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A Review on Geo Mapping with Unmanned Aerial Vehicles

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ABSTRACT: Inexpensive drones are capable of making sophisticated maps. Small, portable drones are quickly deployable. They carry lightweight digital cameras that can capture good quality images. These cameras can be set to take pictures at regular intervals, and digital memory is cheap and plentiful. After landing, the pictures can be knit into geo rectified orthomosaics—that is to say, they can be geometrically corrected to a uniform scale, adjusted so that they adhere to a common geographical coordinate system, and knit together. Lightweight GPS units enable drones to make spatially accurate maps. Because there is no need for the information in real time, drones do not have to carry data links that add weight and complexity. Such drones can be used at a local level to create maps rather than having to rely on centralized mapping authorities. They complement other mapping methods and fill in imaging gaps left by satellite mapping and traditional surveying. While drone mapping is a new practice, practitioners around the world have already begun to incorporate this new variety of aerial imagery into their work. In this paper, we present the process of geo mapping using drones and discussed about the useful softwares.

KEYWORDS: Geo mapping, unmanned aerial vehicles (UAV), photogrammetry,

I. INTRODUCTION

The term drones covers a very broad category of unmanned aerial vehicles (UAV) that can be used for anything from military or commercial purposes, to personal entertainment. In popular culture, when people talk about drones they are frequently referring to any of a range of quad copters that have become trendy over the last few years.

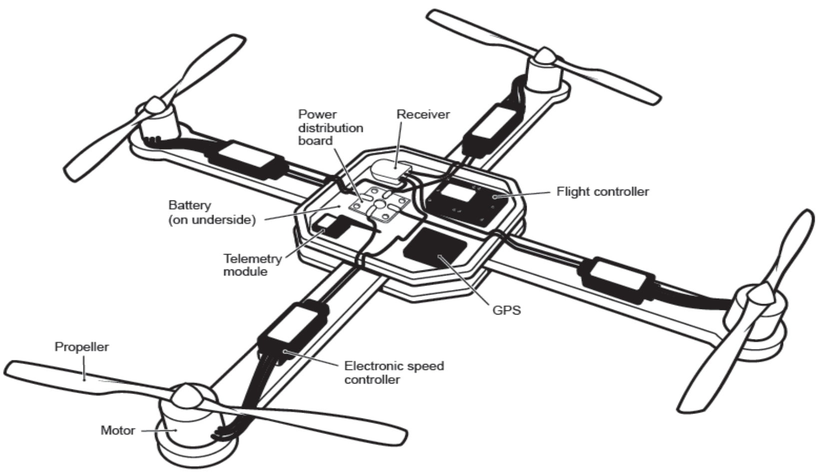

Figure 1. Architecture of a drone

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Unlike regular helicopters, quad copters have two sets of propellers, making them easier to man euvre both indoors and outdoors. Further aiding ease of use, modern quad copters have begun incorporating a range of new technology, including electronic sensors that stabilise them, with some models even controllable via a smart phone app instead of bulky controllers. Some models can even be programmed to fly set paths or patterns.

Drones are potent symbols of automation, surveillance, and secrecy, a tangible physical target amid a rush of networked sharing, snooping, and mass data storage. Emerging from collected advances in low-power computing, cameras, positioning, data transmission, sensors, and batteries, drones bring a distinct economy and scale to capturing images and information. It is tempting to take the novelty of drones as epochal given the breadth of technical mastery expressed by these nimble automated aircraft, but the capabilities united in drones, and the dilemmas they raise, are present in a variety of existing and emerging technologies. The symbolism of drones makes them convenient targets in debates about surveillance, citizenship, and technology. But these debates are not really about drones. They are debates over the dynamics of power and representation in science, surveillance, and mapmaking.

In Tanzania, the Swiss organization Drone Adventures is creating a high definition map of the megacity of Dar es Salaam images shot by a fixed-wing Sense Fly e-Bee drone have already been used by the Open Street Map project to accurately trace buildings and roads, improving the maps available to the local community.

