ISSN 2278-3091
Volume 9, No.1.1, 2020
International Journal of Advanced Trends in Computer Science and Engineering
Available Online at http://www.warse.org/IJATCSE/static/pdf/file/ijatcse5991.12020.pdf
https://doi.org/10.30534/ijatcse/2020/5991.12020

Visual Inspection of High Risk Slope by Micro-UAV Air-craft

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ABSTRACT

Continuous monitoring and inspection of slope can provide early warning before the landslide. The conventional method practices now for slope monitoring through routin inspection by inspectors that need to climb the slope and hillside to check visually. Therefore, this study aimed to test the extent to which the use of micro-UAV flight can help in visual inspection and monitoring of the slope. Purposes of this study is to record visual data on the slope obtained using UAVs, before processing and analyzimg visual information in order to determine any damage occurred on the slopes as well as to produce Digital Terrain Model (DTM) and contouring lines. This study was carried out at an area of high risk slope in Bukit Setiawangsa, Kuala Lumpur. The methods involved in this study are start with flight planning and prepa-ration, obtain visual data and information from micro UAV flying height of 30 meters to produce a 3-dimensional image and 2-5 meters before analyze and produce 3D slope model using Agisoft Photoscan software. The 3D model were used to identify the location of the damage on the slope for a long distance of 30 meters and a short distance of 2-5 meters. Slope damages such as erosion, vegetation cover and cracks were visually shown in the 3D model image. Digital Elevation Model '(DEM) was used to mapping different heights area on the slope. Information obtained examination is essential in giving the impression and impact that may occur based on the current situation on the slope structure so that maintenance work can be acted upon before the mishap. The usage of micro UAV aircraft as one of the new alterna-tives to capture and identify the damage for the purpose of monitoring the slope of the surface structure. This method expected to facilitate the work of inspection slopes in addition to saving time, energy and cost as well as to reduce the risk of harm.

Key words : Micro-UAV plane, high risk slope, visual inspection.

1. INTRODUCTION

Generally, Malaysia is tropical climate, with high rainfall and high population density is not exempt from dealing with issues of disaster. Floods, flash floods, landslides and severe haze episodes are some of the natural hazard that is common in this country [1]. Instead, landslides are usually found in the form of slope failure in a man-made slopes, especially the slopes involved with cut and fill activities which often occurs along area highways, residential area and urban [2]. Lately, the use of Unmanned Aerial Vehicle (UAV) is increasingly popular for generating 3-dimensional image. This technology is now used in a variety of applications covering various fields such as detecting soil erosion, landslide detection, dynamic landslides and disaster monitoring [3].

When movement is detected on slope, an important step in the evaluation of a landslide is conducting a quantitative study on the unstable area. This objective is to obtain detailed orthophotos and it is a valuable resource for mapping and classifying morphological phenomena that occur at that point [4].The action taken is like inspecting the slopes in the early stages and the data obtained will help during the maintenance process of the slope. Initial information obtained will provide preliminary information on the slope and slope stability to know the level prior to the occurrence of slope failure [5]. Inspector that inspecting and monitoring will climb up to the top of the slope for the purpose of taking photographs for inclusion in the work report [6]. Thus it can be seen that there are risks and hazards, and take a long time in the process of making a slope or slope data [7]. Micro UAV is a tool that provides visual information more clearly and comprehensively from every desired angle [7].The technology uses a camera mounted on the UAV to take quality video and picture. Micro UAV is widely used in public use for the purpose of mapping for extremely clear images obtained from the image statelit [8].This study focuses on the use of high-resolution digital camera combined with a platform that is very light and is known as a drone to capture images from the aerial [9]. This study was conducted to determine the extent to which the use of Unmanned Aerial Vehicle (UAV) can assist in the inspection of the slope. In this study, there are a number of objectives to be achieved. Among them are:

i. To produce a 3-dimensional model of the slope and contour lines.

ii. To determine defects that occurs on the slopes.

The study involved examining the surface structure of the slope at Bukit Setiawangsa, Kuala Lumpur and a slope that was once the occurrence of landslides and categorized as class IV (high) with a residential area on the slopes. The slopes also have steep angles and the area is relatively large [10]).

