Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 1, 2021, Pages. 3097 - 3104
Received 15 December 2020; Accepted 05 January 2021.

Unmanned Aerial Vehicle (UAV) Visual Monitoring in Construction

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Abstract

Inspections on the construction site are required from one phase to another until the project is completely done. Progress of work can be run smoothly by the planning schedule based on the proper and good inspection on site. Currently, inspections at construction site experience several problems and challenges during data collection as it only depends on human sensory capabilities. The problems occur when monitoring and inspection on the progress of work are when it was conducted in quite a large area of the site. Engineers or contractors are unable to monitor activities that occur visually in all areas for a short period of time. Besides, the limitation and inability to monitor the whole area of the site from different points of view is one of the problems that contribute to the percentage's analysis could not be implemented. The propose of this study is to monitor the progress of work that was conducted visually by using UAV technology and to analyse the visual information in the form of images to assist the monitoring of work on the construction area. This study was conducted at the construction site located on the banks of the BatuPahat river in the city of BatuPahat, Johor. The data was collected by using Pix4Dcapture for two consecutive months where each image was processed by using pix4Dmapper software to produce orthomosaic images that depict the entire study area. The result indicated that there is a progress of work that had been successfully constructed in a certain part of the construction area which could be seen visually through images processed using pix4Dmapper.
Keywords: Unmanned Aerial Vehicle (UAV), Pix4Dmapper software, Orthomosaic images& Construction site inspection.

1. INTRODUCTION

The problem faced by the contractor during the progress of work is the limitation in monitoring the entire area of construction site at a certain time. This is due to the limitations of workers and spacious construction areas thus lead to a longer period of time in solving certain problems and monitoring. In recent years, several delay projects are increasing due to observation of work at the early stage that was not handled properly due to a lack of information regarding the progress of work at the site. The construction industry was one of the branches for the country's economy as it was the utmost important sector to improve economic growth. Generally, there are two types of construction which involve building and civil structure such as bridge, road construction and etc. (Rahman & Kadir, 2018). Construction management is a way to manage an activity that involves work from the beginning until the project end. Systematic monitoring of onsite construction operations can bring an immediate awareness of project-specific issues (Turkan *et al.*, 2013) (Golpayar e*t al.*, 2011) (Golpayar e*t al.*, 2012) (Navon & Sacks, 2007). It could help site engineer to survey, planning, monitoring technical aspect of construction. In the previous year, visual monitoring has been an important part of monitoring every activity that occurs onsite. To

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highlight the deviation in construction progress, several visualization methods are also proposed that color code construction elements based on the metaphor of traffic light color (Golpayar e*t al.,* 2007). However, one of the limitations is that implementing the current method is time-consuming, costly and prone to errors (Yang, 2015). Unmanned Aerial Vehicles/Systems (UAVs/UASs) are defined as any aircraft that works without a human pilot on board (Kaamin*et al.,* 2016). The rapid advances in sensing, battery, and aeronautics technologies, together with autonomous navigation methods and equipped low-cost digital cameras have helped make UAVs more affordable, reliable and easy to operate (Puri, 2005).

Unmanned Aerial Vehicle (UAV) is one of the fastest and most popular technologies in the world nowadays. UAV is one of the technologies that have the ability of captured images and videos from the top of the sky to produce something that difficult to capture from human eyes. Currently, contractors started to use this medium to facilitate their work in conducting and monitoring work processes in construction sites. Technological advancements in recent years have resulted in a more reliable, cheaper, and easy-to-control aircraft design system without UAV (Mokhtar, 2018). Next, by capturing a huge collection of photos and videos, along with visual data processing methods into 3D models, these platforms often perform construction site surveys, monitor ongoing work, create security documents, and inspect existing structures (Kaamin *et al.,* 2016). With the development of real-time monitoring technology, UAVs provide many positive applications in civil engineering to control the process of building any building, bridge, and infrastructure system by recording videos and photos from the display section of the project site as much as possible. Some studies have considered UAVs to inspect the structure during maintenance (Dastgheibifard & Asnafi, 2018). Due to the small size and maneuverability of UAVs, they can collect data from very low altitudes, starting from the ground surface, sweeping the project at various heights and perspectives, as well as fly-over views above the site (Tatum, 2017). Furthermore, monitoring on the progress of construction site projects is one of the important tasks in a construction project (Omar *et al.,*2018) (Vick &Brilakis, 2018). Progress assessments provide an opportunity to identify current conditions such as constructed projects efficiently, identify differences between the progress that has been built and those that have been planned and to aid in deciding on corrective actions as well. Construction inspection and monitoring is very important for website condition assessment. Progress monitoring is considered an important success factor to be timely deliver construction projects, according to estimates, and within the required quality as well as being one of the most difficult tasks due to the complexity and interdependency of activities (Kopsida*et al.,* 2015) (Kropp*et al.,* 2018) (Alizadeh&Yitmen, 2018).Thus, this study purpose to monitor the process of work at the construction site efficiently and to analyses the information visually. This study implements Micro UAV which is a technology that is in the current circulation. The micro UAV able to produce more accurate information on real site construction with more specific problems. This technology has a "sensor" if it is close to an object on it. It will alert the remote controller by the alarm. Thus, the project conducted will not be facing the project delays that are related to monitoring the progress of work.

