Issue 39 May 2014

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

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Joint Ground Robotics Enterprise Direction

By Chris O'Donnell, Joint Ground Robotics Enterprise, Christopher.c.odonnell.civ@mail.mil

The Department of Defense (DoD) went through rapid growth in unmanned systems in the last 10 years. Thousands of air, ground and maritime systems have been deployed that provide needed ISR capabilities, standoff IED neutralization and underwater detection. These systems have become part of everyday military operations and a generation of users has come to trust these platforms and the capabilities they provide.

Many of these efforts were focused on providing immediate impact to the operator. Through the urgent operational needs process and the standup of various task forces, the deployment and continuous improvement of these systems became a high priority for deployed forces and the acquisition community. Much of the funding for these efforts came from Other Contingency Operations funding and the department is now transitioning many of the programs into more formal programs of record. That transition has highlighted the need to address many of the "ilities" that will make the systems more effective and efficient in the future.

The Joint Ground Robotics Enterprise (JGRE) was started in 1990 to coordinate unmanned ground systems across the DoD. The JGRE has refocused in the last few years from being a small "e" technology acceleration effort to a big "E" coordination effort across the department. The focus of the big "E" will be in the areas of interoperability, Test and Evaluation and Modeling and Simulation.

The unmanned ground systems (UGS) community has recently come to agreement on how to begin to institute interoperability based on open interface standards. The JGRE funded development of the Joint Architecture for Unmanned Systems (JAUS) that has transferred over to an SAE AS-4 unmanned systems standard. The Navy and Army have worked to increase the utility of JAUS by addressing logical, electrical, mechanical, and data interface standards. The Robotics Interoperability Profiles (IOP) has been demonstrated on multiple systems and forms the basis for the Advanced Explosive Ordnance Disposal Remote System (AEODRS).

The second area for interoperability reaches beyond the UGS community to the tactical unmanned air systems (UAS) community. Current tactical systems were fielded with commercial solutions for control and video transfer. The JGRE will work with the Joint Tactical Networking Center to identify military waveforms and hardware that can be used for small tactical UGS and UAS.

The Defense Test and Evaluation community has identified the ability to evaluate unmanned systems as a focus for further improvement. Many of the current systems were fielded through capabilities and limitations reports and not through a more rigorous test and evaluation process. The JGRE plans to work with the test community to formulate a plan on how to develop the processes, procedures, work force and infrastructure to prepare for fully evaluating unmanned systems.

The DoD has developed a wide range of physics-based M&S tools over the past few years. Two of the M&S tools, the Virtual Autonomous Navigation Environment (VANE) and the Autonomous Navigation Virtual Environment Laboratory (ANVEL), provide fast, easy ways to visualize high-fidelity robotics simulations. The future focus will be how to assimilate these tools into higher level war gaming simulations to demonstrate the utility of UGS to overall warfighting capability.

Chris O'Donnell is the Staff Specialist for the Joint Ground Robotics Enterprise in the Office of the Undersecretary of Defense; Acquisition, Technology and Logistics; Tactical Warfare Systems; Land Warfare and Munitions. He has spent the last 20 years leading the development of robotic solutions in the ground, maritime and air regimes for the Joint Service EOD community.

Director's Corner

Dr Timothy H Chung, CRUSER Deputy Director

With the "Season of CRUSER" behind us, having successfully concluded not only April's Robots in the Roses and CRUSER Technical Continuum (TechCon) events but also recent activities including the CRUSER Tech Expo and NPS Campus Lab/Poster Sessions jointly held with the Mine Warfare Technical Symposium (MINWARA), we are reminded how such information exchanges are at the essence of CRUSER's success. With the mantra that "conversation leads to collaboration, and collaboration leads to innovation," CRUSER continues to tie in various and diverse activities pertaining to robotics and unmanned systems, ranging from concept generation (such as the upcoming Systems Engineering Analysis capstone project final project reviews later this month) to field experimentation (such as the recently held Joint Interagency Field Experimentation (JIFX) event). As such, there's never a dull moment with CRUSER (which is why we keep coming back for more)!

3D Printed Solutions for Emergency Response

By Alberto Lacaze, President, Robotic Research, Gaithersburg, MD, info@roboticresearch.com, www.roboticresearch.com

A growing number of Federal departments and agencies are recognizing the benefits of additive manufacturing / 3-D printing. It can quickly, efficiently, and cost-effectively produce critical items for homeland security, the military, and government, for a variety of missions.

