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CRUSER NEWS

Consortium for Robotics and Unmanned Systems Education and Research

FROM TECHNICAL TO ETHICAL...FROM CONCEPT GENERATION TO EXPERIMENTATION

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Robots Take the Field at Fort Benning, Georgia

By Mr. Keith L. Singleton, Maneuver Battle Lab, MCoE, Ft. Benning, GA

In late June, the Maneuver Battle Lab and the Maneuver Center of Excellence hosted the 2012 Robotics Rodeo (20-29 Jun 12) at the McKenna Urban Operations Complex, Fort Benning, Georgia. The Robotics Rodeo concept was started by Lieutenant General Rick Lynch, who was the III Corps commander at the time. The purpose was to obtain a snapshot of the state of robotics from industry and determine if any systems existed that could fill requirements defined in Operational Needs Statements (ONS) for III Corps. The inaugural Robotics Rodeo was held at Fort Hood, Texas in September 2009 with a subsequent event hosted by the Maneuver Battle Lab at Fort Benning, Georgia in October 2010. The Rodeos, sponsored by the Tank Automotive Research, Development and Engineering Center (TARDEC), achieved the purpose of bringing Soldiers and technologist together to ignite innovation.

The 2012 Robotics Rodeo was co-sponsored by TARDEC and the Joint Improvised Explosive Device Defeat Organization (JIEDDO). Over 600 attendees and 52 different organizations from academia, industry and research development communities participated in the event. Distinguished guests included: staff members from the Senate Armed Services Committee, the Civilian Aide to the Secretary of the Army, the U.S. Army's Chief Scientist and Chief Robotics Scientist, the JIEDDO Deputy Director and the MCoE Commanding General.

This year's Rodeo consisted of three major events: the Robotic Technology Observation Demonstration and Discussion (RTOD2), the Robotics Extravaganza and the Collaborative Autonomous Navigation with Interactive Networked Engagement (CANINE). The RTOD2 evaluated technologies in three tactical vignettes that assessed tasks supporting the combat outpost and four technical challenges that assessed tasks supporting Counter-Improvised Explosive Device (C-IED) operations. The Robotics Extravaganza served as a venue for industry participants to display their technology and conduct live demonstrations. The CANINE program was a collaborative effort conducted by TARDEC and the Robotics Technology Consortium (RTC) in which industry and academia demonstrated their unique technology approaches to replicate a military dog locating threats, providing protection and clearing patrol routes.

Overall, there was great participation from the Joint Services, industry, academia and several international countries. The technology providers attempted to autonomously dig fighting positions, detect and track an opposing force, detect and disrupt simulated improvised explosive devices (IEDs), and conducted events that assessed how many objects the technology could find and how fast and far the technology could go. In total, the robots completed 112 kilometers (approximately 70 miles) of the endurance course; successfully combined to disrupt the majority of the concealed buried simulated IEDs and successfully found a preponderance of the hidden objects in an urban structure. Industry and academic participants displayed innovative unmanned ground technologies and the collaborative relationship has evolved to create an unstoppable momentum for robotics in the Military. The Robotics Rodeo will continue to serve as a premier venue to identify technologies and help advance technology development as capabilities for war-fighting Soldiers, Sailors, Airmen and Marines.

robotics RODEO

RDECOM

Director's Corner

In support of Concept Generation, one of the major tenets of CRUSER, over 50 participants including NPS students and early career engineers from across the fleet will converge here at NPS on 17 September to explore innovative concepts for advancing the Design for Undersea Warfare. Participation slots for this event are already filled but if you are interested in receiving the Final Report or want information on the next Warfare Innovation Workshop scheduled for March 2013 please contact me at cjoneal@nps.edu. This workshop will focus on innovative concepts involving the relationship between submarines and UUVs.

CAPT Carol O'Neal USN (ret)
CRUSER Director of Innovation and Concept Generation

UTC Aerospace Systems

by Heather Griffith, Manager, Technology and Innovative Applications

UTC Aerospace Systems has been a global market leader in intelligence, surveillance and reconnaissance (ISR) systems and sensors for manned and unmanned platforms for over 60 years. The company offers a full range of reconnaissance sensors for the rapid, effective collection of intelligence for military and civil applications across land, sea, air and space - and provides full data processing, exploitation and dissemination (PED) systems. Using its state-of-the-art sensors and PED portfolio, actionable intelligence is effectively and swiftly collected, processed, analyzed and delivered to decision makers, wherever required. UTC Aerospace Systems' ISR systems have a significant and growing presence internationally and are deployed with forces in North America, Europe, Africa, Middle East and Asia.

