Paper ID: 372

Optimization of Conventional Land Survey Techniques Using Modern Technology

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Abstract: As far as a land surveying project is being considered, the knowledge about the accuracy, precision, time consumption and the cost efficiency are factors that must be equally taken into consideration before conducting the project. The success of any surveying project relies upon all the above components and hence the choose of the most appropriate technique for data collection is vital in the mentioned scenario. In the current situation, the conventional land surveying techniques, GNSS Surveys and Drone surveys have emerged through the society and are widely being used for surveying applications. Yet, their applicability in the most fruitful manner in obtaining the best results is still not known. Hence, the objective of this study is to evaluate and compare the accuracy, precision, time expenditure and cost efficiency of the conventional land surveying techniques, Survey Grade and Mapping Grade GNSS Receivers and Aerial Drone Surveying techniques. This study attempts to investigate the best appropriate technique to be adopted for the surveying projects depending upon the requirements of the survey.The data for this study is accumulated through the field surveys conducted using the considered techniques for a particular area selected. The same plot of land is surveyed using all the different techniques and the accumulated data is then analyzed and compared together in order to understand their accuracy and precision along with the respective time consumption and cost efficiencies. Hence, the most appropriate technique for the relevant surveying project can be investigated based on the project's requirement. Thus, the ultimate objective of this study is to analyze the different surveying techniques so that the best appropriate method of surveying can be inferred in order to yield the maximum harvest from the projects to be conducted.

Keywords: Area Calculation, Drone Survey, GCP, GNSS, RTK

Introduction

Land Surveying has been an essential task since the earliest generations. The techniques that have been used for these various types of land surveys have been advanced and refined over the cause of time from the primitive chain surveys to much advanced new technological instruments. Hence, the conventional land surveying techniques have been now developed up to Global Navigation Satellite System (GNSS) Surveys, Aerial Drone Surveys and other advanced techniques. The accuracy, precision and the productivity of these techniques have said to be more increased and advanced than the conventional methods, yet their productivity has to be addressed in greater extent (Geospatial World, 2020).

As far as the modern technological survey instruments are being considered, they occupy an initial cost which is considerably higher than the conventional survey techniques. The initial cost to be invested when acquiring a Survey Grade GNSS Receiver or a Drone will be comparatively higher than the expenditure to be allocated over a conventional Total Station. Yet, their

productivity is much higher when the consumption of other resources, the consumption of human force and the time expenditure are considered over the conventional land survey techniques (Wingtra, 2020).

This study mainly focusses on the Aerial Drone Surveys and the establishment of the Ground Control Points (GCP) for fixing the surveys conducted by the drones. This establishment of GCPs can be done using either the Total Station or the GNSS receivers (Survey Grade and Mapping Grade). Depending upon the accuracy and precision that is expected through the project, the suitable technique to be adopted can be decided.

Coordinates of the established GCPs is a mandatory requirement for fixing the aerial Imagery of any drone survey and hence, the accuracy and precision of the coordinates of the GCPs will be a strait effect on the output of the survey.

Thus, this study attempts to compare and analyse the accuracy and precision of the land survey techniques along with their cost efficiency and time consumption in proving coordinates for the established GCPs used for drone surveys, which will subsequently examine the productivity of the surveying project conducted. This will hence enable the surveyors to fruitfully incorporate and organize the project in a satisfactory manner depending upon the project requirements. So that the maximum advantage can be obtained minimizing the desolation of physical and human resources along with the minimum consumption of time as applicable.

Hence, the conventional land surveying techniques, RTK and Mobile Mapper are to be applied together with the Drone Imagery in calculating the extent of land through this study and is attempted to investigate the best appropriate technique to be adopted for such surveying projects depending upon the requirements of the survey.

Methodology and Experimental Design

This research was conducted using the field data collection using the conventional land survey technique also known as Total Station Surveys where the whole area was surveyed only using the Total Station and the area is calculated precisely. Next, drone surveys will be conducted in the same area, for which the GCPs were established according to our preference and coordinates were provided for the established points independently using Total Station, Survey Grade GNSS Receivers (GNSS RTK), Hand-Held GPS Receiver (Mobile Mapper).

The data for this were accumulated using the field surveys conducted at the 'Diyatha Uyana' in the Western Province of Sri Lanka. 'Diyatha Uyana' which is currently a leisure and recreational park of Sri Lanka, contains a very undulation when the shape of the plot is considered. This undulated shape of the plot was the basic reason for selecting this study area as the surface area of this plot can be a convenient measure to compare the accuracy and the precision of the techniques that are being used.

Hence, the following field practicals were conducted in the plot for data collection. Initially, the whole plot was surveyed using a Ground Survey from Total Station and the extent of the land was kept for the future reference of the extent of the plot.

Next, GCPs were established for fixing the drone image and the coordinates were provided for the established Points using a Total Station Traverse, GNSS RTK and Mobile Mapper independently. Table 1 elaborates the coordinates obtained using each technique.

Table 1 : GCP Coordinates

SN	Total Station		RTK		Mobile Mapper	
	North	East	North	East	North	East
A	489368.052	404658.380	489368.041	404658.398	489370.264	404655.934
B	489340.975	404645.671	489341.002	404645.693	489343.673	404642.945
C	489343.480	404640.381	489343.501	404640.369	489345.374	404642.573
D	489364.117	404688.325	489364.098	404688.348	489366.079	404695.914
E	489373.922	404663.742	489373.948	404663.76	489376.391	404660.967
F	489379.237	404665.600	489379.212	404665.58	489382.143	404663.465
H	489327.376	404684.530	489327.401	404684.551	489324.755	404682.652
I	489359.874	404699.976	489359.894	404699.955	489357.971	404702.343
J	489357.174	404705.581	489357.156	404705.559	489358.269	404702.985

After, the drone survey is conducted, these three sets of coordinates were separately used for fixing the Aerial Image.

