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THE ADVANTAGES OF DRONE TECHNOLOGY IN URBAN FLOOD STUDIES
ŞEHİR TAŞKINI ÇALIŞMALARINDA DRONE TEKNOLOJİSİNİN AVANTAJLARI

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ABSTRACT

Some research such as in geography, engineering, disasters, surface flow, etc. requires use of a Digital Surface Model (DSM). Problems are often experienced when the available data are not at a high enough resolution to be useful. The resolution size of a few easily-accessible reference sources and spatial data, such as SRTM and ASTER DEM, is 30 meters. The acquisition of high resolution spatial data is expensive and poses difficulties. Today, drone technology and photogrammetry software allows high-performance for collecting spatial data and creating a spatial database. This paper aimed to use drone data for studying urban floods. The lower basin of the Hacılar River in the municipality of Arhavi (Artvin, Turkey) was selected as the study area. Research was carried out using the DJI Phantom 4 drone, capturing images at an altitude 150 meters above the ground and taking a total of 168 photographs in a 0.41 km² area. Aerial photos were acquired via photogrammetry software in order to align the photographs and by setting the accuracy at medium then creating a Dense Point Cloud at medium quality. A DSM with spatial resolution size of 22.6 cm per pixel and RMS error of 1.38 pixels was generated. The DSM has a surface level difference ranging from -18 to 120 meters. As a result, a DSM within highly accurate parameters and of high resolution was obtained to use in the study and analysis of urban floods covering part of Arhavi town. Additionally, drone technology and the method used in this study are capable of producing a DSM for use in other applications that require high-resolution details.

Key words: *Drone technology, Aerial photography, GIS, Urban Floods.*

ÖZET

Coğrafya, mühendislik, afet, yüzeysel akış gibi bazı araştırmalar Sayısal Yüzey Modeli (SYM) kullanımına ihtiyaç duyarlar. Uygulama için sıklıkla yaşanan veri problemi; mevcut verinin yeterli çözünürlükte olmamasıdır. SRTM ve ASTER DEM gibi az sayıda kolay ulaşılabilir birkaç referans kaynağı ve mekânsal verinin çözünürlük boyutu 30 metredir. Yüksek çözünürlüklü mekânsal verilerin temini ise hem pahalıdır ve hem de zorluklara sahiptir. Günümüzde, drone teknolojisi ve fotogrametri yazılımı, mekânsal veri toplama ve mekânsal veri tabanı oluşturma konusunda yüksek performans göstermektedir. Bu çalışmada, Dron verisinin şehir seli çalışması amaçlı kullanılması hedeflenmiştir. Arhavi belediyesinde (Artvin, Türkiye) sınırları içindeki Hacılar Nehri aşağı havzası çalışma alanı olarak seçilmiştir. Çalışma; DJI Phantom 4'ü dron kullanarak, 0.41 km² lik alandan, zeminden 150 metre yükseklikte, toplam 168 adet hava fotoğrafı çekerek gerçekleştirilmiştir. Çekim uygulaması, fotogrametri yazılımı kullanılarak hazırlanan foto çekim hatları ve çekim konumlarını planlanması ile yapılmıştır. Daha sonra bu fotolar kullanılarak orta kalitede "Dense Point Cloud" oluşturulmuştur. Her piksel için 22,6 cm'lik mekânsal çözünürlük boyutu olan SYM, 1.38 piksel RMS hatası ile üretilmiştir. Üretilen SYM; -18 ila 120 metre arasında değişen bir yüzey seviyesi farkına sahiptir. Sonuç olarak, Arhavi kasabasının bir bölümü için şehir taşkını çalışmasında kullanılmak üzere, yüksek doğrulukta ve yüksek çözünürlükte SYM elde edilmiş ve analizlerde kullanılmıştır. İlaveten, drone teknolojisi ve bu çalışmada kullanılan yöntem, yüksek çözünürlüklü ayrıntılara ihtiyaç duyan diğer uygulamalar için DSM üretme kabiliyetine sahiptir.

Anahtar Kelimeler: *Drone teknolojisi, Hava fotoları, CBS, Şehir selleri.*

1. INTRODUCTION

The studies that require the use of the Digital Surface Elevation (DSM) feature often suffer from a lack of DSM resolution. When the researcher need to use the high-resolution of DSM, the cost of acquiring data is quite expensive. The standard DEM currently used is ASTER GDEM (Tachikawa et al., 2011) and SRTM DEM (U.S. Geological Survey, 2015) with original resolution is 30 meters per pixel. The application of these DEM is not as detailed as it should be, affect the discrepancies of the results. In this study, the authors have done research on the flash flood in urban areas. This requires information detailed about the high-resolution of terrain elevation. In the study area, there is a problem that the information is not highly-detailed. Due to this reason, it has applied Remote Sensing (RS) technology to create the DSM, with the capabilities of today's small Unmanned Aerial Vehicle (UAV) technology and continuously evolving software. The researchers have used the drone (UAV) to collect the aerial photography of the study area and to create a DSM with a digital photogrammetric process. This is the source of the high-resolution of the DSM creation using the drone and the software.