Two market-leading products are the SYERS (Senior Year Electro-Optical Reconnaissance Sensor) and its derivative, the DB-110 sensor. SYERS has equipped the U-2 high altitude reconnaissance aircraft for decades and the SYERS 2 is providing detailed intelligence on enemy orders of battle, movement plans, disposition and offensive and defensive capabilities. The Goodrich DB-110 sensor, with three independent optical fields of view, generates simultaneous high resolution visible and infrared imagery for high-altitude tactical reconnaissance missions and is in service on fast jets and maritime patrol surveillance platforms - and has a proven UAV performance.

UTC Aerospace Systems is pioneering the emerging area of wide area motion imagery and persistent surveillance. Wide area surveillance sensors support traditional ISR sensors, such as FMV, with around-the-clock, visible and infrared data, improving situational awareness for ground troops in both urban and rural environments. Since 2004 Goodrich has worked with the Army Night Vision and Electronic Systems Directorate and the Navy and Air Force Research Laboratories to adapt its tactical reconnaissance systems to the challenges facing U.S. ground forces today. The resulting CA-247 dual band, wide area, persistent surveillance camera has now been produced in several versions for research, development, test and evaluation (RDT&E), tactics development and operational employment. This sensor incorporates advanced optics, stabilization, and software, providing wide field of view imagery with tailored multiple, narrow-field-of-view, high resolution data windows.

The company has also developed, and is a high volume producer of near-infrared (NIR) and shortwave infrared (SWIR) cameras and systems, offering visibility in low light conditions with laser detection and tracking. Based on Indium Gallium Arsenide (InGaAs) materials, these can be integrated into gimbaled systems, laser rangefinders, precision guided munitions systems and ground-based surveillance and reconnaissance solutions. Their small size, weight, and standard output signal, means these cameras can operate on many platform types including unmanned vehicles of every size.

UTC Aerospace Systems is working with customers across defense, civilian and academic arenas, examining current operational issues and predicted capability gaps. Our Next Generation Systems team is evolving effective, innovative sensor and data processing solutions for future airborne manned and unmanned platforms, ensuring our sensors and systems continue to make the vital contribution they do today - to space exploration, keeping the peace and protecting our armed forces around the world.

For more information please go to: http://isr.goodrich.com/
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DB-110 on Predator B during Trial Falcon Prowl

CRUSER News Contributions

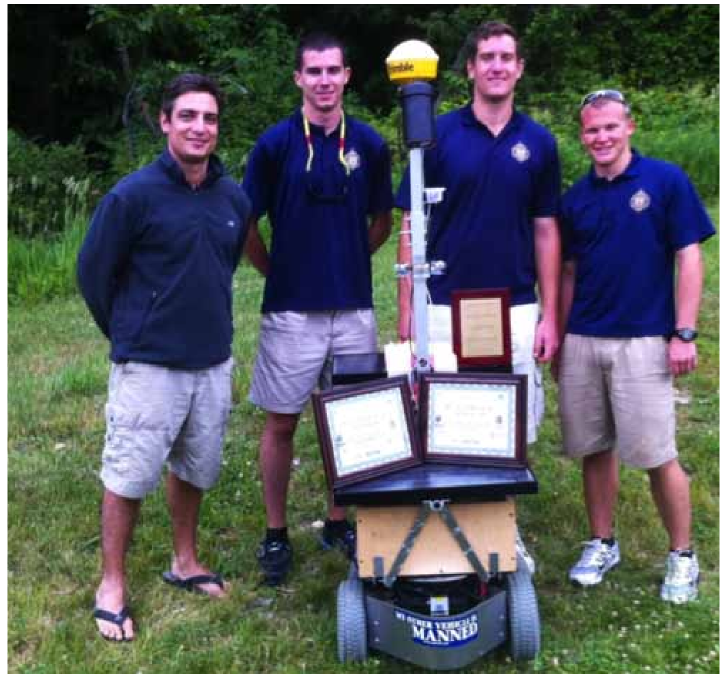
Short articles of 300-400 words are needed for future CRUSER News'. Please contact Lisa Trawick at cruser@nps.edu for additional information

