The Use of Unmanned Aerial Vehicles for Façade Surveying Application in Sri Lanka

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***Abstract*:** *Unmanned Aerial Vehicle-systems (UAVs) or Drones have reserved an important place in the construction and engineering industries over the last few decades. Drones are employed in various parts of the construction and engineering industries, including project creation, project management, and inspection, construction surveying, construction safety, construction inspection, volume measures, Modeling in 3D, and other related services UAV technical advancements and structure from motion methodologies have resulted in UAVs being typical platforms for 3D data collecting. Drones appear to be an ideal choice for urban applications due to their flexibility and capacity to reach inaccessible urban areas. Reconstructions from drone data have the potential to drastically reduce labor costs for rapid upgrades of already reconstructed 3D cities. However, a rigorous quality assessment is required, particularly when updating existing scenes acquired from different sensors. Many authorities demand as-built surveys to prove the placement of a facility at a specific moment in time. These are very vital for the site's upkeep and future expansion. Total station was employed to accomplish this duty in the past, but it is more expensive, time demanding, and requires more qualified surveyors to complete. The objective of this research is to examine the use of Unmanned Aerial Vehicles (UAV) system for façade surveying in Sri Lanka. The study's findings demonstrate that the UAV's ability to produce as-built survey mapping can be realized, and that it also simplifies as-built survey work by saving time and eliminating the need for trained surveyors. As a result, UAVs are ideal for engineering tasks*

Keywords: Unmanned Arial Vehicle, Orthomosaic, Structure from Motion (sfm), As-built

1. Introduction

In this highly developed era, numerous new technologies have been created to help surveyors in their work in the geospatial industry. Using a total station is the traditional method of conducting a "as-built" survey that is the most accurate. Although this method is expensive, time demanding, and requires the surveyor's competence to handle. These unmanned Aerial Vehicles (UAV) are rapidly being employed for a variety of purposes in the construction industry, including mobile surveillance, environmental monitoring, and as-built surveys. The UAV is light, tiny in size, and easy to manage, and it takes less time and energy to fly across a large region or a long range. This UAV technologies enable each project to retrieve data with the right level of accuracy, whether absolute accuracy is needed for the design, engineering, and construction phases, or relative accuracy for data collection. Accuracy is critical in an aerial mapping job if competent results are to be obtained. In terms of UAV accuracy, as camera resolution has grown, it has the capacity to digitize the globe with greater precision than previous research by discovered that the use of UAVs can be a more cost-effective and time-consuming method in building an aerial photograph map.

We are already seeing an increase in demand for urban planning applications, where easily cheap UAVs are very effective. They are critical for smart city management and monitoring (Gruen, 2013; Mohammed et al., 2014). They can indeed be utilized for rapid change detection and disaster response as miniature flying vehicles (Qin, 2014). Drones look to be an ideal alternative for construction surveying due to their adaptability and ability to access tricky urban areas. One of the most common consequences of UAV urban application is three-dimensional building models. Although laser scanning data is frequently used to create building models (Dorninger and Pfeifer, 2008; Borkowski and Jóków, 2012; Perera and Maas, 2014), there has been very limited work reported on modeling using LiDAR equipped UAV. Drones equipped with photogrammetric or recording devices are commonly utilized to offer information for building reconstruction (Haala et al., 2012; Feifei et al., 2012). The collected pictures, when combined with various Structure from Motion approaches and reconstruction workflows, allow us to develop 3D building models with varying levels of detail.

The proposed research in this study explored optimal ways for doing as-built surveys using UAV. This study compares an as-built survey with an image mosaic of the Bachelor accommodation block on the Southern Campus taken with a UAV.

In this study various measurements are computed and presented in quantitative analysis to acquire a deep understanding of the output's quality. Basically, the comparison step will show how far that UAV orthomosaic images can be accurate for the conventional surveying techniques.