2. METHOD

2.1. Study area: The Lower Hacilar Basin area where located in the eastern Turkey, the Black Sea region, in the Arhavi Municipality Area, Artvin province was used as a case study (Figure 1). The study area far from the municipal office in east direction around 1 km, covers an area of 0.41 square kilometers. The topography is a narrow-flood plain along the Hacilar Stream, flanked by very steep hill slopes, made the basin center of the V-shaped. The flat land area is used as a residential area and commercial district as well as community and schools. The area on both hillsides of the basin serves as an agricultural area for tea cultivation and is partially used for residential purposes.

2.2. Tools: To create the high-resolution of the DSM has been used the photogrammetric process. Air photos are very useful spatial data resources to create the surface terrain. The aerial photographs of the study area have been taken by using the DJI Phantom 4 drone (DJI, 2016) (Figure 2). The drone was controlled in autopilot mode by using Pix4D Capture Android-Application (Pix4D, 2012). The digital photogrammetric process was used Agisoft Photoscan (Agisoft Team, 2017) to generate high-resolution of the DSM (Figure 3).

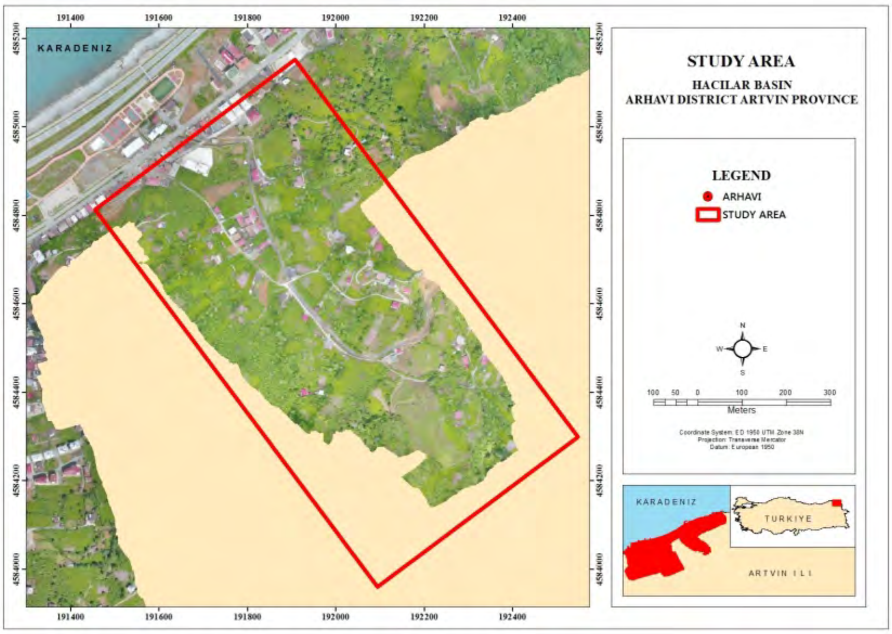

Figure 1: The study area.

Figure 2: The DJI Phantom 4 drone

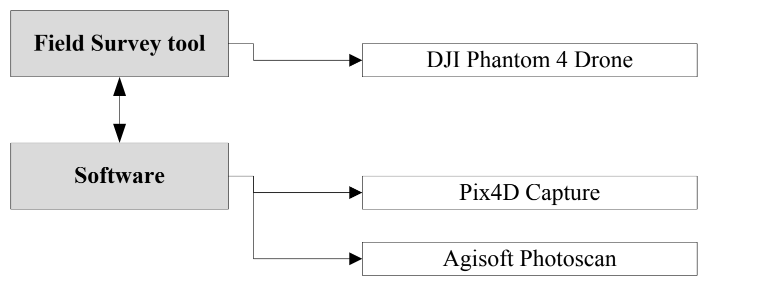

Figure 3: Tools and software

2.3. Methodology: The flight plan to collect the aerial photos from study area was carried out by the autopilot flying mode set up a flight plan in the Android software connected to the drone by drone remote control. The drone flight was controlled by the autopilot software. And the flight plan settings were configured according to the photogrammetric process. Due to the photogrammetric requires, to analyse the degree of terrain surface was used overlapped images by setting the aerial photo to overlap 80 percent on both front and side overlaps. The drone fly in a grid pattern, and take the photo in vertical aerial photography type in 90 degrees vertically. The flying altitude of drone was used the drone start point as the reference altitude of 0 meter and fly up to 150 meters high from the reference point throughout the study area (Table 1). The image size is 4000x3000 pixels (12 MB). Once the flight plan was completed, then flying of the drone was start around the area.

