EXCELLABUST

EXCELLING LABUST IN MARINE ROBOTICS

EXPERT VISIT 5

15 - 16 November 2018

University of Limerick

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691980.

1. VENUE

Gray Hall
University of Zagreb
Faculty of Electrical Engineering (UNIZG-FER)
Address: Unska 3, Zagreb, Croatia

2. PREREQUISITES FROM PARTICIPANTS

It is required to download the following documents from Internet and read relevant sections:

NI myRIO Project Essentials Guide

The myRIO Project Essentials Guide serves as the guide to interfacing NI myRIO to the wide variety of sensors, actuators, and displays contained in the NI myRIO Starter Kit, NI myRIO Mechatronics Kit, and NI myRIO Embedded Systems Kit that students will need for projects. Each project concentrates on a specific component or device using a mixture of text and video to guide the student through the learning process necessary to successfully integrate the component or device into the student's system.

Web link:
https://learn.ni.com/teach/resources/92/ni-myrio-project-essentials-guide
Direct link:
https://www.dropbox.com/s/vcrx1xx8koxrvrt/myRIO_project_essentials_guide.pdf?dl=0

NI myRIO Vision Essentials Guide

Through a mixture of written materials, video tutorials, and guided hands-on projects, students learn the essential techniques necessary to add vision to their NI myRIO project. Additionally, students create NI myRIO applications that interact with the visual world to sense motion, take physical measurements, read barcodes and printed labels, inspect products for defects, and respond to colours. Students will add LCD displays, switches, and servomotors and create a complete stand-alone application that controls physical apparatus such as a marble sorter and an auto-panning camera.

Web link:
https://learn.ni.com/teach/resources/208/ni-myrio-vision-essentials-guide
Direct link:
https://www.dropbox.com/s/8eet2xurazs47p8/NI_myRIO_Vision_Essentials_Guide__2015-07-23.pdf?dl=0

NI myRIO-1900 User Manual

The National Instruments myRIO-1900 is a portable reconfigurable I/O (RIO) device that students can use to design control, robotics, and mechatronics systems. This document contains pinouts, connectivity information, dimensions, mounting instructions, and specifications for the NI myRIO-1900.

Web link:
http://www.ni.com/pdf/manuals/376047c.pdf
Direct link:
https://www.dropbox.com/s/0h0jpzsf54woj7g/myRIO%201900%20User%20guide%20and%20Specifications.pdf?dl=0

Hardware & Software Requirements

Lecturer Edin Omerdic will bring the following equipment:

1. NI myRIO-1900 (one unit) with Starter Kit.
2. Laptop with preinstalled software (LabVIEW 2017 SP1 32 bit) and other NI modules necessary to work with myRIO-1900.

Host FER Zagreb should provide the following equipment:

1. Dual channel oscilloscope.
2. DC Power supply with adjustable output: 0-24VDC.
3. One Blue Robotics T200 thruster with ESC controller.
4. Webcam with USB interface.
5. Ethernet switch and network cables.

3. SCHEDULE

Day 1: 15 November 2018 (Thursday)

14:30 – 14:40	**Introduction & Overview of Lectures** by Edin Omerdic
14:40 – 15:10	**NI myRIO: Getting Started** by Edin Omerdic
15:10 – 15:40	**NI myRIO: Deployment of a Standalone Executable App** by Edin Omerdic
15:40 – 15:50	BREAK
15:50 – 16:20	**NI myRIO: SPI Serial Communication** by Edin Omerdic
16:20 – 17:20	**Hands-on: PWM Control of T200 Thruster** by Edin Omerdic

Day 2: 16 November 2018 (Friday)

14:00 – 14:10	**Introduction & Overview of Lectures** by Edin Omerdic
14:10 – 15:00	**Hands-on: Discrete LED Demo** by Edin Omerdic
15:00 – 15:10	BREAK
15:10 – 16:10	**NI myRIO: Machine Vision** by Edin Omerdic
16:10 – 16:20	BREAK
16:20 – 17:20	**Hands-on: Machine Vision** by Edin Omerdic

4. EXPERT VISIT PLANNED OUTCOMES:

- Learn how to connect, configure and use NI myRIO to design control, robotics, and mechatronics systems.
- Explore ways to use NI myRIO in Artificial Intelligence/Machine Vision applications.

5. LECTURE DESCRIPTION:

NI myRIO: Getting Started (Day 1)

In this lecture, students will learn how to connect myRIO to PC, how to set up software and configure hardware, and how to create first myRIO application.

