Issue 25 Mar 2013

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

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Unmanned Systems for Maritime Security and Law Enforcement: Protecting Ocean Resources as a Vital Component of National Security

by Dr. Philip A McGillivary and Ms. Liz Taylor

In China a comprehensive coastal surveillance system of eleven unmanned aircraft system (UAS) bases is currently under construction.1 Likewise, in Norway a partnership between the government, universities and the national oil company, Statoil, has been funded to establish routine UAS operations for tracking fisheries and other vessels, monitoring possible oil pollution, and for real-time sea ice assessment in relation to vessel traffic management. These Norwegian efforts build on their ongoing work with Portugal (c.f. CRUSER Newsletter, Jan. 2013) to develop command, control and communication methods between autonomous underwater vehicles (AUVs), autonomous surface vessels (ASVs) and UAS. Similarly, Canada has recently established the Center for Aerospace Research (CAR) at the University of Victoria, BC (http://aero-cfar.uvic.ca/?section=home) as a west coast operations center for routine UAS surveys of rivers, ports and coastal areas, and for integrating UAS into the NEPTUNE/VENUS ocean observatories off Vancouver, and the Arctic Ocean observing system in the Canadian Northwest Passage (http://www.neptunecanada.com). This Center complements a Canadian east coast unmanned system research center (c.f. CRUSER Newsletters Jan. and March 2012), and operates several UAS using a "chase" van for UAS communications and control as part of joint projects with UAS centers in Brazil, Portugal, South Africa, the UK, and the University of Virginia. CAR personnel plan to begin coastal UAS operations off Vancouver in summer 2013 under either a Special Flight Operation Certificate (SFOC) or a Special Scientific Survey Certificate (SSSC).

In the US, in accord with Congressional requirements, deliberations between the FAA and inter-agency Remote Operating Area Working Group (ROAWG), headed by US Coast Guard CAPT Matt Sisson, are developing protocols for federal UAS operations in Alaska. Safety studies of North Slope land-based UAS launch and recovery sites have been filed with the FAA, including the US Air Force Oliktok Point airbase now used for UAS operations over land. The goal of US DHS, US Coast Guard, NOAA and NASA is to begin UAS flights over the Arctic Ocean from land and ships for collection of environmental data (e.g. ice cover, ocean color, greenhouse gas fluxes) and to improve operational mission capabilities including surveillance for search and rescue, illegal fishing, marine pollution, and ship routing in relation to ice conditions or marine mammal activity. Use of unmanned systems will improve capabilities for these essential components of national security to help safeguard the oceans and food security from the highly productive Alaskan coast, and can serve as a basis for deployment of similar methods along coastlines around the US and world.

Survey flights of UAS over the ocean off Alaska will increase experience in UAS operation and development of methods for integrating UAS use with AUVs and ASVs for better protection of coastal waters. These methods can be used in other maritime areas that include Marine Protected Areas (MPAs). The United States has three very large marine National Monuments in the Pacific Ocean and fourteen National Marine Sanctuaries all of which could benefit from UAS to patrol for illegal fishing activities while passively collecting environmental data. UAS patrols may also prove useful in reduction of ship strikes on whales, particularly the critically endangered North Atlantic and North Pacific Right whales. This technology can directly benefit others struggling with the problem of marine enforcement over large areas. Recently, MPAs have been established in vast, remote areas of the world's oceans. The Costa Rican Cocos Island MPA, the mid-Pacific Phoenix Island Marine Protected Area of Kiribati, and large MPAs around the Cook Islands and New Caledonia will require new maritime surveillance methods because these countries lack resources for manned ship and aircraft surveillance and law enforcement. Similar needs exist around Africa. Although World Wildlife Fund and Google are working to utilize UAS to address poaching of elephants and other wildlife on the land, and groups such as Conservation Drones are putting very low cost UAS to work, there is a critical shortage of marine enforcement where larger, longer range systems are needed. MPAs that lack law enforcement capabilities attract a variety of illegal activities which are known to proliferate into international security threats. Developing and implementing persistent maritime security capabilities for MPAs is critical for national security and ocean health, and can be advanced with autonomous systems. In the future, development of high altitude UAS with wide, persistent surveillance coverage will be useful to provide surveillance guidance for low altitude UAS, ASVs and AUVs. Whereas the technology for high altitude UAS is still under development (c.f. CRUSER Newsletter, May 2011), an immediate focus on use of lower altitude UAS, and their integrated operation with ASVs and AUVs, will help improve safety of life at sea, conservation of ocean resources, marine food security, and sustainable use of the oceans.

