Engineer Research and Development Center

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UAS Support to Flood Risk Management Operations

The *Unmanned Aerial Systems (UAS) Support to Flood Risk Management* work unit is a multi-lab effort to identify (and develop when needed) robust, defendable UAS-based methodologies and products that seamlessly integrate with numerical models. The research component of this work unit, led by the Coastal and Hydraulics Lab, Environmental Lab, and Geospatial Research Lab, is being accomplished through:

(1) the execution of a large evaluation experiment designed to quantitatively assess existing UAS methodology, sensors, and data processing approaches;

(2) development of new technology where existing tools are lacking (i.e. nearshore bathymetric mapping); and

(3) development of tools that allow seamless integration with USACE's numerical models for improved storm risk and impact assessments.

The transition component of this work unit will involve frequent presentations and interactions with interested USACE Districts, culminating in a series of District pilot projects to enable rapid technology transfer.

Problem

Static infrastructure combined with dynamic coastal landscapes creates navigation, flooding, and environmental management challenges that are exacerbated by coastal hazards. Without accurate, quantitative, and efficient assessment technologies, district engineers are left with inadequate funds, tools, and data to properly plan for and assess damages from these coastal and flood risk hazards. UAS remote sensing methods have the potential to substantially alter how the Corps collects, processes, and exploits geospatial products for a variety of flood management applications. Assessment of UAS technology is needed to ensure that USACE utilizes the most appropriate UAS-based technology in its coastal emergency management practices. Adapting UAS to help solve these issues demands an understanding of existing methods and identification of gaps or short-comings with current techniques. Research is needed to develop new approaches and provide guidance and insight regarding new tools that can address these gaps, as well as exploring potential future capabilities.

Technology

The rapid growth of the UAS market (platforms, sensors, software) has created a wide-range of potential solutions with variable data quality, methodologies, and cost. UAS platforms can provide high-resolution spatial data captured at low-altitudes that can fill the gap between traditional ground and high-altitude surveying. Most UAS airframes are either fixed-wing or multirotor airframes, equivalent to an airplane or a helicopter, each supporting different data collection approaches. Deployable instrumentation can range from consumer cameras to platform-designed lidar scanners. Raw imagery generally comes in the form of Red-Green-Blue (RGB) as well infrared (IR) wave lengths. Analyses, such as Structure from Motion (SfM), can transform these photogrammetric mapping data into high-resolution georectified orthomosaic images, Digital Elevation Models (DEMs), .las point clouds, and additional value-added products for infrastructure, topography/bathymetry, and land cover assessment.

This work unit is also designing a model-data assimilation framework to efficiently link new data sets with USACE numerical models, particularly those that provide flood risk assessments. The work includes developing techniques to handle data source disparity e.g. variable resolution, quality, and coverage) and quantifying the impacts of variable quality observations (e.g. beach elevation, wave conditions, plant coverage) on the accuracy of model predictions (e.g. bottom boundary conditions, volume change estimates, inundation elevations).

Benefit

Coupled with the proto-type model-data assimilation framework, UAS technology will reduce the data gaps currently existing at numerous USACE flood risk management initiatives by facilitating frequent, accurate monitoring datasets. The work unit's efforts will support:

- the development of material for guidance documents regarding use of UAS in support of Corps' coastal and flood risk management activities
- the ability to make timely and cost-effective monitoring measurements of coastal and riverine terrain, infrastructure, and ecosystem health using methodology that reduces risks to personnel while providing increased access to critical data that is needed to effectively manage flood risks.
- improved use of Flood Control and Coastal Emergency (FCCE) Act funding for post-disaster beach re-nourishment & shore protection
- the development of integrated model-remote sensing approach solving for flood risk management challenges
- UAS-based products that transcend multiple business lines, disciplines, and labs (CHL/EL/GRL/CRREL/GSL/JALBTCX)
- solutions applicable to all Districts, Other Feds (USGS, NRL, NOAA), NGOs, academia, industry, stakeholders in water resources management

Status

Following background research and district solicitation, ERDC executed the Duck UAS Field Experiment in June 2017, which brought together participating UAS flight teams from four ERDC labs, other federal government agencies (NOAA, USGS, NGA), academia, and private industry (11 teams total). Data collection included RGB imagery, as well as IR & thermal, multispectral, and lidar data that are applicable to a variety of FRM applications. Since the experiment, researchers have been aggregating, processing, analyzing, and documenting data from the experiment.

At the end of FY18 and beginning of FY19, UAS teams completed several pilot deployments with districts, including Norfolk, Wilmington, Charleston, and Sacramento districts. During FY19 teams have been analyzing this data and using it to modify their concept of operations (CONOPs) based on lessons learned and upcoming collection needs. These collaborations have already informed the districts' understanding of platform and analysis capabilities, while improving the research team's understanding of district emergency flood risk management needs and priorities for UAS technology deployment. Meanwhile the team has been refining data assimilation capabilities, including integrating UAS data with USACE numerical models and developing a web-tool for processing of bathymetry UAS data in order to enhance the prediction of coastal flood inundation from an approaching storm.

ERDC Points of Contact

Questions about UAS support to coastal, flood, and/or emergency management in your district?

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