US Naval Academy Competes at three AUVSI Autonomous Competitions during Summer 2012

by Prof Matthew Feemster, Prof. Joel Esposito, CAPT Jack Nicholson, USNA faculty

The Weapons and Systems Engineering Department at the U.S. Naval Academy currently fields three student led teams in autonomous ground, marine, and underwater competitions sponsored by the Association for Unmanned Vehicle Systems International (AUVSI).

For the 4th consecutive year of competition, Systems Engineering students from the U.S. Naval Academy traveled to AUVSI's Intelligent Ground Vehicle Competition (IGVC), in Rochester Michigan. They placed 2nd of 52 teams in the Autonomous Navigation Event, traveling 1001 feet on the outdoor obstacle course. They took 3rd place Overall, winning $2,500 in prize money. Now in its 20th year, the competition requires student teams to design autonomous vehicles to traverse an outdoor obstacle course. The robot is approximately the size of a wheel chair and uses sensors such as GPS, cameras, and laser range finders to navigate without human intervention. This year's team, included ENS Adam Albrecht (USNA '12), 1/C Cory Oberst, 1/C Jason Case and ENS Nick Mehalic (USNA '11) (who wasn't available to travel to the competition). They are advised by Assoc. Prof. Joel Esposito.



2012 USNA IGVC Team (from left to right): Assoc. Prof. Joel Esposito, Midn. Case, Midn. Oberst, Ensign Albrecht

The 2012 USNA Autonomous Surface Vessel (RoboBoat) Team competed in the 5th AUVSI International RoboBoat autonomous surface competition held in Virginia Beach, VA in late June. This is the 3rd year that a USNA has competed. The team was led by two, year long members: ENS Trentt James and ENS Bill Queen, and consisted of two TAD ENS specialists: ENS Greg Hase and ENS Matthew Minkoff, and two summer internists 1/C MIDN David Jackson and 2/C MIDN Emily Hughes.

For 2012, the RoboBoat team focused their efforts on the integration of machine vision for aid in vehicle navigation. As a result of this thrust, the team qualified 5th for participation in the final navigation round and placed 7th overall out of a field of 19 teams. The addition of the vision servoing capabilities allowed the USNA team to attempt an amphibious landing with a detachable vehicle in an effort to retrieve a hockey puck located up on the shore. The 2012 RoboBoat team was jointly advised by Assoc. Prof. Matthew Feemster and LCDR Kirk Volland.

2012 USNA RoboBoat Team (from left to right): 2/C MIDN Emily Hughes, ENS Greg Hase, ENS Matt Minkoff, ENS Bill Queen, ENS Trentt James, 1/C MIDN David Jackson

The USNA Autonomous Underwater Vehicle (AUV) Team competed in the 15th AUVSI International RoboSub Competition in San Diego CA in July. This year's team built an entirely new vehicle in order to provide enough room to carry a complete set of devices to make it capable of accomplishing all mission objectives. The new vehicle also carries two lateral thrusters to allow it to move sideways and control its position in three dimensions. A team of three just-graduated ensigns, a midshipman summer intern, and their faculty advisor travelled to San Diego, where they finished seventh in an international field of 31 competitors. The AUV team is advised by CAPT Jack Nicholson.

2012 USNA Autonomous Underwater Team (from left to right) ENS Jace Fincher, ENS Chase Hansen, MIDN 1/C Robert Bruss, ENS Marianne Topp

STUDENT CORNER

Students: LT Timothy Stevens, USN

Title: Nondeterministic Search Pattern Optimization for Minimization of UAV Counterdetection