Figure 1 : Processed Drone Image

The following table (Table 2) will more elaborately discuss the technical specifications of each instrument used for the above purpose.

Table 2 : Techniques & instrument Details

Technique	Instrument Specifications		
Total Station	Total Station		Sokkia IM50
Drone with Total Staion	Drone	Drone Model	Phantom 4
		Flying Height	100m
	Total Station		Sokkia IM50
Drone with RTK	Drone	Drone Model	Phantom 4
		Flying Height	100m
	RTK		HI-Target v60
Drone with Mobile Mapper	Drone	Drone Model	Phantom 4
		Flying Height	100m
	Mobile Mapper		Spectra MM50

Next, the extent of the plot was calculated using all the three fixed images and the output results was analysed together with the consumed time and the cost that was associated with the respective techniques. For this analysis, the expenditure for the survey instruments, the other required human resources and number of labour force needed along with their expenditure were taken into proper consideration.

Figure 2 : Area Calculation

Results and Discussion

After the plot is being surveyed using the Drone Survey, the accuracy and precision of the survey were analysed and evaluated using the calculated extent of the plot. The respective time consumptions, expenditure for physical and human resources were also taken into consideration for the three techniques used in providing coordinates.

The results of the area calculation of the drone survey and the details about allocated time and the required cost expenditure are depicted in the below tables.

Table 3 : Time and the Required Cost Expenditure

Technique	Instrument	Initial Cost	Rental Cost (Per Day)	No of Labours	Labour Cost (Per Day)	Duration
Total Station	Total Station	800,000	25,000	6	12,000	3 Days
Drone with Total Staion	Drone	320,000	20,000	8	16,000	1 Day
	Total Station	800,000	25,000			
Drone with RTK	Drone	320,000	20,000	3	6,000	5 hr
	RTK	1,600,000	25,000			
Drone with Mobile Mapper	Drone	320,000	20,000	3	6,000	4 hr
	Mobile Mapper	80,000	5,000			

Hence, it is undoubtedly evident that the area calculated using the coordinates provided by the Total Station, Survey Grade GNSS Receivers contains a precision less than 7 m2. At the same time when compared with the extent obtained from the initial survey conducted using the Total Station, which is

the currently considering area calculation techniques of Sri Lanka, the Drone Survey associated with Survey Grade GNSS Receiver shows an accuracy of 6 m2 and the Drone Survey associated with Total Station shows and accuracy of 1 m2. Thus, it is evident that for any small-scale map smaller than 1:1000 scale, using of any of the above methods will be equally accurate. Yet, if the purpose of the survey is, preparation of map larger than 1:1000 scale, the two methods will show a relatable difference in the generated output.

Table 4 : Area Comparison

Technique	Area	Area Deviation with respect to Total Station
Total Station	18038.819 m^2	-
	1.803882 ha	-
Drone with Total Staion	18039 m^2	0.181 m^2
	1.8039 ha	0.000018 ha
Drone with RTK	18032.19 m^2	6.629 m^2
	1.803219 ha	0.000663 ha
Drone with Mobile Mapper	18024 m^2	14.819 m^2
	1.8024 ha	0.001482 ha

Thus, when the required amount of human, physical and other resources are concerned, it is clear that the survey Grade GNSS Receivers allow the surveyors to obtain the results using very limited human and physical resources and with the lowest requirement of time than conducting a drone survey associating a total station. Thus, it is much obvious that GNSS RTK technique can be adopted to obtain a proper accuracy for an Aerial Survey using the minimum wastage of resources for any small-scale survey. But the initial cost for acquiring these instruments will be higher than the expenditure on a Total Station. The depicted approximate rental costs will also provide a specific notion about the cost for the survey to be conducted.

Once the Mobile Mapper is considered, the results undeniably prove that the expenditure for the survey will be much lower compare to any other land survey technique. Thus, this cost is much manageable for any surveyor. Still, with the comparison of its accuracy in the area calculation compared to the Initial Ground Survey using the Total Station, it should be highly noted that this technique should not be used for instances where a pinpoint accuracy will be needed. This can be applied for surveys and projects with the purpose of preparing smaller scale maps more productively as this contains the lowest amount of human, physical, financial and other resources.

Conclusion and Recommendation

After the decent analysis conducted using the conventional Land Survey Technique, Aerial Surveys associated with GNSS RTK and Mobile Mapper, it is evident that these modern technologies can be optimized over the conventional land survey techniques depending on the requirements of the survey. The needed accuracy range, precision, scale of the prepared output should be considered vitally along with the allocated time frame, available physical, human and financial resources for the relevant project when selecting the land survey technique to be used. Thus, in order to obtain the maximum benefit through the land survey project to be conducted, it is recommended to optimize the modern technological methods of surveying over the conventional techniques with proper consideration about the scale of the output, the required accuracy and precision of the work to be conducted. Hence, the most applicable technique can be selected with the prior consideration of the requirements of the survey and the available human, physical and financial resources.

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Acknowlegdement

We hereby pay our heartfelt gratitude to the Faculty of Built Environment & Spatial Sciences (FBESS), Southern Campus of Kotelawala Defence University (KDU) for their assistant, guidance and inspiration provided for the betterment of this research. We also make this a chance to express our sincere thanks to the BHOOMI-TECH (pvt) ltd for the assistance given in conducting the field surveys and in obtaining the surveying instruments needed for this research. At the same time our heartiest gratitude will be forwarded to the Prasad Surveys (pvt) ltd for their assistance in completing this piece of work. Also, we make this opportunity to thank each and every individual who has contributed to make this research a success.

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