



# CRUSER • NEWS

Consortium for Robotics and Unmanned Systems Education and Research

## FROM TECHNICAL TO ETHICAL FROM CONCEPT GENERATION TO EXPERIMENTATION



NAVAL  
POSTGRADUATE  
SCHOOL

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### Global Hawk provides Hurricane Reconnaissance

by Prof Patrick Harr

It is well known that over the western North Atlantic, an operational hurricane surveillance program exists in conjunction with the National Oceanic and Atmospheric Administration (NOAA) and the United States Air Force (USAF) 53rd Weather Reconnaissance Squadron (Hurricane Hunters). Whereas tropical cyclones occur over many ocean basins, operational reconnaissance is only conducted over the western North Atlantic. During the summer of 2010, an experimental program named the Genesis and Rapid Intensification Project (GRIP) was conducted by the National Aeronautics and Space Administration (NASA) in which a specially equipped a NASA-operated, Global Hawk was used to conduct reconnaissance over several Atlantic hurricanes (Figure 1). The potential benefits of the Global Hawk for storm reconnaissance over the traditional manned aircraft include increased time on station and increased altitude. Time consistency is important to define the ever-changing environment in which the storm is moving and observations from above the storm provide a full three-dimensional view of the storm structure. Experiments using the Global Hawk to perform storm reconnaissance over the western North Atlantic will continue in 2012-2014 in the NASA program named Hurricane and Severe Storms Sentinel (HS3), which is being lead by Dr. Scott Braun at the NASA Goddard Space Flight Center.

The ocean basin that contains the largest annual number of tropical cyclones is the western North Pacific. Tropical cyclone activity over this ocean basin often has significant impact to United States Navy (USN) and USAF shore- and float-based activities. The Joint (USN/USAF) Typhoon Warning Center at Pearl Harbor Hawaii is responsible for providing tropical cyclone forecast support to all facilities over the western North Pacific. However, reconnaissance operations over the western North Pacific are not conducted operationally. During the summer of 2008 and the summer of 2010, several field programs [THORPEX Pacific Asian Regional Campaign (T-PARC), Tropical Cyclone Structure – 2008, (TCS-08), Interaction of Typhoons and the Ocean over the Pacific (ITOP)] were conducted under funding from the Office of Naval Research and the National Science Foundation. In these experiments, Hurricane Hunter and Naval Research Laboratory (NRL) P-3 aircraft were used to examine the structure of tropical cyclones over the western North Pacific and the environment in which the storms exist. During these scientific programs the manned aircraft operated from Andersen AB, Guam, Kadena AB, Okinawa, and Yokota AB, Japan based on direction from the science operations center at the Naval Postgraduate School.

Based on the successes of manned and un-manned aircraft reconnaissance over the western North Pacific and the western North Atlantic, there is interest in expanding the use of the Global Hawk for obtaining data that would increase forecast accuracy of these dangerous storms. Directly, there are new instrument packages being developed to provide remotely-sensed observations of the storm and its environment and in situ observations using dropwindsondes released directly from the Global Hawk air frame.

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**“Rather than reinventing the wheel and developing a UAS from the ground up for a specific task, why can’t we capitalize on what we have already and make slight modifications to adapt to new situations?” - Capt Dino Cooper (page 4)**

## DIRECTOR'S CORNER

Since CRUSER start up in March 2011, our consortium has grown to over 350 researchers, students, industry representatives, government engineers, and military officers. The CRUSER News, CRUSER Wiki, and CRUSER website provide conduits for information exchange, cooperative research and experimentation, and professional meetings. We have coordinated concept generation workshops, sponsored speakers, and laid a foundation for future cross-discipline research. And this is just our start up year! Fiscal year 2012 will be the CRUSER transition year and we hope each of you continue to seek opportunities and find value in your CRUSER membership.

**CAPT Jeff Kline, USN Ret, CRUSER Director**



### European university robotics teams gain deeper understanding of autonomous underwater vehicle challenges

By Edward Lundquist

For the ten teams participating in the Student Autonomous Underwater Vehicle Challenge—Europe (SAUC-E), held at the NATO Undersea Research Centre (NURC) July 4-11, 2011, it wasn't the difficult course, or even the highly qualified competition that worried them. The biggest obstacle was the underwater environment, with its limited visibility, currents and salty water.

