NCG
NOBLES CONSULTING GROUP, INC.

UAV APPLICATIONS

Pit Mining UAV Aerial Mapping

Nobles Consulting Group has been providing surveying and mapping services for mining operations for over 25 years. Most of these services have included providing topographic data intended for volumetric calculations on various materials. As many of you know, the mining industry can be a rather hazardous occupation. We have all heard stories of accidents and tragedies, but the mining industry is a necessity to our way of life. For us, it wasn't until recently that technology allowed us to perform a safer and more cost-effective way of doing business. Many of these technological advancements have expanded our business into activities that fall outside the traditional sense of surveying and mapping. Our most recent business expansion has been in the use of Unmanned Aerial Vehicles (UAVs).

To give you a little background information, in 2014 we began educating ourselves on the uses of UAV's. We were immediately intrigued with the possibilities that UAV's provided for our business. So we researched and tested the technology until we were mostly satisfied using commercial grade quadcopters for developing stockpile volumes on sites in the southeastern United States. But we're surveyors and the one question that was always in the back of our minds was "Is UAV derived mapping data accurate enough for surveying purposes?" If you don't know any surveyors or have never been around the surveying and mapping profession, you may not understand that surveyors are driven by the notion that every bit of data has to be accurate and precise. This notion can be so strong that you would think it is a part of our DNA or we were designed to think this way.

During our due diligence phase, NCG formed a partnership with Altavian. Altavian is a UAV manufacturing company based in Gainesville, FL that specializes in UAV's for mapping. We were convinced after our first meeting that this would be a lasting relationship and help push us into the upper echelon of UAV mapping. Our first purchase was the NOVA F7200. The NOVA F7200 is a fixed wing aircraft capable of flying for approximately 90 minutes and capturing up to 3000 acres of imagery. The camera system that mounts inside the fuselage of the aircraft allows us to capture RGB (True Color) or color IR imagery. The UAV is equipped with PPK GPS that repeatedly provides 1-3-centimeter accuracy. This is helpful when limited ground control is available. This aircraft is truly a work horse.

One of our latest projects and the subject at hand, is producing highly accurate topographic maps for pit mining. Our project includes a 70-acre pit with approximately 100 feet of relief. Our client tasked us with calculating the volume of dirt that was removed from the original surface. Keep in mind this project has been going on for years. We originally located the natural topography using conventional surveying

FIGURE 1 – POINT CLOUD PHOTO

methods before extraction began at the site, and over the years, we have continued using these methods. Our client is confident in these services that we provide them, so when we introduce new technology, our client sides to the caution. To set their mind at ease, we performed a comparable analysis on the subject site, first by using conventional surveying equipment to locate the extracted ground area and establish a baseline for the topographic study. This method typically includes locating the bare-earth on 50-foot grid intervals and the abrupt grade changes (top and/or toes of the slope) to create a digital terrain model (DTM) of the surface of the earth. To calculate the amount volume of dirt that was removed from the pit, we overlay the original natural ground surface (DTM) onto the newly created surface (DTM) and subtract the difference. The CADD program generates a report and we submit the results to the client.

For second method, we used the aerial photography derived from our NOVA F7200's camera payload. The geo-tagged photos are processed using a photo software to create a ortho-mosaic photograph and 3D point cloud. Now there are several ways to process the aerial photos, and we performed a comparable analysis on these procedures as well.

Our first comparable analysis for using aerial photography is using ground control points resulting from a control survey and aerial targets. During the initial process, the control points (X, Y, Z) are imported into the photo software and tagged on the individual photos. This procedure geo-references the project to real world and provides the control restraints necessary for accurate mapping purposes. After processing is complete, a 3D point cloud and ortho-photo is produced.

The second comparable analysis uses the Post-Processed Kinematic (PPK) GPS to provide the necessary control values needed during the photo processing. PPK is similar to Real-time Kinematic (RTK) GPS, but PPK allows the user to check the vector baselines between the ground base station and the on-board GPS.

Not having to set aerial targets and performing a control survey is a time-saving benefit to using PPK GPS. In addition to the time-savings, PPK is advantageous when mapping agricultural, forestry, and mining projects. Most of these types of projects have very little color variation from photo to photo leaving few places to create manual tie points to help scale the final outputs. Camera location, payload sensor and color all play a role in aligning and piecing individual photos together to form one ortho- photo and 3D point cloud. In other words, if camera position is not detectable and photos have homogenous coloration, the software has difficulty stitching the photos together properly. That's where highly accurate X, Y, Z coordinate values derived from the PPK GPS come into play. The post-processed geotagged photos are positioned correctly, and the software applies the necessary algorithm to create an ortho-photo.

FIGURE 2 – 3D MODEL

Now that we have explicated a simplified version of the various methods used in this comparable study. We would like to share our results from of our findings. Below is a sample dataset of randomly chosen conventional surveyed ground points vs points selected from the point cloud produced from UAV mapping.

Sample Dataset

Conventional Method	UAV Method	Aver. +/-
273.25’	272.23’	-.02’
271.20’	271.23	.03’
265.65’	265.67	.02’
262.35’	262.44’	.09’
258.89’	258.86’	-.03’

The results of our findings proved to our client that UAV technology can be used to produce accurate results, provide a safer and more cost-effective method of creating volumetric reports.