2. METHODOLOGY

The visual monitoring in this study involves planning before the actual work could be done. The preparation for handling and controlling the UAV is the first step that needs to be counted. The UAV must be controlled carefully during observation on-site and capturing images to prevent any crashers occurs. Full attention during handling and flying the UAV

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was required. Apart from that, the selection of a construction site is also one of the important parts of the planning process. Besides, several interviews with the person in charge were also be carried out to identify and gain the information needed relating to the construction site. This method was important to provide a clear view of the work that was conducted on this site. The analysis for this project was also manipulated from the opinion of the person in charge. Finally, the last planning was to set up the starting point for the UAV. The point that was selected must be far from the circumstances that could affect the UAV activities.

The data collection was the next process in this study. This data was collected by using Pix4Dcapture as it was the most suitable method to collect data. Overall mapping of the construction area could be generated when all the data collected was fully processed. The image captured by UAV through this application was combined by the Pix4Dmapper during the analysis stage. The method used to perform this flight is by setting the 'Grid Mission for 2 Maps' in Pix4Dcapture and the mission used as illustrated in Fig. 1. When the mission use is selected, the UAV flies only once for one mission according to the grid settings and the data required in the area. The area and time used were not similar for both months during data collection. After the area has been set, the start and end points appear for data collection in the area. The data collection settings were shown in Fig. 2. The area that the UAV covered to collect the data is 587 m×50 m and time to execute the mission in 15 minutes. The pictures capture for both missions in October and December are 171 and 393 respectively with the total data of 564.

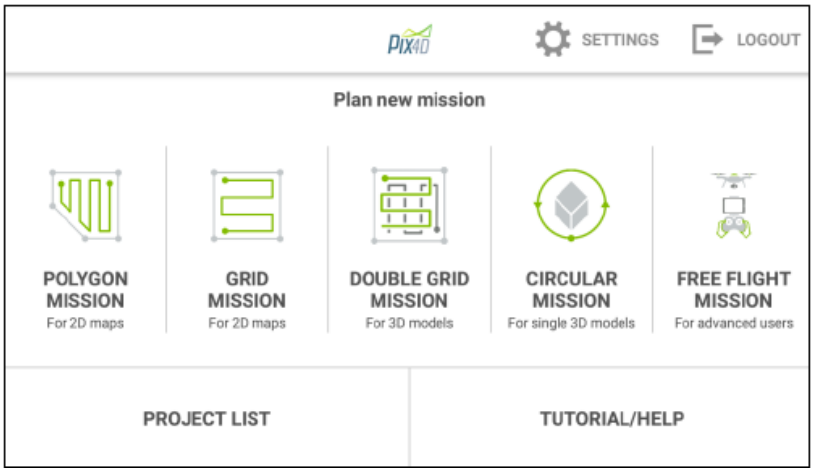

Fig. 1. Mission in Pix4Dcapture

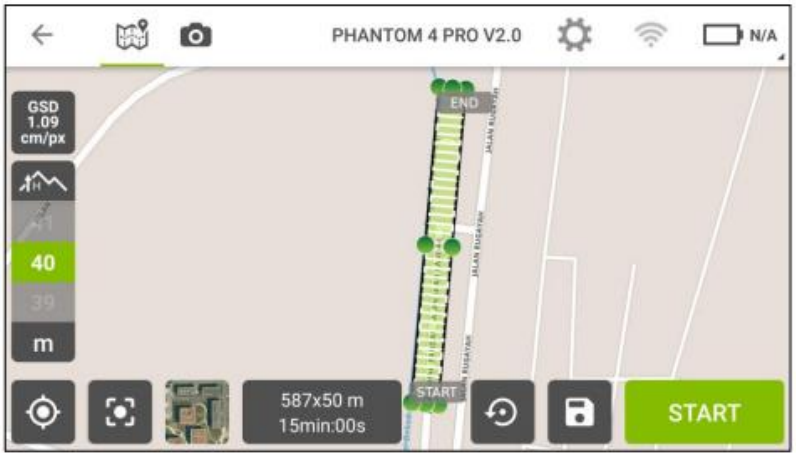

Fig. 2. Data collection process

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Next, the UAV flight speed was set to the to maximum speed as to shorten the data collection in the area. The angle used for the camera to record data is 90 degrees vertically down. This angle allows the view of the area to captured accordance to the objective of this study and the set up was shown in Fig. 3.

