Method for the visualization of landform by mapping using low altitude UAV application

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Abstract. Unmanned Aerial Vehicle (UAV) and Digital Photogrammetry are evolving drastically in mapping technology. The significance and necessity for digital landform mapping are developing with years. In this study, a mapping workflow is applied to obtain two different input data sets which are the orthophoto and DSM. A fine flying technology is used to capture Low Altitude Aerial Photography (LAAP). Low altitude UAV (Drone) with the fixed advanced camera was utilized for imagery while computerized photogrammetry handling using Photo Scan was applied for cartographic information accumulation. The data processing through photogrammetry and orthomosaic processes is the main applications. High imagery quality is essential for the effectiveness and nature of normal mapping output such as 3D model, Digital Elevation Model (DEM), Digital Surface Model (DSM) and Ortho Images. The exactitude of Ground Control Points (GCP), flight altitude and the resolution of the camera are essential for good quality DEM and Orthophoto.

1. Introduction

After a decade, the instruments for data acquisition in geodesy have been rapidly improved. The instruments become cheaper, smaller, more accurate and can gather a huge number of data within a very short time interval. These devices are light, mobile, completely automated, providing access to even most unavailable study area. It is simple to be used so that, in addition to the mapping, they are also used for various purposes of concept and other kinds of designs application. [1]

UAVs as remote sensing platforms have given many research groups the chance to obtain information at adequately minimal cost to legitimize the utilization of remote sensing in any case. These platforms may, therefore, become the catalyst for many new clients and uses of remote sensing, and will turn out to be so significantly when airspace regulations have been adapted to acknowledge them as a regular airship. UAV Photogrammetry provides information used for image stitching. Autopilot system guarantees planned flight path, camera triggered auto-control to take a picture at every waypoint. Geodetic coordinates of each image projection center are available. UAV Photogrammetry is a very promising technology that needs to be better investigated A UAV is the prominent part of an entire framework which is very important to fly machine around. Physically there is no pilot on board to exhibit the aircraft, it flies autonomously with the aid of applications designed to control the aircraft. [2] [3][4][5]
Miniaturized sensor, enhance battery innovation, and the accessibility of (UAV) have provided a new chance in engineering applications. The UAV gives a stage to short proximity and low height aerial photography. Landform hazard assessment, remake, and evaluation of degradation process are gradually being studied through digital surface modeling of landscapes. Nevertheless, the panorama of any area will reliably be extra abounding compared to any PC portrayal. The main reason for modelers isn’t photorealistic depiction, yet rather convincing ones that recount story required for correspondence with customers, partners, and anybody occupied with the landscape arrangement procedure. [6][7][8]

The photogrammetric UAV technique permits to study unsafe range with dependability, accuracy, and safety. The post-elaboration methodology must be carried out, to bring up complex geometric surfaces attributes identified with geological and hydrological information. LAAP provides 3 ways of information; forward information, documentation, and the preliminary investigation. The conventional photogrammetric documentation technique delivers good quality Geographical information with high spatial resolution, especially on the utilization of the aerial platform of flight elevation and the degree of territories. The conventional photogrammetric documentation technique provides very quality and high spatial resolution Geographical Information, particularly considering the degree of the territories examined and flight elevations of the aerial platform utilized. [9][10]

2. UAV and technical specification
The DJI Phantom 4 Pro quadcopter UAV was used for the image acquisition as shown in figure 1. The drone automation weight around 1.388 kg makes it a powerful, low cost, low weight UAV class. The cruising speed of UAV is on average 45mph with 28 minutes flying period in low wind condition. It is viable to cover a 5km radius from take-off point. Flight altitude can be differently and must follow the national aviation regulation which is 120 m from ground level, obviously for the need of image resolution, the altitude should be adjusted to achieve the preferable Ground Sampling Distance (GSD). Imagery has been taken using high-resolution 1-inch 20-megapixel CMOS sensor. It has integrated GPS facilitates every image with geodetic coordinates with maximum frame size of 5472 × 3078 pixels.

![Figure 1. DJI Phantom 4 Pro quadcopter.](image)

3. Image acquisition
The normal workflow accepted for image acquisition has been used by many practitioners. Following are the steps for image acquisition as shown in figure 2.

