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UAV BASED CROP MONITORING

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ABSTRACT

Today, UAV based monitoring considerably is being used in agriculture studies. The main reasons of this inevitable popularity are the advantages of UAV systems such as ease of use, speed, portability, and low operating costs. Besides, the UAV systems become more powerful with photogrammetric improvements. Photogrammetry allows us to create different topographic digital data such as digital elevation models and orthophotos. In this study, a photogrammetric UAV flight plan was prepared, and aerial images of a 22 ha. cornfield is collected in Şanlıurfa/Çamlıdere ''Fig. 2''. The main purpose of the study is to determine the deficit effects of excessive water. Therefore, the collected aerial images were photogrammetrically processed, and the affected area was automatically calculated as 1.5 ha.

1. INTRODUCTION

There is a strong relationship between the history of civilization and agriculture. That is, they depend on each other. Without precision agriculture applications, it was hard to track crops and fields.

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 farm's field operations more insight-driven, and potentially more productive and efficient.

The agriculture ecosystem has already started to invest in these digital technologies. Multispectral satellite images are widely used for large fields, farms, and city-scale studies. In smaller areas, unmanned aerial vehicles (UAV) are popular. UAV systems bring new opportunities to all engineering fields as well as agriculture studies.

Depending on the mounted sensor, it is possible to produce different base products such as maps, digital elevation models, and orthophoto with the UAV. In an earlier study, (Uysal et al. 2015) generated a DEM with UAV photogrammetry and analyzed its accuracy. (Polat and Uysal 2017) generated digital terrain model from UAV based photogrammetric dense point cloud. (Ulukavak et al., 2019) used a UAV to model an archeological site. (Kaya et al. 2019) calculated an artificial pond volume with UAV and compared the results with terrestrial surveys.

Among all these engineering applications, vegetation purposed studies are also existing. Radoglou-Grammatikis et al. (2020) present a survey regarding the potential use of UAVs in precision agriculture. (Gao et al. 2020) try to design an agriculture framework to monitor plant diseases. A detailed study about UAV-based agricultural landscapes can be found in a previous study (Librán-Embid et al. 2019).

This study aimed to monitor the cornfield and detect the damaged area of overflowing water with a UAV. Moreover, it is also aimed to take measures by determining where the overflowing water flows and where it accumulates.

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 Preparation 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

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throughout the calibration process since such masses 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 to avoid split operations which may cause deviation in RGB analysis with the change of sunlight and atmospheric conditions. The study took 35 minutes, and 310 images were collected. The date was 26 September 2020. The mission started at 1.40 pm. The flight was covered about a 22-hectare. The followed flight route and image overlaps are given in ''Fig.1''

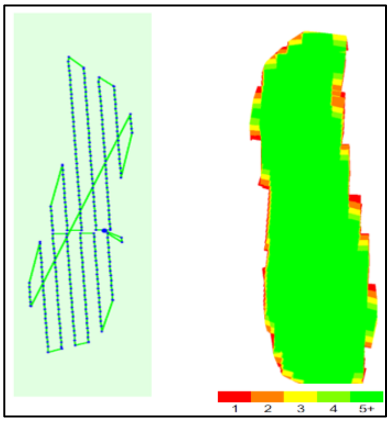

Figure 1. Flight route and image overlaps

2.2 VARI

VARI (The Visible Atmospherically Resistant Index) is an RGB index for leaf coverage. In other words, it stands for the average density of vegetation covering the ground. This index is used to estimate the fraction of vegetation in an image with low sensitivity to atmospheric effects.

Areas with abundant leaf coverage indicate that the biosphere is actively using hydrosphere for plant growth which is good (pix4d support). Therefore, the higher the value is, the better the optimum irrigation acquired.

VARI= (GREEN – RED) / (GREEN + RED – BLUE)

3. Study area and equipment

The study area is a corn field in Şanlıurfa/Çamlıdere. The area is located heading east 38 km from the city center of Şanlıurfa ''Fig.2''. The land has a streambed in the middle of the field. That means the land has a slopy character.

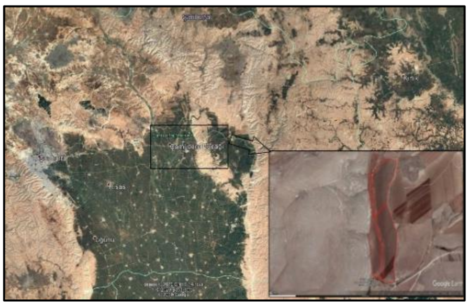

Figure 2. The location and shape of the interested corn field.

