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Comparison of Point Accuracies on Digital Elevation Model Obtained from Digital Air Photographs with Different Specifications

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Dear colleagues and friends,

It is our great pleasure to invite you to attend the EURASIAN GIS Congress 2018 held in Baku on 04-07, September 2018. EURASIAN GIS Congress 2018 is a candidate of one of the most important event in the scientific schedule and tenders a possibility for researchers and academicians who researches on GIS and related disciplines. You can find a first class programme of plenary speakers, technical sessions, exhibitions and social events in this book. You will be able to catch up with the developments in Geographical Information Sciences, Information Technology, Environmental Management and Resources, Sustainable Agriculture, Surveying, Photogrammetry and Remote Sensing, meet friends and experience the traditional and fascinating culture of AZERBAIJAN. As a international congress in the field of geo-spatial information and remote sensing, EURASIAN GIS Congress 2018 is devoted to promote the advancement of knowledge, research, development, education and training in Geographical Information Sciences, Information Technology, Environmental Management and Resources, Sustainable Agriculture, Surveying, Photogrammetry and Remote Sensing, their integration and applications, as to contribute to the well-being of humanity and the sustainability of the environment. The EURASIAN GIS Congress 2018 will provide us an opportunity to examine the challenges facing us, discuss how to support Future Earth with global geo-information, and formulate the future research agenda.

150 scientists from 13 countries attended to the congress. 7 plenary speakers, 120 oral presentations and 8 poster presentations, all together with 135 in total, are presented during the congress. 135 presentations take place in 21 sessions in three days. **Yaman, et al., (2019)** presented in the organization was selected for publication in **IJEGEO 6(1) as Short Communication.**

The Congress is carried out with the support of the organizations as the Konya Technical University, Selcuk University, Azerbaijan National Academy of Sciences Institute of Geography, Baku State University, Ministry of Agriculture of Azerbaijan Republic, General Directorate of Land Registry and Cadastre, General Directorate of Agricultural Reform of Turkey, International Federation of Surveyors (FIG), International Society for Photogrammetry and Remote Sensing (ISPRS) and Igdir University. In addition, the congress is also supported by the commercial organizations of INTEGRIS LLC, KUTLUBEY Engineering Co, RUBIKON Geosystems LLC, NETCAD, HARMIAD Surveying Engineers Businessmen Association, GEOGIS Engineering Co, MESCIOGLU Engineering Co, EMI Group Information Technology Co, PaksoyTeknik, and 4B Ölçüm.

Finally, we cheer on all of you to participate in this congress of EURASIAN GIS , and special thanks to all sponsorships and government partners for the congress. Enjoy your time and share your experiences with your friends.

Baku/Azerbaijan, September, 2018

Prof. Dr. Ferruh YILDIZ
Chair of The Organizing Committee

Prof. Dr. Ramiz Mahmudoglu MAMMADOV
Co-Chair of The Organizing Committee

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Short Communication

Comparison of Point Accuracies on Digital Elevation Model Obtained from Digital Air Photographs with Different Specifications

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Abstract

Photogrammetry is a map production technique or science applied by measurements made from terrestrial images with terrestrial cameras or more commonly used images taken with airborne cameras. With the development of technology, digital photogrammetry has been widely adopted in almost all areas of mapping. Especially digital orthophotos and digital elevation models, which are photogrammetric products, are being intensively utilized by the private sector due to their easy interpretability. Digital photogrammetry is also a good method to automatically collect digital elevation models. Digital elevation model production is an important process in photogrammetry. A digital elevation model is an important product by itself as well as plays an important role in creating products such as orthophoto. The geometrical accuracy of digital elevation model used in geomatics applications is of even greater importance. In this study, three different digital elevation models were produced using digital aerial photographs of 7 cm, 15 cm and 25 cm ground sample distance taken in 2011 of Aksaray University campus area. Then, by using the heights measured by GPS and read the same heights from the digital elevation model, root mean square errors of ground control points, check points and tie points were calculated and compared with recommended standards. When the results are examined, it is seen that the values were close to and below the recommended values. Therefore, it can be seen that the digital elevation models produced with the aerial photographs taken at 7, 15 and 25 cm ground sample distances can be used for studies that do not require.