2. SLOPE MONITORING

Slope is associated with the height of an area. The researchers believes that the higher the gradient of the area will also be more steep. Whereas, 'Ruins' means objects that have fallen, container and other buildings damaged. The exposed slopes have an angle to the horizontal angle of the slope known as uncontrolled [11].The slope can be categorized into two types of natural or man-made such as fill or cutting slope [12].

The effectiveness of monitoring depends on the extent of the slope give adequate warning before it failed, and depends also on the ability of the monitoring system to detect the warning [13].Visual inspection of the slope often needs to be done to check the stones are loose and potentially dangerous. Besides identifying the deterioration slope caused by weathering, erosion, cutting and blasting damage. Instead of probing failure will occur. The emergence of crack can be an early sign of failure and it is important to monitor the cracks occur. This can be done by recording the number and width of cracks at regular time intervals. This is suitable for low hazard potential failure [14].

Unmanned aerial vehicles (UAV) developed for a variety of uses in this century in the construction industry such as monitoring the construction site, construction inspection, thermography, infrared, photogrammetry, transport applications and also for marketing activities [15].The most obvious application is as a platform for UAV camera. Aerial photography for the project using an airplane or helicopter conventionally has led to high expenses. However with the use of UAVs to replace the conventional method capable of providing images of high quality video to a lower cost [16].

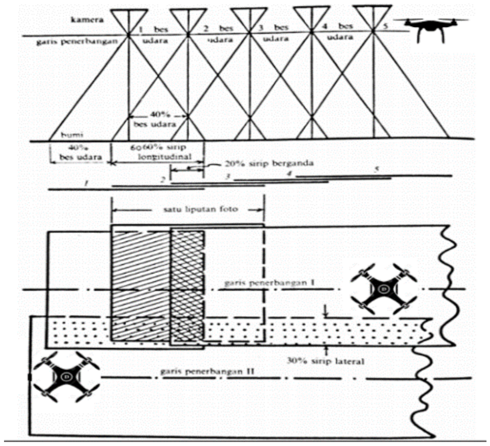

Figure 1: Taking of Aerial Photography at 60% Front Fins and 30% Side Fin

Image of aerial photographs taken in accordance with the characteristics of the flight path that is straight and parallel. Images are taken at intervals a certain time so that the area covered by each image along the flight path contains most of the photo image area covered by the previous image. Thus, each pair of photo image is composed of two pieces of adjacent images in which the image content is 60% identical at the two images that between the two images must be at least 60% fins. Every band photos must also be drawn so that there is approximately 30% between the two lateral fins adjacent strips to ensure that all parts of the earth are not left behind in the shooting [17] as shown in Figure 1.

3. RESEARCH METHODOLOGY

The research methodology of this study is to ensure that the data collection methods used to be achieved the objectives. Figure 2 below describes briefly the overview of the process and workflow involved in the study.

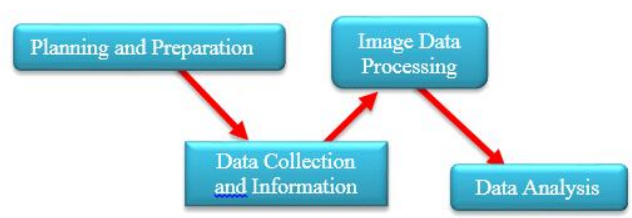

Figure 2: Workflow process

There are two methods of data collection in this study. The first method is a snapshot image of the distance of 2-5 meters as shown in Figure 3(a) from the slope surface using horizontal flight patterns to identify the image damage to the structure of the slope and snapshot image for a distance of 30 meters from the downslope to produce slope structure in the 3D model using software Agisoft PhotoScan and detect failure by visual as shown in Figure 3(b).

Figure 3: Flight track of snapshot image at height (a) 2-5 meters and (b) 30 meters from the surface

To get the coordinates and the altitude more accurate Global Positioning System (GPS) GPSMap 78s model is used as shown in Figure 4(a) to facilitate the work of decision-ordinates. There are coordinates of Ground Control Point (GCP) as the control point on the ground. 7 GCP required in this work so that 3-dimensional images can be generated accurately as shown in Figure 4(b).