"This proved to be extremely challenging last year and was so again, many of the team's performances were better than the previous year, nevertheless they all found the conditions extremely challenging and careful consideration needs to be given to the tasks in 2012 to ensure they remain within the capabilities of teams whilst continuing to stretch their technical capabilities," said Vladimir Djapic of NURC, the SAUC-E technical director.

"Strongly supported by 10 Universities from four European countries the standard has again improved, both in terms of the student's technical prowess and the facilities that the NURC was able to provide," said Dr Dirk Tielbueger, director of NURC. "The challenging environment, wave action, visibility, salinity, tidal and sonar conditions have raised the competition to a new level, but one which was achievable by nearly all of the teams."

Tielbueger said it is extremely important that research establishments like the NURC support and foster the next generation of undersea scientists. "Competitions such as SAUC-E are a springboard for the next generation of scientists; they expose the students to the scientific and industrial community and us to them," he said. "Without such mentoring we run the risk of losing these talented and enthusiastic young men and women to other scientific disciplines."

Teams could be comprised of a combination of students, faculty, industrial partners, or government partners with a maximum of 10 people per team.

Unlike some competition in fresh water pools, the SAUC-E teams were operating in salt water with limited visibility. If a vehicle failed, a diver had to search for the vehicle before it could be recovered.

**Full article and results on the CRUSER Wiki at:**

<https://wiki.nps.edu/display/CRUSER/CRUSER+News+Articles>

### CRUSER News Contributions

Short articles of about 200-300 words are needed for future CRUSER News'. Please contact Lisa Trawick at [cruser@nps.edu](mailto:cruser@nps.edu) for additional information

### Continued from front page

Current design and experiments using dropwindsondes from the NASA Global Hawk are concentrating on the capability to release tens of dropwindsondes in intervals of seconds as the Global Hawk flies over the top of a tropical cyclone. These types of observations would provide an unprecedented data coverage to allow real-time mapping of the full structure of the storm.

It is anticipated that the development and experiments being conducted in research during programs over the western North Atlantic will establish the improvement in forecast accuracy that could be achieved with the data coverage provided by a platform such as the Global Hawk. Then, these results will be brought forward to promote the continued use of the Global Hawk technology over the western North Pacific in conjunction with operational activities throughout that ocean basin and surrounding facilities.

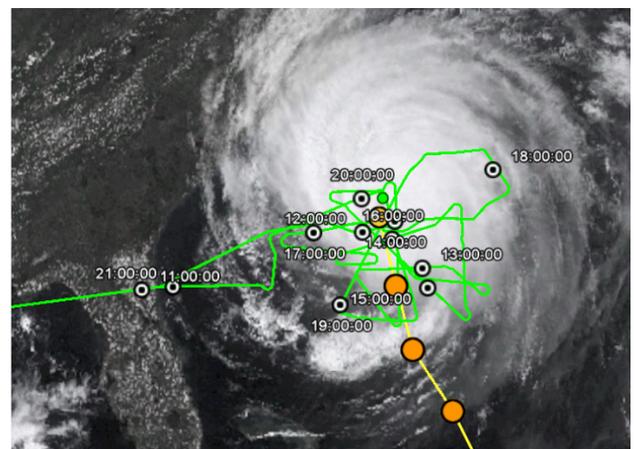


Figure 1 Geostationary visible satellite image at 1900 UTC 2 September 2010 of Hurricane Earl off the southeastern coast of the United States. The green line defines the flight path of the NASA Global Hawk as it flew over Earl after take-off at Dryden Flight Research Center, California. The hours in the day along the flight are noted along the flight path. The orange circles define the recent track of Earl. (image courtesy of <http://grip.jpl.nasa.gov/grip/index.jsp#>)

## Ethical Behavior in Lethal Autonomous Systems Expert Lectures at NPS

By MC1 Leonardo Carrillo



Throughout the history of mankind, war has been a constant aspect of the human condition. Equally persistent is the impact of technological advances in weaponry, and how this shapes the outcome of conflicts.

