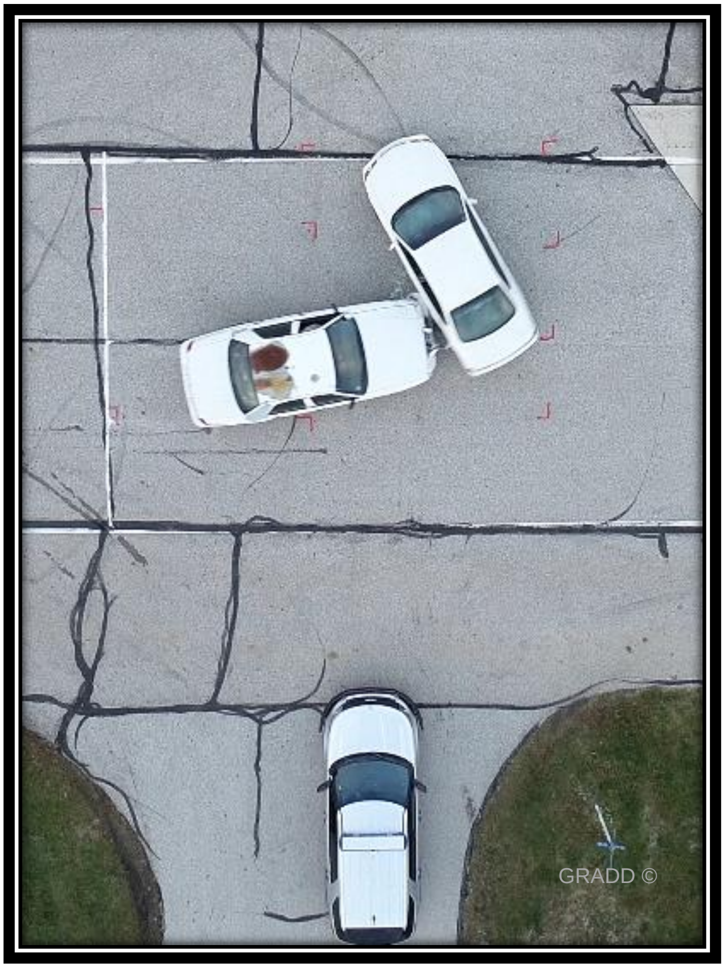


Crash Scene Reconstruction (CSR)Using Drones, DSLR Cameras & Point-to-Point Laser Measurers: Capturing High Resolution Data in a Fraction of the Time

ABSTRACT

Capture a Crash Scene from Every Angle, using UAS, DSLR cameras, and a Point-to-Point Laser Measurer

Case Study Data collected by GRADD CO. in collaboration with the Ohio Attorney General's Office/Ohio Peace Office Training Academy. The Ohio Attorney General's Office and the Ohio Peace Officer Training Academy do not endorse or recommend specific products.

Crash Scene Reconstruction (CSR) Using Drones, DSLR Cameras & Point-to-Point Laser Measurers: Capturing High Resolution Data in a Fraction of the Time

Using UAS (Unmanned Aerial Systems – AKA drones) at crash scenes: Data collected by GRADD CO. in collaboration with the Ohio Attorney General's Office

"Working together with Reza Karamooz of GRADD, we were able to capture all the required aerial images, DSLR images and point-to-point laser measurements from the scene in about 30 minutes."
James "Doug" Daniels
Senior Law Enforcement Training Officer / Part 107 Remote Pilot
Ohio Attorney General's Office/Ohio Peace Officer Training Academy

Abstract

"Crash scene reconstruction is the systematic practice of investigating, analyzing, and drawing conclusions about the origins and sequence of events for a traffic incident. Reconstructionists are engaged to perform in-depth collision analysis to ascertain the cause of the crash and contributing factors. Crash scene reconstruction typically requires images of the scene from many different angles to capture all relevant aspects of the scene including the vehicle(s) at final rest position, evidence of the area of impact, collision debris distribution, road evidence, operator's and witness's views, and vehicle damage. These photographs can also be used for creating scaled diagrams of the scene, modeling objects, and measuring various distances. Traditionally, taking these photographs involves law enforcement personnel performing on-scene investigations, which consumes time and also may expose the law enforcement personnel to secondary collisions. Many different technologies are utilized to reduce the clearance time after a crash and the exposure of personnel to secondary collisions, including total stations and photogrammetry."
Johns Hopkins Applied Physics Laboratory

This white paper reviews the steps for accurately documenting a crash scene while also capturing the scene from every angle, using UAS, DSLR cameras, and point-to-point laser measurers. In the past few years some law enforcement agencies have started to add UAS as one of the tools for crash scene investigation and reconstruction.