Table 1: The autopilot setting

Flight pattern	: Grid
Image overlap	: 80%
camera angle	: 90 Degree
Flight path	: 4528 mt
Flight altitude	: 150 mt

All aerial photos taken with the aerial photography process was taken into photogrammetric processing by using software (Figure 4). The first step in these processes is to align the photo, to align the lines of the photo or to combine all the aerial photos into one file; this is the first process of 3D modeling. In this process, the software parses the points of multiple photos with the same detail together at the same point. The next step is the Build Mesh, which creates a 3D shape from aligning photo. The next step is to create a dense cloud as a 3D process on the surface being photographed. The surface areas in a dense-cloud model based on the dense points was created by software. The last step is to create a DSM. DSM assigned with 22.6 cm spatial resolution was created from dense cloud.

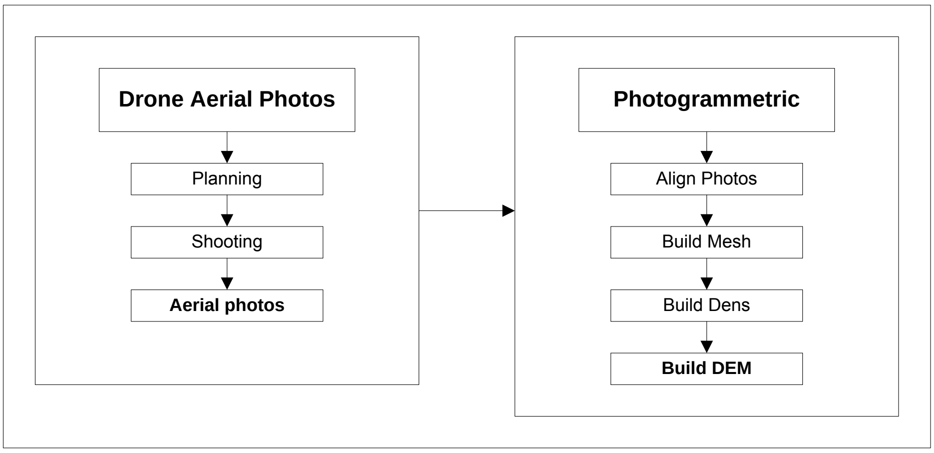

Figure 4: The methodology.

3. PROCESS

Flight process: End of the shooting aerial photography process were taken 168 photos and the flight takes 11.18 minutes. The drone was fly about 150.00 meters height from the ground. The taken aerial photos have coverage from Atatürk Street to the south along Ali Rıza Çakmaklı Street. The distance in the west - east is 430.00 m. The north-south equals 1010.00 m. Total shooting area is 0.41 square kilometers.

Software process: Following the photogrammetric process, all aerial photos were uploaded to the software as following steps below. (1) **Loading Photos:** Importing aerial photos from the drone into the software is the first process. Loading all 168 images to prepare for the next step. (2) **Aligning Photos:** When aerial photos are loaded into software, in this step, the software will find the position and orientation of the camera for each aerial photo and builds a sparse point cloud model. In the Align Photos Parameters select the desired alignment accuracy options setting at medium and Pair preselection setting at Reference following Table 1. (3) **Building Dense Point Cloud:** The software generates and visualizes a dense point cloud model based on the estimated camera positions from the aligning Photos step. The program calculates depth information for each aerial photo to be combined into a single dense point cloud.

Table 2: Setting of parameter in each photogrametric process.

Process	Parameter	Setting
Aligning Photos	Accuracy	Medium
	Pair preselection	Reference
Building Dense Cloud	Quality	Medium
	Depth Filtering modes	Aggressive

Align Photos

Dense Cloud

Figure 5: The comparison between Align Photo and Dense Cloud process.

