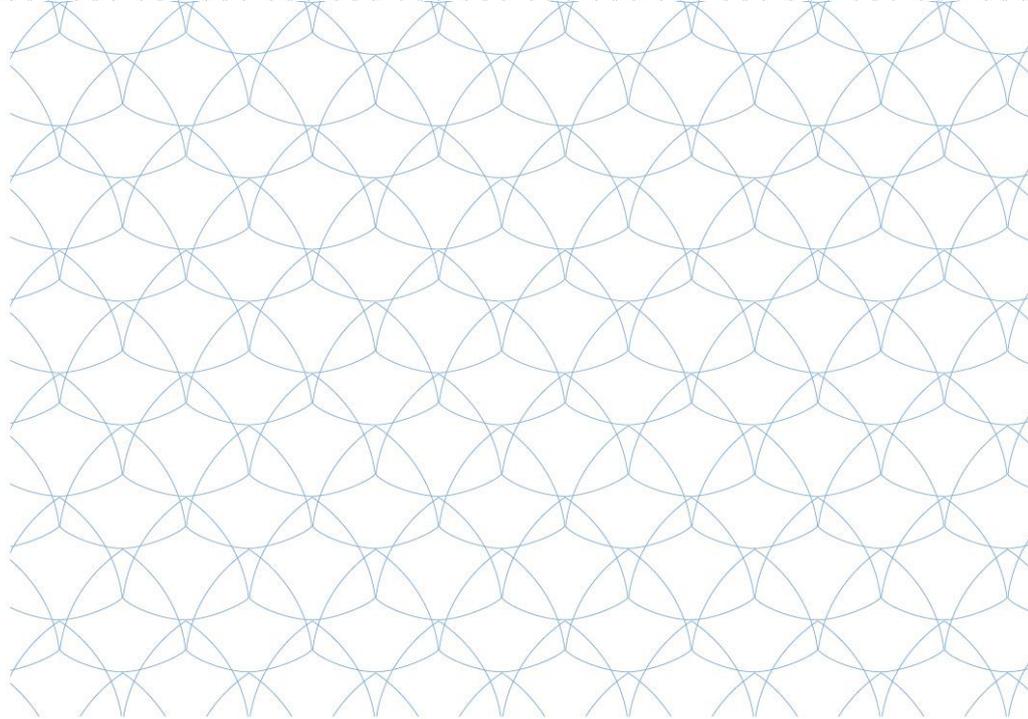




**EXCELLABUST**  
EXCELLING LABUST IN MARINE ROBOTICS

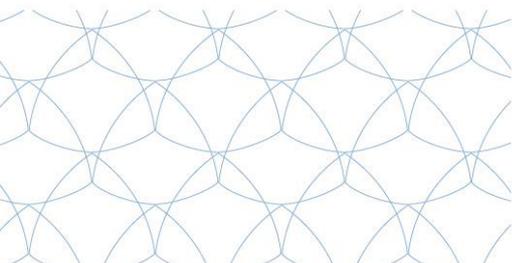


# Staff exchange 2

## *Report*

Jun – Jul 2016

Nadir Kapetanović @ Institute for  
Research of Intelligent Systems for  
Automation (ISSIA) in Genova



This project has received  
funding from the European  
Union's Horizon 2020 research  
and innovation programme  
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691980.



Nadir Kapetanović has been a guest researcher during June and July 2016 in Genova at the Institute for research of intelligent systems for automation (ISSIA), which is a part of National Research Council of Italy (CNR). CNR is a public organization founded in 1923, with seven departments and 106 institutes. ISSIA is distributed in three cities in Italy, namely Genova, Bari and Palermo. All three of them have specific research areas in robotics and automation in general.

Department of Field and Interaction Robotics, located in Genova, is composed of 8 researchers, 5 assistant researchers, 1 technologist, and 4 technicians. They have over 20 years of experience in robotics, both in terms of theoretical and applied research. Their research interests include: system modelling and identification, navigation, cooperative guidance, visual odometry, IT and telecommunications.