In Ethiopia, researchers have used drone imagery to map water sources likely to harbour the larvae of malaria-carrying mosquitoes, allowing them to be destroyed before the mosquitoes spread sickness throughout the region.

In Borneo, indigenous Dayak people have begun to use unmanned aerial vehicle (UAV) imagery to document illegal use of their land and to delineate boundaries, enabling them to better defend themselves against the land grabbing practices that are common in Southeast Asia. However, drone operators need a high tolerance for risk and a willingness to troubleshoot. Fieldwork with mapping UAVs remains in its early days. There is room for considerable innovation, but also for unforeseen problems and technical challenges. Changing and uncertain regulation of drones also poses difficulties.

II. TYPES OF MAPS

UAVs can produce a number of different types of maps: geographically accurate orthorectified two-dimensional maps, elevation models, thermal maps, and 3D maps or models. If properly produced, these data products can be used for the practice of photogrammetry, which is most simply defined as the science of making measurements from photographs. Two-dimensional maps are still the most commonly created products from imagery collected by a UAV. The simplest way to create a mosaic from aerial imagery is by using photo stitching software, which combines a series of overlapping aerial photographs into a single image.

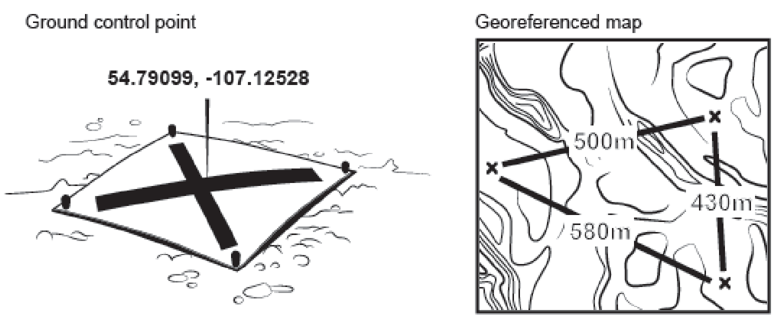

Figure 2.Accurately surveyed ground control points are used to geo reference orthomosiac maps produced from UAV imagery.

However, without geometric correction, a process that removes the perspective distortion from the aerial photos, it’s hard to accurately gauge distance. Images that have been simply stitched are continuous across boundaries, but don’t have perspective distortion corrected. Geometric correction is only one step in making a usable map. A modern mapmaker also wants to know what point on the map corresponds to what precise latitude and longitude on

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Earth. Accurately ascertaining geographical references is difficult to carry out without the aid of ground control points, accurately surveyed locations that are identifiable in the imagery as shown in figure 2. An orthomosaic is a series of overlapping aerial photographs that have been geometrically corrected (orthorectified) to give them a uniform scale. This process removes perspective distortion from the aerial photos, making the resulting "mosaic" of 2D photographs free of distortion. Orthorectified photos can be used to produce GIS compatible (geographic information system) maps for archaeological applications, for construction, for cadastral surveying, and for other applications. 3D models, which permit researchers to make volume calculations from a set of aerial images, are increasingly common outputs from UAV technology, as new hardware and software have made it easier than ever to produce them. Instead of flat, two-dimensional output created by standard photo-stitching techniques, 3D models resemble video games that let you navigate virtual worlds from within Classic photogrammetry required the use of metric cameras that had been precisely calibrated. Drone mapping instead uses a technique called "Structure from Motion" which uses the information from multiple images to obviate the need for precise camera calibration. A cadastre is a record of who owns what land, compiled for tax purposes. Other data products that can be made from UAV-collected imagery include digital elevation models (DEM), NDVI (vegetation) maps, and thermal maps, which require specialized payloads and processing software.

