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Analysis of the possibilities of using aerial photographs to determine the bathymetry in shallow coastal zone of the selected section of the Baltic Sea

Lukasz Cieszynski (1,2) and Kazimierz Furmanczyk (1)

(1) University of Szczecin, Faculty of Geoscience, Institute of Marine and coastal Sciences, Remote Sensing and Marine Cartography Unit, Szczecin, Poland, (2) West Pomeranian University of Technology in Szczecin, Faculty of Computer Science and Information Technology, Szczecin, Poland

Bathymetry data for the coastal zone of the Baltic Sea are usually created in profiles based on echo sounding measurements. However, in the shallow coastal zone (up to 4 m depth), the quality and accuracy of data is insufficient because of the spatial variability of the seabed. The green laser – LIDAR – can comprise a solution for studies of such shallow areas. However, this method is still an expensive one and that is why we have decided to use the RGB digital aerial photographs to create a model for mapping the seabed of the shallow coastal zone.
So far, in the 60's, researchers in the USA (Musgrove, 1969) and Russia (Zdanowicz, 1963) developed the first method of bathymetry determining from aerial panchromatic (black-white) photographs. This method was adapted for the polish conditions by Furmanczyk in 1975 and in 2014 we have returned to his concept using more advanced techniques of recording and image processing.
In our study, we propose to determine the bathymetry in shallow coastal zone of the Baltic Sea by using the digital vertical aerial photographs (both single and multi-channel spectral). These photos are the high-resolution matrix (10 cm per pixel) containing values of the grey level in the individual spectral bands (RGB). This gives great possibilities to determine the bathymetry in order to analyze the changes in the marine coastal zone. Comparing the digital bathymetry maps - obtained by proposed method - in the following periods, you can develop differential maps, which reflect the movements of sea-bottom sediments. This can be used to indicate the most dynamic regions in the examined area.
The model is based on the image pixel values and relative depths measured in situ (in selected checkpoints). As a result, the relation of the pixel brightness and sea depth (the algorithm) was defined. Using the algorithm, depth calculations for the whole scene were done and high resolution bathymetric map created. However, the algorithm requires numbers of adjustments resulting from, e.g., the phenomenon of vignetting, distribution of light, or the collapse of the rays of light at the atmosphere - sea interface. We have developed the algorithm with correction formulas and created a final model in MATLAB. It allows one to obtain three-dimensional bathymetry visualization for a specific region from a digital color aerial photograph. This model enables to determine the bathymetry of the most dynamic areas in the marine coastal zone up to 3-4 meters depth with a relatively good accuracy. In addition, the possibility to take pictures from the drone instead of a plane, significantly reduces the cost of the process.
In the poster presentation, we will present the model and its results for the area of the Polish west coast.
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