The Department of Homeland Security (DHS) and Robotic Research, LLC are working together on an affordable and adaptable system that utilizes 3D printing technology for first responders. This collaboration started as a Small Business Innovation Research (SBIR) topic by DHS's Science and Technology Directorate, awarded to Robotic Research, LLC to provide robotic assets to first responders. During Phase I of this project (called Sensor-smart Affordable Autonomous Robotic Platforms (SAARP)) Robotic Research engineers determined that rapid 3D printing technology, combined with basic part kits and an intuitive on-line library resource for 3D printable models, would significantly reduce costs while providing an effective solution. In February 2014, 3D printed air and ground prototypes, developed under the SAARP program, were demonstrated at the Joint Interagency Field Experimentation Program (JIFX) experimentation at Camp Roberts, CA in February 2014.

In today's uncertain environment, DHS, together with state and local emergency response organizations and first responder units, must be prepared to effectively cope with a broad set of possible scenarios. Selecting and prepositioning appropriate robotic assets is difficult for a variety of reasons: prohibitive platform cost and unknown factors, such as correct size, weight, types of attachments (sensors), or tracks (wheels) that match the tasks required.

On-scene incident commanders need rapid access to all kinds of spare and replacement parts as well as specialized items in order to sustain operations. Many of these items can be manufactured on-site and on-demand using mobile 3-D printing labs equipped with an on-line parts library. These labs can be pre-positioned in a given FEMA Region or quickly deployed to an incident scene.

Robotic Research, LLC had already developed a solution that solves similar problems for the military, called Nugenis™, and modified it for the DHS mission. The system contains a library (powered by Nugenis™) of robot models and other items that can be 3D printed on-site. The Nugenis™ library has a "storefront" that allows third party developers to maintain their intellectual property and receive compensation if their devices are printed. Compatible Nugenis™ libraries are being developed for commercial and government use.

Figure 1. Robotic Research, LLC designed a 3D-printed ground robot for DHS, called TOSR (image is property of Robotic Research, LLC)

Not all components of a robot can be 3D printed, e.g. motors, sensors, and controllers. A common set of these non-printed parts is specified by DHS as "kits" so robot designers know what parts to use. Component interchangeability will reduce inventory and procurement costs, so if a hundred robots require a small motor, they all use the same motor, rather than stocking a hundred different motors.

Robotic Research designed an initial set of platforms for proof of concept, including the TOSR (Throwable Orientation Switching Robot) -- a small, throwable, two-wheeled remote controlled platform. Because TOSR is 3D printed, it is easily adaptable to new mission needs and can be quickly modified to carry additional payloads. As demonstrated at JIFX, TOSR provides an easy-to-use, adaptable, low-cost robotic platform ideal for situations where recovery of the platform may not be possible (chemical or biological survey or use in hazardous environments.

How do you achieve interoperability for unmanned systems? Here's the standard answer.

By Captain Edward H. Lundquist, U.S. Navy (Retired), excerpt from Jan 2014 issue Naval Institute Proceedings magazine

The pithy expression "plug and play" is the military community's favored way to evoke interoperability, which is becoming increasingly important with unmanned underwater and air systems. And while achieving this state sounds simple, ensuring that multiple systems have complementary protocols, technologies, and business models is a lengthy process.

When it comes to the underwater domain, achieving interoperability is currently impossible due to the lack of common standards and protocols for wireless communication. But this is beginning to change.

Interoperability Challenges

"If a common communication system could be established in the underwater domain, the advantages would be immense," said Mandar Chitre, Ph.D., assistant professor at the department of electrical and computer engineering and head of the Acoustic Research Laboratory at the National University of Singapore's Tropical Marine Science Institute. "Subsystems from various vendors could be integrated into larger systems easily."

Almost all underwater vehicles or sensors currently use proprietary interfaces and protocols for communication, especially for wireless communication in water. This means that devices from different manufacturers cannot communicate with each other. "In many cases vehicle and sensor manufacturers include communication technology, such as underwater modems, from other manufacturers," he said. Because the protocols and data formats used by devices are not standardized, it is not even guaranteed that two devices that have modems from the same manufacturer can communicate with each other.

But interoperability is possible, according to Chitre. "In practice, the major challenge is to get various technology vendors to agree on a common standard and protocols. It is necessary to have a basic framework that is standardized while letting technology providers innovate and provide differentiated products that fit within the framework. This would ensure that technology vendors do not lose their competitive edge by agreeing to standards, but instead create a larger market where their products can easily be integrated with other vendors' products to create systems beyond what is possible today." Such a framework would require industry players to make a concerted effort. Companies like Subnero, with which Chitre is affiliated, are now making their software-defined underwater modem technologies customizable and open.

Organizations like the NATO Centre for Maritime Research and Experimentation (CMRE), located in la Spezia, Italy, are also helping this effort through standardization initiatives and encouraging development of software-defined modems and networks.

