SEABED OBJECTS DETECTION BASED ON SIDE SCAN SONAR IMAGES COMPARISON METHOD

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 original method for automatic sonar images comparison is presented below. It can be used not only for surveillance purposes, but for any kind of bottom objects detection.

DATA ACQUISITION
Side scan sonar survey was conducted in Gdynia harbor area using EdgeTech-2270 side scan sonar and RIB boats. In order to obtain images to be used in comparison method development process, Sonographs were recorded before and after an installation of test objects within the controlled areas. In this way, free images of a part of a research area 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.

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 occurred.

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 end use it as a tool for comparing sonar images for potentially dangerous objects detection.

IMAGE COMPARISON ALGORITHM
Four steps of a complex image comparison algorithm:
1. Images enhancement - optimal processes like beam pattern correction, various gain corrections and despert filter applied correctly by most hydrographic software;
2. Images alignment - techniques based on positioning system data and automatic reference points checking can be combined - Fig. 4;
3. Image comparison for areas concerned on pixels chosen by the objects detection algorithm (jobs are the elements from modified EGM techniques, described in [2]) - Fig. 5;
4. Changes detection based on similarity functions (metrika described in [3]) were used - Fig. 7.

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.

REFERENCES

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 result of the automatic alignment process.
Fig. 5. The result of the automatic string echoes detection algorithm.
Fig. 6. The scheme of data computation. Pairs of both images, related to the location of strong echoes on the compared image, are compared with a family of scatter kernels, giving a weight over 1.0.
Fig. 7. The results of automatic objects detection algorithm based on sonographs comparison: 1 - correct detections, 2 - undetected test object at the edge of analyzed area.
Fig. 8. Detected objects' positions over the satellite image.

ACKNOWLEDGEMENTS
Presented method was developed as a part of PhD thesis "Side scan sonar images comparison method for the purposes of hydroacoustic harbor surveillance system", defended in Polish Naval Academy. Knowledge and experience gained through The Wenner Foundation and GEBCO Training Programme Scholar Program, class 9 email: katarina.zwolek@gmail.com