1 http://www.chinadaily.com.cn/china/2012-08/28/content_15713428.htm
http://www.theatlantic.com/technology/archive/2012/12/google-gives-5-million-to-drone-program-that-will-track-poachers/266133/
http://conservationdrones.org/

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Director's Corner

Unmanned systems and robotics continues to expand its role and relevance in not just defense-related missions of the DoD, but also in diverse application areas across all domains. Even further, the impacts of active research, development, and operations with unmanned systems clearly resonate across social, political, economic, and of course, scientific and technological communities, as evidenced by this issue's breadth of articles. The lessons we learn that can be shared across this broad sample of stakeholders and others like it certainly continue to enhance and enrich our larger CRUSER Community of Interest.

Dr Timothy H Chung
CRUSER Director of Education and Research

Institute for Homeland Security Solutions (IHSS) Launches Program to Evaluate the Potential for Social, Behavioral, and Health Research with Unmanned Systems

by Joe Eyerman, PhD, RTI International, Co-Director IHSS and David Schanzer, Duke University, Co-Director of IHSS

The Institute for Homeland Security Solutions has launched an initiative to evaluate the application of unmanned systems to social, behavioral, and health research. IHSS will examine the potential to use unmanned aircraft, watercraft, and surface vehicles to augment current methods used for population based research. This may include the use of unmanned systems for survey research, data collection, crowd analysis, epidemiology, environmental exposure studies, traffic studies, group dynamics, population movements, sports and performance studies, and other adjacent fields.

As part of this effort IHSS is collecting and analyzing opinion and policy data to better understand the decision-making environment faced by end users as they consider these technologies for their mission space. Current research includes surveys of law enforcement leaders at the state, local, and university level in large, medium, and small organizations to examine their perceived barriers to adoption and ideal applications of these new technologies. IHSS is also conducting a general population survey to examine public perceptions about these technologies and identify areas of greatest concerns and acceptable use. IHSS is also conducting a policy assessment that will be designed to assist decision makers in law enforcement and first response community with planning for technology adoption. Finally, IHSS has initiated a privacy assessment to better understand and engage privacy protection organizations in a constructive dialogue to help facilitate a smooth adoption of the technology in an appropriate manner.

The Institute for Homeland Security Solutions (IHSS) was established in 2008 to expand the resources available to the Department of Homeland Security and other agencies to conduct social and behavioral science research in support of the national homeland security mission. IHSS conducts applied social and behavioral science research that seeks to improve detection, analysis, and understanding of homeland security threats and enhance response and recovery. IHSS is administered by RTI International in cooperation with Duke University, the University of North Carolina at Chapel Hill, and the North Carolina Military Foundation.

IHSS is federally funded and coordinates its research activities with the DHS Science and Technology Directorate, Resilient Systems Division. http://sites.duke.edu/ihss/

RTI International is one of the world's leading research institutes, dedicated to improving the human condition by turning knowledge into practice. Our staff of more than 3,700 provides research and technical expertise to governments and businesses in more than 75 countries in the areas of health and pharmaceuticals, education and training, surveys and statistics, advanced technology, international development, economic and social policy, energy and the environment, and laboratory and chemistry services. www.rti.org

Joe Eyerman is the Co-Director of IHSS and the Director of the RTI Center for Security, Defense, and Public Safety. He is a senior research methodologist studying social behavior and public opinion related to political action, terrorism, conflict, security and safety.

David Schanzer is the Co-Director of IHSS and Director of the Triangle Center on Terrorism and Homeland Security at Duke University. He is an Associate Professor at the Duke Sanford School of Public Policy. Prior to his appointment at Duke he was Staff director for the House Committee on Homeland Security from 2003 to 2005. David's research interest includes privacy and civil liberties, terrorism, and counterterrorism law and policy.

CRUSER Monthly Meetings

CRUSER monthly meetings are an opportunity to hear short presentations on current research and to participate in the open discussion session with other CRUSER members. The meetings are available via VTC or Elluminate to watch the presentation and audio is available via dial-in.

Contact Lisa to schedule a presentation at cruser@nps.edu

Upcoming CRUSER Monthly Meetings

Fri 15 Mar 2013, 1200-1250 (PDT)
Root 242, VTC, or dial-in 831-656-6681
Wed 15 May 2013, 1200-1250 (PDT)
Root 242, VTC, or dial-in 831-656-6681

Meteorological Measurements from an Unmanned Aerial Vehicle

by Peter Guest, NPS Dept of Meteorology, pguest@nps.edu and Thomas Vaneck (and others), Physical Sciences Inc.

Dr Peter Guest participated in the Joint Interagency Field Exploration (JIFX) 13-2 on 14 Feb 2013 with an ad hoc experiment utilizing a quadrotor UAV. The quad rotor helicopter is perfect for getting very low level and crucial atmospheric information that is not feasible with Radiosondes, Scan Eagles or other fixed wing UAVs. Below is a description of the experiment and next steps which will be taken.