CMRE has developed standardized agreements that codify acoustic communications underwater between two platforms. This will allow data to pass from modem to modem underwater so that a U.S. unmanned underwater vehicle (UUV) can communicate with a British UUV, for example.

Cooperating through Communication

According to CMRE research scientist John Potter, Ph.D., military maritime operations have been driven by a relatively small number of large, expensive platforms dealing with well-defined threats to which those platforms could be designed to address.

Eventually, Potter said, it will be possible to develop and deploy clandestine networks of large numbers of small, long-endurance, inexpensive robots to detect, classify, track and, if necessary, prosecute enemy submarines. "Not every nation can contribute a destroyer, but most can offer something smaller like an unmanned system. If you need the different nations to contribute to a pool of multiple autonomous assets, AUVs have a relatively low threshold of participation." And if these systems could interoperate, they could be deployed in a more flexible manner.

Communication between underwater maritime systems is complex due to the sheer physics involved, and is limited by low bandwidth and prone to frequent disruptions.

Janus, a new standard for underwater communications being developed through an effort led by CMRE, can provide a way to send and receive messages. "This language opens a portal between two domains—two different operating paradigms—through which they can talk," said Potter. "It's primarily a physical coding protocol, which is rather like a language, and many different kinds of hardware can be made compatible since it is so simple and does not require a great deal of computing power or memory." Once the standard is adopted, Potter predicts that many existing comms systems will be brought into compliance.

The simple digital underwater signaling system can be used to contact underwater assets using a common format, announce the presence of an asset to reduce conflicts, and allow node discovery to enable a group of assets to organize themselves into an ad hoc network. It is the first digital underwater coding standard being developed to provide global interoperability in underwater communications, said Potter. "

Janus is very simple and low bit-rate, intended to be robust. "Janus is not a magic bullet for collaborative and cooperative behavior; just because two people are able to communicate with a common language does not guarantee that they will be friends. But it is an important starting point," Potter said.

Edward Lundquist is a retired captain who served as a surface warfare officer and public affairs officer. His last assignment on active duty was commanding the 450 men and women of the Naval Media Center. He is currently a principal science writer for MCR Federal LLC.

STUDENT CORNER

Student: CWO4 Carlos S. Cabello, USA

Title: Droning on: American strategic myopia toward unmanned aerial systems

Curriculum: Defense Analysis

Link to Completed Thesis: http://hdl.handle.net/10945/38890

Abstract:

Throughout the past decade of wars, the U.S. has deployed unmanned aerial systems, commonly referred to as drones, from Africa to Asia collecting intelligence and targeting adversaries. The nation now stands at a crossroad seeking to develop future American drone policy against an evolving threat while at the same time shaping global norms. The past decade of American drone use focused on short-term benefits, intelligence collection and lethal targeting, rather than on the long-term consequences of technology diffusion, or ethical and legal frameworks. Myopic drone strategies threaten to establish a global precedent that could undermine the stability of international relations, as state and non-state actors (SANSA) have begun to build, arm, and operate lethal unmanned systems at an alarming rate. Unmanned technology development and usage is outpacing international norms, regulations, and policies. These systems will usher in an era of unrestricted drone usage unless international regulations and standards are developed. This thesis examines whether American drone strategy is myopic and whether it is creating a dangerous international precedent. A qualitative analysis will identify the short-term benefits and long-term consequences of U.S. drone strategy, focusing on unmanned technology diffusion, ethical justifications, and legal frameworks. Examining American drone strategy can help explain why a myopic policy may be beneficial in the short-term, yet may increase threats to national interests in the long-term. The thesis concludes with an assessment of whether strategic myopia has already set a dangerous international precedent, which SANSA will use to justify their future drone programs.

CRUSER Librarian Corner

Military Technology Issue - April 2014, v. 19, no. 2
Unmanned Aerial Vehicles
http://www.kmimediagroup.com/military-training-technology/440-articles-mtt/unmanned-aerial-vehicles

Hoover Institution Stanford University
Law and Ethics for Autonomous Weapon Systems: Why a Ban Won't Work and How the Laws of War Can
http://www.hoover.org/publications/monographs/144241

Rand
Armed and Dangerous?: UAVs and U.S. Security
http://www.rand.org/pubs/research_reports/RR449.html

Joint Interagency Field Experimentation (JIFX) 14-4 Call for Papers

11-15 August 2014 at Camp Roberts, CA and Yerba Buena Island, San Francisco, CA.

Whitepaper submissions are due no later than 1 July 2014
http://www.nps.edu/fx to review the Request for Information (RFI) and apply to attend

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

- Unmanned Systems/Robotics research
- New Program/Systems/Projects
- Other aspect of Unmanned Systems/Robotics

CRUSER Monthly Meetings

Mon 16 June, 1200-1250 (PDT)
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