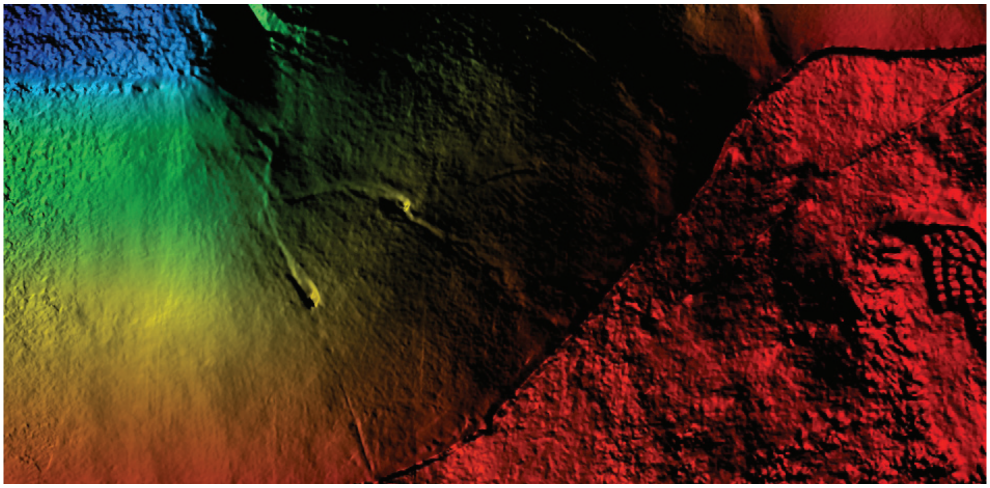


Geospatial Services Evolve for the Solid Waste Industry

Wilson & Company has been providing professional geospatial and imagery services to the solid waste industry throughout the country for over 30 years. For the most part, the approach and methodologies for acquiring imagery and generating photogrammetric data for mapping applications and volumetric computations have remained constant. With the recent advent of Small Unmanned Aerial Systems (sUAS) technology and a revolution in processing software, new processes for increased efficiency and decreased costs are now possible for landfill geospatial products. The use of sUAS's are far more economical for small acreage sites such as landfills, and software improvements in photogrammetric processing reduces the amount of labor needed to generate topographic data for inventory reports.

Problem

The utilization of photogrammetry for generation of volumetric and remaining air space quantities in annual reporting for landfills is a common practice. The deadlines for these reports are critical, and often the aerial photography, mapping, and imagery processing can take as long as 30 days. Finding a solution to expedite this operation is desirable for landfill managers. A reduction in fees would add even more value. Wilson & Company's experimentation with sUAS technology is proving to be a viable solution accomplishing quicker turnaround times and reduced costs.

Overview

Possibly the most popular subject in our profession for the past years is the use of sUAS for commercial application. Much has been written in professional publications and journals about the commercial uses and the concerns of FAA regulations regarding their use. Recent litigation, court decisions, appeals, and overturned rulings have added to the confusion of the future legality and practicality of the technology for most applications. The overriding concern always being the safety of people and property on the ground, as well as other manned aircraft.

When considering the potential uses for the sUAS technology, the landfill industry immediately is identifiable as being a potential application. Most landfills are located far away from significant urbanized development which mitigates some of the basic safety constraints of flying the sUAS. The landfill industry and their requirements for geospatial data and ortho corrected imagery is a field that we already have an existing client base and strong resume of successful services.

In 2013, Wilson & Company recognized the potential to use sUAS for specialized applications of topographic data collection and aerial imagery. Although the company had over five decades of experience in photogrammetry and aerial acquisition, our operational knowledge of sUAS systems was limited. To supplement and develop our knowledge, we turned to nationally recognized experts in the field Dr. Kevin Price and Dr. Deon van der Merwe of Kansas State University to form a cooperative partnership. Through their support and guidance, we purchased and customized our first sUAS, a Skywalker Revolution 1800, named "Arrow 1."

Solution

After months of training, our sUAS pilot gained sufficient expertise that we began performing test flights in relatively remote locations, perfecting navigation and GPS systems, communications, auto flight, and camera systems. One of the sites utilized was Deffenbaugh Industries' Johnson County Landfill in Shawnee, Kansas. After determining an appropriate 80 acre cell of the landfill and waiting for acceptable weather conditions, we mobilized the sUAS flight crew to acquire the landfill sample imagery. Our goal was to test the performance of the aircraft and verify the accuracy and suitability of the resulting imagery for topographic mapping and digital ortho imagery.

Specifics for the flight mission are in the sidebar to the right. The resulting collected imagery was processed using Agisoft PhotoScan photogrammetic software, which incorporates an image correlation algorithm for generating a surface model DEM, as well as performing image rectification from the DEM for digital orthos. Wilson & Company survey crews established photo-identifiable control points after the flight, as well as more than 20 check points to be used for analyzing the accuracy of the surface model. The Sony NEX5T camera used in the sUAS is a non-metric sensor, meaning that the lens has not been calibrated. The potential error that may be introduced by not compensating for lens distortions, as is done with a metric aerial mapping camera, was minimized by the redundancy of increased number of exposures covering every point in the project area.

