UAV Based Image Acquisition Data for 3D Model Application

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Abstract. The UAV mapping has a huge potential for a number of sectors including construction, agriculture, mining, infrastructure inspection and real estate. The demand for high quality aerial data capture from UAVs or unmanned aerial vehicle (UAV) is growing fast and increase rapidly. In civil application, UAVs are used as an assisting tools for a large scale aerial mapping of the building which in general it’s a challenging task for surveyor to do because of the unreachable access area, time consuming and often cost expensive due to the limited resources and equipment. In this thesis, the UAV based mapping is introduce to overcome this problem. The selected place to do the research is the building around Taman Sri Layang, Mentakab Pahang. A flight mission plan was developed in two path that is path A and path B and uploaded in UAV. In this study, the DJI Mavic Pro drone is used to do the mapping process. Besides that, the UAV will capture and collecting visual image when flying from different flight path. Both flight path covers 6 acres area, with 80% overlap and 70% side lap. The total picture is captured using path A and path B around 157 and 147 figures respectively.

1. Introduction
UAV is an unpiloted miniature aircraft flying autonomously with on-board Global Positioning System (GPS), stabilizing on-board 3-axis gyro sensor and magnetometer in autopilot microchips, and tracking UAV telemetry at Ground Control Station (GSC); The aircraft is controlled at the ground control station (GSC) via radio control and changed to autonomous at a fixed altitude [1]. The UAV system also features various sensor such navigation control, barometer, sonar, flight control and inertial navigation system [2–6]. There are several types of UAVs which are affordable on the market. UAV photogrammetry defines measuring systems that function either as autonomous, semi-autonomous or remote. The concept includes gliders, airships, kites, balloons, rotary, and fixed wing UAVs with the capability for photogrammetric data acquisition in automated, semiautomatic, and
manual flight modes [7]. UAV's flying height is about 100 to 300 m above the ground level and flying below cloud. The correct Earth-based flying height is necessary to prevent distortion of the picture. The flight time is dependent on the energy source being used. For hand launch of lightweight or micro UAV, the maximum payloads are 1-2 kilograms only. Usage of various power sources can impact flight length and area coverage. The aircraft perform 2 or 3 flights for battery power to cover a large area [1].

Over recent years, the applications of UAVs have become popular in the field of geomatics. Photogrammetry is a technique used for mapping by using drones. The science of making measurements from photographs are known as photogrammetry. UAV photogrammetry is a new measuring tools in photogrammetric purposes with combining a close-range photogrammetry, aerial mosaic imaging and terrestrial photogrammetry [8-12]. Mapping is the prime use of UAV photogrammetry. Both planimetric and topographic maps can be compiled from aerial photographs to a specified level of accuracy. In the other hand, it also one aspect of the geomatic program used to calculate and chart the surface of the earth. The ground and aerial photos are used respectively to derive the descriptions and building shapes [13]. The small format digital camera can be mounted onto UAVs. This platform provides various modes of flight, such as manual, semi-automated or fully automated [14]. Furthermore, this also introduced a real-time application and it is a low-cost alternative compared with the classical manned aerial photogrammetry.

This study is carried out by doing mapping for Taman Sri Layang, Mentakab Pahang using the image captured and mapping technique by drone. The UAV used in this study is the DJI Mavic, Professional. The UAV weight (including propellers and battery) is about 743 g and the diagonal size (excluding propellers) is 335 mm. The maximum speed can exceed 5 m/s (no wind at ATTI mode) and has a GPS feature that uses GLONASS satellite. The UAV maximum flight time is approximately about 1620 seconds. This UAV can be operated by a single person to capture the image data. This study used a 12.35 M pixels camera sensor with 4000 x 3000 resolution and the process of camera calibration also improves of principal points, focal length, tangential lens distortions and radial lens distortion. These camera parameters have to be included in digital image processing during the process of interior orientation.

2. Methodology
This study includes two phases which include preliminary analysis and planning and preparation of data collection. The approach plays a significant part in the proper execution of this an. The first step involves the preliminary study and work preparation which are critical aspects of the analysis involving a lot of planning. The first step involves also identification, calibration UAV and data measurement. The next additional constraints the collection of data using UAV. Then, data are processed using computer.

In this UAV system, the pilot act as Ground Control Point (GCP) that control and keep monitoring when drone is in autonomous flight mode. Furthermore, the GCP also sent UAV commands from ground. Besides that, UAV used Global Positioning System (GPS) when flying that made it were known as autonomous navigation system. The UAV sending a real-time streaming of the image to GCP when hovering in the air and move from one waypoint to another while captures image on the ground. The block diagram in figure 3.2 below shows the operation of UAV when doing mapping to capture image for collecting data.
2.1. Calibration Process of UAV System

First of all, calibration is an important thing to do before fly. Equipment such as UAV’s, remote controller & computer needs to be checked whether it works well or not to avoid crash and system failure due to malfunction. Subsequently, this phase should be done carefully to verify that UAV is in good state and ready for take-off. The DJI Go 4 apps is used for calibrating in this project. The apps are connected directly with drone. The calibration that needs to be done is compass, camera and IMU.

