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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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Unmanned Technologies Enable Information Superiority in Multinational Maritime Security and Humanitarian Assistance Exercise

by Mr. Brendan Applegate, NPS Research Assoc, Deputy Director for Planning, NPS Center for Asymmetric Warfare

In August, the Naval Postgraduate School's Center for Asymmetric Warfare conducted maritime and unmanned aircraft operations in support of US Pacific Command's (USPACOM) Pacific Endeavor 2012 (PE12) exercise. PE12 is a multinational humanitarian communications exercise which uses timely and relevant disaster scenarios to assess and document the methodologies in which participants might effectively use communication and information technologies to respond and recover from a disaster. This year's event was hosted in Singapore from 15-21 August, and included participation by over 20 nations.

Contributing to the multinational effort, the Center for Asymmetric Warfare (CAW) designed and developed a remote exercise component to feed real-time information to command and control elements using leading-edge communications technologies and established internet-based protocols. Deploying a Puma All-Environment (AE) unmanned aircraft from CAW's 85-foot research vessel, CAW-1, off the coast of Southern California in a communications-austere environment, the team sent high-definition video and telemetry, as well as photo and text situation reports, to command elements in Singapore. This real-time decision support capability was enabled by satellite and microwave backhaul and web-enabled visualization technologies and provided unparalleled situational awareness regarding concurrent law enforcement and homeland security efforts underway in the midst of humanitarian assistance and disaster relief operations.

The scenario for this remote information node focused on the threat of regional narcotics and human smuggling, a continuation of CAW's Coastal Trident Regional Maritime Security Exercise, which was conducted in June of this year and included the participation of over 170 personnel from 54 local, state, federal, and private sector organizations. During the live exercise, the Puma AE aircraft was deployed from CAW-1 to investigate reports by local law enforcement of a suspicious vessel observed transiting the Channel Islands National Park. After locating, identifying, and keeping station above the suspect vessel, command elements aboard CAW-1 and in Singapore were able to confirm the presence of illicit weapons and narcotics and interdict the vessel using embarked law enforcement assets.

The effort was a success by all measures, providing imagery and vehicle telemetry, as well as photo and text situation reports, to command and control personnel across the Pacific as well as receiving tasking and instructions to drive interdiction and investigation operations. In addition, the opportunity was leveraged to demonstrate these leading edge technologies as critical force multipliers and operational enablers to local law enforcement, emergency response and emergency management agencies.

CAW's demonstration and evaluation of unmanned technologies in a maritime environment to enable law enforcement and emergency response operations will continue next year, as part of the planned Coastal Trident 2013 exercise.

For more information about this and other CAW efforts, please go to http://cawnps.org or contact Mr. Alan Jaeger, CAW's Director and Principal Investigator, at (805) 989-1786.

PUMA AE system being deployed from the 85ft CAW-1 Research Vessel

Picture from the PUMA AE of the suspect vessel with simulated narcotics on board

Director's Corner

Conceiving, developing, and employing unmanned systems in operational environments is a complex topic that involves multiple disciplines across a variety of issues. It is the goal of CRUSER to inspire at least a conversation, and at best cooperative research between those disciplines to reach the national objective of intelligently employing our new technologies in the most effective manner. Open up our CRUSER calendar to see where you might be able to join in the many activities in our community of interest!

CAPT Jeff Kline USN (ret)
CRUSER Director

Large Scale 3D Mapping and Change Detection using Unmanned Aerial Vehicles

by Srikanth Saripalli, Assistant Professor, School of Earth and Space Exploration, Arizona State University
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Over the past year the Autonomous System Technologies Research & Integration Laboratory (ASTRIL) at Arizona State University has been developing fully automated large scale 3D mapping and change detection techniques using Unmanned Aerial Vehicles. Our main platform is an autonomous helicopter equipped with a downward looking Canon 5D (shown in Figure 1).

