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CRUSER • NEWS
Consortium for Robotics and Unmanned Systems Education and Research

From Technical to Ethical...From Concept Generation to Experimentation

Contents

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AUV Docking Station Integration with Monterey Inner Shelf Observatory

by Sean Kragelund, Research Associate, CAVR, spkragel@nps.edu, PI: Doug Horner, Research Associate Professor and Co-Director of CAVR (http://www.nps.edu/Academics/Centers/CAVR/index.html), dphorner@nps.edu

The Naval Postgraduate School (NPS) has begun a project to deploy a seafloor docking station for its REMUS Autonomous Underwater Vehicles (AUVs) in Monterey Bay. Engineers from the NPS Center for Autonomous Vehicle Research (CAVR) and the Department of Oceanography are developing an interface so that the Monterey Inner Shelf Observatory (MISO), located in 16 m deep water 600 meters offshore from NPS, can host a REMUS docking station developed by Woods Hole Oceanographic Institution (WHOI).

Conceptual picture of the REMUS AUV entering the docking station

Autonomous Underwater Vehicles (AUVs) are free-swimming vehicles used to collect oceanographic data and seafloor imagery. They lack permanent connections, or tethers, to external power sources and the amount of time they can be deployed in an operating area is limited by their battery capacity. An underwater docking station allows an AUV to periodically recharge its batteries and upload its data to users during a single long-duration mission. Last month, NPS completed several preliminary tasks in preparation for deploying the WHOI dock.

First, NPS tested the beach side of the shore cable supplying power and Ethernet to the MISO cable termination package. Although power to the MISO has been off for over two years, the copper conductors in the shore cable used for electrical power were free of ground faults.

Next, NPS contracted with the Moss Landing Marine Labs (MLML) Science Diving Team to perform a dive operation on October 18, 2012. Two divers set to work cleaning the MISO support frame and uncovering the shore cable from the seafloor. The divers succeeded in cleaning off the bolts securing the cable termination package to the MISO frame, but found that the shore cable was buried too deep in the sediment to recover it using hand tools.

The divers also surveyed the area offshore from the MISO structure in a 50-meter radius to identify a safe location and geometry for the REMUS to approach the docking station. The divers found nothing but flat sand in this area, in agreement with a survey conducted by the Monterey Bay Aquarium Research Institute (MBARI) in 2006.

During a follow-up dive, the MLML science divers used a water jet to successfully excavate 25-meters of shore cable so the termination package could be raised to the surface for inspection. This revealed that one of the bulkhead connectors had failed after several years underwater, and the housing had flooded with seawater. While the original electronics package was badly corroded, the copper conductors and all but one of the fiber optic terminations were fortunately still intact.

After NPS personnel performed repairs, replaced the electronics payload, and re-sealed the housing with a new endcap, a test cable was connected to one of the new bulkhead connectors. From the work boat, NPS verified receipt of power and data at the termination package, successfully connecting to the NPS network with full internet access. This connectivity will be critical for monitoring persistent AUV operations in Monterey Bay via the seafloor docking station.

Diagram of preferred AUV approach route for docking relative to the MISO structure (photo courtesy of MBARI)

Finally, the dive team lowered the cable to the seafloor and reattached the termination package to the MISO frame.

The next steps for this project include designing a power/data interface to convert the MISO's 300-volt shore power into a 32-volt, 10-amp power supply capable of charging the REMUS AUV and installing this interface onto the seafloor docking station. The NPS CAVR looks forward to testing this docking capability in early 2013.

This work is supported by Susan LaShomb (PMS485 Maritime Surveillance Systems) and Dr. Tom Drake (ONR).

Director's Corner

We just launched our second CRUSER Innovation Thread in September with the successful execution of our Warfare Innovation Workshop focused on Advancing the Design for Undersea Warfare. The final report was just released so please e-mail Lyla Englehorn at laengleh@nps.edu if you would like an electronic copy. Check it out if you are interested in reviewing operational concepts generated by 6 teams comprised of over 50 players representing NPS students and early career engineers. Selected concepts will be advanced through our two-year innovation thread cycle for further development. Our next workshop is scheduled for March 2013 and will focus on the relationship between manned submarines and UUVs. Be watching our e-newsletter for registration information.

