4th Intercontinental Geoinformation Days

igd.mersin.edu.tr

Comparison between multicopter UAV and total station for volume calculation

Mustafa Ozkan [*1], **Nizar Polat** [2]

[1]*Harran University, Engineering Faculty, Geomatics Engineering Department, Şanlıurfa, Türkiye*

Keywords
Volume Calculation
UAV
Photogrammetry
Geodesy
Total Station

Abstract

Currently, the UAV (Unmanned Aerial Vehicle) has become an alternative for different engineering applications, especially in surveying; one of these applications is the calculation of volumes of stockpiled material, but there are questions about its accuracy and efficiency; the purpose of this article is to compare traditional surveying methods for estimating total volumes through data obtained by total stations and data obtained by a multicopter UAV. In order to answer these questions, we obtain data from the exact location. This study is located in Şanlıurfa/Haliliye in a Hospital construction excavation. The data from the same location, which are gotten different methods, were compared.

1. Introduction

In these days, volume calculation is becoming harder with traditional methods. Companies demand monthly or twice in a month volume calculation. That's why terrestrial systems are becoming unuseful, and it's hard to get more details with human power.

The good news is that new digital technologies now make it possible to collect and process huge amounts of critical data at minimal costs—thus making a field operation more insight-driven, and potentially more productive and efficient.

This saves time, human resources, and also transportation costs because it is possible to map a large object in one day using a UAV, whereas mapping the same object using traditional methods could take up to a week. Furthermore, it is possible to map areas that are dangerous or difficult to access using an UAV, whereas it would be necessary to use some form of special equipment for mapping it otherwise. Using an UAV is also contactless, so it is possible to map 2088 sensitive areas, without driving or walking on the endangered area. In endangered areas, where getting a flight permit is difficult, terrestrial photogrammetry or laser scanning could be used as an alternative (Dlouhy et al., 2016; Burdziakowski, 2017).

Therefore, we aimed to compare old methods with photogrammetry. Firstly, excavating areas got with a total station and has been created a surface before then excavation. At the same time, this process was made with the UAV. All area gotten with Multicopter and DTM, DSM, and Point cloud has been created. All GCP (Ground Control Points) giving from the same polygon points.

2. Method

This study map is made with the Structure from Motion (SFM) photogrammetry technic. SFM runs under the same basic conditions as stereoscopic Photogrammetry. It uses overlapping images in order to get a 3D structure of an interested object. Existing software can generate a 3D point cloud such as Pix4d mapper (commercial software) that has been used in this study.

The software advances in UAV applications and allows generating orthophoto in a willed coordinate system. For full performance of software, it is recommended to use a powerful computer due to the huge amount of data.

2.1. Preperation and Flight

The flight plan was prepared with Pix4d-Capture mobile application. The drone was set up in the field. All calibration settings were checked. Calibration settings must work properly. Big metal masses must be avoided throughout the calibration process since such masses

* **Corresponding Author**

*(surveyozkan0@gmail.com) ORCID ID 0000-0002-1476-9756
(nizarpolat@harran.edu.tr) ORCID ID 0000-0002-6061-7796

Cite this study

Ozkan, M., & Polat, N. (2022). Comparison between multicopter UAV and total station for volume calculation. 4th Intercontinental Geoinformation Days (IGD), 25-27, Tabriz, Iran

locally affect Earth's magnetic field and satellite signals which is used for calibration by UAV.

The flight had two separate missions. All missions have 100 meters altitude and %80-%80 overlap. The drone was set up according to the pre-flight preparations in the field. The flight was performed with multiple batteries which is DJI Phantom 4 Pro V2. In this study 9 GCP's has been used and they have been determined with total station.''Table.1''.

Table 1. GCP's Coordinates Table

YKN1	484.693.429	4.115.742.488	520.655
YKN2	484.772.010	4.115.750.681	520.047
YKN3	484.812.369	4.115.689.421	520.578
YKN4	484.907.310	4.115.749.711	530.27
YKN5	484.933.462	4.115.814.434	535.623
YKN6	484.901.557	4.115.879.010	538.635
YKN7	484.861.587	4.115.825.045	533.447
YKN8	484.784.872	4.115.840.921	529.81
YKN9	484.848.105	4.115.910.520	536.768

2.2. Creating Surface with Total Station

All excavation area is 31 ha. And all area has been taken with total station. The study took 15 days with 3 persons. With UAV study took 45 min. There is a big difference between of two methods. But in this study, we only aimed in a 1.9 ha. Stockpile area.'' Fig.1''. After the excavation process, 1.9 ha area was taken with Total Station (Leica Ts09). This process took half a day with 3 people.