When calibrating compass, make sure to keep away from magnetic objects as it will disturb the accuracy of compass. The Inertial Measurement Unit (IMU) that include the accelerometer of UAV need to calibrate first to set up the standard attitude of UAV and reduce errors caused by inaccurate sensor measurements. The image quality is determined by the camera performance so to determine the lens parameters, camera also need to calibrate too.

2.2. Path Planning Determination

Flight planning eventually help to achieved mission goals, keep track of flying height restrictions, to avoid restricted air spaces and battery life performance. For mapping, it can be very helpful to plan out the number of flight paths or waypoints, area to be flown, number of images taken at certain area, determine the time taken for one complete flight mission and the overlap between the images.

The flight path is develop using Drone Deploy application that can be access from laptop or smartphone as shown in Figure 2. This study focused on mapping to capture visual image of selected ground area. In this apps, there were several autonomous plans operation that is maps & models, photo report, video and panorama. For this project, the map and models were chosen as it suitable for development of flight path and waypoint for mapping process.
Next, the mapping area is selected and flight path or waypoint is generated according to the size of the area. The area of this project is 6 acres and flight attitude are set up at 200 feet above the ground. Other advance setting is also set up for flight direction, flight speed during mapping, starting waypoint, obstacle avoidance, the front overlap and side overlap. Figure 3 shows the setting of parameter for flight path before take-off.

After all parameter setup, the flight plan is uploaded into UAV, the UAV is ready for take-off as shown. The UAV will go back to Return-To-Home (RTH) automatically when the mission is complete. In this study, the capturing image and collection data is done in a good weather and the present of sunlight. Besides that, there are 2 flight path that were develop in this research that is path A and path B as shown in Figure 4.
Then, the data from UAV is transferred to computer using USB cable. The UAV is turned on and connected to computer through a USB cable. The data is placed in one folder before proceeding to image processing part.

3. Result
Drone planning includes managing of study area dimension, number of strips required, pixel size, flying height of the image scale, and percentage of the end lap and side lap. The DroneDeploy used is a drone friendly app and can design for the drone and can develop drone planning. There are approximately 157 and 147 image numbers with 200 feet of height generated in drone planning using paths A and B respectively. The aerial images will usually be overlapped by at least 80% and the side by at least 60%. To ensure quality photogrammetry results can be obtained, this requirement must be met. As shown in Figure 5 the personalized parameters such as spatial endlap, sidelap, altitude, resolution, and wind direction.

![Figure 5. Flight planning for acquisition of data.](image)

The flight planning is uploaded to the UAV after parameter setting of the flight planning is completed in the DroneDeploy. After uploading, press the Start button to start acquiring the image. Once it began the UAV gave information about the mission’s current altitude. Images are automatically taken every 2.5 seconds after the UAV has reached the survey area, and the same speed is used to ensure accurate data. Upon completion of the mapping the UAV returned to the take-off site and immediately landed. The UAV has taken 593 seconds to capture 157 images using path A, as shown in Figure 6.

![Figure 6. Captured image by UAV using vertical path mapping](image)
Meanwhile, 147 images were taken by the UAV through path B for 646 seconds as shown in Figure 7, which is slower than path B mapping technique as shown in Figure 7. Left and right of the images show the overlap and side lap of captured image by the UAV. Both path technique covered 80% overlap and 70% side lap.

![Figure 7. Captured image by UAV using horizontal path mapping](image)

4. Conclusion and Recommendations
As conclusion, the flight path planning was developed in 2 path using DroneDeploy software. Then, it was upload into the UAV in order to design path mapping. After that, all visual image from UAV during flight from different flight path was collected. Using the DroneDeploy software to create 3D image the mapping is produced from the UAV images. All the images went through the process of scaling and leveling which also made reference to orientations such as interior, relative and exterior orientation. It is shown that the UAV, together with the digital camera, is capable of successfully acquiring aerial photograph in a short period of time for large-scale mapping. This study shows that UAV is also able to generate mapping of road in the selected area of study. Various types of UAV can be used to increase the versatility of survey works; for example, a fixed wing UAV will cover a wide area for the building map to get more data. To optimize the quality of UAV image processing different methods of camera calibration could be applied. UAV should use different flying heights to achieve better results for precise 3D model.

Acknowledgments
The Faculty of Engineering Technology is highly acknowledged for providing the facilities for carrying out this work. The authors would also like to thank all people who have participated directly or indirectly in this study.

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