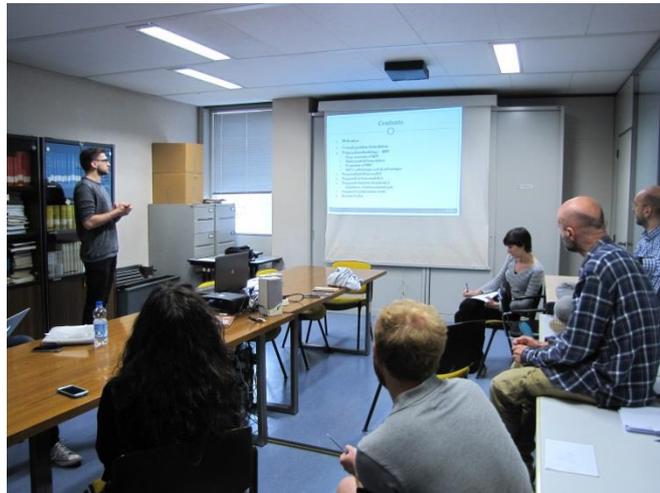


Figure 1. Presentation of the research plan

Nadir Kapetanović had been involved in research in the field of marine robotics. More precisely, his research goal was to apply model predictive control to line following manoeuvre. Put in a wider perspective, this was the first part of an algorithm which would navigate a marine vehicle (surface and/or underwater) during seabed sonar scanning tasks, in such way that the path along which the vehicle moves is the path along which the most interesting and new information about the seabed is gathered. Motivation and methodology are explained in more detail in the Research plan which Nadir has submitted before his arrival to ISSIA. His work was supervised by dr. Massimo Caccia and dr. Marco Bibuli. Also, Andrea Ranieri introduced him to the software which is being used at ISSIA, in order to integrate his software with ROS (Robotic Operating System) which is widely used in robotics research. Enrica Zereik, Mauro Gaggero, and Cristiano Cervellera helped him a lot with discussions about optimal control, model predictive control and optimization algorithms' complexity and their use in real-time applications.



Figure 2. Working on simulator integration with dr. Andrea Ranieri

The result of this two-month research is a model predictive control framework which uses state-of-the-art optimal control solvers under ACADO toolbox, integrated into ROS environment. The control problem being solved is line following problem with disturbance, i.e. sea current. One goal of this integration was to make this framework as modular as possible, to allow it to be used and tested on various systems, their parameters etc. Another goal was to prepare this framework to be integrated with the simulator and low-level controllers of ISSIA's vehicles, which can be used in real-life sea experiments. This interface is planned to be implemented in September 2016, so that the real-life experiments on the sea can be carried out in Biograd na Moru during Breaking the Surface workshop in October 2016.

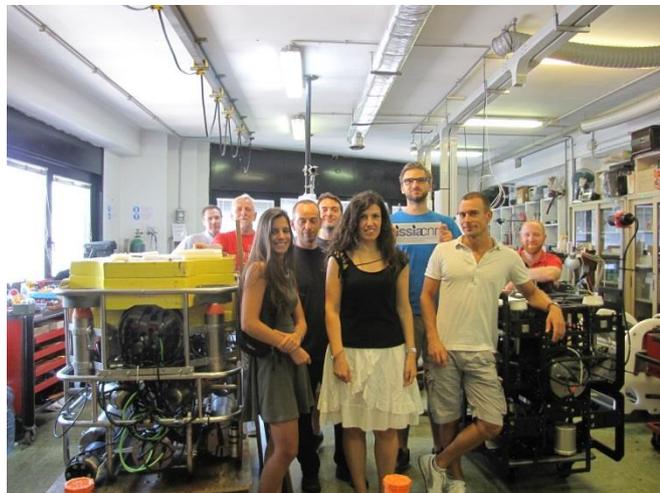


Figure 3. CNR ISSIA team

Major results accomplished during and shortly after staff exchange are:

- Implementation of the proposed MPC framework for the real-time line following manoeuvre without the external disturbance using ACADO toolbox.
- Implementation of MPC framework for the same control problem, but with added disturbance rejection.
- Integration of ACADO toolbox with ROS environment.