A research study conducted by Johns Hopkins Applied Physics Laboratory concluded that: “The main finding of the study is that utilizing UAS for CSR can significantly reduce the data collection time at a crash scene, resulting in shorter road closure times and officer on scene times, if logistical, administrative and technology challenges associated with UAS use are resolved. **Operational data collected in the study shows that data collection by UAS is on average one hour shorter than data collection by a robotic total station and two hours shorter than data collection by a manual total station.** However, these gains can be realized only if UAS can replace total stations.”

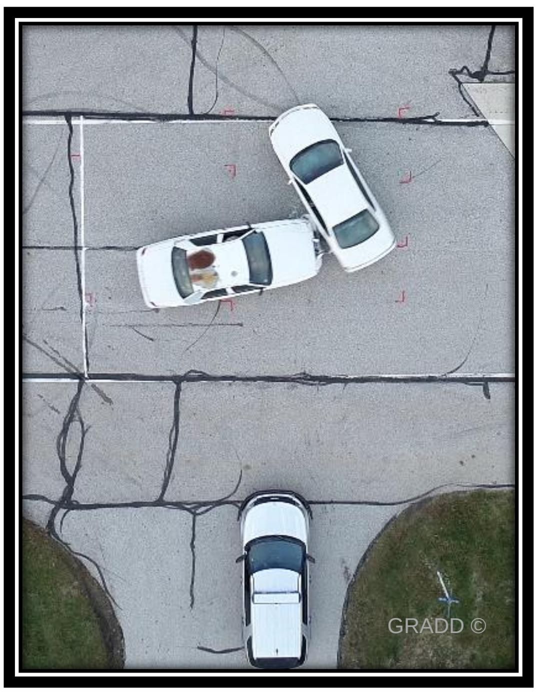
Using UAS offers a faster, and in some cases, a more accurate method of crash investigation and documentation. UAS may also be utilized in combination with existing technologies to provide more effective methods of data collection for accurate analysis of crash scenes.

Background

GRADD’s crash scene reconstruction solution utilizes aerial drone images coupled with 1mm accurate point-to-point laser measurements of ground control points to assist law enforcement, first responders, and military to enhance and speed up investigations of vehicle, aircraft, and train accidents. When an accident occurs, investigators need to document the scene as accurately and completely as possible before the scene is cleared.

“Full benefits of UAS for CSR can be realized by using aerial photographs for measurements, which would negate the need for total stations at least in some crash investigations. This requires established trust in the accuracy, precision and repeatability of UAS measurements and an increased availability of UAS for timely deployment. When used for measurement purposes, UAS require photogrammetry software that can combine the aerial photographs and calculate distance between points of interest." Johns Hopkins Applied Physics Laboratory

Drones can be launched at a crash scene to acquire high resolutions aerial images to provide investigators with the necessary data for processing, analysis, and the creation of 2D maps and 3D models, for inspection and conducting accurate measurements. Drones also provide a birds-eye-view of the crash scene (image below).



Case Study

On November 1, 2019, GRADD and the Ohio Attorney General's Office collaborated on a case study involving a staged two-vehicle crash, in order to study and reconstruct the scene. The vehicle crash was in a controlled area, under the leadership of Ron Thayer, a law enforcement training officer at the Ohio Peace Officer Training Academy. Two vehicles were placed perpendicular to each other at an intersection. One vehicle (empty) was pushed into the intersection where it was struck in the rear driver side quarter panel by the other vehicle driven by an officer, to create a side-impact crash scenario. Shortly after the crash, a DJI Phantom 4 Pro drone was launched to capture aerial images of the crash.

Several hundred aerial images of both vehicles, as well as the entire crash scene were captured with a drone flying specific missions over the crash. A DSLR camera was used on the ground to capture images of both vehicles for the purpose of creating high resolution 3D models of each vehicle. A laser measurement device - the Leica DISTO S910 - was used to provide measurements of several control points to scale the 3D models.

Once the necessary data was collected, all the drone and ground image sets were uploaded to a photogrammetry software – Reality Capture - for post-processing and the creation of high-resolution 3D models.