Digital elevation models are distinct from 3D models— they are more akin to topographical maps. They represent only the underlying terrain; surface features such as buildings, vegetation, and other man-made aspects are removed, revealing the underlying surface. In a digital elevation model, a given point in the plane has a unique height, so features with cavities—like buildings—cannot be adequately represented. NDVI maps, most commonly used for agricultural applications, are made from specialized Normalized Difference Vegetation Index (NDVI) images, which are taken with cameras that can see in both the visual and the near-infrared spectrum.NDVI imagery is used to assess whether a certain area has green vegetation or not, based on the amount of infrared light reflected by living plants. Standard point-and-shoot cameras, such as the Canon A490, can be modified to capture the wavelengths required for the imagery used to create NDVI images, considerably bringing down the cost of gathering this data.

Thermal maps image the temperatures of a given mapping area, and are useful for applications such as detecting structural damage to roads, identifying the source of groundwater discharge, spotting hidden archaeological ruins, and detecting roe deer fawns that may be harmed by mowing operations. Specialized thermal imaging cameras, such as those made by FLIR, are light enough to be mounted on a UAV and are increasingly being adopted by civilian pilots interested in gathering thermal imagery. Many of these systems remain quite expensive, and some are subject to export restrictions.

III. FLIGHT PLANNING

Planning a mapping mission entails a number of considerations. A first-order decision is whether the flight will be done under autonomous control between GPS waypoints or will be controlled manually. In either case, it is important to analyze the area to be mapped before liftoff. The area should be walked, driven around or otherwise evaluated before the mission starts so as to identify obstacles such as power lines, large trees, sensitive areas, or other potential pitfalls. Finally, it is good practice to use existing satellite imagery to plot out a flight before takeoff. The decision of whether to use manual or autonomous control hinges on many factors, but perhaps the most important is to distinguish clearly between inspection or monitoring of events or conditions in real time, and gathering information in order to create a static record like a map or a 3D model after the flight is complete. Both types of missions can be flown in either manner, or indeed, in a hybrid of manual and automatic control, however, manual control is generally more useful for inspections (say beneath a bridge) that aim to react to information in real time, while autonomous control is, as a rule, more useful when one is trying to fly in a systematic pattern to create a map. The majority of UAV mappers use autonomous control, though some pilots fly their missions entirely manually, relying on their own skill and judgment instead of trusting the computer. Pilots should know how to competently fly their UAV, even if they do plan to use it primarily for autonomous missions. UAVs should remain within the visual line of sight of pilots unless the pilots have sufficient experience, specific need, and regulatory approval to fly beyond their line of sight.

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If something goes wrong with the autonomous system, the pilot should be able to take over manual control or engage an appropriate fail-safe, like an emergency parachute. At present, commercially available autopilots do not have sophisticated sense-and-avoid capabilities, and are limited to flying from one preset waypoint to another. (Algorithmic sense-and-avoid capabilities are, however, improving.) Those who choose to fly their missions manually, in entirety or at least in part, say it is because software for autonomous flight is not always reliable under every condition. GPS interference, bad weather, or simple technical error can cause the UAV to behave erratically. Proponents of manual flight also note that it is easier to manually fly a UAV in particularly tight and unpredictable areas, such as below forest canopies or in busy urban areas, with manual control permitting changes in course and altitude to be made more quickly. Partisans of autopilots say that using an autopilot is in fact safer because it reduces the possibility of human error and of radio interference disrupting the signal between a manual controller on the ground and the drone. Some countries require that UAV operators be able to take manual control at all times in case there is a software malfunction or other issue. It's important to check the regulations in your planned area of operation before flying.

IV. DESIGNING A FLIGHT ROUTE

The design of flight paths is an important component of UAV mapping. This is typically done using software packages; many drone manufacturers offer proprietary software with their drones. Mission Planner, an open-source software package, is the single most widely used solution. The functionality of several competing software packages is broadly similar. UAV mapping missions are usually flown in a specific pattern of parallel lines, commonly described as "transects," which are connected to a series of "waypoints"—think of a connect-the-dots pattern of parallel lines, or the pattern in which you might mow the lawn. A transect flight pattern is a method of ensuring that the UAV captures an adequate quantity of images that overlap to the degree required for the processing software to create a high-quality and accurate map. For maximum quality, some UAV mappers suggest flying two different overlapping patterns over the same area but at different heights. This method collects a large quantity of data and helps to resolve elevation variation problems, which result when tall geographic features throw off the scale of the rest of the image. Others recommend adjusting the altitude of the drone to keep a constant altitude above ground level, even as features on the ground vary in altitude. To create a flight plan with transects using current software such as Mission Planner, the pilot first connects with the UAV's flight controller via either a ground control radio attached by USB cable to a computer or tablet, or a direct USB link from the UAV to the computer. (Flight plans can also be generated on the computer and uploaded to the flight controller later). The pilot opens the software and defines an area to be mapped with a polygon, then specifies the camera model, the desired operational altitude, and how the camera will be triggered to take photographs. Once these factors are entered, Mission Planner generates

