SEABED OBJECTS DETECTION BASED ON SIDE SCAN SONAR IMAGES COMPARISON METHOD

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INTRODUCTION

Hydroacoustic harbor surveillance system based on sonar images comparison was developed in Polish Naval Academy. The system allows detecting suspected objects on the harbor bottom. The oryginal method for automatic sonar images comparison f is presented below. It can be used not only for surveillance purposes, but for any kind of new bottom objects detection.

DATA AQUISITION

Side scan sonar survey was conducted in Gdynia harbor area using EdgeTech-272TD side scan sonar and RIB boats. In order to obtain images to be used in comparison method developing process. Sonographs were recorded before and after an installation of test objects within the controlled area. In this way, the images of a part of a seabed, with and without test objects visualization, were obtained during the survey. A set of **base images** and **compared images** was created for the purpose of presented method development and testing.

Fig. 1 One of the survey boats used during data aquisition in Gdynia, Poland.

A PROBLEM

Hydrographic software supports comparison of the sonographs obtained in different time moments, although it is still performed by an operator. There are some methods of objects detection presented in literature, but they apply to a single sonograph.
A problem of several sonographs comparison occured.

SEARCHING FOR A SOLUTION

A variety of images comparing methods from areas unrelated to hydrography was examined during the development process, including comparative navigation, closed-circuit television images comparing and a wide range of biometric techniques.
A biometric facial image recognition method, called Elastic Graph Matching (EGM), deserves a particular interest. Although it is difficult to find any similarity, in terms of content or receiving by the observer, between sonographs, and images of the faces, many analogies in the approach to comparison method development can be found. Thus, similar techniques can be used in the analysis of these two types of images. It was decided to modify the EGM method and use it as a tool for comparing sonar images for potentially dangerous objects detecting.

IMAGE COMPARISON ALGORITHM

Four steps of a complex image comparison algorithm:
1. **Images enhancement** - optional processes like beam pattern correction, various gain corrections and despecle filters offered currently by most hydrographic software;
2. **Images alignment** - techniques based on positioning system data and automatic reference points choosing can be combined - **Fig. 4**;
3. **Jets computation** for areas centred on points chosen by the echoes detection algorithm (jets are the elemnts from modified EGM technique, described in [2]) - **Fig. 6**;
4. **Changes detection** based on similarity functions (metrics described in [3] were used) - **Fig. 7**.

AN EXAMPLE OF USAGE

Fig. 2 The base image.

Fig. 3 The compared image. Test objects were placed at the bottom of the harbor basin.

Fig. 4 The compared image after the automatic alignement process.

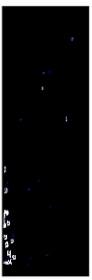
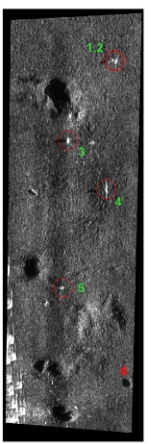


Fig. 5 The result of the automatic strong echoes detection algorithm.



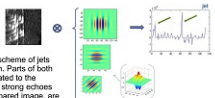


Fig. 6 The scheme of jets computation. Parts of both images, related to the locations of strong echoes on the compared image, are convoluted with a family of Gabor kernels, giving a vector called jet.

Fig. 7 The results of automatic objects detection algorithm based on sonographs comparison: 1-5 - correct detections, 6 - undetected test object on the edge of analysed area.

Fig. 8 Detected objects' positions over the sattellite image. Source: 'Gdynia', 54°32'01,00"N and 18°32'37,58"E, **Google Earth**, January 04, 2011. November 15, 2014.

CONCLUSION

There are some restrictions for the developed method of sonographs comparing, related in particular to the specifics of sonar data acquisition. Nevertheless the method allows successful new objects detection at the controlled area.

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