The high-resolution 3D models of each vehicle were completed using Reality Capture software and then uploaded to the GRADD LAS3D cloud online viewer for further inspection and measurement.

The 3D model of the entire accident scene was also created using the Reality Capture software, and then uploaded to LAS3D.com for inspection and measurements.

Once a 3D model is uploaded to LAS3D (online or desktop), accurate measurements can be made on any part of the 3D model between any 2 points in the 3D point cloud. Distances, areas, angles, and heights can be measured, and cross-section profiles can be viewed in real-time, to determine such information as the slope of the road and elevation differences.

Creation of high resolution 3D models of each vehicle digitally preserves their condition, to assist with ongoing investigation and inspection of each vehicle, just as they were immediately after the crash.

Solution

When a crash occurs, investigators are tasked with working quickly to properly and accurately document the at-scene information and related evidence. This includes capturing photographs of the crash scene from a variety of angles to include the surrounding environment, as well as documenting damage sustained by vehicles, people, and other elements. After processing the collected data, the results are used to perform the careful task of crash reconstruction. With the addition of UAS, crash investigators are able to capture all the necessary images, and measurement data in a fraction of the time. These images are then used to create 2D maps and 3D models with photogrammetry software, such as Reality Capture or Pix4Dmapper.

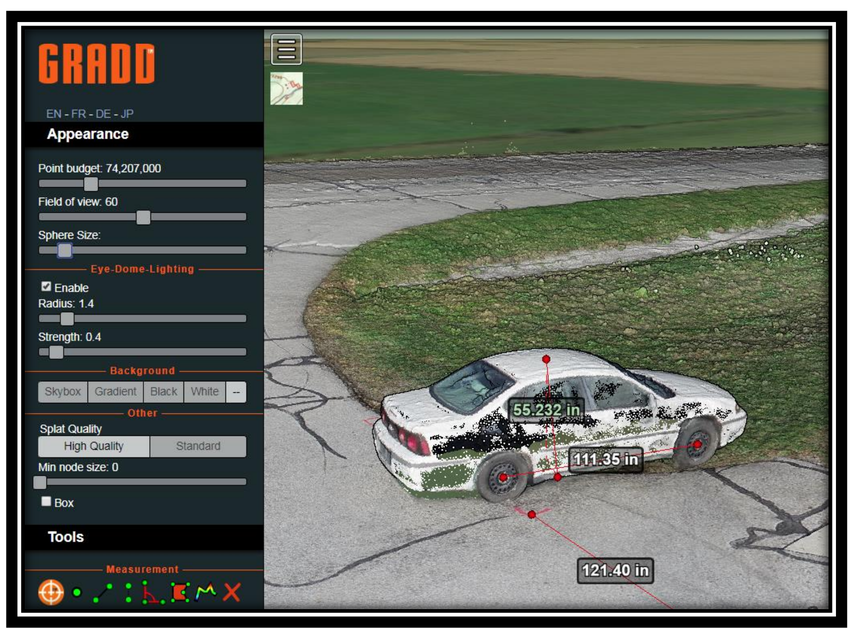
As shown in this white paper, use of UAS helps officers clear the road faster, reduce the risk of secondary accidents or injuries to officers and first responders. The GRADD crash scene reconstruction solution delivers an efficient workflow, and provides excellent results that provide high-resolution 3D models of the crash scene environment.

Conclusion

With the advancement of drone technology and better on-board GPS accuracy, coupled with improvements in photogrammetry software to process the drone images, it is now possible to achieve the desired measurement accuracy of crash scenes using drones. When the resulting 2D maps or 3D models of a crash are scaled using laser measurements (ground control points), it is possible to match or exceed the accuracy achieved using current methods. GRADD provides the complete solution for capturing data and verifying that the data is valid and complete, while still at the scene. In addition, GRADD has developed a unique desktop software to view the 3D models, scale them, inspect them and conduct accurate measurements.

Crash Investigation Process Using Drones

1) Arrive at accident scene
2) Launch drone for data collection
3) Verify image quality and quantity while still at the scene
4) Process the images into 3D models
5) Evaluate and perform calculations and reconstruct accident
6) Present and provide conclusive evidence



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Equipment and software used in this case study:

Drone:
DJI Phantom 4 Pro

Laser measurer:

Leica DISTO S910

Photogrammetry Software:
Reality Capture

DSLR Camera:
Nikon D5500
18-55mm VR II lens

Software for viewing and measuring the 3D models:
GRADD's LAS3D