From just the right stick to swing at an enemy's head to the latest supersonic cruise missile, technology has played its part in shaping war.

As technology advances, armed conflict changes as well, and one of DoD's most embraced new technologies is unmanned systems. Autonomous robots that once were relegated to science fiction are now a reality, but one of many questions is, how do these systems change the ethics of war.

Addressing this question, the Naval Postgraduate School (NPS), in the forefront of the development of unmanned systems, hosted a lecture titled "Governing Ethical Behavior in Lethal Autonomous Systems" presented by leading expert in the field Georgia Tech University Regents' Professor Ronald C. Arkin.

The lecture, sponsored by NPS' Consortium for Robotics and Unmanned Systems Education and Research (CRUSER), addressed directly the question of ethical behavior in unmanned systems with lethal capabilities. It touched on the dilemmas facing the increasing integration of these systems that become deadlier and more autonomous as they develop.

"That's the insidious aspect of autonomous systems," said Arkin. "They are creeping up on us through continuous development and enhancements of unmanned capabilities."

The idea of lethal autonomous systems conjures science fiction apocalyptic images of humans losing control of the machines they built to serve them. For Arkin, the reality of this issue is much more than the plot of a blockbuster movie.

"Lethal autonomy is already here," said Arkin. "It already exists and it is already used in the military."

Arkin says that, whether we want it or not, these types of systems are being developed by the United States, our allies, and

even our enemies. He argues that the arrival of these systems is here and the issue of ethical behavior must be addressed.

Arkin pointed out that the pace of war has become faster and more lethal than a human's ability to react and that the benefits of unmanned systems are becoming more evident.

"Intelligence is being pushed further and further towards the tip of the spear," said Arkin. "We are fundamentally limited by the speed in which we can process information."

However, Arkin noted that these realities made him become more concerned with the effects these systems would have on the nature of warfare. He saw this become more and more evident in the first years of the 21st century when he saw that his own projects were succeeding.

"We were seeing that our work was making a difference and it made me think long and hard about the kind of research that I should be doing," said Arkin. "I wanted to make sure that we as a community became interested in discussing the actual issues of what happens when we succeed, not if we succeed."

Arkin offered solutions, possible scenarios, and examples of situations in which the use of these systems could be quite beneficial. He pointed out that humans are inherently not designed for warfare. In many instances, when we go to war, we essentially ask our soldiers to go against their survival instincts and risk their lives in battle. Also, Arkin said, humans are filled with emotions that affect their effectiveness in combat such as fear, hate and revenge ... machines don't have those characteristics.

"We have a responsibility as scientists to be able to try and find ways in which we can reduce man's inhumanity to man – and that includes the battlefield." Added Arkin, "It especially should include the battlefield, because that's where humanity, some would say, is at its best but also is at its worse."

Of course, no system is fail-safe, Arkin conceded. There would be instances in which systems would fail, but if these systems make fewer mistakes than a human being does, it would be a success.

Touching on the philosophical aspect of the subject, the computer scientist closed with poignant questions. "Should warfighters be robots, or in many respects, don't we try to re-engineer human beings to comply in ways that are inherently unnatural in the conduct of war?" He continued, "And should robots be soldiers? Could we actually create combat systems that behaved in a more humane manner than human beings do, in the battlefield?"

### Thesis Topics from DoD Organizations

Does your DoD Organization have a potential graduate thesis topics related to unmanned systems they would like NPS students to research? Please contact Lisa at [cruser@nps.edu](mailto:cruser@nps.edu)