Description:
For this experiment, we attached a standard Vaisala RS-92 radiosonde (usually used for weather balloon measurements of pressure, temperature and humidity) to the InstantEye quad rotor helicopter, developed and manufactured by Physical Sciences Inc. Over the course of 65 minutes (1010 – 1115 PST), 9 atmospheric profiles were performed in the lowest 350 AGL with most below 50 meters AGL. The data looked clean and accurate (Figure 1).

This experiment demonstrated the feasibility of using InstantEye for performing low level meteorological measurements. This is an especially important part of the atmosphere because it strongly affects surface operations, including optical and radio systems. Radiosondes do not sample this region with sufficient resolution. The InstantEye unmanned aerial vehicle was particularly useful for performing low level meteorological measurements due to its small size, ease of use, low cost, ability to perform multiple profiles, ability to deploy in a variety of wind conditions and lack of need for takeoff and landing runways.

Next steps:
Dr. Guest plans to use InstantEye for future measurement programs. It will be tested for use on research vessels with the goal of performing needed low-level atmospheric measurements for scientific studies and perhaps various Naval operations needing this type of information. We plan to deploy InstantEye in the upcoming US Navy Trident Warrior 2013 field exercise in July 2013 (onboard the R/V Knorr) and also on a cruise in the Arctic Ocean.

Caveats: the mention of any brand name (in this case InstantEye by Physical Sciences Inc.) does not imply any kind of official Navy or DoD endorsement of this product.

Quad rotor helicopter UAS with controller (left side). The main UAV is grey colored; the person is holding a white radiosonde (a meteorological instrument used to measure air temperature, humidity and pressure) which is attached to the bottom of the UAV. The temperature and relative humidity sensors are in the silver probe exenting to the right of the radiosonde.

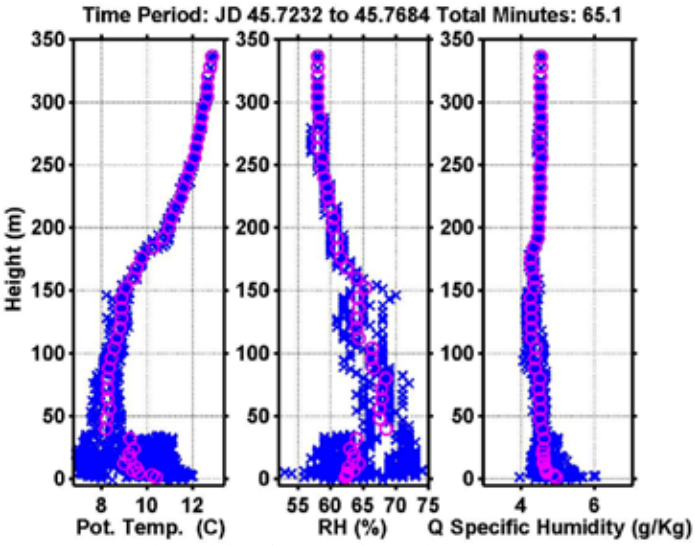

Figure 1. Meteorological data from a radiosonde using InstantEye as a measurement platform. Plots (left to right) show (1) potential temperature, (2) relative humidity and (3) specific humidity. Blue crosses show individual data points while purple circles are elevation-binned median values. The large variability below 5o m is due to the atmospheric warming up over the course of the hour of the experiment. Only two profiles went above this level and only one above 150 m, therefore less variability is seen at the higher elevations. Note the bend in the data around 150 m; this indicates the level where the surface solar heating effect had reached at the time of the measurements. Also note the average (purple circle) decrease in temperature and specific humidity right above the surface indicating upward fluxes of sensible heat and moisture (latent heat). This is what was expected for these conditions and demonstrates the usefulness of this system for these very low locations that are not well-resolved with standard weather balloon measurements.

NSWC Indian Head Division Overview

by Deran Eaton, System Design Engineer, deran.eaton@navy.mil

RDT&E at NSWC Indian Head Division (IHDIV) often flows from IHDIV's core product line: Energetic materials, devices and systems. This covers rocket propellants, warheads, gas generators, cartridge devices and SWaP-reducing, MEMS-based weapon controls and electronics. As such, to broaden CRUSER's awareness towards achievable unmanned system (UxS) device engineering, IHDIV envisions engaging collaborative RDT&E workload with CRUSER in five areas:

1) Military robotics engineering standardization, with focus upon EODTECHDIV robotics.

2) UxS swarm technologies. Several possible contexts exist -- multi-UUV torpedoes; torpedoes spawning daughter UUVs or warshots, and so on for UAVs, UGVs or USVs. IHDIV's RDT&E enterprise does include underwater weapons and device development, plus we have experience with GN&C such systems would need.