CAPT Carol O'Neal
CRUSER Director, Innovation and Concept Generation

NPS Celebrates Opening of Systems Engineering Research Laboratory

by MC1 Grant Ammon

U.S. Navy photo by MC1 Grant P. Ammon

NPS President Dan Oliver, left, Dr. Timothy Chung, center, and Dr. Clifford Whitcomb, right, cut a ceremonial ribbon signifying the grand opening of NPS' Department of Systems Engineering's (SE) newest research lab, Advanced Robotic Systems Engineering Laboratory (ARSENL), Oct. 31. Providing a diverse academic and research venue, ARSNEL fosters the holistic, multi-disciplinary approach to the design, employment and future concept development of robotic and unmanned systems.

"ARSENL provides a venue for fostering cross-disciplinary collaboration between students and faculty across the campus," noted ARSENL director and CRUSER's Director of Education and Research, Dr. Timothy Chung. "The lab has stations for physically building, testing, and programming robots, such as unmanned aerial vehicles (UAVs), situated next to computation, modeling and simulation resources, that involves students from a variety of disciplines."

Although ARSENL's grand opening was recently celebrated, research work is already underway from the newly formed laboratory. Current research projects include the Aerial Combat Swarms grand challenge competition effort, that seeks to apply future concepts of swarm and counter-swarm autonomous systems with a goal of 50 vs. 50 UAV live-fly field experimentation. Additionally, ARSENL provides a working lab that fosters diverse student projects for ground, surface, amphibious, and other aerial robotic applications and related operational contexts.

According to Chung, the cross-disciplinary focus of effort created through ARSENL strengthens the academic vigor of NPS programs, and adds depth to the graduate-level education provided at the university.

"ARSENL really gives our students a chance to work together with peers that may have different skills," noted Chung. "We could have a student that is very knowledgeable in electronics, but might not know a lot about programming, or a programming person that might not know mechanical design. Getting all of these students to sit in the same lab and share information is really part of a rich graduate educational experience."

Students participating in ARSENL include representatives from all naval unmanned systems domains, five countries, and more than six different academic departments across the NPS campus.

For additional information on ARSENL, please contact Dr Timothy Chung at thchung@nps.edu

DoD Organizations are invited to give a 15 minute presentation at an upcoming CRUSER Monthly Meeting about their research/projects
Contact Lisa at cruser@nps.edu to sign-up

Upcoming CRUSER Monthly Meetings
Mon 19 Nov 2012, 1200-1250 (PST)
Root 242 or dial-in 831-656-6681
Mon 3 Dec 2012, 1200-1250 (PST)
Root 272 or dial-in 831-656-6685

Space Samples Retrieval System and Elements of NextGen Navigation

By Prof. Oleg Yakimenko, oayakime@nps.edu, NPS Faculty member

NPS features several laboratories that are working on developing and testing onboard algorithms for a variety of unmanned systems. The latter include traditional systems like maritime, ground, aerial systems, and some nontraditional systems. One of them is an unmanned payload delivery system (PDS) Snowflake developed by the Aerodynamic Decelerator Systems Center (ADCS) at the Mechanical and Aerospace Engineering department in collaboration with the University of Huntsville in Alabama in 2008. Snowflake PDS (Fig 1) is a fully autonomous unpowered parafoil-based system that relies on the steering commands produced by an onboard autopilot allowing delivering small payloads within 10 meters from a stationary or moving target. This system also features a global reach capability allowing Snowflake's autopilot to be accessed from anywhere in the world using the Internet or voice portal. Another distinctive feature of the Snowflake PDS is that it has a predictable trajectory it follows every time you deploy it assuring landing into the wind (Fig 2).