NI myRIO: Deployment of a Standalone Executable App (Day 1)

During typical development, NI myRIO is connected to PC with a USB cable or wireless/wired network. After development is completed, it is possible to deploy the project as a stand-alone application stored on the myRIO solid-state hard drive, which start automatically when myRIO is powered up. This lecture explains steps for the deployment.

NI myRIO: SPI Serial Communication (Day 1)

This lecture is focused on demonstration of myRIO features how to configure SPI serial communication and how to send, read and process data.

Hands-on: PWM Control of T200 Thruster (Day 1)

This practical session is focused on development of interface between control software and physical actuators (thrusters) using NI myRIO. Two approaches will be explained: (i) approach based on Express VI (RT only, without need to develop FPGA code), and (ii) approach based on RT & FPGA code development. Methods to overcome friction/dead zones for low speed rotations will be demonstrated for both approaches. The practical session will demonstrate how to use FPGA to generate PWM signals for high precision speed and direction control of Blue Robotics T200 thrusters.

Hands-on: Discrete LED Demo (Day 2)

This practical session is focused on describing the essential concepts related to LEDs, selection of suitable current-limiting resistor and two different ways to control LED through myRIO DIO: current-sourcing interface and current-sinking interface.

NI myRIO: Machine Vision (Day 2)

Machine vision systems play a critical role in manufacturing automation, shape and colour analysis, and robotics. With little more than a USB webcam students can create NI myRIO applications that interact with the visual world to sense motion, take physical measurements, read barcodes and printed labels, inspect products for defects, and respond to colours. The first part of this lecture introduces students to a generalized application development flow suitable for all of the machine vision projects in LabVIEW. The development flow includes defining the application's requirements, configuring the imaging system and acquiring representative images, calibrating to real-world units, developing the vision processing script with NI Vision Assistant, and developing and validating the complete machine application with NI LabVIEW. It also introduces the "Queued State Machine" design pattern that serves as the basis of the "Machine Vision App" (MVA) LabVIEW project template that students will use to implement selected application projects. The second part of the lecture will provide more insight into a procedure how to set up and calibrate camera.

Hands-on: Machine Vision (Day 2)

In the first part of practical session, students will learn how to connect a USB webcam to myRIO, how to acquire and process a single image and a video stream, how to set a webcam attribute such as saturation and how to use NI-MAX software to determine available video modes and attributes for a webcam. In the second part, students will explore a subset of ten advanced projects (Coin Counter, POS Terminal, Keyed Optical Lock, DMM Test Stand, Gauging Station, Product Label Inspector, Component Placement Inspector, Motion Detector, Auto-Pan Camera, Marble Sorter). Each of these ten design-oriented projects introduces new machine vision concepts and associated NI Vision implementation techniques.

6. DESCRIPTION OF THE PARTNER INSTITUTION:

University *of* Limerick

Address: **University of Limerick**
V94 T9PX
Limerick
Ireland

Website: http://www.ul.ie

The University of Limerick (UL) with over 13,000 students and 1,300 staff is an energetic and enterprising institution with a proud record of innovation and excellence in education, research and scholarship. The dynamic, entrepreneurial values which drive UL's mission and strategy ensure that we capitalise on local, national and international engagement and connectivity. Research at UL is renowned for its close alignment to real world problems and the university has an enviable reputation in fundamental research, which can have real impact on society and the economy alike. This strong focus allowed UL to gain a five-star rating for innovation and excellence from QS, the international ranking body. UL has a strong international reach and Involvement in the European Framework actions from FP2 to FP7, and current involvement in Horizon 2020 has grown UL's international network of collaborators.

CRIS Centre for Robotics & Intelligent Systems

Address: **Centre for Robotics & Intelligent Systems**
ECE Department
University of Limerick
V94 T9PX
Limerick
Ireland

Website: http://www.cris.ul.ie

Established in 2000 by Director Dr. Daniel Toal, the Centre for Robotics & Intelligent Systems (CRIS) in the University of Limerick is the only research centre focused on the application and development of marine robotics within the island of Ireland. This research centre consists of a mix of academics, postdoctoral researchers, research engineers and PhD students from various disciplines including electronic, computer, mechanical and aeronautical engineering backgrounds. The research centre brings together a highly capable engineering group focused on developing innovated, practical and industrial relevant marine technologies and field robotics. From marine robotics to navigation, sensor development, emergency response planning, remote operated vehicle (ROV) and unmanned aerial (UAS) technologies, they are actively involved in developing a diverse range of practical technologies in national funded, European funded and industry collaborative projects. The core research activities of the research centre are listed below:

