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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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Special Edition - Director's Corner

Challenges in Robotics Leadership

By Raymond Buettner, CRUSER Director

When CRUSER was created one of the concerns it was (and still is!) intended to address was the potential disconnect of naval priorities related to robotics and unmanned systems from the priorities of the rapidly growing commercial sector in an emerging global market place. The goal is to avoid what has happened in the computer and internet domain where the Defense Department went from being the primary player to a niche player no longer able to significantly influence the direction of technological development in the broader market. There is little evidence that this occurred due to any planned action or inaction but rather that the situation simply evolved into its current state.

CRUSER, with its membership made up of industry, academe and government members, hopes to help the Department of the Navy, currently a leader in some key areas related to robotic and unmanned systems, stay in the game as a partner, if not a leader, as the field blossoms into a key global industry. One of the keys to this challenge is the recognition that robotics and unmanned systems is a global enterprise. CRUSER, and the naval enterprise, will need to understand the global playing field to stay near the cutting edge in the coming years. As in the world of computer networking, there is no real technological distinction between the military and commercial sectors with regards to robotics and unmanned system.

Currently the naval enterprise is reaping the benefits of wise investments over the past decade or so. In the air, the X-47B is able to, without human intervention achieve what many pilots consider one of the most difficult of aviation tasks, land a plane on an aircraft carrier. On land, the USMC is testing the LS3 "Big Dog" robotic pack "animal" in simulated combat conditions. Underwater, the tactics, training and procedures are under development for the Large Displacement Unmanned Undersea Vehicle (LDUUV), a vehicle that will operate submerged for up to 70 days. Finally, on the surface, the Office of Naval Research recently demonstrated the ability of a small surface swarm to autonomously defend a manned surface combatant. The Navy is currently at the forefront in robotic mobility, autonomy, endurance and cooperative behavior. Of course this is not to say that there are not those within the naval enterprise that will resist the changes that these technologies will impose. The gap from R&D to operations can be a challenging one to cross.

This type of technical leadership brings to mind the days when the fastest and most powerful computers were being developed by DoD organizations and the internet was spawned. Names like Grace Hopper and Art Cebrowski illustrate the impact of naval leadership on the emergence of the Information Age. With computing then, as with robotics now, DoD was the leader in the field, literally helping to create the global environment. The United States used the foundations created by its defense research enterprise to lead the world in this revolution, yet today defense is a tiny share of the computing and networking market. Indeed the use of computers has become so ubiquitous that it is not easy to extract meaningful data related to the size of the global markets related to these systems. While still at the table, especially in areas where there is no commercial application, DoD no longer drives the development of technologies in this area and is instead a larger customer among many. Even the United States as a whole is being challenged for leadership in computer technology with the world's fastest super computer having been developed by China's National University of Defense Technology and Japan, Switzerland and Germany also sharing spots in the top 10 with the U.S.

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However there are significant differences between the early days of computing and these early days of robotics. First, the early days of computing required massive investment to initially construct systems and later to connect them effectively. Indeed one reason that the U.S. has been an early leader in large unmanned systems is that it could afford to create larger, more complex systems. However it is very likely that the most critical advancements in this area will not be dependent on platform size hence reducing the barriers to entry and increasing the probability of rapidly evolving capabilities.

In addition to the challenges presented by lower barriers to entry the earlier information revolution means that knowledge related to advances in the field of robotics and unmanned systems may proliferate much more rapidly around the planet. Some in the corporate sector have succeeded, for example, in competing using an open source business model that leverages other areas of competitive advantage. In any case, the difficulty in protecting intellectual property is made clear as almost daily headlines describe companies, including those that design advanced weapons systems, being compromised via cyber exploits.

Another important change from the early days of the computer revolution is that the growing additive manufacturing and 3D printing capabilities will mean that the sources of manufacturing for robotic systems will vary widely and not be concentrated in a few state of the art factories.

Finally, while policy and law may not still be where they need to be to provide optimal freedom and security in cyberspace they clearly have come a long way. In the early days of the internet it was not even clear what types of activities could be prohibited or regulated. The default was that most cyber actions were legal until deemed otherwise. The courts played an important role in developing the body of laws that now regulate life on line in an imperfect compromise between personal, commercial and government priorities.

In the United States we face a very different regulatory challenge, especially with regard to unmanned aerial systems where existing law is being applied in the most conservative way possible. This risk adverse approach is driving some of the largest and potentially most innovative companies to conduct research and development overseas while driving smaller operators into the shadows in order to develop their systems. Obviously there is a need for regulations to avoid potentially disastrous consequences but few could argue that the approach of extrapolating requirements for a manned aircraft to much smaller unmanned (actually not even possible to man) systems makes good sense.

Luckily for the naval enterprise, operating areas at sea are well outside of FAA controlled air space and other methods can be used to safely execute research and development activities once a platform reaches a certain level of maturity. The Navy, like its sister services, also has access to restricted air space within the United States, but operations in these areas is under scrutiny as well and the risk adverse mindset is more prevalent than at sea. The ability to fly in foreign airspace over the last decade also allowed the generation of enormous knowledge with regards to the fielding, operation and maintenance of these systems.