In some cases, one might want to map, say, a river or a road, in which case the flight pattern would be less of a grid and more of a single out-and back path. Also, other applications in which covering a large area quickly is more important than systematic photograph overlap, for instance search and rescue, call for different patterns. a series of transects with waypoints and displays the estimated ground sampling distance, required number of photographs, and other useful information. The user can then change the distance between each photo, the amount that photos will overlap, the altitude of operation, and other parameters.

The software also attempts to compensate for the effects of wind. All these numbers can be experimented with before leaving for the flight area, making it relatively easy to plan. When complete, the mission file is saved to the computer and can also be saved to the UAV's flight controller. If there is a working Internet connection available, missions can be planned at the site of the anticipated fieldwork. Otherwise, it's possible to save the planned mission to the computer to access while in the field. Once in the field, the operator can, by the flick of a switch on an RC transmitter or computer, launch the drone. During the mission, software displays in-flight data on computer or tablet screens, including altitude, GPS status, battery status, and ground signal status.

A.SENSORS

Drone mappers use a wide range of cameras for their missions. Most cameras used for UAV mapping are lightweight and can be programmed to shoot pictures at regular intervals or controlled remotely. Some specialized devices that can be mounted on a UAV include LIDAR (light detection and ranging) sensors, infrared cameras

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equipped for thermal imaging, and air-sampling sensors. The cameras required to carry out good mapping work are not necessarily the same as those used for professional video or photography work. Cameras with wide-angle lenses, like the GoPro, are very popular for video and photography uses. However, these lenses create distortion that isn't ideal for mapping work and has to be edited out in post-processing, meaning they're not well suited to this kind of project. The same fisheye consideration goes for the proprietary cameras that are paired with some commercial UAVs, such as the DJI Phantom Vision and Vision+ product line.

The internal GPS functionality of Canon's lightweight S100 and SX260 models makes them particularly popular for UAV mapping. They can be used with the Canon Hack Development Kit, which can program the camera to take pictures at a certain interval or to take a picture based on distance or upon encountering a certain waypoint. Mounting the camera to the drone can be accomplished in various ways. As drone mapping is generally performed at only one or two angles, gimbals may be relatively simple as compared to those used by filmmakers. Motorized gimbals provide image stabilization, which can help compensate for turbulence and produce clearer imagery. Gimbals are also used for changing the angle of the camera from vertical (straight down) to oblique. Some mappers do not use gimbals at all or construct their own from other components.

B.ALTITUDE

Altitude is an important consideration when flying a mapping UAV, both for practical purposes and in the interest of flying safely and legally. Although higher altitude results in lower resolution, it allows the UAV to fly tracks that are farther apart. Higher-altitude photography also can help reduce the distortion found in images of buildings and other objects on the ground. While lower-altitude photography increases the GSD and thus the image quality, it also increases the time required to map a certain area. Aside from trade-offs in method, legality is a paramount consideration when picking an operating altitude. In many countries it is illegal to fly above 500 feet (400 feet in some cases) or 150 meters. Prudence should always be used when flying at higher altitudes, even if local regulations do not prohibit higher-altitude flight outright. It is the drone operator's responsibility to make sure flights do not get in the way of manned aircraft.