Keywords: Accuracy, Digital elevation model, Ground sample distance, RMSE

Introduction

Photogrammetry is a map production technique or science applied by measurements made from terrestrial images with terrestrial cameras or more commonly used images taken with airborne cameras. The basic data produced by photogrammetric methods are topographic vector maps, orthophoto maps, digital terrain models, and digital elevation model data, which have varying scales. Aerial photographs and satellite images are the most used sources for the production and revision of this type of data and current maps (Özbalmumcu, 2007; Şahin, 2007).

With the development of technology, digital photogrammetry has been widely adopted in almost all areas of mapping. Especially digital orthophotos and digital elevation models, which are photogrammetric products, are being intensively utilized by the private sector due to their easy interpretability (Rabiu & Waziri, 2014).

Digital photogrammetry is also a good method to automatically collect digital elevation models. Digital elevation model production is an important process in photogrammetry. A digital elevation model is an important product by itself as well as plays an important role in creating products such as orthophoto. The geometrical accuracy of digital elevation model used in geomatics applications is of even greater importance.

DEM is a quantitative representation of the Earth terrain which gives basic information about its relief and elevations.

Choosing a correct DEM accuracy and quality is important to ensure that a orthophoto produced with DEM generated is accurate and precise.

In the European Union countries, the accuracy of the digital elevation model is derived from the check points. The accuracy for the digital elevation model under the instruction of "Assessment of the Quality of Digital Terrain Models" issued by EuroSDR (European Spatial Data Research) is determined according to "0.53× GSD" for heights (Kapnias, 2008).

According to the national standarts in Turkey (2018), the accuracy for the check points should be smaller than ± 0.75 × GSD for "x" and "y" coordinates (Böhhbüy, 2018).

In the "Accuracy Standards for Digital Geospatial Data, March, 2014" issued by the American Society for Photogrammetry and Remote Sensing (ASPRS), the accuracy of ground control points is classified according to the method used and accuracy. Accordingly, it is recommended that the root mean square errors of the ground control points are less than 0.00625 × map scale formula for Class I studies that require very high accuracy (ASPRS, 2014).

This paper presents a case study of generating digital elevation models (DEMs) with digital air photographs of Aksaray University Campus area taken at different ground sample distances and compared the values with recommended standards.

Figure 1 present the campus of Aksaray University, Turkey, in which the current study was undertaken.

Figure 1. Study area: The campus of Aksaray University.

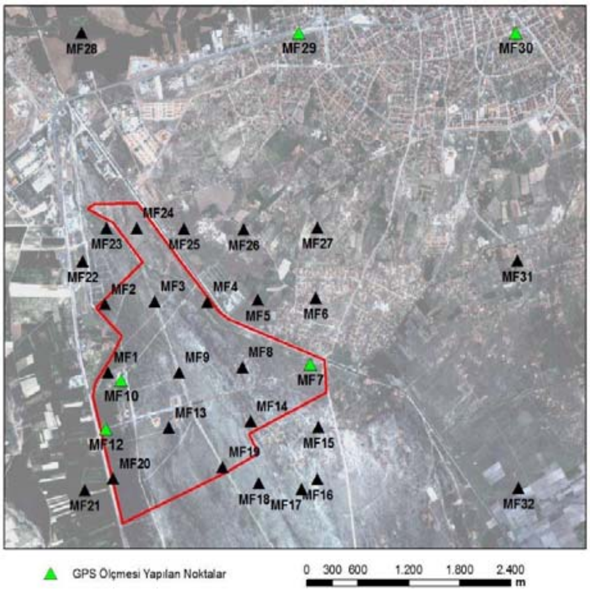

Figure 2: Distribution of ground control points in the study area.