A quick look outside the lifelines is sobering as well. For the time being the United States has a strong lead in the development of maritime systems but analyst suggest that this will erode over the next decade as other nations piggy back on the foundational work that has been done. Many investment advisors, nervous about domestic regulations, are suggesting that overseas markets, especially in China and India, might make better investments for their customers. Some of the best work is being done outside the U.S. with the Japanese generally thought to be the leaders in humanoid robotics, Germany leading in autonomy, and so on. The Chinese are moving up the ladder across the board with major research institutions across the nation in all areas of robotics. While the Russian's have become more closed of late they too are moving strongly across the board in the development of these systems.

So for the reasons discussed it may be difficult for the Navy and Marine Corps to maintain its current leadership in robotics and unmanned systems. At the same time it seems clear that it is critically important to remain engaged at the cutting edge even as domestic and global investment overtakes and eventually dwarfs military spending on these technologies. CRUSER by its very nature can assist by enhancing the spread of a robotics and unmanned systems knowledge into the naval culture. CRUSER members need to increase their awareness of the dynamic world context that surrounds the navel enterprise and help to bring forward issues for discussion and exploration.

As described, some of these issues are more related to economics, policy and law than the software and hardware issues that technologists are usually focused on. In part that is why CRUSER selected the tag line "From ethical to technical…" to describe its role. CRUSER is ramping up its educational component with most future events including focused learning activities and the award of Continuing Education Units for participants. We will be hosting discussions across the Navy about the right mix of education and training for the forces as well as continuing to support the graduation education efforts here at the Naval Postgraduate School. Finally we will be adding to the CRUSER Newsletter a series of thought provoking articles by leading thinkers, in and out of government.

Of course none of this works unless the CRUSER Community of Interest invests its knowledge and experience into the process. We solicit your suggestions and thoughts and look forward to working with you to keep the naval enterprise riding the leading edge of the robotics revolution!

CRUSER Monthly Meetings

Mon 3 Nov, 1200-1250 (PST)

Mon 1 Dec, 1200-1250 (PST)

details at: http://CRUSER.nps.edu

JIFX: 3-7 Nov 2014 at Camp Roberts

The 13th Annual 2015 Student UAS Competition at NAS Patuxent River, Webster Field

by Wayne Devereux, AUVSI Seafarer Chapter VP and SUAS Head Judge, wayne.devereux@wyle.com

The Seafarer Chapter of the Association for Unmanned Vehicle Systems International (AUVSI) hosts the annual Student Unmanned Aerial System (SUAS) Competition to stimulate and foster interest in unmanned systems and technology careers. The competition focuses on engaging undergraduate students in a challenging mission requiring the design, fabrication and demonstration of a system capable of completing specific aerial operations autonomously, and performing several additional tasks involving autopilot and sensor integration, target acquisition and identification, RF communications, actionable intelligence, airborne delivery, and National Airspace (NAS) integration with new interoperability and Sense, Detect and Avoid tasks.

Student teams are judged based on their system design and performance with technical journal papers, proof-of-flight videos, flight readiness presentations and flight-mission demonstrations. Top teams may earn a share of the prize money. Teams also gain opportunities for interaction with top UAS and payload designers, engineers, scientists and Navy leadership. Additional events and interactions include an awards banquet and recruiting opportunities where students may be interviewed for careers in UAS and other exciting technology fields.

The 2014 SUAS Competition was held 18 to 21 June 2014, with 48 teams registered (27 domestic schools, 18 international schools and 3 high schools) although several were unable to compete. Of these, 33 competed for the technical journal papers, while only 28 teams showed up at Webster Field to present their flight readiness review, and 27 flew to compete in the flight-mission demonstration phase for over $51,000 cash prize awards. These are the final 2014 SUAS competition team rankings:

2014 SUAS Overall Winners:
1st Place – North Carolina State University
2nd Place – Cornell University
3rd Place – Delhi Technological University (India)
4th Place – Kansas State University - Manhattan
5th Place – Technion, Israel Institute of Technology

Judges' Awards:
Best Overall Rotary Wing – Politehnica University of Bucharest (Romania)
Best Overall High School – The Gilman School, Maryland (12th overall placement)
Dr. Arthur Reyes Safety Award – North Carolina State University
JustJoe Sportsmanship Award – Rutgers University

Preparations for the 2015 SUAS Competition are underway to be held 17 to 21 June 2015 at the United States Navy's Webster Field, site of the Naval Air Warfare Center Aircraft Division (NAWCAD) UAS Test & Evaluation Squadron in St. Mary's County, Maryland – an emerging technology corridor on the Chesapeake Bay and a center of excellence for UAS development and test. The DRAFT 2015 Rules have been posted on the Seafarer's website (www.auvsi-seafarer.org), and University Day Call-in Teleconference is scheduled to be held Thursday 9 October 2014 from 11:00 - 12:30 PM EDT. The 2015 SUAS Registration will open to all teams when the 2015 SUAS Final Rules are posted on the Seafarer's website, about 23 October 2014. To become a corporate sponsor, or volunteer as a judge or staff, contact the Seafarer Chapter.