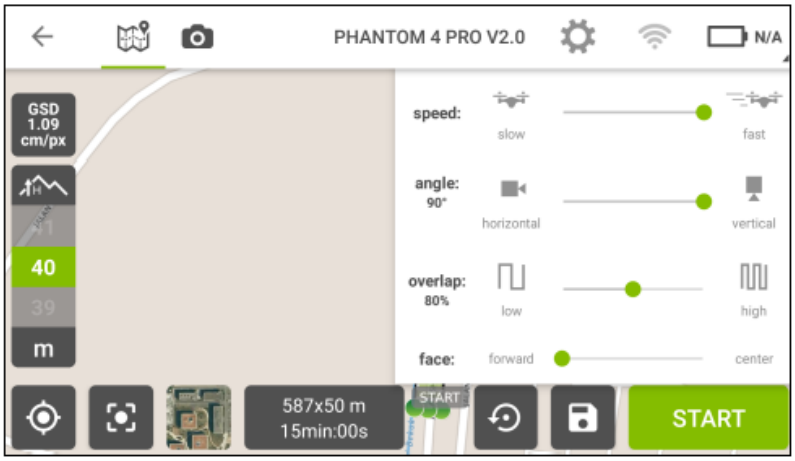

Fig. 3. UAV flight mode settings

3. RESULT AND DISCUSSION

This project was conducted at a construction site located at the banks of the BatuPahat river by using UAV as a tool for visual monitoring. The data observed was generated in the form of images and the mapping process has been executed using Pix4Dmapper. The image obtained was fully captured and analyses from ongoing activity or progress on the construction site. To identify the progress of work, the data was divided into two maps which October andDecember. Referring to Fig.4 and 5 it can be concluded that this construction site was currently active with work in a certain part of the area. Several works had been done for example lane of the walkway, set of playground and concrete work. The whole data has been incorporated into a large image encompassing the entire area.The images captured from top can be used to visualize the construction site aswell as the construction progress work. The images can be used as a progressphotography in progress document.Ultimately, the purpose of construction monitoring is to provide information on the latest conditions that are being updated, so that practitioners can control potential or poor performance or deviations. Predictionthe future is that construction progress can be analyzed and project schedule can be automatically checked throughobservations from visual images and videos.

Mapping Fig. 4. Mapping during October

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Fig. 5. Mapping during December

Progress on the project can be analyze and identify by comparing the picture that had been captured from October and December. The comparison of progress work within a month in the same location was stated in Table 1.

Table. 1. Progress of work

No.	October	December	Description
1			• Site Clearing • Ongoing concrete work • Site active
2			• A lane of walkway has been built • Site active
3			• No ongoing work at the site. • Site inactive

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4			• No ongoing work at the site • Site inactive
5			• Ongoing landscape work • Concrete work • Walkway has been built • Site active
6			• Set of playgrounds has been installed • A walkway has been installed. • Site active
7			• Ongoing fountain work • Site active
8			•Uninstalling formwork • Brick installed in walkway • Site active

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4. CONCLUSION

Studies have been carried out in the construction site area to assist in the work involved in the inspection and monitoring. Each construction area should be inspected and monitored regularly to ensure all the progress of work followed the schedule and planning. UAV was successfully to be part of the monitoring stage as it can monitor the entire construction area, especially with large area sites. Through the study conducted in the construction area on the banks of the BatuPahat river, verify that this construction site was currently active with work in a certain part of the area. Besides, the effective use of drone data is shown in terms of smart construction monitoring It has been shown that this fully automated system can reduce the effort required in traditional construction monitoring and reporting procedures. The system does not just providesimple and intelligent way of supervising and managing a website but also producing effective operations, planning and customization in a better place.

ACKNOWLEDGEMENTS

This research was made possible by funding from research grant Tier 1 Vot H123 provided by the Universiti Tun Hussein Onn Malaysia (UTHM). The authors would also like to thank the Centre of Diploma Studies, Universiti Tun Hussein Onn Malaysia (UTHM) for its support.

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