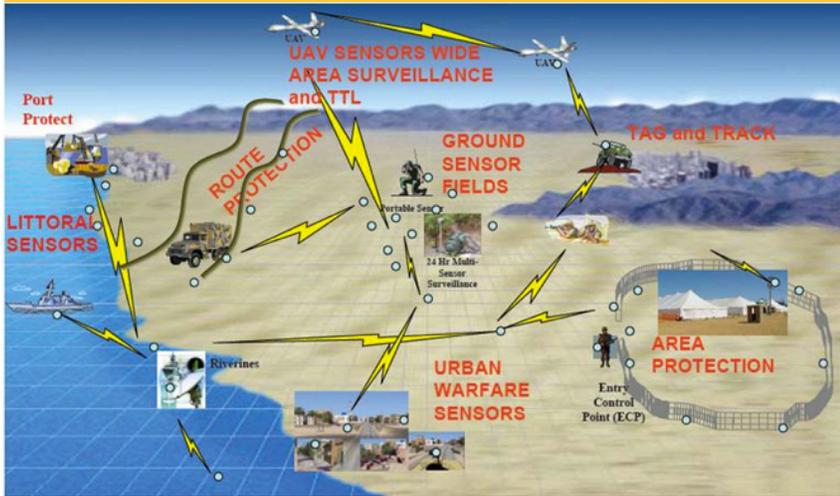
## STUDENT RESEARCH: IN-PROGRESS

**CAPT DIONISIO COOPER, USMC  
INFORMATION WARFARE SYSTEMS ENGINEERING CURRICULUM**

**TITLE: "THE DISPERSAL OF TAGGANT AGENTS WITH UNMANNED AIRCRAFT SYSTEMS (UAS) IN SUPPORT OF TAGGING, TRACKING, LOCATING, AND IDENTIFICATION (TTLI) OPERATIONS"**

This thesis explores the capability, and degree of effectiveness, of using an Unmanned Aircraft System (UAS) to deliver a chemical tag to a target area or person of interest making them detectable through the use of a Tagging, Tracking, Locating, and Identification (TTLI) system. TTLI systems are made up of two distinct components that make them useful in improving Information, Surveillance, Reconnaissance (ISR) and Target Acquisition (TA) in the Contemporary Operating Environment (COE): first, the taggant portion of TTLI systems, available in liquid, encapsulated, spray, powder, and triggered release forms; second, the portion of TTLI systems made up of sensors designed to detect and identify the unique chemical signature or optical wavelengths of the corresponding taggants. Experiments in which an RQ-11 Raven successfully dispersed simulated encapsulated Perfluorocarbon Tracers (PFT), serving as the chemical taggant of a TTLI system, support the use of UASs in TTLI operations. Additional consideration is given to other available TTLI systems to be dispersed and detected with other available UASs.

Full Executive Summary (with photos) at <https://wiki.nps.edu/display/CRUSER/CRUSER+News+Articles>



TIAX – TTLI (Tagging, Tracking, Locating, and Identification) sensor Network (Singh, 2011)

### **CNO: Adm. Gary Roughead delivers remarks at 2011 AUVSI Unmanned Systems Symposium, 19 Aug 2011**

Excerpts from ADM Roughead's remarks:

"...There's no question, those of you who follow national security issues and defense issues, that warfighting and fiscal realities I believe are going to drive us more rapidly and in a much more focused way beyond our traditional platforms and to the inclusion of unmanned systems...many of our unmanned systems still operate on the periphery of naval operations. Indeed, I would say many of all of the unmanned systems operate on the periphery of all of the operations which we conduct. They clearly are not optimally integrated into our ships, into our squadrons, and into our concepts of operation. But I think that the pace of development, the culture that we tend to have within the military, indeed within any large organization, and the need to this point are why we have not seen that optimal integration...because in my mind it truly does portend a significant change in the advantages and the power and the versatility of naval carrier aviation. Because if we can blend the unmanned on an aircraft carrier and the manned on an aircraft carrier, we've changed the dimension of carrier naval aviation in a way that has not happened in decades..."

Full remarks at <https://wiki.nps.edu/display/CRUSER/CRUSER+News+Articles>

## CALENDAR OF EVENTS

The CRUSER Calendar of Events is located on our Wiki:

<https://wiki.nps.edu/display/CRUSER/>

**Submit your events:**

[http://www.nps.edu/Research/cruser/cruser\\_EventSub\\_Form.html](http://www.nps.edu/Research/cruser/cruser_EventSub_Form.html)

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