Abstract: Unmanned Aerial Vehicles (UAVs) have become a mainstay of modern day military operations, such as surveillance and reconnaissance missions. Adversaries of the United States are fully aware of this shift and are developing weapons and training to counter these unmanned assets. Many of the counter-UAV weapons under development and testing require that a target lock be maintained on the UAV for some discrete amount of time. By randomizing the flight pattern, e.g., when conducting ISR missions, and limiting the time the UAV travels on any single flight leg we can minimize the vulnerability of these assets. To accomplish this randomization we employ a Levy distribution function to determine the length of each search leg, while changes in searcher heading are drawn from a uniform distribution. We model realistic flight limitations using Dubins' curves, which define the minimum distance path between two points of different heading orientation given the minimum turn radius capability of the searcher. Through convolution of these two distributions and incorporation of Dubins' path we derive the expected coverage rate. Analysis is conducted through varying of the Levy input parameters to maximize the final coverage ratio for any search area of given size. Further, a Bayesian target detection probability update defined by sensor capability is incorporated into a looping search function. Should no detections occur within a specified amount of time, the searcher will travel directly to the area of highest target probability and recommence the search. Analysis regarding looping time and sensor characteristics is conducted to produce a detection probability distribution. The overall goal of this thesis is the optimization and computer simulation of this nondeterministic looped Levy search, so as to derive the maximum coverage ratio over a discretized search area while also considering the searcher's probability of counterdetection.

Clock Synchronization Through Time-Variant Underwater Acoustic Channels

by LCdr Pascal Gagnon, Royal Canadian Navy

Clock synchronization among distributed sensor nodes is necessary when data from multiple nodes are to be co-processed. In the context of underwater target detection, the accuracy of the localization of a target is directly related to the synchronization of the nodes' clocks.

The challenge in underwater acoustic clock synchronization lies in correctly estimating the time delay between the transmission of a signal from node A and the reception of that signal by neighboring node B. The propagation medium between A and B introduces environmental factors such as latency, multipath, scattering, refraction, transmission loss, noise and non-reciprocity. These factors have significant effects on the reciprocal channel impulse responses and our ability to synchronize separated nodes. Our goal is to develop a method to counter the effects of multipath, time-variability and latency when synchronizing the clocks in a pair of neighboring nodes.

Clock synchronization involves the determination of two relationships. The first is the skew, which is the oscillator frequency difference between two clocks. The second is the offset, which is the time difference between the two clocks at a fixed time. Our solution differs from previously published clock-synchronization protocols by evaluating time-variant multipath of the channel.

Physics-based computer simulations of the acoustic channel provide statistical measurements of the time-variability of the communication channel. The success of the simulations led to testing in a real underwater environment. The accessibility of Del Monte Lake situated on the NPS campus made it an easy choice as a test location. Unfortunately, the shallow depth of the lake makes this environment susceptible to severe time-variability. Nevertheless, the results from the experiment support our theory and synchronization approach, and also revealed possible ways on how to improve upon it.

Accounting for the time-variant multipath channel will improve the accuracy of clock-synchronization and increase the utility of sensors within underwater acoustic networks.

The NPS thesis research summarized here is in partial fulfillment of the M.S. Engineering Acoustics and M.S. Electrical Engineering degrees. Thesis co-advisors are Prof. Joe Rice (Physics Department) and Dr. Grace Clark (Lawrence Livermore National Labs). LCdr Gagnon will present this work at the Underwater Communications Conference (www.ucomms.net) organized by NATO Centre for Maritime Research and Experimentation, convening September 2012 in Italy.

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

Librarian's Corner - A New Paradigm for Small UAS

ABSTRACT: Small Unmanned Aircraft Systems (UAS) are different than almost any other kind of aircraft. They can fly in places where no manned aircraft flies or where it would not be desirable to fly. They also pose different risks based upon their small size and performance. Today, the FAA regulates all navigable airspace, which extends to the ground. Within this airspace, there are some areas in which manned aircraft are simply not capable of flying by existing Federal Regulations. This may include areas that are very close to the sides of buildings, under bridges, below tree cover, and near power cables. Our research envisions that small UAS might make use of this airspace, which would be considered non-navigable by traditional manned aircraft due to the proximity of obstacles. Additionally, a small UAS may weigh only ounces. An aircraft that small is likely to pose a vastly different risk to people and property on the ground than would manned aircraft. Considering usage of airspace and the associated risk in this manner represents a departure from current thinking and may influence the methods of regulating these new aircraft. This paper explores and discusses this potential new paradigm further, and illustrates the implications with a set of operational scenarios.

Full article available on the Unmanned Systems Guide at https:// http://libguides.nps.edu/unmanned