Fig 1 Snowflake payload delivery system

Fig 2 Birdseye view of Snowflake's trajectory

Snowflake PDS paired with a catapult-launched belly-landing Arcturus T20 UAS by the Arcturus UAV, a long-standing ADSC's partner, forms a self-sufficient delivery system Blizzard capable of delivering a payload of up to 75 lbs within a 400 miles range. In 2009 this system was successfully demonstrated at the US Army / Air Force Precision Airdrop Technology and Demonstration event at the Yuma Test Center.

Since 2009 ADSC looked into a number of applications that could benefit from utilizing Snowflake technologies. For example, Snowflake PDS can deliver small payloads (water, batteries, cell phones) to the disaster areas, deploy a grid of unattended sensors in the locations otherwise not accessible or hazardous, bring ground robots to the close vicinity of remote inspection sites or IED, covertly establish a short-range network, conduct vertical replenishment-at-sea, etc.

In September-October of this year in collaboration with Universities of San Jose, Idaho and Nevada the ADSC led several experiments exploring another potential usage of Snowflake technology – precise delivery from stratosphere.

Fig 3 Snowflake over Washington/Idaho

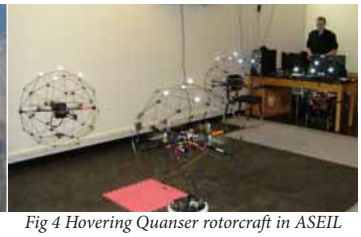

Fig 4 Hovering Quanser rotorcraft in ASEIL

In the case of success such a system could be used as a last stage of multi-stage system to retrieve samples from a low-earth orbit (international space station). To this end, Fig 3 features Snowflake deployed from over 60,000ft by a balloon. Another interesting concept that is also being tested is a round-canopy version of Snowflake. In this case steering towards a desired direction is accomplished by utilizing different layers of a jet stream, descending through one layers faster and another ones slower. The only control in this case is a variable area of a round canopy.

The Autonomous Systems Engineering and Integration Laboratory (ASEIL) at the Systems Engineering department of NPS deals with another type of UAS – indoor rotorcraft (Fig 5). The algorithms ASEIL students and faculty are working on are devoted to developing the Detect, Sense, and Avoid (DSA) capability, the most important capability that would enable unmanned aerial vehicles entering the national airspace.

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18th International Command & Control Research & Technology Symposium (ICCRTS) Call for Papers

Dr. Mark Nissen, Naval Postgraduate Systems Professor of Information Sciences and Management, is chairing the new Autonomy C2 Track for the 18th International Command & Control Research & Technology Symposium (ICCRTS), which will be held in Alexandria, VA next June. The ICCRTS is a high-quality, peer-reviewed conference venue that attracts top researchers and practitioners from around the world to discuss cutting-edge developments in C2. Technical, behavioral, social and organizational papers--theoretical and empirical alike--are all welcome, but the track seeks to focus in particular on the integration of people and machines in organizational contexts. Abstracts are due (via email is fine) on 30 November. Manuscripts will be due and reviewed in early February, and final papers will be completed in late April. http://www.dodccrp.org/

Please contact Dr. Nissen (MNissen@nps.edu) regarding your interests, topic ideas or questions regarding the ICCRTS conference.

AUVSI Launches Public Education Website to Highlight Benefits of Unmanned Systems

Arlington, Va. - The Association for Unmanned Vehicle Systems International (AUVSI) launched a new public education website, http://www.increasinghumanpotential.org to highlight the valuable and endless benefits of all unmanned systems and robotics.

The website shows how the unmanned systems and robotics industry literally increases human potential by working for the human in dull, dirty, dangerous and difficult tasks.

