The Feasibility of Using Small Unmanned Aerial Vehicles for Mapping News Events

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ABSTRACT

News organizations are facing massive declines in revenue simultaneous to ever increasing pressures for new and original content. Small Unmanned Aerial Vehicles (sUAS) are gaining significant attention in a range of industries for their ability to gather photos, videos or data at very low cost. Multiple academic disciplines, such as Geography, Archaeology and Agronomy, are using sUAS to map and model areas of interest with high degrees of precision using off-the-shelf hardware and specialized software. However, time pressures for academic research are very different from those of daily journalism. We present a feasibility study using the most commonly available sUAS system and a computer setup frequently used in newsrooms to determine if such mapping could be done on news deadlines. The results are promising but likely require a different approach to field computing than most news organizations currently practice.

General Terms

Measurement, Documentation, Design, Economics, Reliability, Experimentation.

Keywords

sUAS, Unmanned Aerial Systems, PhotoScan, photogrammetry.

1. INTRODUCTION

UAVs make it easy to capture aerial video and images for telling stories. But the emerging technology has potential for far more innovative data gathering uses that have yet to be explored in the context of journalism. One example is the use of UAVs for generating three dimensional terrain and structure models of areas of interest. In August of 2014, the Drone Journalism Lab's Ben Kreimer travelled to Turkey at the invitation of the Antiochia ad Cragum Archaeological Research Project. The Lab was invited to photograph the site, which had grown beyond the project's ability to document safely from ground based cranes or bucket trucks. As part of this effort, the Lab purchased additional equipment to attempt to map the site using a DJI Phantom 2, a popular sUAS. Unlike most Phantoms, which are used for carrying a GoPro nested in a gimbal, Kreimer attached a Canon point-and-shoot camera for taking aerial photographs. Then, using the automated flight capabilities of the Phantom 2, Kreimer created a flight path that took the sUAS over the site's excavations in coordinated and overlapping segments. The camera was programmed to take a photograph every two seconds and the aircraft programmed to fly one meter per second. During the flights, the camera captured about 400 aerial images, with GPS coordinate points recorded for each image. Using specialized software, the images were merged together and processed into three-dimensional models. Similar processes have been used at archeological sites for several years, with promising results. Our results show those techniques can be used for news purposes and show similarly promising results. However, the overall process, when undertaken with a stock laptop common to mobile field journalists, takes a great deal of time that may not meet deadline pressures of today's online newsrooms.

2. RELATED WORK

Journalism as a discipline does not have an extensive history with remote sensing or geographic techniques[1], and what little discussion in the literature exists is either hopeful[5] or quixotic[7]. In 1987, late in the Cold War, a group of journalists at an American Enterprise Institute discussion on remote sensing tools for news gathering discussed launching their own network of satellites (called mediasats) to ensure they had access to higher resolution imagery for news events. According to reports from the gathering, media were tantalized by imagery from the Chernobyl disaster. However, the price tag given to them by the government was somewhere between $215 and $470 million (or $451 to $947 million in 2014 dollars). That did not include the $10-15 million per year to operate it ($21 to 32 million in 2014 dollars). At that price, the three major broadcast outlets and CNN, who were considering the satellite scheme, would spend $35,000 to $73,000 per image (more than $73,000 to $151,000 in 2014) if they used one every day for an entire year. Suffice it to say, the project never went forward. Since then, the most common use of remotely sensed images for news organizations is for illustration, a small handful of examples notwithstanding[6].

The literature of archeological uses of remotely sensed images generally and sUAS-gathered images specifically is significantly richer. The first photogrammetric recordings of archaeological sites date back to the 19th century[3]. Archaeologists and others studying antiquities have used balloons, kites, ultralight aircraft, fixed wing and rotary wing aircraft and satellite imagery to document sites with resolutions ranging from the centimeter to decimeter level[2]. Cost is a significant factor in platform choice for archeologists, and the high cost of manned flights has driven researchers toward low cost options such as kites or balloons. However, those choices come at a cost. Philip Sapirstein, an assistant professor of art history at the University of Nebraska-Lincoln who specializes in digital documentation and digital reconstruction of antiquity, said that he has watched kites careen into the ground, their onboard camera's colliding with rocks. Sapirstein said that he's also observed balloons in action, but that they become useless with any wind. An increasing number of researchers are turning to sUAS[4], and multiple methodological studies have been undertaken with largely positive results.