3) UxS reduced SWaP armaments. CRUSER's "non-kinetic strike" pursuit for FUNS (Future Unmanned Naval System) suggests either missile technologies (e.g., rocket or gas generators that IHDIV regularly makes), or directed energy weapons. Either may yield UxS self defense measures not current on today's UxS equipment.

4) UxS plug-n-play accessory modules. This enabling technology derives from the above three interests, allowing faster UxS field changes, increasing the variety of military robotics kits.

5) CBNRE remote sensing. IHDIV being heavy with chemistry and explosives knowledge enables UxS sensor engineering capabilities, particularly with improving sensory 'data to decision' discernment.

STUDENT CORNER

Student: 1st LT Begum Ozcan, Turkish Air Force

Title: The Effectiveness of UAVs in helping secure a border characterized by rough terrain and active terrorists

Curriculum: Operations Research

Abstract: Border security is of great importance for most countries. Many countries have spent significant portion of its budget to protect its border against terrorists, smugglers, and illegal immigrants over decades. Turkey has been in conflict with terrorist groups since the eighties. Up to now, more than 40,000 people have been killed, including the Turkish soldiers and civilians. The porosity and openness of Turkey's Iraq border has been a problem in counter-terrorism. Additional with the hard geography of the region, border porosity creates a passage for terrorist groups to move material and personnel support through the border. Unmanned Aerial Vehicles (UAVs) are critical component of modern day reconnaissance and surveillance. Technical capabilities of UAVs can be used to improve coverage along the borders. However; their effectiveness is highly dependent on the characteristics of the region. This analysis examines the impact of UAVs on detection and classification of terrorists who use the southeast border, characterized by rough terrain, as passage from Northern Iraq into Turkey.

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

DARPA's New TERN Program Aims for Eyes in the Sky from the Sea

March 01, 2013

Performers sought to develop systems to enable small ships to serve as mobile bases for UAVs

Effective 21st-century warfare requires the ability to conduct airborne intelligence, surveillance and reconnaissance (ISR) and strike mobile targets anywhere, around the clock. Current technologies, however, have their limitations. Helicopters are relatively limited in the distance and flight time. Fixed-wing manned and unmanned aircraft can fly farther and longer but require either aircraft carriers or large, fixed land bases with runways often longer than a mile. Moreover, establishing these bases or deploying carriers requires substantial financial, diplomatic and security commitments that are incompatible with rapid response.

To help overcome these challenges and expand DoD options, DARPA has launched the Tactically Exploited Reconnaissance Node (TERN) program. Seeking to combine the strengths of both land- and sea-based approaches to supporting airborne assets, TERN envisions using smaller ships as mobile launch and recovery sites for medium-altitude long-endurance (MALE) fixed-wing unmanned aircraft (UAVs). Named after the family of seabirds known for flight endurance – many species migrate thousands of miles each year – TERN aims to make it much easier, quicker and less expensive for DoD to deploy ISR and strike capabilities almost anywhere in the world.

"It's like having a falcon return to the arm of any person equipped to receive it, instead of to the same static perch every time," said Daniel Patt, DARPA program manager. "About 98 percent of the world's land area lies within 900 nautical miles of ocean coastlines. Enabling small ships to launch and retrieve long-endurance UAVs on demand would greatly expand our situational awareness and our ability to quickly and flexibly engage in hotspots over land or water."
To familiarize potential participants with the technical objectives of TERN, DARPA will host a Proposers' Day on Tuesday, March 20, 2013, in the DARPA Conference Center. For details, visit: http://go.usa.gov/2gxJ. Registration closes on Wednesday, March 18 at 12 p.m. ET.

DARPA seeks proposals that would design, develop and demonstrate a MALE UAV and an associated automated launch and recovery system. The UAV would have to carry a 600-pound payload and have an operational radius of 600 to 900 nautical miles from its host vessel. The launch and recovery system would have to fit Littoral Combat Ship 2 (LCS-2)-class ships and other surface combat vessels as feasible.
Key technical challenges include:
• Devising a reliable launch and recovery technique that enables large aircraft operations from smaller ships, even in rough seas;
• Designing an aircraft with range, endurance and payload comparable to emerging land-based unmanned aircraft, while still meeting the demands of the maritime environment;
• Ensuring the entire system can operate with minimal, and preferably reversible, ship modifications and minimal personnel requirements for operations and maintenance; and
• Packaging the system to fit into the limited space aboard ships.

DARPA plans to roll out TERN in three phases over approximately 40 months, culminating in a full-scale launch and recovery demonstration.

"We're trying to rethink how the ship, UAV and launch and recovery domains – which have traditionally worked in parallel – can synergistically collaborate to help achieve the vision of base-independent operations for maritime or overland missions," Patt said.

http://www.darpa.mil/NewsEvents/Releases/2013/03/01.aspx

Short articles of 300-500 words for CRUSER News are always welcome - cruser@nps.edu

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