Material and Methods

For the study, digital aerial photographs that have 7 cm, 15 cm and 25 cm ground sample distances in 2011 of study area were available. The number of digital photographs taken was 106 for 7 cm ground sample distance, 38 for 15 cm and 40 for 25 cm. The interior and exterior orientation parameters were obtained from the calibration report of the "Intergraph DMC" digital aerial camera. In addition, 32 ground control points distributed across the region, and the coordinates were available. Distributions of these points are shown in Figure 2. The three different digital elevation models of the study area produced using "Erdas LPS" software based on different ground sample distance of 7 cm, 15 cm and 25 cm are presented in Figures 3 to 5, respectively.

Then, by using the real heights and read the same point's heights from the digital elevation model, root mean square errors of ground control points, check points and tie points were calculated.

In the European Union countries, it is recommended that the check points' accuracy have to be small or equal "0.53 × GSD" for the accuracy of the digital elevation model.
According to the national standarts in Turkey (2018), the accuracy for the check points should be smaller than "± 0.75 × GSD" for "x" and "y" coordinates.

In the "Accuracy Standards for Digital Geospatial Data, March, 2014" issued by the American Society for Photogrammetry and Remote Sensing (ASPRS), the accuracy of ground control points is classified according to the method used and accuracy.

Table 1 presents the horizontal accuracy standards and root mean square errors for digital orthophotos based on this classification.

Table 1. The horizontal accuracy standards and root mean square errors.

Horizontal Accuracy Data Production Class	Photogrammetric Triangulation RMSE.(x), RMSE. (y) (cm)	Ground Control Points RMSE.(x), RMSE.(y), RMSE.(z) (cm)
Class-I	0.0125 × map scale	0.00625 × map scale
Class-II	0.0250 × map scale	0.01250 × map scale
Class-III	0.0375 × map scale	0.01875 × map scale
Class-N	N × 0.0125 × map scale	N × 0.00625 × map scale

Conclusions

Root mean square errors were calculated for the check points, the ground control points, and the tie points in all three sample distances. The found results and the recommended values were compared as shown in Table 2.

When the results are examined, it is seen that the values are close to and below the recommended values. Therefore, it can be seen that the digital elevation models produced with the aerial photographs taken at 7, 15 and 25 cm ground sample distances can be used for studies that require sensitivity.

Table 2. The found results and recommended values.

7 cm GSD		
For Check Points	Found value: σz = 16.58 cm (2.4 pixel)	Recommended value: σz= 0.53 × GSD (by EuroSDR) σz= 0.75 × GSD (by national standards)
For Ground Control Points	Found value: σz= 18.92 cm (2.7 pixel)	Recommended value: σz= 0.00625 × map scale (For class I)
For Tie Points	Found value: σz= 17.86 cm (2.5 pixel)	Recommended value: -
15 cm GSD		
For Check Points	Found value: σz = 11.80 cm (0.8 pixel)	Recommended value: σz= 0.53 × GSD (by EuroSDR) σz= 0.75 × GSD (by national standards)
For Ground Control Points	Found value: σz = 20.08 cm (1.3 pixel)	Recommended value: σz= 0.00625 × map scale (For class I)
For Tie Points	Found value: σz = 22.28 cm (1.5 pixel)	Recommended value: -
25 cm GSD		
For Check Points	Found value: σz = 23.25 cm (0.9 piksel)	Recommended value: σz= 0.53 × GSD (by EuroSDR) σz= 0.75 × GSD (by national standards)
For Ground Control Points	Found value: σz = 26.04 cm (1.0 piksel)	Recommended value: σz= 0.00625 × map scale (For class I)
For Tie Points	Found value: σz = 45.67 cm (1.8 piksel)	Recommended value: -

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