Specifications of Landfill Flight

Altitude:
400' above mean terrain

# of Flight Lines:
20

# of Exposures:
738

Flight Duration:
26 minutes

Overlap:
75% side, 80% forward

Ground Sample Distance:
0.025m

Time on site:
1 hour

sUAS Specifications

- Skywalker Revolution 1800 Airframe
- 3D Robotics Pixhawk
- Airspeed sensor and 915mhrz telemetry package
- Hitec Aurora 9 transmitter and Optima 6 receiver
- 5200mah 4 cell battery (lasts approximately 30 minutes)
- Sony NEX5T 16.1 Mb camera

Results

The results of the comparisons of the field surveyed elevations and auto-correlated elevations are shown below in the schematic check point layout and corresponding table of elevation discrepancies. The mean square error of ~0.35 feet is a magnitude well within what would be expected of a surface model sufficient to generate a two foot contour interval used for most landfill inventory reports that we have previously performed.

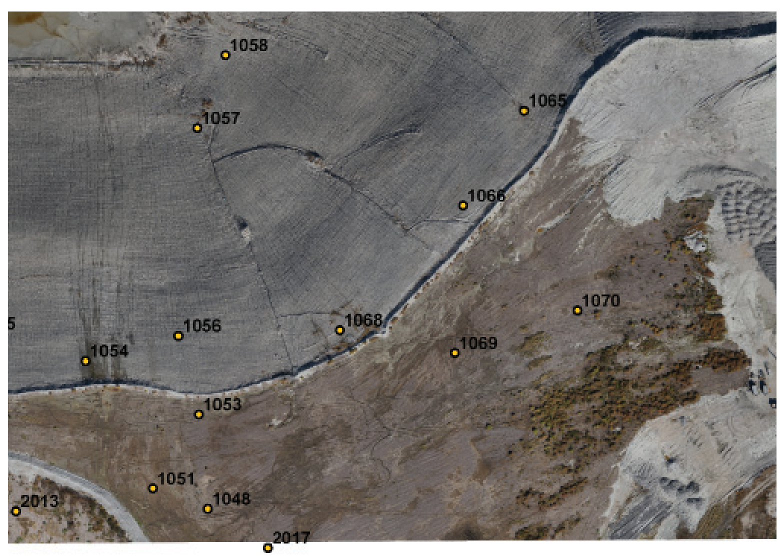
Table of Elevation Discrepancies

Number	Easting	Northing	Known Z	Laser Z	Dz
1049	2219751.993	268876.714	971.746	972.400	+0.654
2013	2219409.736	268828.908	948.247	948.770	+0.523
1068	2219975.175	269145.778	966.863	967.360	+0.497
2016	2219749.286	268880.918	971.461	971.930	+0.469
1088	2219406.855	568824.822	946.669	946.930	+0.261
1052	2219593.502	268980.183	969.036	969.290	+0.254
1087	2219404.801	268829.715	947.825	948.030	+0.205
1069	2220176.751	269105.735	980.888	981.050	+0.162
1067	2220092.742	269313.941	957.664	957.790	+0.126
1053	2219728.846	268998.122	972.784	972.900	+0.116
1050	2219744.531	268879.372	971.976	972.020	+0.044
1071	2220406.843	268849.530	982.486	982.500	+0.014
1054	2219530.592	269091.649	952.916	952.910	-0.006
1070	2220391.341	269179.655	986.026	986.000	-0.026
1058	2219775.167	269625.975	814.877	814.700	-0.177
1051	2219648.510	268868.745	970.874	970.590	-0.284
1066	2220191.876	269363.310	972.907	972.560	-0.347
1048	2219744.591	268833.260	972.600	972.230	-0.370
1056	2219692.665	269135.235	942.009	941.560	-0.449
1065	2220298.175	269529.099	967.473	967.000	-0.473
1057	2219725.492	269498.633	829.676	829.180	-0.496
all values are shown in feet					
	Average dz	+0.033	Average magnitude		0.283
	Minimum dz	-0.496	Root mean squre		0.341
	Maximum dz	+0.654	Std deviation		0.348

Conclusion

Through our testing at the Deffenbaugh facility and other similar test flights, we have confirmed our hypothesis of a sUAS approach for efficiency, timeliness, and cost. After the flight acquisition was accomplished at the landfill, ortho imagery was provided within 24 hours and the topographic data was completed and verified within days.

The need for expensive manned aircraft and metric mapping sensors are minimized when having the tool of a sUAS available to utilize in appropriate conditions and locations. Wilson & Company has purchased additional Skywalkers to increase our capacity to mobilize quickly to landfills throughout the Midwest. This revolution in aerial acquisition techniques and imagery processing for automated topographic data holds great promise for further development and improvement, as well as immediate benefit to the landfill industry.



Ground Control Points

WILSON & COMPANY

Please contact Eric Cenovich for additional information or fee quotations for these or other related services at:
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