- Remotely operated vehicle smart systems- fault tolerant control, auto tuning, one-click auto survey, augmented reality visualisations (transparent ocean).
- Remote & auto flight control of tethered parafoil kites for airborne wind energy & aerial sensor/comms platforms.
- Sensored telemetry streaming from fixed wing aircraft, system identification, controller design.
- Emergency response exercise planning & coordination. UAVs deployed in segregated airspace over three-day exercise. Key partners: Irish Aviation Authority, Irish Naval Service, Irish Coast Guard, Commissioner of Irish Lights.

- Long Range High Bandwidth comms- remote presence, live interaction with distant robotic vehicles independent of existing infrastructure.
- Ocean sensing platforms with daughter mini ROVs- for persistent remote presence offshore with global satellite comms (controlled & monitored anywhere in world).

Over the last ten years the CRIS research centre has developed OceanRINGS – a suite of smart technologies for subsea operations, designed to be integrated with any ROV – support vessel combination. It includes advanced control solutions for full range of ROVs – from mini ROVs used for remote monitoring & inspection to full-size work-class ROVs. Remotely Operated Vehicle (ROV) LATIS is a 1000 m depth-rated underwater robot developed at CRIS and has been used to test and validate OceanRINGS. System validation and technology demonstration has been performed over the last six years through a series of test trials with different support vessels off the north, south and west coast of Ireland and in the Mediteranean sea.

7. BIOGRAPHIES OF LECTURERS

Dr. Edin Omerdic
Senior Research Fellow

Website: http://www.mmrrc.ul.ie/dotnetnuke/mmrrc/People/PostdoctoralResearchers/EdinOmerdic.aspx
Email: edin.omerdic@ul.ie

Edin Omerdic received the Dipl. Eng. and M.S. degree in Electrical Engineering from the University of Zagreb, Croatia, in 1997 and 2001, respectively. In 2001 he joined the Mechatronics Research Centre, University of Wales, Newport, UK and took part in the EPSRC funded IMPROVES project. He received his PhD in Electrical Engineering from the University of Wales in 2004, with the thesis titled "Thruster Fault diagnosis and Accommodation for Overactuated Open-frame Underwater Vehicles".

Edin is currently employed by the University of Limerick as a Senior Research Fellow at the Department of Electronic and Computer Engineering. He is engaged in numerous research projects funded by the Higher Education Authority and the Marine Institute in the area of submersible robotics, he is also the main developer & designer of OceanRINGS concept & software suite, including design of state-of-the-art control architecture for ROV LATIS, MRE ROV and I-ROV. Edin's research interests include: Modelling & Simulation of Dynamic Systems, Real-Time Simulators & Real-Time Embedded Control Systems, Virtual Reality, Augmented Reality, Simulated Reality, Multi-Modal Human Machine Interface for Cyber-Physic Systems based on AI techniques (VR headsets, speech recognition, hand gesture recognition), Machine Learning, Application of AI Techniques (Neural Networks and Fuzzy Logic) in Intelligent Systems, Guidance, Navigation and Control System for Marine Platforms, Nonlinear Control Systems, Underwater Robotics, Fault-Tolerant Systems, Internet of Things and Network Security.

Up to date he has 25 journals, 6 book chapters, 2 books, 59 papers in conference/workshop proceedings, 15 invited lectures, 4 keynote/plenary talks, 11 tutorials, 22 presentations & technology demonstrations, 2 articles in business magazines, 2 online articles, 1 desk study. Dr. Omerdic received five awards for his work, including First Prize Winner in National Competition in Mathematics (Bosnia, 1985), Society of Underwater Technology (SUT) Prize for Best Multimedia Presentation (GCUV 2003) 'Thruster Fault Accommodation for Underwater Vehicles', IFAC prize for best on-line demonstration (MCMC 2003) 'Fault Detection and Accommodation for ROVs', IMarEST SMI Donald Maxwell Award Prize for Best Journal Paper (2004) 'A Fuzzy Track-Keeping Autopilot for Ship Steering' and Curriculum Paper Contest National Instruments International Competition LabVIEW in the Curriculum 2006 (First Prize Winner) 'Virtual Underwater Lab: Efficient Tool for System Integration & UUV Control Development'.