When finished all of process in step 1-3 of photogrammetric process, we can generate visualize a Digital Surface Model (DSM) by using **Build DEM Tools**. The DSM represents a surface model as a regular grid of height values. The DSM can be rasterized from a dense point cloud from step 3 of photogrammetric process. The high-resolution of DSM results, cover a total of 0.41 square kilometers. The resolution of the DSM is 22.6 cm per pixel, the data size on hard disk of 43.96 Mega Byte. The lowest elevation is near the Hacilar community that's located in the northwestern part of this DSM, the lowest elevation is -18 meters when compare with the drone launch position. The highest elevation is 120meter compare with the drone launch position, located in the SE part of the DSM where the hills area.

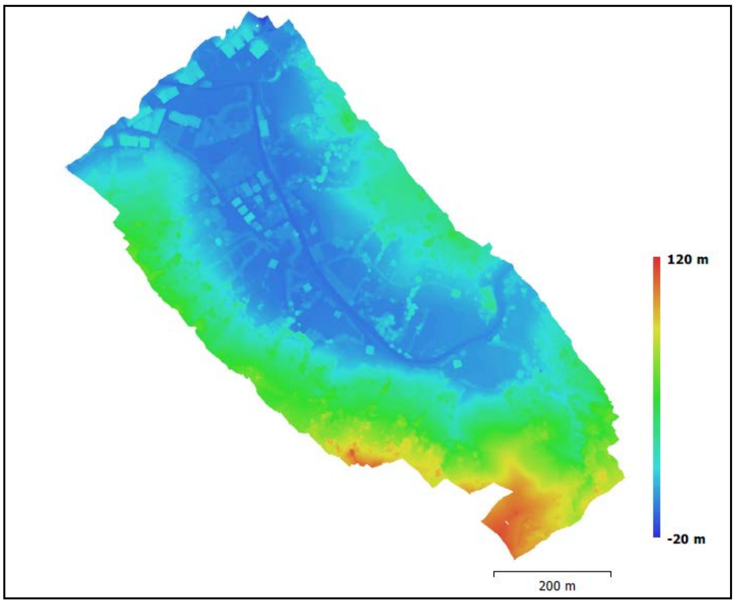

Figure 6: Completed DSM and perspective 3D view looks from NW to SE.

4. RESULT

In this article, we have studied the way to build a high-resolution of the DSM using the drone technology and software to support the DSM data for the urban flood analysis. It was found that the creation of DSM using data from the drone together with the digital photogrammetric process has the ability to create highly detailed of the DSM. Based on this experiment, it is possible to provide the detail of 22.6 cm per pixel, which is enough to apply in the field of flood modeling study. In previous work, the researchers rely on DEM from ASTER GDEM or SRTM DEM, which has a resolution limit of 30 meters per pixel. When using this new technique, the researchers will not have to worry about the detail of image resolution. Due to the potential for the DSM generation, in the future, it is highly possible that studies that require high resolution will not be limited by the quality of the DSM anymore.

The advantage of this study is the high-resolution DSM that can be built to provide the resolution we need to apply. It also has a lower cost compared to creating or acquiring other methods with similar resolution size. It also can convert data from DSM to DEM. For the disadvantages of this method of study, the DSM is higher-resolution detail it takes longer to process of aerial photos in the photogrammetric process. It also requires high-performance computer resources. The Ground Control Points (GCPs) must be configured to adjusting the correct of elevation of the DEM because the elevation of the DEM is based on the height of the drone.

Overall, this capability can be applied in applications requiring high terrain surface details. It may be popular and may replace the satellite DEM data in the future.

5. REFERENCES

Agisoft Team. (2017). Retrieved July 12, 2017, from Agisoft: http://www.agisoft.com/

DJI. (2016). *DJI PHANTOM 4*. Retrieved Jan 16, 2017, Access address: http://www.dji.com/phantom-4

Pix4D. (2012). *Pix4D Mobile*. Retrieved July 2, 2017, Access address: https://support.pix4d.com/hc/en-us/categories/200300675-Pix4D-Mobile#gsc.tab=0

Tachikawa, T., Kaku, M., Iwasaki, A., Gesch, D.B., Oimoen, M.J., Zhang, Z., Danielson, J.J., Krieger, T., Curtis, B., Haase, J., Abrams, M. and Carabajal, C. (2011). *ASTER Global Digital Elevation Model Version 2 – Summary of Validation Results*. Earth Resources Observation and Science (EROS) Center, NASA, 27 p. Access address: https://pubs.er.usgs.gov/publication/70005960

U.S. Geological Survey. (2015). *Shuttle Radar Topography Mission (SRTM) 1 Arc-Second Global*. Retrieved July 3, 2017, Access address: https://lta.cr.usgs.gov/SRTM1Arc