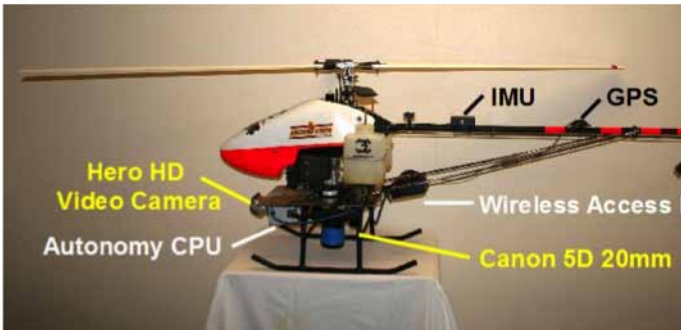

Figure 1: Autonomous Helicopter Platform

This platform has been outfitted with a vibration isolating camera mount to which a downward looking camera (a Canon 5D) is attached. The helicopter is flown autonomously over a pre-defined area and images with attitude and GPS information are collected. These images, along with the IMU and GPS information is used in our Structure for Motion algorithm (SFM) to obtain geo-referenced 3D models.

Figure 2 shows a typical 3D terrain model obtained from our UAV. Figure 3 shows the altitude and position of the UAV calculated using SFM, as the images were taken. This model was generated in Las Cruces, New Mexico, for an area approximately 2000 x 1000m. The model has a resolution of 10cm/pixel and an accuracy of 20 cm. This has been determined using pre-surveyed points using a Total Station.

Figure 2: 3D model of the Las Cruces test site (2km x 1km) generated using our UAV

We have also been developing techniques for change detection using the point clouds generated from our 3D modeling process. To validate these techniques we are using pre-and-post point clouds generated using airborne LIDAR. Our technique uses a windowing approach to determine the correct displacements and an information theoretic approach for determining the regions where these local displacements are present. We are able to discern displacements 1 m over 2×2 km using point clouds collected via airborne LIDAR.

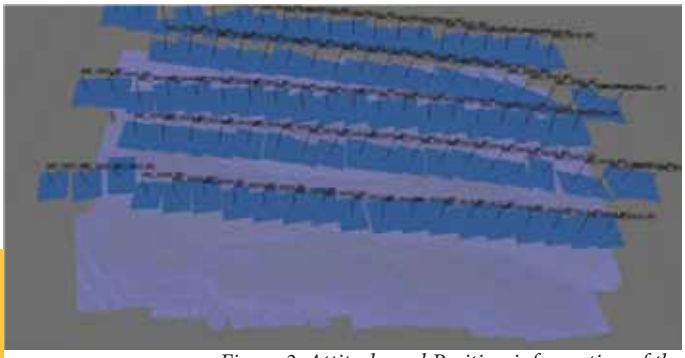

Figure 3: Attitude and Position information of the UAV overlaid on the 3D Model

Short articles of 300-400 words for CRUSER News are always welcome Contact us at cruser@nps.edu for additional information.

Press Release: Discoverer II maiden flight

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UNMANNED® SYSTEMS GROUP

Unmanned Systems Group (UMS) is proud to announce the maiden flight of the Discoverer II Remotely Piloted Air System on 3rd September 2012 from the Karlskoga airfield in Sweden. The production prototype was built in the company's facility in Linköping and was flown by the UMS Head of Flight Operations, Dave Cummins during its 5 hour operational testing. Dave commented on the flight "I was very impressed with the aircraft's responsiveness and handling characteristics – it was a delight to fly and we are all very pleased with this success story – just 5 months from design to first flight is a measure of teamwork and dedication that is seen within the UMS team. The flight was a great success and we are all very pleased."

The Discoverer II is the largest RPAS in the UMS inventory and is capable of simultaneous carriage of a high-performance Electro-Optics turret and highly capable Surveillance radar such as the Selex Galileo Sea Spray 5000 series.

Link to Data Sheet: http://www.unmannedgroup.com/index.php?page=2&subpage=6

Press photos: http://www.unmannedgroup.com/ftp/files/ums_discoverer_2.zip

NWDC/CRUSER Warfare Innovation Workshop 17-20 September 2012

To directly support the NWDC Line of Operations CRUSER will hold a three day and a half day Warfare Innovation Workshop (WIW) focused on Advancing the Design of Undersea Warfare (DUSW). The WIW is scheduled during Summer Quarter 2012 Enrichment Week from Monday, 17 September through Thursday morning, 20 September.

Nearly 50 participants representing over 20 different organizations include NPS students from across campus, newly selected Strategic Studies Group (SSG) Director's Fellows, and nominated participants from the greater CRUSER Community of Interest including NUWC, JHU/APL, Electric Boat, COMPACFLT and Battelle among others. Participants will participate in an Innovation Seminar and then break into teams to develop a response to a proposed scenario addressing undersea warfare operational concepts.