Visit www.increasinghumanpotential.org today to learn more about the endless applications of unmanned systems and robotics. IHP is also on Twitter @unmannedupdate

STUDENT CORNER

Student: LT Kyungnho Kim, USN

Title: Integration of UAS in NAS: Analysis of Loss of link factors

Curriculum: Department of Information Sciences and Technology

Abstract: The objective of this study is to develop formal methods of evaluating the primary factors causing the loss of link condition and to investigate effectiveness of the coordinated path following and vision based target motion estimation approaches in mitigating the risk of mid-air collision

Assistance Needed: As a part of my literature review, my advisor recommended finding an answer for:

1. How many UAV related incidents (which will provide a significance of the study)
2. What are the probable causes of the incidents
3. Which factor is the most significant and How significant is "Loss link condition (including communication issue in general)", then, who will be beneficiaries for this study?

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Current research addresses all three DSA components in different-class airspace: the potential threats (non-cooperative aircraft) should be reliably detected, relative geometry (intentions) well understood and a collision-avoidance maneuver timely developed and executed. Algorithms developed in the ASEIL for rotorcraft are then transferred onto outdoor platforms and tested at Camp Roberts, CA.

While developed image processing capabilities to address a detection portion of DSA using the EO/IR sensors will be presented at another time, Fig 5 shows a recent experiment based on a different approach when multiple aerial platforms share their position information to facilitate joint operations deliberately, using the Next Generation Air Transportation System (NextGen) Automatic Dependent Surveillance-Broadcast (ABS-B) system. Figure 6 shows Arcturus T20 aircraft equipped with a Sagetech Mode S ADS-B Out transponder broadcasting UAV's GPS position, and Fig.9 features a situational awareness display where data from the UAV and manned aircraft flying nearby are blended together using a Sagetech Clarity ADS-B receiver providing a WiFi interface. These data are available to both pilot of a manned aircraft and UAV autopilot, so that the latter could dynamically change its flying pattern to avoid a collision if needed (such algorithms have been developed and tested at ASEIL already).

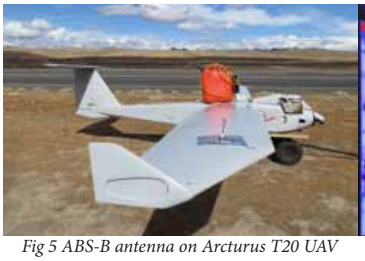

Fig 5 ABS-B antenna on Arcturus T20 UAV

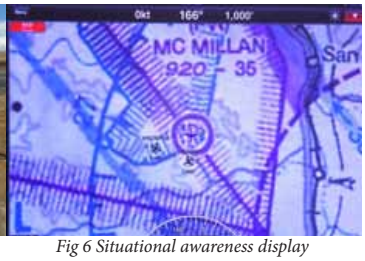

Fig 6 Situational awareness display

Short articles of 300-400 words for CRUSER News are always welcome. Contact us at cruser@nps.edu for additional information.

Does your DoD Organization have a potential thesis topic for NPS Students? Contact us at CRUSER@nps.edu

Librarian's Corner:

CRS Report - Pilotless Drones: Background and Considerations for Congress Regarding Unmanned Aircraft Operations in the National Airspace System

Abstract: "Growing interest in the use of unmanned aerial vehicles (UAVs), particularly for homeland security and law enforcement applications, has spurred considerable debate over how to accommodate these unmanned aircraft and keep them safely separated from other air traffic. Additionally, the use of these pilotless aircraft, popularly referred to as drones, for aerial surveillance and law enforcement purposes has raised specific concerns regarding privacy and Fourth Amendment rights and potential intrusiveness. These issues have come to the forefront in policy debate in response to provisions in the FAA Modernization and Reform Act of 2012 (P.L. [Public Law] 112-95) that require the Federal Aviation Administration (FAA) to begin integrating unmanned aircraft into the national airspace system by the end of FY2015. While drones have been used extensively by the military and small radio-controlled model aircraft have been around for more than 50 years, advances in more complex vehicle controls and imaging sensor capabilities are spurring public sector and commercial interest in unmanned aircraft for a variety of purposes, including law enforcement, homeland security, aerial imaging, and scientific research."

This and other articles are available on the Unmanned Systems Guide http://libguides.nps.edu/unmanned Questions? We're here to help! libcruser@nps.edu