C.VIEWS

The two aerial views most commonly used in UAV mapping are known as nadir (overhead) and oblique. Nadir photographs are shot directly above the subject, with the camera looking straight down. This is the perspective most associated with a traditional map. Oblique photographs are taken at an angle to the subject below, rather than from directly overhead. They can be taken from a high or a low angle, collecting information about the landscape that overhead photos cannot, and vice versa. Photos taken from these two different angles can be combined in photogrammetry software (such as Agisoft PhotoScan or Pix4D31), creating imagery that gives users the ability to view and manipulate multiple perspectives in a single computer-generated model. Such three-dimensional model scan be used for post-disaster damage assessment, accurate urban modeling, and creating more accurate flood simulations, among other projects. During each flight, the angle of the camera shouldn't change, as this will make the resulting images considerably more difficult to process.

D.3D MODELS

3D models can be generated from either nadir imagery (shot vertically, straight down) or oblique imagery (from an angle to the side), but the most detailed models combine both into a single representation. To generate a 3D map, software requires hundreds of overlapping still images. As an example of the usual 3D-model creation workflow, Agisoft PhotoScan software first carries out the automatic process of photo alignment by searching for common points on photographs and matching them. It also deduces the position of the camera for each picture so that it can refine its camera calibration parameters. Once photo alignment is completed, the software generates a sparse point cloud with a set of associated camera positions and internal camera parameters. A point cloudis exactly what it sounds like—a set of points in 3D space, where each point, in addition to its coordinates, may have additional information such as color. A sparse point cloud is simply such a point cloud with relatively few points. A sparse cloud may be adequate to produce a less detailed 3D model that doesn't need to be precisely georeferenced. Agisoft PhotoScan requires this set of camera positions and an optimized sparse point cloud to advance in the process of producing a dense point cloud, which can

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often take as long as 15 hours on a reasonably high-powered laptop. Next, the software builds a 3D polygonal "mesh" based on the dense point cloud, representing the surface of the object—think of a net thrown over a three-dimensional object. In the final step, the software lays texture taken from the original photographs over the 3D mesh, giving the original flat imagery a sense of depth and volume. The final outcome is a detailed 3D model that can be used for a variety of specialized analyses, including archaeological research, the creation of flooding models, and disaster damage assessment

V. GPS AND GEOREFERENCING

Geo referencing is an essential process if you want your UAV map to adhere to a real-world scale. In simplest terms, geo referencing is the "process of assigning spatial coordinates to data that is spatial in nature, but has no explicit geographic coordinate system." While it's possible to create maps without any geo referencing, these maps do not correlate to the real world and can't be used for measurement. Geo referenced UAV maps are also much easier to work with, as they can be overlaid on existing coordinates in software as shown in figure. Professional UAV mapping projects almost always geo reference their work.

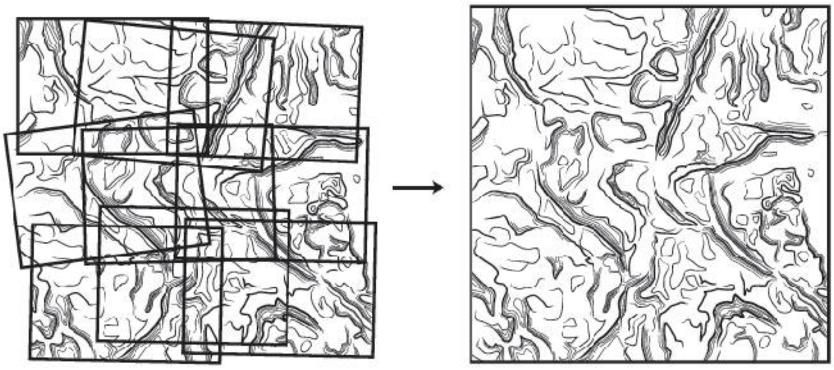

Figure 3.Processing software combines many photographs into a single orthomosiac image, which can then be geometrically corrected (orthorectified) and made to adhere to a real world coordinate system (geo referenced).