In this study, it is used DJI Mavic Pro as UAV system ''Fig. 3''. Mavic Pro drone is a pretty useful equipment for small areas. Mavic Pro has 25 minutes flight time. Mavic Pro is equipped with FC220 camera. FC220 has a 6.16mm*4.55 mm sensor size and has a 12.35 MP. We used pix4d capture flight planning and pix4d capture Works with ctrl+dji mobile application for android devices. Predefined settings of Pix4d capture provided us a quick and easy flight plan.

Figure 3. DJI Mavic Pro

4. RESULTS

All processes are made in Pix4d software. The ground sample distance (GSD) was calculated as 3.35 cm. The point cloud, triangle mesh, and orthomosaic map were created in the study.

The point cloud has 1540030 points. The orthomosaic map was generated with a 15 cm spatial resolution. The final product was VARI which is generated from orthomosaic ''Fig.4''.

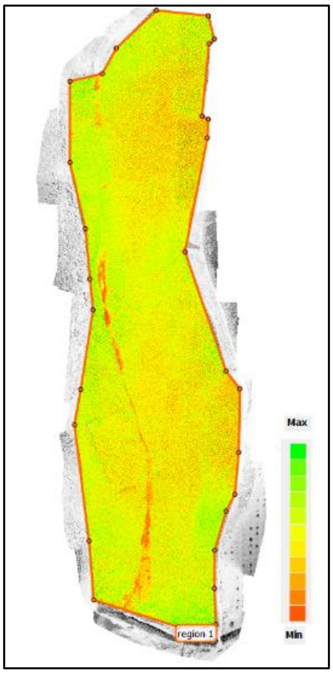

Figure 4. The generated VARI image.

The greener values indicate higher VARI values, where the corns' irrigation level is healthy. The damaged area is shown with reddish where the corns are over-irrigated. The area of interest was also calculated manually to be sure. In the end, the damaged area was calculated as 1.44 hectare manually and as 1.5 hectares automatically.

5. CONCLUSION

In this study, a 3D model of a corn farm was created with a process of aerial images obtained by UAV. The main purpose of the creation of this model is to detect damaged crop fields due to waterflood. In the end, a visible region vegetation index called VARI was generated and the damaged part of the cornfield was detected.

All processes took approximately 3 hours from flight to VARI generation thanks to the advantages of UAV and powerful computing. If this study was carried out with the traditional methods such as walking through the cornfield, it would have taken an entire day or more.

In future studies, it is planning to mount a multispectral camera that allows us to generate both VARI and normalized difference vegetation index to get more accurate crop monitoring.

REFERENCES

Gao D., Sun Q., Hu B., Zhang S. (2020). A Framework for Agricultural Pest and Disease Monitoring Based on Internet-of-Things and Unmanned Aerial Vehicles. Sensors 2020, 20, 487; doi:10.3390/s20051487

ibrán-Embid F., Klaus F., Tscharntke T., Grass I. (2020). Unmanned aerial vehicles for biodiversity-friendly agricultural landscapes - A systematic review. Science of the Total Environment 732 ,139204. https://doi.org/10.1016/j.scitotenv.2020.139204

Kaya Y., Şenol H.İ., Memduhoğlu A., Akça Ş., Ulukavak M., Polat N. (2019). Hacim Hesaplarında İHA Kullanımı: Osmanbey Kampüsü Örneği. Türkiye Fotogrametri Dergisi– 2019; 1(1); 07-10

Pix4D Mapper website

Polat N., Uysal M, (2017). DTM GENERATION WITH UAV BASED PHOTOGRAMMETRIC POINT CLOUD. 4th International GeoAdvances Workshop, 14–15 October 2017, Safranbolu, Karabuk, Turkey

Radoglou-Grammatikis P., Sarigiannidis P., Lagkas T., Moscholiao I. (2020). A compiliation of UAV application for precision agriculture. Computer Network, 172 ,107148

Ulukavak M., Memduhoğlu A., Şenol H.İ., Polat N. (2019). The use of UAV and photogrammetry in digital documentation. Mersin Photogrammetry Journal – 2019; 1(1); 17-22

Uysal M, Toprak A.S., Polat N. (2015). DEM generation with UAV Photogrammetry and accuracy analysis in Sahitler hill. Measurement 73 (2015) 539–543