![Figure 2. Workflow of image acquisition.](image)
The UAV mounted camera receives capturing pictures during autonomous flight. The smartphone application, Map for Pilot (MAP) or Drone Deploy mission planner and autopilot board are used during autonomous flight. The Google Earth feature is used to imply waypoint and flight. This feature activates self-sufficient pictures and autonomous take-off and landing. Mission Planer highlights waypoint passage by point-click and alters the coveted flight parameter before transfer the mission, so that the UAV can take off to perform the mission. Vital component of nature of the information checking is image resolution and clarity. The captured pictures are examined right after the consummation, and if needed, a flight is rehash. All the data collections and examinations are done in real time.

Experimental flight using DJI Phantom 4 Pro plan to conduct a short flight and gather imagery. Arranging for the flight relied upon great climate, still wind and optimal altitude. UAV flight was carried out over the airspace domain of Universiti Sains Malaysia Nibong Tebal (USM) and Universiti Malaysia Perlis (UNIMAP), the northern region of Malaysia. About 5 ha and 7 ha of flight territory in USM and 15 ha in UNIMAP. Landform with same geomorphologic was specially picked as the focus was on the use of photogrammetric means for image capture in USM. Meanwhile, in UNIMAP the image captured at the landform with differential geomorphic features. The flight strip was produced as square polygons with obtained imageries. It was conducted about 60m above ground, which enables to capture GSD of the 3.5cm image.

4. Photogrammetry Image processing
The photogrammetric technique includes many processes for example orientation, aerial triangulation, bundle adjustment, build dense cloud, build mesh, build texture. The camera parameters, focal length, principal points coordinate, and the pixel sizes are essential for interior orientation. The detailing of these camera parameters is outlined right before the handling stage. The points between images are exchangeable through image connection algorithm at relative orientation. The Tie points are used to adjust images in alike conditions.

![Flowchart of Image Processing Using Agisoft Phothoscan](image)

*Figure 3. Flowchart of Image Processing Using Agisoft Phothoscan.*
The outputs were extended to local coordinate system by Ground control points (GCP) prior to image processing. While Real Time Kinematic Global Positioning System (RTK-GPS) collects the GCP, and it is essential to adjust the height elevation value because drone mapping has high error in z elevation compared to the x and y coordinates. Landform with different morphology requires the use of GCP with at least more than 5 readings. The outcome of this study is being discussed in digital orthophoto and digital slope model. These both input can be exported into other softwares such as Global Mapper for further analysis. The figure 3 below shows the flowchart of image processing using Agisoft PhotoScan software to extract the orthophoto and digital surface model.

5. Results and discussion

The study is presented in digital orthophoto and digital surface model. The tie points and GCP are used to generate Digital surface model prior to aerial triangulation process. Independent orthoimages are used to generate digital orthophoto in photogrammetry process. figure 4, 5, and 6 shows the example of DSM and digital orthophoto after photogrammetric processing. Based on these outputs, the study area contour also can be created by underlying the digital orthophoto and DSM in Global Mapper Software.

![Figure 4](image1.png)
(a) Digital Surface Model (b) Digital orthophoto in USM Site A.

![Figure 5](image2.png)
(a) Digital Surface Model (b) Digital orthophoto in USM Site B.
The landform can be categorized based on the visualization of the 3D model and digital orthophoto. A better understanding of the overall landscaping of the area can be achieved through this method. This technique could be a preliminary step for remodeling or restoration of the landform with a complete understanding of the overall study territory. The remodeling and restoration/improvement scheme can be designed by considering evolved local topography, enhancement of the economic and ecological value. The application of digital photogrammetric workstation is partially functional. Therefore, cartographic data collection and the UAV image processing needing spatial software. DEM analysis detaches from the generated produce, shows appositeness of DSM adjusting precision mapping tool.

6. Conclusion

Low altitude UAV capable to produce data to further understanding and analyzing the landform by covering the whole study area. Modern devices such as GPS satellites can be very helpful for photogrammetry process and advanced visualization techniques, these help to fulfilling the landscape documentation and visualization. Geographic framework, finished 3D digital reconstruction and rendering technique constitute a prevalent modern and coordinated method for depicting a landscape and also manage with its protection and progression.

Acknowledgments.

The author would like to express their appreciation to Universiti Sains Malaysia Research University(RU) Grant (1001/PAWAM/814192) for the financial support to carry out this research.

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