This drone technology is unique in above sense and surveys can be completed at record speed with high quality data. In other words, one of the most common uses of drones is to measure areas that are otherwise inaccessible to vehicles and people. The technique provides a cost-effective alternative to surveying, allowing for surveys to be completed in hours rather than days or weeks. As a result, UAVs are critical in assisting with as-built surveys. Furthermore, the equipment and software that will be utilized for this study are technologically based, thus employing this alternative method will not only save the time demanding job, but it may also minimize the cost of the as-built survey work.

Sri Lanka, being a developing country, needs to find new ways to improve its development. In the construction industry, we are still lagging behind in terms of creating 3D facades and BIM models. Cameras linked to cutting-edge technology have transformed and expedited the construction process. Drones are becoming increasingly important in the construction industry for site surveying, building inspection, auditing, and building energy modeling. In fact, in industrialized countries, manual field inspection methods or traditional methods of identifying the facts of associated structures may not be used. In this research study, the integration of UAVs with the most recent Building information models, as well as the digitization of the construction process, will be discussed, as will the utilization of these combinations and the development of the 3D façade. This is a literal merger or integration of UAVs with BIM.

2. Methodology

The study procedure begins with site planning and preparation, which includes site review of the selected area and drone training sessions, as shown in the Figure 1.

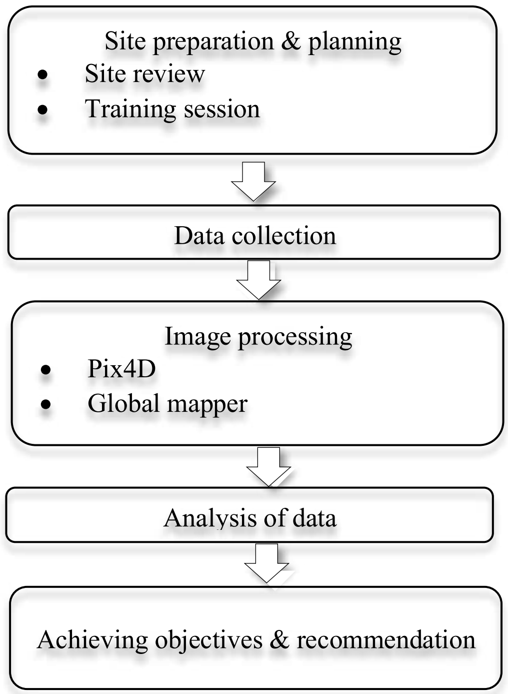

Figure 1: Conceptual Framework of the Study

The field work was divided into two stages, pre-flight and in-flight. Before flight planning and preparation to acquire in the planning area of flight and training sessions under the supervision. Collect images in order to obtain and check for defects in drone capture images. During this process, the drone will capture images, but the pilot will judge and monitor its flight. Pilots must also be wary of flight failures. This is also to improve connectivity in order to maintain a safe distance from the building wall structure even if the collision prevention is in place. The weather should be fine for the drone, and a broad exposure in the morning is suggested.

The next stage after image acquisition is image processing. Pix4D and Global Mapper are used forimage processing. Then the images were
processed in three stages:

- Initial processing.
- DSM and point cloud.
- Mosaic orthography and index.

Process the image using the objective design plan of the selected area. This data is obtained from Pix4Dmapper and passed to Global Mapper, which takes overlapping images and generates 3D point cloud output using Structure from motion techniques. This technology derives the 3D texture of the landscape and the objects on it from overlapping images, resulting in 3D point cloud images. Data collected by drones is usually used for terrain-based calculations. For this study, the building was measured for

identification, and a comparison of design objectives with actual on-site construction is made. For this research study, the data collection analysis was divided into two

