Application of UAV in measurements of earth structure deformation

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Unmanned Aerial Vehicles (UAV) are currently one of the most popular methods of collecting photogrammetric data. A short time of data acquisition and low costs are the key advantages of this solution, especially important during cyclical measurements of various types of objects.

The aim of this paper is to assess the possibility of using images obtained from UAV to determine the deformation of earth structures. The object of measurement was Krakus Mound located in Cracow (Poland). It is one of the oldest mounds in Cracow, preserved to this day. The history of this hill is unknown but it is assumed that the mound was built in stages. In 2013, the site was renovated.

As a part of the research, between 2015 and 2019, cyclic photogrammetric flights were carried out over Krakus Mound. For this purpose, DJI S900 aircraft equipped with a non-metric visible light camera Sony Alpha a6000 was used. The measurements were taken every year in spring and autumn. In total, 7 measurement sessions were performed, during which the coordinates of ground control points and check points were measured each time. As part of fieldwork, numerous comparative measurements were also carried out using other surveying instruments, such as GNSS receivers, total stations and terrestrial laser scanner.

This paper presents the results of research aimed at observing the geometry of the mound in 2015-2019. Low-altitude images obtained in combination with the Structure from Motion technique allowed to generate photogrammetric products to determine the deformation of the object. Generated UAV-derived point clouds and digital terrain models were used for the analyses. They were compared with reference data, i.e. photogrammetric products created on the basis of data obtaining during the first UAV flight and the results of total station and satellite measurements. This made it possible to determine the influence of the low vegetation on the results of measurements and to check whether the object is deforming. The research also included terrestrial laser scanning of the mound and usage of available LiDAR data to compare scanning data with low-altitude photogrammetric products. Numerous analyses allowed to create methodology of inventory measurements of earth structure covered with low vegetation using UAV-based photogrammetry.