3. THE SITE

The ancient city of Antiochia ad Cragum sits several hundred feet above the Mediterranean Sea on Turkey's southern coast in the region known in antiquity as Cilicia Tracheia (Rough Cilicia). Located on a hillside with steep slopes and cliffs that plummet to the sea, the site, which features a harbor and protected inlets and coves, may have once been an outpost for pirates who raided coastal communities of the eastern Mediterranean. After Roman general Pompey eradicated the region's pirates in 67 A.D., Rome's client-king of Rough Cilicia, Antiochos IV of Commagene, founded the city in A.D. 72. The region experiences hot, dry summers and rainy, cold winters. The landscape features short trees, grasses and prickly bushes.

Figure 1. The site.

The Antiochia ad Cragum Archaeological Research Project was founded in 2005 by University of Nebraska-Lincoln art history professor Michael Hoff, and Rhys Townsend, professor of art history at Clark University. Excavations have included a third-century imperial temple, possibly dedicated to Apollo, a Roman bath house, acropolis, colonnaded street with shops, and a 1,600-square-foot Roman mosaic, considered the largest in the region. These structures are located within in an area stretching over 24 hectares. Hoff, director of the excavations, approached the Drone Journalism Lab because he wanted aerial images of the Antiochia ad Cragum dig site. Hoff said that he recognized the nimbleness of sUAS systems, making them a more capable imaging platform than a manned aircraft, and at a fraction of the cost. Prior to Kreimer's arrival, Hoff received official permission to perform the sUAS based aerial survey from the Turkish Ministry of Culture and Tourism's Archaeological Directorate office.

Kreimer, who had previous experience at the site excavating portions of the temple as a student in the summer of 2011, flew at the site from August 6th through 13th. His days began at 6:30 a.m. when the excavation diggers started working, and ended at 1 p.m. when temperatures approached or exceeded 100 degrees Fahrenheit. Early mornings were generally calm, with the exception a light breeze traveling west down the coast. Strong steady winds, gusts and updrafts became issues as the day progressed and the temperatures climbed. With the exception of one day which remained overcast, most days were partly cloudy, clearing up by afternoon.

4. HARDWARE AND SOFTWARE

We chose the DJI Phantom 2 for this project because of it's small size, cost, durability, autonomous capabilities, flight path programmability, and ease of use based on our own positive previous experiences with the Phantom platform. And because of the ubiquity of the Phantom 2, we wanted to see if a readily available off the shelf sUAS could carry a camera larger than a GoPro while performing tasks often reserved for higher end and larger payload capacity sUAS systems.

For a camera we chose the 12.1 megapixel Canon Powershot SX260 HS, which contains an onboard GPS for automatically tagging images. The SX260 and earlier models are popular choices for aerial mapping and modeling work because of their GPS receiver, which is useful during the image processing stage, and for the Canon Hack Development Kit (CHDK), a reliable open source firmware package that provides the camera with additional features such as an intervalometer, which tells the camera to take a photograph at user defined intervals. Such a feature is essential for taking images destined to become three-dimensional models.

Figure 2. The DJI Phantom 2 with Canon SX260 attached.

When purchased, the DJI Phantom 2 platform cost $679, while the entire field-work system, including the Canon SX260, cost $3500.

Table 1. Costs of the sUAS used.

Major Component	Price at purchase
DJI Phantom 2	$679
Six additional Phantom 2 batteries	$846.45
Black Pearl 5.8 GHz FPV Screen	$204.99
DJI 2.4GHz Datalink	$249.95
Canon SX260 HS	$225
5.8 GHz FPV Video Transmitter	$70
iPad Air	$500

We used Agisoft's PhotoScan to assemble three-dimensional models of the excavations at Antiochia ad Cragum. PhotoScan is a powerful piece of software that packages complex and resource intensive image processes into a user-friendly interface. The following overview focuses on what a new user can expect from the program, and the experiences and results Kreimer had analyzing the 2,800 (16.37 GB) aerial photographs he took at Antiochia ad Cragum.

Figure 3. A standard image of the pool and mosaic site.

Kreimer used a MacBook Air with a 1.7 GHz Intel Core i7 processor, a solid-state hard drive, and 8 GB of RAM. The Air, because of it's weight and form factor, is a common laptop model for mobile and field journalists. After the flights, Kreimer took the images from the memory card on the camera and moved them to the laptop. From there, he brought them into PhotoScan. He then followed the software's workflow, first aligning the photos by searching for and matching up common points on the images, then building a density cloud whereby the software calculates object spatial characteristics based on edges and contrasts in the image. Next Kreimer had the software create a polygonal mesh surface over the terrain's density cloud's points. Finally he added the texture, draping the three dimensional model with lifelike surface details from the processed images.

The Roman mosaic model was assembled in PhotoScan, following the above workflow, from 249 aerial images. The processing time from start to finish for the model was about 8 hours. In comparison, the model of the imperial temple and its surroundings, took about 30 hours to assemble from 949 images.