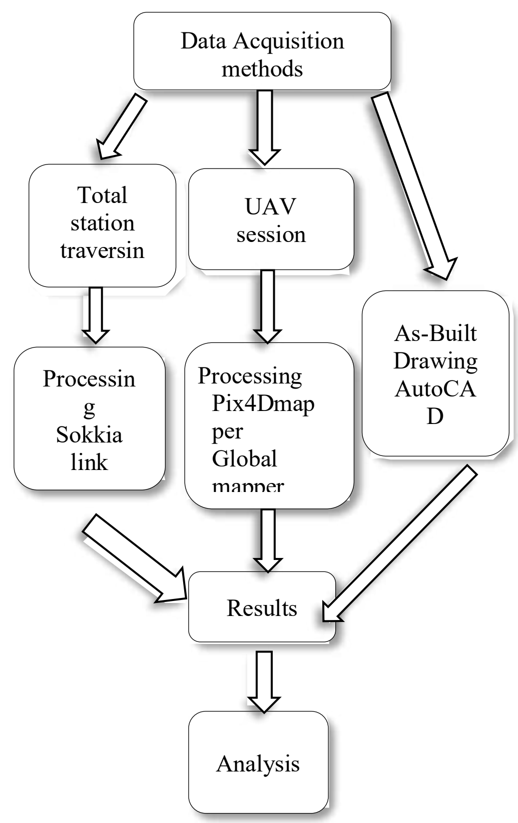

Figure 2: Data Collection Workflow

phases. A focused method is to use an UAV to collect, process and analyze relevant data for the digital output of an as-built survey as shown in Figure 2.

For the accuracy assessment of this study need to conduct total station traversing data for the conformation of the as-built details with the conventional accurate method. Therefore, it is required to establish control points via go through with the traversing and levelling. Finally, it was required to take the as-built survey details through

3. Results and Discussion

All images obtained during the flight of the UAV must be processed with the Pix4Dmapper tool to produce orthogonal photogrammetry. Information such as location is extracted from products processed by the Pix4Dmapper and Global Mapper applications, statistics about the area and measurement items in the selected building.

A. Image processing

Each drone image must be processed with the Pix4Dmapper software and generate a complete orthogonal image that meets the mapping requirements as shown in Figure 3.

Figure 3: Orthomosaic image of Bachelor residential building of Southern Campus

B. Proposed drawing of the study area

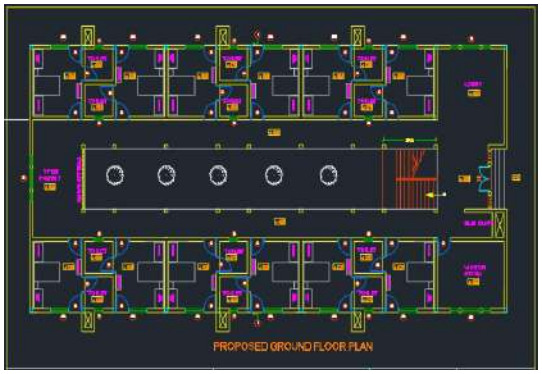

Figure 4: Proposed Auto CAD drawing of the building

Figure 4 shows the proposed AutoCAD drawing for the bachelor accommodation. With the help of AutoCAD software, data about the generated study area is designed to collect reliable data for dimensions and measurements that can be compared with orthogonal mosaics.

D. Measurement analysis

Using the data generated by Pix4Dmapper and transmitted to Global Mapper, the mosaic images was used for the comparisons of measurements between actually built on the site and proposed prior to the construction of the bachelor's residence building. Based on Table 1, it shows each measurement of the front façade of the building. When considering the wall, its having most accurate data for the building while having ±0.001m variant. And also, the captured data of the front door gives maximum 0.005m variant accuracy compared to the As-Built and UAV images. Therefore, those UAV images can be applicable and used for as-build survey mapping.