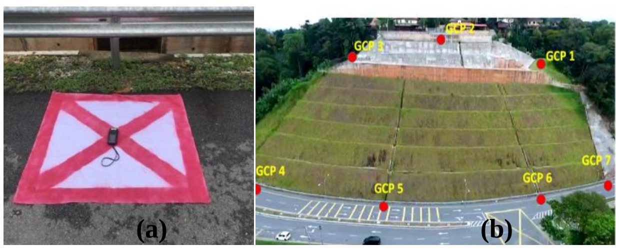

Figure 4: Placing GPS Map 78s at the location of Ground Control Point

Results from two different flight pattern data will be processed by software Agisoft Photoscan for generating 3D images are required. Data from a height of 30 meters will be processed by using Agisoft Photoscan in the production of 3D images and data at a distance of 2-5 meters is processed to find defects that occur on the slopes.

4. RESULTS AND DISCUSSIONS

4.1 Data Analysis for 3D Structure Slope Model and Labelling Slope Location

Data obtained in the form of an image that is 30 meters from the foot of the slope angle of the camera as opposed to the surface of the slope will be reviewed to insert images into Agisoft Photoscan. The selection focuses images overlapping images of at least 60% of 2 layers of images taken. The selection is made in such a way to ensure the quality of the 3D model of the structure slope will be more accurate and neat as shown in Figure 5. Figure 6 shows a 3D model of the entire slope area of study. Next, the marking of 7 coordinates on the 3D model of slopes to be linked into the Google Earth Pro software to identify the position of the slope as shown in Figure 7. Table 1 shows 7 coordinate value marked on the slopes of the 3D model.

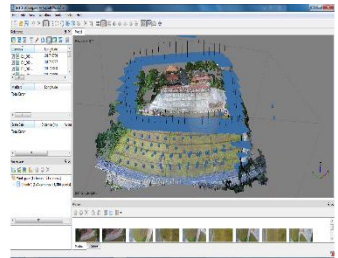

Figure 5: Combination of 42 Pieces Pictures by Agisoft PhotoScan Software

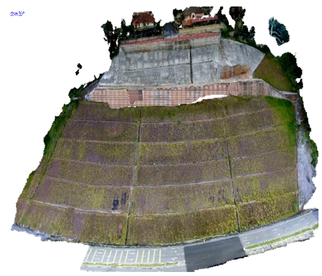

Figure 6: Structure 3D Model Slope at Research Area

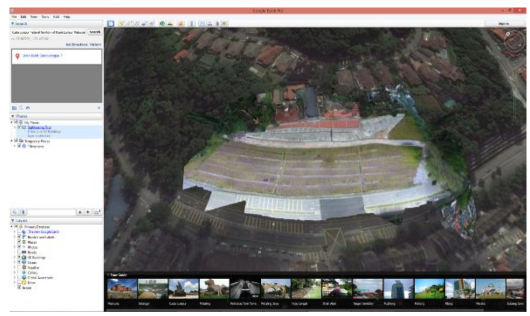

Figure 7: Location in the Study Area In Google Earth Pro

Table 1: The Coordinates for Longitude, Latitude and Altitude entered at Each Point for Marking Coordinates

Markers	Longitude	Latitude	Altitude
point 1	101.443600	3.110770	123.139200
point 2	101.443440	3.110880	131.368800
point 3	101.443270	3.111010	126.796800
point 4	101.443060	3.111000	111.801600
point 5	101.443170	3.110680	116.433600
point 6	101.443340	3.110680	115.214400
point 7	101.443450	3.110620	113.080800

4.2 Data Analysis for Determining Damage Structure Slope Images

Data obtained in the form of snapshots within 2- 5 meters from the surface of the slope studied to identify structural damage to the surface of the slope. Some structural damage to the slope in the results of this study have been identified. The images captured along the slope will be combined in Agisoft Photoscan software to produce 3D models. After investigation, there are three types of damage that have occurred on will be slopes of cracks, cover plants and sediment. There are two cracks were found, one in the concrete wall and another ground cracks. In fact, there are two settlement prevailing happen on soil. In addition, the plant cover also the damage that has been found. All the damage was combined and produces a 3D model where each is shown in Figure 8-12.