For additional information, contact Ms Lyla Englehorn, CRUSER Program Manager, laengleh@nps.edu

STUDENT CORNER

Students: Master of Science in Systems Engineering DL Cohort 6

(J. Ball, R. Bringas, M. Fella, S. Filali, E. Mantz, C. Nguyen, M. Petersen, J. Rodriguez, C. Shortridge)

Title: DEVELOPMENT OF SYSTEM ARCHITECTURE IN SUPPORT OF QUALIFICATION OF UAV DECK HANDLING SYSTEMS ABOARD AIRCRAFT CARRIERS

Advisor: Mark Rhoades, Department of Systems Engineering

Second Reader: Rama Gehris, Department of Systems Engineering

Abstract: This research investigated the integration of large, fixed-wing Unmanned Air Vehicles (UAVs) into the deck environment of a nuclear aircraft carrier (CVN). This report contains a system Concept of Operations (CONOPS), system architecture, and system specification, which describe the operation of a UAV deck handling system during catapult launch operations.

The researchers tailored a published systems engineering process (From Buede 2009) and executed it from problem definition to system design decomposition. Research and interviews with stakeholders provided the initial problem definition. The team conducted a detailed reference mission analysis which defined the system CONOPS and scoped the problem to catapult launch operations. The researchers used a quality functional deployment (QFD) approach to convert originating requirements into performance characteristics and top-level functional requirements. Researchers transformed the performance characteristics into system performance requirements and decomposed the top-level functional requirements into the system functions. Engineering judgment, research, and modeling and simulation provided justification for these products. The team used the decomposed functions and performance requirements to write system specifications and to formulate the system architecture, guided by Department of Defense Architecture Framework (DoDAF) 2.0.

For additional details, please contact Roberto Bringas Jr. of Naval Air Systems Command at roberto.bringas@navy.mil

UAV Alternative Navigation

by Dr Jerry LeMieux, Col (ret), USAF, President of Unmanned Vehicle University, administrator@uxvuniversity.com

The majority of UAV systems have come to rely heavily on satellite based navigation. These systems are vulnerable if the satellite signal is lost, countermeasures are applied or the receiver fails. During the last war in Operation Iraqi Freedom (OIF), many small satellite jammers were used to deny navigation. Future conflicts may be fought in low altitude urban environments where satellite navigation signals will be blocked. So we must find alternative navigation systems that are more reliable and less susceptible to interference and jamming. Several alternative navigations systems are describe below

Image aided navigation uses the sensor images to navigate. Measurements of 3D terrain imagery can be obtained from EO/IR sensors. To navigate with images, a Digital Terrain Elevation Data (DTED) map database can be stored in memory. The sensor images can be correlated with the stored DTED map and an error can be computed. This error can be used to update an INS.

Another alternative navigation system is called Locata. This is basically a satellite navigation system installed on a series of ground based towers. It is a ground based positioning system with centimeter accuracy. The signals are one million times stronger than a satellite navigation signal and the accuracy has been demonstrated to on the order of 18 cm at 30 miles.

BAE has recently developed a UAV navigation system that uses signals of opportunity called Navigation Signals of Opportunity (NAVSOP). This system can use cell phone towers, radio towers, microwave towers, TV signals and WiFi signals. All of these types of signals, if available can be used to triangulate position.

A final alternative navigation system that is in development is a cold atom IMU. Ultra cold atom interferometers are used to measure forces acting on matter. Atoms are cooled to a very low temperature where they can be controlled. An INS that uses this technology will have very low drift rates. A typical INS has a drift rate of 1400 m/hr and a cold atom INS will have drift rates on the order of 5 m/hr.

To learn more about UAV technologies visit the Unmanned Vehicle University website at http://www.uxvuniversity.com. The "First and the Best" in unmanned air, ground, sea and space vehicle education and training.

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

Librarian's Corner - Defense Science Board's recent Task Force report on The Role of Autonomy in DoD Systems

According to the transmittal memo from the DSB Chairman - "The Task Force has concluded that, while currently fielded unmanned systems are making positive contributions across DoD operations, autonomy technology is being underutilized as a result of material obstacles within the Department that are inhibiting the broad acceptance of autonomy and its ability to more fully realize the benefits of unmanned systems. Key among these obstacles identified by the Task Force are poor design, lack of effective coordination of research and development (R&D) efforts across the Military Services, and operational challenges created by the urgent deployment of unmanned systems to theater without adequate resources or time to refine concepts of operations and training."

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