Table 1. The front elevation measurement data of AutoCAD & As-built

Feature Name	*Auto CAD (m)*	*As-Built (m)*	*Differences (m)*
Height of window (verticle)	1.200	1.202	±0.002
Width of window (verticle)	0.600	0.618	±0.018
Hight of window (horizontal)	0.600	0.562	±0.038
Width of window (horizontal)	1.200	1.256	±0.056

Table 2. The front elevation data of Orthomosaic & As-buil

Feature Name	*Auto CAD (m)*	*Orthomosaic (m)*	*As-Built (m)*	*Differences (m)*
Height of window (verticle)	1.200	1.204	1.202	±0.002
Width of window (verticle)	0.600	0.620	0.618	±0.002
Hight of window (horizontal)	0.600	0.560	0.562	±0.002
Width of window (horizontal)	1.200	1.254	1.256	±0.002

The as-built details were captured using the total station, and the orthomosaics details were acquired using drone images and processed using the pix4D and Global mapper software were analyzed and shown in above Table 1 and 2. By the way, the taken details are nearly same. In fact, both of these measurements vary by less than 0.003m

Table 3. The side elevation measurements

Feature Name	*Auto CAD (m)*	*As-Built (m)*	*Differences (m)*
Height of window (verticle)	1.200	1.202	±0.002
Width of window (verticle)	0.600	0.618	±0.018
Hight of window (horizontal)	0.600	0.562	±0.038
Width of window (horizontal)	1.200	1.256	±0.056

Based on above Table 3 it clearly shows the basic measurements of side elevation of the building. The differences are ±0.002m and ±0.003m in height

and width of the building respectively in between UAV images process through the global mapper and as-built drawings.

Table 4. Measurements of windows

Feature Name	*Auto CAD (m)*	*Orthomosaic (m)*	*As-Built (m)*	*Differences (m)*
Height of side elevation	3.600	3.192	3.194	±0.002
Width of side elevation	34.972	34.312	34.315	±0.003

When comparing each section relevant details from the table show and proved that the data from the UAV images can be used for as-built survey purposes and mapping.

Table 5. The measurement data of Auto CAD & As-built in windows

Feature Name	Auto CAD (m)	Orthomosaic (m)	As-Built (m)	Differences (m)
• Height of wall front elevation	3.600	3.192	3.193	±0.001
• Width of wall front elevation	19.150	19.030	19.031	±0.001
• Front door (Height)	2.100	2.080	2.082	±0.002
• Front door (Width)	1.800	1.750	1.755	±0.005
• Door frame (Height)	2.200	2.150	2.152	±0.002
• Door frame (Width)	3.200	3.190	3.193	±0.003

Considering the taken measurements of the windows in between in proposed drawing and the Auto CAD details are not severely vary as front and side façade measurements, but this is also having such variations when it constructed.

4. Conclusion

According to the findings of this research, the as-built survey mapping is completed at bachelor residential building of Southern Campus. The use of UAV can provide a variety of results that can be used for a more complete study of building mapping capabilities, particularly in the as- built survey area. The process analysis produced outputs such as a Pix4Dmapper file, orthogonal images of the building, a proposed comprehensive drawing plan and details, and a site layout plan.

As a result of the study, the findings can be used for a variety of purposes and in greater depth based on job requirements. For example, the Pix4Dmapper file and the orthogonal images from this work can be used to create true 3D images with accurate surface rates, including substructure locations and gradients on some surfaces. In addition, files generated by Pix4Dmapper can be used as suggested image.

The chosen method of UAV for built survey mapping has been proved to be suitable for the aim of this study depending on the results of the research, when compared to the current procedure, there are numerous advantages to employing this strategy. Choosing UAV routes for hardware mapping purposes is a sensible decision because it helps both parties. Furthermore, it is appropriate for the most recent technological requirements.

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Acknowledgment

I would like to express my heartfelt appreciation to the research supervisor for allowing me the opportunity to conduct the research and for offering vital guidance during the research and report preparation. Finally, I'd like to offer my heartfelt appreciation and gratitude to everyone who assisted us in various ways.

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