To carry out the process of geo referencing, the image processing software has to know the real-world GPS coordinates of a small number of visibly identifiable locations in the collected aerial imagery. These coordinates are referred to as "ground control points" in the UAV mapping context, and knowing how to collect them, and why, is an important part of understanding the process. It is important to determine the accuracy necessary for each mission, as both overdoing it and under doing it can have some serious drawbacks. Some maps must be accurately geo referenced using GPS technology, permitting them to be used as an accurate overlay on GIS software and in mapping applications like OpenStreetMap and Google Maps. For other uses, however, maps do not need to be painstakingly geo referenced and can instead provide a more general overview of the terrain. In these cases it may not be necessary to invest in expensive UAV hardware and software.

As an example, Indonesian geographer Irendra Radjawali uses a UAV to help the indigenous Dayak people of Borneo document the boundaries of their land and track deforestation and other illegal usage. In 2014, Radjawali mapped 30 hectares of land in West Kalimantan with a tricopter equipped with a Canon SX260 camera with an internal GPS. The Dayaks said their land had been damaged by a bauxite mining operation. As Radjawali's goal was simply to document the damage, he did not use surveyed ground control points—specific, accurately surveyed points on the terrain—to create the map, but instead relied on the GPS inside the camera, as well as his hand-held Magellan explorist 310 GPS. The resulting map, processed. It is also possible, using more sophisticated onboard GPS units, to create accurate maps without reference points on the ground. in Visual SFM, was accurate enough to show the general location of the mining damage. On the other end of the scale, researchers from the University of Twente in the Netherlands wanted to use a UAV to map customary land-use parcels in Namibia. As the goal of the mission was to

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produce an inexpensive and accurate property map that could be used for the adjudication of land borders, geographical precision was a very important consideration. To that end, the researchers designated and surveyed a total of 23 ground control points throughout the area to be mapped. The numerous ground control points were used to ensure that some would remain if the markers were blown away by the wind or removed by local people. The mission was a success, producing a map that could be used for enforcing customary land rights boundaries. In some cases, GPS receivers and IMUs (inertial measurement units) whose intended use is navigation and control are accurate enough to produce usable results for mapping. However, many simple drones do not log their GPS coordinates, but merely use the onboard GPS to feed data into the autopilot system. GPS loggers, such as the Flytrex Core 2 Flight Tracker, collect longitude, latitude, and altitude values during flight, using the same GPS chip used for navigation, in data formats that can be used to help geo reference maps. Some digital cameras, such as the Canon S100, come with the ability to track the GPS location of where each image was captured, producing data that can then be used to geo reference the image with processing software—although the positional accuracy is not as high as that obtained with ground control points.

VI. PROCESSING SOFTWARE

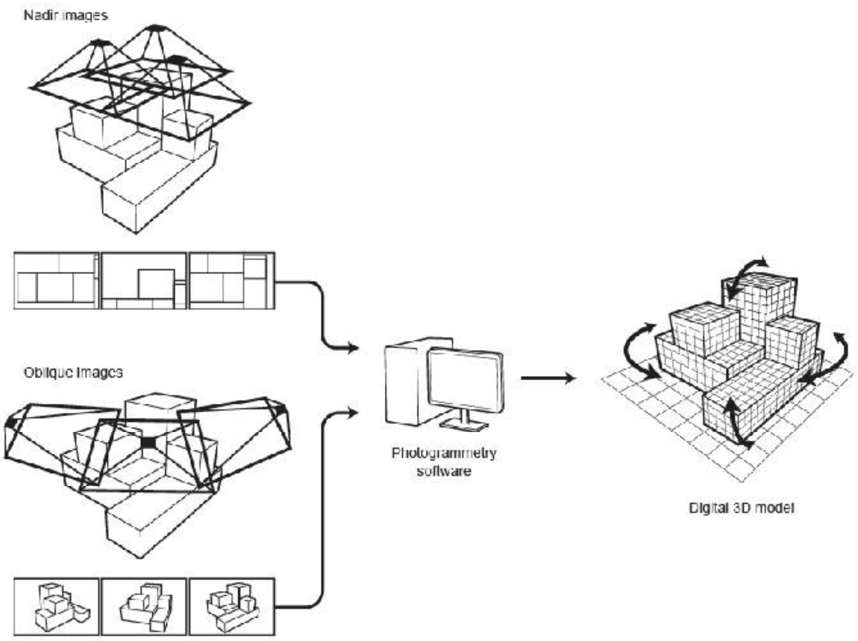

Figure 4. Photogrammetry software combines information from multiple images taken from both overhead and to the side to create 3D models.