Figure 8: Damage Analysis of 3D models Vegetation Coverage

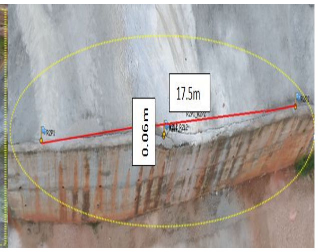

Figure 9: Damage Analysis of 3D models Crack No 1

Figure 10: Damage Analysis of 3D models Crack No 2

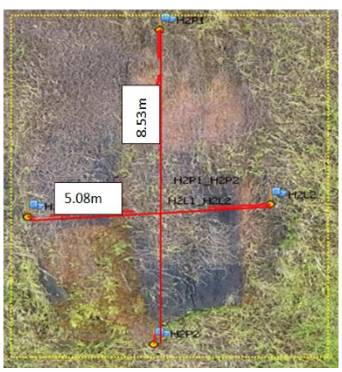

Figure11: Damage Analysis of 3D Models Soil Erosion No 1

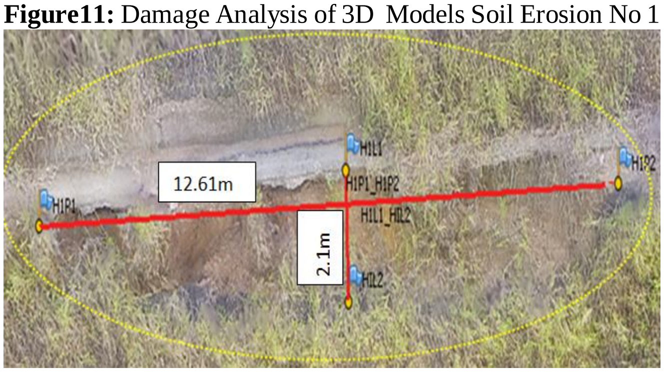

Figure 12: Damage Analysis of 3D models Soil Erosion No 2

All the 3D damaged model are linked to the overall structure of a 3D model of the slope using Google Earth Pro software, as shown in Figure 13. Finally, the coordinates of the damage can be identified from google earth pro, as shown in Table 2

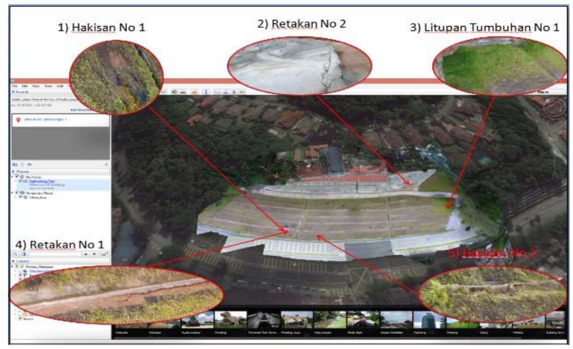

Figure 13: Damage position at The Slope Structure in Google Earth Pro

Table 2: Damage Coordinates of the Structure of Slope Obtained from Agisoft Photoscan

Damaged No	Latitude	Longitude
1	3°11'8.87"N	101°44'32.00"E
2	3°11'7.94"N	101°44'35.51"E
3	3°11'6.93"N	101°44'35.82"E
4	3°11'8.99"N	101°44'32.07"E
5	3°11'8.49"N	101°44'32.52"E

4.3 Data Analysis for Monitoring Process purposed Used on the Slopes.

The findings of inspection of this slope can be used in monitoring the slope. There is some data that can be produced for use in monitoring the slope. Data can be produced is like 'wiremesh line' which has a value of height z coordinates of a place in the AutoCAD drawing. In addition, the acquired data are exported into the format 'tif' to produce 'Digital Elevation Model (DEM). In fact, this data can also be inserted into the ArcGIS software to create a Digital Terrain Model (DTM). Figure 14 show Autocad drawing data in the form of value-xyz and distance while Figure 14 shows the data in the form of a DEM and DTM data also Figure 16 shows process of software ArcGIS. All data are derived from the 3D model Agisoft Photoscan that have been exported. Figure 17 show the contour that can be made from Agisoft Photoscan data and be exported to Global Map to produce the contour lines.