Librarian Corner

Hybrid Control for Large Swarms of Aquatic Drones
http://miguelduarte.pt/media/publications/duarte2014alife_aquatic.pdf

Predator: The Secret Origins of the Drone Revolution
http://www2.gwu.edu/~nsarchiv/NSAEBB/NSAEBB484/

Law Enforcement Use of Drones & Privacy Rights in the United States
http://ssrn.com/abstract=2492192

STUDENT CORNER

Student: Ens Jacob T Jurica

Title: Terrain aided navigation for REMUS autonomous underwater vehicle

Curriculum: Mechanical Engineering

Link to Completed Thesis: https://calhoun.nps.edu/handle/10945/42654

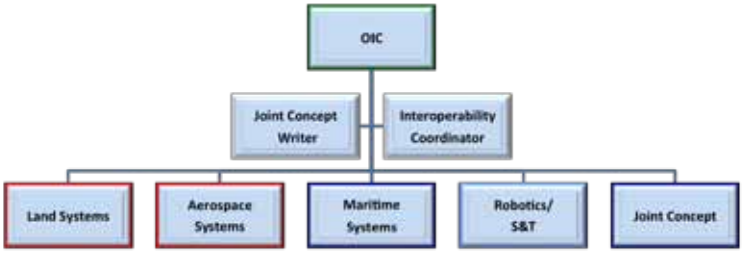
Abstract:

This research investigates the ability to create an undersea bathymetry map and navigate relative to the map. This is known as terrain aided navigation (TAN). In our particular case, the goal was for an autonomous underwater vehicle (AUV) to reduce positional uncertainty through the use of downward-looking swath sonar and employing TAN techniques. This is considered important for undersea operations where positioning systems such as GPS are either not available or difficult to put in place. There are several challenges associated with TAN that are presented: The image processing necessary to extract altitude data from the sonar image, the initial building of the bathymetry map, incorporating a system and measurement model that takes into consideration AUV motion and sensor uncertainty and near-optimal, real-time estimation algorithms. The thesis presents a methodology coupled with analysis on datasets collected from joint Naval Postgraduate School/National Aeronautical Space Administration experimentation conducted at the Aquarius undersea habitat near Key Largo, Florida.

Joint Staff Robotics and Autonomous Systems Team

by Brian K. Hall, Interoperability Coordinator, brian.k.hall4.civ@mail.mil

The Joint Staff Robotic and Autonomous Systems Team (JRAST) established initial operating capability in August 2014 to better synchronize robotic and autonomous systems (RAS) technology development within the Department of Defense (DOD). The JRAST is the action arm to strengthen the Joint Staff's role in the integration of unmanned capability development across the Department in order to achieve the Chairman of the Joint Chiefs of Staff vision for Joint Force 2020.



Background: in September 2007, the Deputy Secretary of Defense established the Unmanned Aircraft Systems (UAS) Task Force under the leadership of the Under Secretary of Defense for Acquisition, Technology and Logistics. The Task Force continues to aggressively coordinate critical DoD UAS issues and develop ways ahead to enhance operations, enable interdependencies, facilitate interoperability and streamline acquisition of UAS. The Task Force is primarily focused on aircraft systems, however some activity such as policy, interoperability, and spectrum carry over to other domain systems. What is needed is more joint warfighter integration to affect the Department's portfolio management and executive decision making processes. In October 2013, the Chairman's Second Term Strategic Direction to the Joint Force spurred Joint Staff action in four focus areas. The Develop Joint Force 2020 focus area analysis yielded a critical objective targeting RAS technology development. The JRAST functional and organizational constructs received the Chairman's endorsement in April 2014. The Office of the Secretary of Defense, the UAS Task Force, Military Services, and the JRAST are quickly establishing mutual support to better represent the warfighting mission area across the entire robotic, autonomous, and unmanned systems portfolio.

Today, the JRAST acts as a joint force point of entry for the unmanned systems enterprise and reports through the Deputy Director, Force Management, Application and Support to the Joint Capability Board on behalf of the Director for Force Structure, Resources, and Assessments, J-8. JRAST's mission encompasses the following five lines of effort:

1. Develop a Joint Concept for Robotic and Autonomous Systems.
2. Identify and advance opportunities for increased interoperability between manned systems and RAS-manned/unmanned teaming.
3. Synchronize and encourage collaboration across the DoD RAS enterprise.
4. Work with Industry, Science and Technology, and academia to identify emerging RAS technologies and align them with DOD requirements.
5. Provide a forum for development of DoD policies concerning RAS.

For more information see: https://portal.js.mil/sites/J8/DDFMAS/JRAST/SitePages/Home.aspx
(CAC registration required for external Joint Staff access; see https://portal.js.mil)

Short articles of 500 words for CRUSER News are always welcome submit to: cruser@nps.edu