Figure 4. 3D model of the pool and mosaic site.

5. FLIGHTS

To capture photographs for creating three-dimensional models, Kreimer programmed the Phantom 2 to fly transects over the area of interest. Using DJI's iPad Ground Station app on an iPad Air, Kreimer programmed the Phantom 2 to fly at an airspeed of one meter per second at altitudes ranging from 25 to 45 meters above the surface of the structures. The camera's intervalometer was set to take a photo every two seconds while the camera's lens faced the ground perpendicularly. With this sUAS and camera setup, the captured terrain images consistently had overlap of about 50%. Overlap is crucial for making three-dimensional models, and so Kreimer wirelessly transmitted the live video feed out of the SX 260 to the hand held Black Pearl LCD screen on the ground to monitor the recorded images. To photograph the Roman mosaic it took about an hour to setup the sUAS system, plan and test the flight paths to ensure desired image coverage, fly two missions, and then pack up. The seven Phantom 2 batteries, used one at a time, allow for approximately 90 total minutes of flight time.

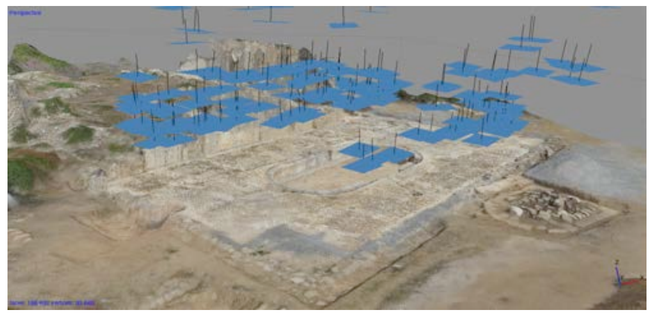

Figure 5. The model including the photo locations.

The wind challenged the Phantom while flying autonomously. Wind gusts and updrafts would occasionally cause course changes or altitude losses, causing a series of counter actions to return to equilibrium. Careful monitoring of the sUAS during automated flight was required to ensure necessary precision in programmed paths. There were no mishaps during the course of fieldwork.

6. CONCLUSIONS

Using an off-the-shelf sUAS, with a modified consumer grade camera and a laptop setup common to field journalists, we were able to produce a highly detailed 3D model and geo-referenced 2D map of an area of interest. However, in the case of the temple area, that effort took nearly two days, when flights and photo processing time are added up. For stories with longer deadlines at sites with few restrictions, this time is acceptable. In a breaking news situation, where pressures to produce are intensified, two-day production times are less desirable.

To speed up the process, two areas need to be addressed: Flight operations and computing resources.

For news purposes, a series of interrelated variables need to be considered when planning a flight. All of the decisions will affect the time needed on site to capture the images and how long it will take to process the photos. A faster forward speed of the aircraft will cover more ground at the cost of image overlap. Higher altitude flight will cover more terrain, but at a cost of image resolution and detail. The limited flight times per battery of the sUAS will also limit the amount of ground covered, as will the finite number of batteries brought to the site. Also governing these decisions will be the image overlap needed for accuracy. More overlap, as well as more oblique angles, improves the detail of the resulting model, but at the expense of time. Another constraint is light: photographing the site under similar lighting conditions is necessary for consistent tone and texture details in the resultant models.

Figure 6. Details of the mosaic site from the 3D model.

The time gains that can be made on flight times are small in comparison to the gains that could be made with additional computing resources and different processing procedures. The most significant computing resource that could speed things up is RAM. PhotoScan devours RAM, and though the company doesn't list system requirements, the processor's power, the number of cores it contains and the amount of RAM available will dictate the number of photos that can be processed at once and how fast they are processed. A more powerful computer could have done the same work in a fraction of the time. Such a machine would feature a quad core or greater fast Intel i7 or Xeon processor and at least 16 GB of RAM, with more preferred. The software also harnesses the graphics card's GPU. A high end graphics card like the Nvidia GTX 780 is recommended. Also recommended: If working with hundreds of images do not process all images at once. Divide them into chunks, the term used by PhotoScan to group images together for processing.

Going forward, more research into how journalists could adopt the photogrammetric techniques used by archaeologists to document sites of interest on news deadlines is recommended. Assessment of the impact of adopting faster flight speeds and higher altitudes would reveal the cost of quicker production. And a more formal methodology for news sUAS mapping should be created, along with training for journalists interested in this kind of work. Looking forward, media consumers could go from watching a prepared video piece to actively exploring newsworthy three-dimensional environments made possible by the techniques presented here.

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