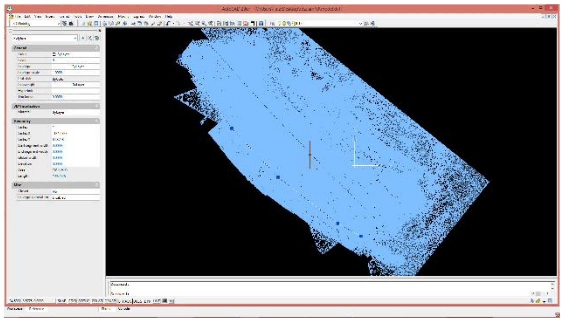

Figure 14: The geometry of the area in AutoCAD

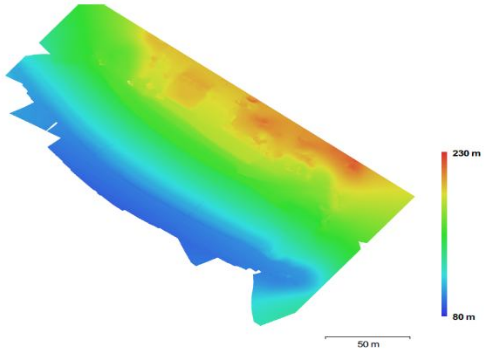

Figure 15: Digital Elevation Model

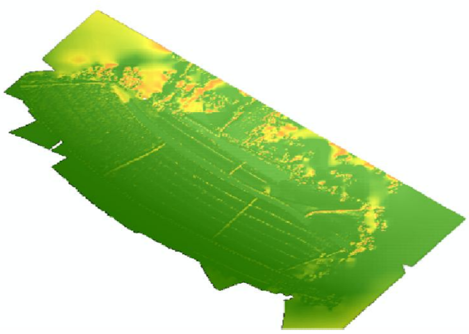

Figure 16: Digital Terrain Model of software ArcGIS

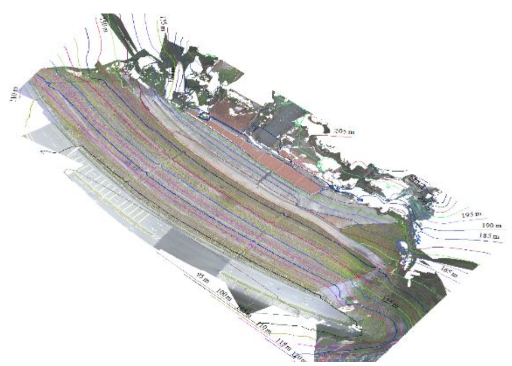

Figure 17: Contour Lines On Global Map sofware

5. CONCLUSION

The latest advances in digital imaging, low cost, navigation systems, and software development has created a tool that can generate 3-Dimensional model accurately without using a data acquisition system that is expensive grade mapping such data porolehan taken by plane. In addition, advances in mobile mapping systems such as Unmanned Aerial Vehicle (UAV) has resulted in a 3-Dimensional model that is more accurate and can be used when needed. In conclusion, the use of micro-UAV flight in assisting the work of inspection should be introduced for the slopes inspection especially in high risk slopes. This method can improve the slope inspection for the saves time and energy also to guarantee the safety of inspectors. In addition, through this research is what can be described as the study is suitable to be performed on a man-made slopes due to man-made slopes usually have a flat surface against the natural slope of trees.

ACKNOWLEDGEMENT

The authors would like to express our deepest gratitude to all parties who have contributed to this research, especially to Tier 1 Vote H123, Office for Research, Innovation, Commercialization and Consultancy Management, (ORICC), Center of Diploma Studies (CeDS) and Fakulti Awam dan Alam Sekitar (FKAAS), UTHM.

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