EXCELLABUST

EXCELLING LABUST IN MARINE ROBOTICS

INVITED TALK

23rd May 2016

Unmanned Maritime Vehicle Laboratory: Heterogeneous Adaptive Maritime Mobile Expeditionary Robots (HAMMER)

Dr. Vladimir Djapic
SPAWAR Systems Center - Pacific

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FER University of Zagreb Faculty of Electrical Engineering and Computing

LABUST Laboratory for Underwater Systems and Technologies

Consiglio Nazionale delle Ricerche

University of Limerick Ollscoil Luimnigh

Universitat de Girona Institut de Recerca en Visió per Computador i Robòtica

Girona Underwater Vision and Robotics

1. INVITED TALK DETAILS

Date: 23rd May 2016
Time: 14:00 – 15:00
Location: Gray Hall, University of Zagreb Faculty of Electrical Engineering (UNIZG-FER)
Unska 3, Zagreb, Croatia

Title: Heterogeneous Adaptive Maritime Mobile Expeditionary Robots
Name: Dr. Vladimir Djapic
Affiliation: SPAWAR Systems Center - Pacific
Chief Scientist, Unmanned Maritime Vehicles Lab

2. ABSTRACT

For the ONR-funded Heterogeneous Adaptive Maritime Mobile Expeditionary Robots (HAMMER) project, we work on cooperative autonomy for a fleet of unmanned vehicles working together in the aerial, water surface, and underwater domains. Each of these systems work well independently, but our goal is to integrate their performance into one system of vehicles that can safely perform cooperative tasks. The challenges we are working on include creating reliable communications links between vehicles in the harsh low bandwidth maritime environment, integrating novel onboard sensors and inter-vehicle communication to create filters to estimate the state of the network, and creating autonomous takeoff-and-landing algorithms between the aerial/underwater vehicles and the surface "mothership" vehicle. The surface vehicle is envisioned to be capable of transporting the aerial and underwater vehicles as well as providing mission-lengthening power. Possible applications of this system include automated deployment and recovery of data-collecting unmanned underwater vehicles and an ad hoc wireless network where the aerial vehicle relays time-sensitive data collected from the surface or underwater vehicle to a human on a ship many miles away. In a separate but related project, we are also determining human-autonomy teaming required for future Naval programs, assessing the state-of-the-art algorithms, and creating open challenge problems to academia to fill gaps based on the Navy's need.

Despite longstanding effort, COTS UAVs, UUVs and USVs are still limited in their capabilities by battery life, challenging communication, and their ability to know their location in space in GNSS -denied situations. Also, even though microprocessor, sensor, and battery technology will continue to improve drastically in the future, the energy cost per bit and maximal bitrates on an RF communication channel are beginning to hit their physical limits. Furthermore, as the size of the networked system of unmanned vehicles grows, each vehicle gets a smaller bandwidth on which to transmit. Conversely, onboard computations are becoming increasingly more energy efficient; a BeagleBone Black computer consumes 210-460 mA at 5V. Therefore, one can utilize inexpensive onboard computation resources in novel ways: to determine the optimal allocation of expensive/limited resources (RF communication channel); to extract more information more reliably from data sources; and, to enable new sensing paradigms. Specifically, we argue that in GNSS-denied environments, sophisticated navigation algorithms can be inexpensively run onboard a team of unmanned vehicles that result in high-quality, reliable navigation solutions at a lower communication cost. We aim to develop a framework that utilizes the currently available sensors (IMU, DVL, RADAR, Stereo camera, LIDAR, Virtual Reality RF tags), along with sensors that will soon be available (low power electric field and magnetic field sensors for electrolocation and geophysical navigation), within more solution paradigms that fully utilize today's computational platforms to go beyond the extended Kalman filter.

3. BIOGRAPHY OF LECTURER

Dr. Vladimir Djapic

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Vladimir Djapic received the B.S. and M.S. degrees from the University of California at San Diego,in 2000 and 2001, and the Ph.D. degree from the University of California at Riverside, Riverside, in 2009, all in electrical engineering. He returned to the Unmanned Maritime Laboratory in Space and Naval Warfare Systems Center Pacific in San Diego in 2014 where he is a Chief Scientist and a lead Principal Investigator (PI) for projects that utilize Maritime Autonomous Systems (air, surface, and subsurface). Dr. Djapic is also leading numerous international collaborative efforts, for example, Next Generation Autonomous Systems (NGAS) with multiple international partners and Coalition Warfare Program (CWP) with Croatia. From 2008 to 2013 he worked at Center for Maritime Research and Experimentation (CMRE), former NATO Undersea Research Centre (NURC), La Spezia, Italy, and served as a Scientist-in-charge for 5 major NATO sea trial that involved two CMRE ships, as well as shore-lab experiments set-ups with heterogeneous autonomous robots: Autonomous Surface and Underwater vehicles (ASVs and AUVs). The objective of his research effort at CMRE was to design an inexpensive, but robust and effective autonomous mine neutralization system and perform multiple at-sea experiments. From 2002 to 2007, he worked at Space and Naval Warfare Systems Center Pacific in San Diego. His ONR funded work focused on utilizing advances in navigation, control, and sonar processing to exploit AUVs for complex missions, for example, ship hull inspection.

Dr. Djapic has served as Technical Director of Student Autonomous Underwater Competition-Europe (SAUC-E, sauc-europe.org) since 2010 and since 2013 as a PI for European Robotics Athlon (euRathlon, www.eurathlon.eu/site) and Robocademy (www.robocademy.eu). He has over 50 publications at prestigious international journals and conferences and has served as an editor and reviewer during his scientific career.

4. DESCRIPTION OF THE INSTITUTION:

Unmanned Maritime Vehicles Lab,
SPAWAR Systems Center - Pacific

Address: 53560 Hull St, San Diego, CA 92152, United States

Website: http://www.public.navy.mil/spawar/Pacific/Pages/default.aspx

SPAWAR Systems Senter (SSC) PACIFIC is the Naval, Joint and National knowledge superiority through quality research, development, acquisition, test and evaluation (RDAT&E) and life cycle support of effective Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR), Information Operations (IO), Enterprise Information Services (EIS) and Space capabilities. Our mission is to enable Information Dominance for our Naval, Joint, National and Coalition warfighters through research, development, delivery and support of integrated capabilities. Our vision is to have SSC Pacific the Nation's pre-eminent Technical Leader for Integrated C4ISR Solutions for Warfighters.

Unmanned Marine Vehicles Laboratory supports numerous undersea robotics efforts, including the primary focus of development, testing and evaluation for Fleet unmanned undersea vehicles. Programs of interest include extensive efforts to evaluate and deliver Fleet UUV assets, largely for the EOD community, and the LBS-UUV (Littoral Battlespace Sensing) effort for METOC missions.
More recently Unmanned Marine Vehicles Laboratory efforts aim to successfully integrate autonomous unmanned surface (USV), aerial (UAS), and underwater vehicles (UUVs) in order to gather data from the ocean over several months and expand the capability to track and sample ocean dynamic features. UAS and UUVs are autonomously launched, recovered, and recharged by the USV at sea. The goal for this Heterogeneous Unmanned System is to navigate both in GPS enabled and GPS denied environments.