"Having images is not the same as having a map," observes UAV mapper Cristiano Giovando of the Humanitarian OpenStreetMap Team, and he's right. Collected imagery must be processed on a computer to generate a map. Choosing a software package is highly dependent on your budget, the processing power you have available, and what you want to accomplish. There is some variety in the processing software used for UAV mapping, and the market is changing as UAVs increase in popularity. As of this writing, Pix4D and Agisoft PhotoScan are the two most popular paid aerial imagery and photogrammetry processing choices, with relatively simple user interfaces and comprehensible manuals, as well as an established track record of use for professional aerial mapping applications. Both programs are regularly updated and improved upon, as the demand for UAV mapping and the market for photogrammetry software expand. However, paid photogrammetry software is expensive and can require considerable processing power to operate, which should be factored into mapping budgets. Open-source software is another possibility for aerial imagery post-processing, including MapKnitter from Public Lab, OpenDroneMap, and Visual Software from Motion

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(VisualSFM). Microsoft ICE (Image Composite Editor) is an established choice for panoramic image stitching, although it does not create geometrically corrected orthophotos. Such open-source and free software packages can be more difficult to use and may have fewer features than their paid counterparts, but they are nonetheless powerful enough to achieve useful results. The Flight Riot website (http:// flightriot.com) provides a comprehensive overview of open-source mapping software and associated techniques, with instructions on the proper use and selection of cameras, UAV platforms, and processing software. Processing big batches of high-definition aerial imagery can be slow, and depending on how many images are being used, this can require a powerful computer processor. Some field workers will do low-quality image processing in the field to check that they have shot an adequate number of images with adequate overlap, then create a higher-quality model when they return to their computing workstations. In particular for scientific applications requiring precision, care must be taken to avoid systematic errors created by processing software. For instance, the combination of radial lens distortion and many images taken from near-parallel directions can introduce an effect called "doming," which makes a flat surface into a dome.

VII. CONCLUSION

Technology will change, faster processors will stitch together and georectify images more quickly. The acuity of photographic sensors will improve, as will the endurance and range of drones. Increasing levels of autonomy in both flight software and post-processing software will allow for the creation of cheap maps with increasingly less direct human intervention. However, the basic principles explained in this chapter—how a drone uses a camera to capture an image, how many of those images are combined with one another, and how they are geo referenced— will remain unchanged for the foreseeable future.

REFERENCES

1. Dries Raymaekers, "UAV Mapping in Ethiopia," DIY Drones, February 10, 2015, http://diydrones.com/profiles/blogs/uav-mappingin-ethiopia-looking-for-malaria-hotspots.
2. Faine Greenwood, "Drones to the Rescue," Future Tense (blog), Slate, June 3, 2015, http://www.slate.com/articles/technology/future_tense/2015/06/community_drones_helps_indonesia_s_dayaks_protect_their_land.html.
3. F. Remondino, L. Barazzetti, F. Nex, M. Scaioni, and D. Sarazzi, "UAV Photogrammetry For Mapping And 3D Modeling – Current Status And Future Perspectives," International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences XXXVIII1/C22(2011).
4. David DiBiase, "8. Digital Elevation Model (DEM)," The Pennsylvania State University, John A. Dutton E-Education Institute, College of Earth and Mineral Sciences, 2014.
5. Charles W. Culbertson, Thomas G. Huntington, James M. Caldwell, and Cara O'Donnell, Evaluation of Aerial Thermal Infrared Remote Sensing to Identify Groundwater-Discharge Zones in the Meduxnekeag River, Houlton, Maine, U.S. Geological Survey, Department of the Interior (Pembroke, NH, 2013).

BIOGRAPHY

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