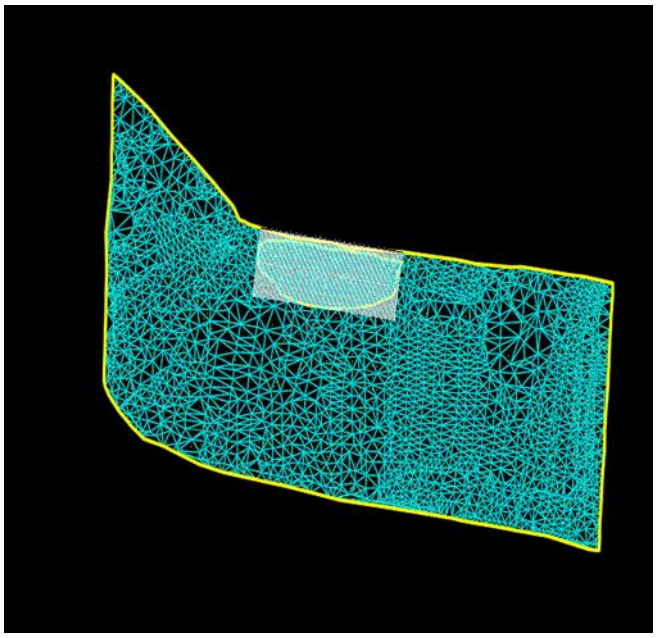

Figure 1. 1.9 ha. Surface Model in Autocad Civil3D

3. Creating point cloud with UAV

This work has been done with Phantom 4 pro V2 drone. After the excavation process, the second flight was done for 2.5 ha. area. It took 15 min. with same altitude (100 m) and same overlapping (%80-%80). The point cloud was created in Pix4d software. The other works for volume calculation have been done in Virtual **Surveyor** software. Virtual Surveyor more useful for CAD processes than Pix4d. That's why we decided to use Virtual Surveyor for volume calculations.''Figure.2''.

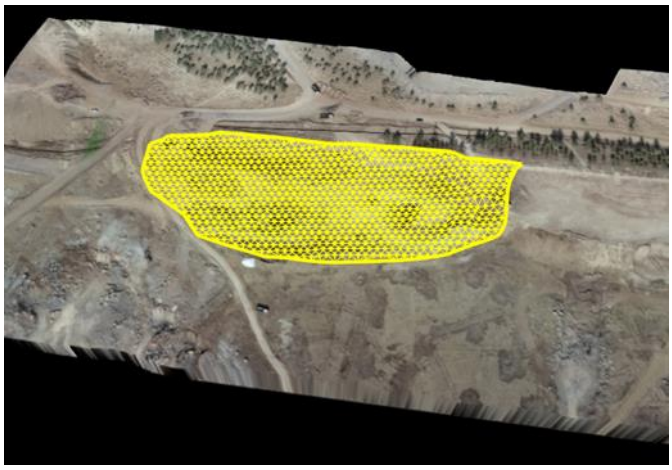

Figure 2. Surface Model in Virtual Surveyor

4. Results

All processes are made in Pix4d software. The ground sample distance (GSD) was calculated as 2.74 cm. The point cloud, DSM, DTM, and orthomosaic map were created in the study. And all volume calculation has been done in Virtual Surveyor''Fig3''. The result of Virtual Surveyor is 102265.40 m^3.

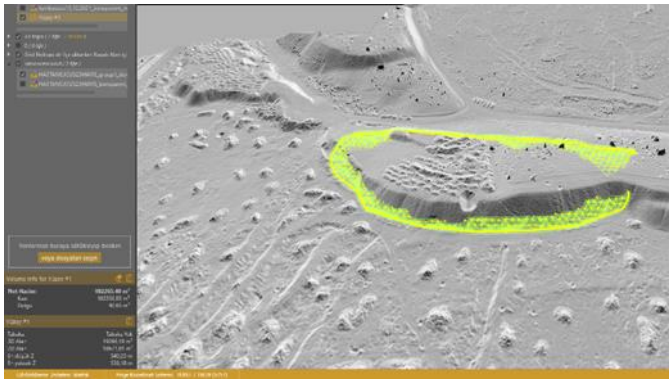

Figure 3. Volume calculation in Virtual Surveyor

On the other hand, all CAD process has been done in CİVİL3D ''Fig.4'', The result is 101958.20 m^3.

Figure 4. Volume calculation in Civil3D

5. Conclusion

In this study, the traditional method with TST to estimate volumes of stockpile were compared with UAVs, data from the same site were taken and the post processing was done in Virtual Surveyor with a TIN model from the point cloud data obtained with TST and in Pix4D from data obtained by the UAV The results were compared with the actual volume of material, which was obtained from one of the engineers of the site where the data collection was performed.

At the end of all processes, we can see two results. There is a too small difference of the % 0.3. It's a pretty good result for the volume calculation. The volume calculation with photogrammetry is quite adequate and reliable, as we can see.

References

Kavanagh, B. F., & Glenn Bird, S. J., (1996). Surveying principles and applications (4 Ed.). Prentice Hall. pp. 257–264. ISBN 0- 13-438300-1.Pix4D, website https://support.pix4d.com (accessed, April 15, 2015)

Burdziakowski, P. (2017). Towards Precise Visual Navigation and Direct Georeferencing for MAV Using ORB-SLAM2. In: 2017 Baltic Geodetic Congress (BGC Geomatics). Gdansk, Poland, 394 398. doi: 10.1109/BGC.Geomatics.2017.21.

DJI 2020. https://www.dji.com/ee/phantom-4-pro-v2 Accessed 05.05.2020

Yakar, M., & Yilmaz, H. M. (2008). Using in volume computing of digital close range photogrammetry. *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences. Vol. XXXVII. Part B3b*.

Leica Geosystems, website http://www.leicageosystems.com/en/Leica-FlexLine-TS02plus_99086.htm (accessed, June 20, 2015)