Texas A&M Transportation Institute

PROJECT SUMMARY

Texas Department of Transportation

0-7063: Guidance for the Use of UAS during Suboptimal Environmental Conditions

Background

Several challenges exist for the effective use of unmanned aircraft systems (UASs) at the Texas Department of Transportation (TxDOT). Operational challenges include current and evolving regulations, limitations in platform endurance, difficulty operating UASs along interstate highways and urban corridors, and suboptimal environmental conditions, such as high winds, rain, low ambient lighting, or fog.

This research documented key challenges and developed and tested procedures for data collection and processing, with a focus on traffic incident management (TIM) activities such as crash reconstructions. The research included a review of historical crash data trends in Texas, simulation of the effect of environmental factors on the quality of photogrammetric data collected with UASs, completion of UAS-based data collection tests, development of recommendations for UAS operations, and development of recommended updates for the *Unmanned Aircraft System (UAS) Flight Operations and User's Manual*.

What the Researchers Did

The researchers conducted simulations to assess impacts of suboptimal environmental conditions on the use of typical nonmetric digital red-green-blue (RGB) cameras used for surveying crash scenes with UASs. Simulated factors included the impact of wind speed and direction on UAS flight operations, impact of aerial imaging network design on three-dimensional (3D) crash scene reconstructions using commercial structure-from-motion (SfM) software, impact of ambient lighting and low visibility on UAS-SfM reconstructions, self-calibration versus preflight calibration procedures for consumer-grade nonmetric digital RGB cameras, impact of suboptimal conditions on visual image quality, and impact of camera properties on UAS image quality.

The researchers conducted seven daytime and nighttime flight tests that included simulated crash scenes, actual crash tests at the RELLIS Campus in College Station, Texas, and simulated car crashes at the Texas Department of Public Safety Tactical Training Facility in Florence, Texas. It was not possible to conduct sample flights at actual fatal crash locations or under adverse environmental conditions such as fog or rain because the relevant federal and state agencies did not issue approvals to conduct UAS

Research Performed by:
Texas A&M Transportation Institute

Texas A&M University–Corpus Christi

Research Supervisor:
Cesar Quiroga, TTI

Researchers:
Michael J. Starek, Texas A&M University–Corpus Christi (TAMUCC)
Jorge Maldonado, TTI
Edgar Kraus, TTI
Stanton Taylor, Center for Public Safety, Northwestern University
Youngjib Ham, TTI
Tianxing Chu, TAMUCC

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flights under these conditions. Nevertheless, the seven data collection tests complemented and confirmed results from the various simulation exercises.

What They Found

The data collection and corresponding analyses included two large groups of activities. The first group focused on a systematic assessment of positional accuracies and 3D reconstruction fidelity, which included surveying ground control points and checkpoints that were used in all photogrammetry software processing. It also included an in-depth analysis of SfM point cloud data and calculations, as well as terrestrial laser scanner (TLS) data. The second group of activities focused on typical activities associated with the reconstruction of crashes, leading up to the calculation of relative distances between points that are relevant to the crash reconstruction process.

The researchers grouped major lessons learned into the following categories: impact of ground control on SfM results and distances between points, impact of processing software on SfM results, selection of coordinate system settings for SfM processing, effect of calibration method on SfM results, effect of scale constraint on SfM results, effect of nighttime settings on SfM results, and impact of UAS platform on SfM results. A major benefit of using UASs is the ability to replace traditional forensic "feet on the ground" surveying methods using a total station or TLS with a method that involves the use of photogrammetric techniques. The research demonstrated the feasibility of using low-cost UASs and SfM software for this purpose.

What This Means

The researchers made several recommendations based on the lessons learned from the simulations and field tests, including the following:

- Establish a program to use UAS-based platforms to support TIM activities, primarily at the metro districts.
- Focus on low-cost, consumer-level UASs to support TIM activities.
- Begin the UAS implementation with small pilot programs but concurrently develop a strategic plan that involves a potentially large fleet of UASs.
- Monitor the evolution of the UAS market as well as federal and state laws and regulations governing the use of UASs for public use.
- Establish a program to test and certify UAS equipment and related software.
- Develop and implement a comprehensive UAS-SfM training program.
- Partner with public safety agencies throughout the state to encourage the use of UAS-SfM platforms for traffic incident management, including crash reconstructions.
- Examine the feasibility of using UAS-based platforms for other applications at TxDOT.

For More Information

Project Manager:
Chris Glancy, TxDOT, (512) 416-4747

Research Supervisor:
Cesar Quiroga, TTI, (210) 321-1229

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Research and Technology Implementation Office
Texas Department of Transportation
125 E. 11th Street
Austin, TX 78701-2483

www.txdot.gov
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