DOI: 10.37102/1992-4429_2025_53_03_05

THE METHOD FOR RECOGNITION UNDERWATER ARTIFICIAL OBJECTS

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The article is devoted to the current problem of detecting underwater presumably artificial objects (AO) within the framework of a seabed monitoring mission using an autonomous unmanned underwater vehicle (AUV) equipped with a stereo camera. Such objects include, along with underwater industrial infrastructure objects, sunken objects, military objects, etc. In particular, a pressing task is to detect objects near pipelines and other communications. Detection of these objects involves their automatic localization and recognition of characteristics indicating the artificial nature of the object's origin. In contrast to the traditional approach based on comparing input data with an a priori given model of the object, this paper proposes a method for direct recognition using computer vision methods of elementary geometric elements (GE) characteristic of the object in the input 3D point cloud obtained by processing a stereo pair of images. Such GEs include spatial segments (parallelepiped edges), spherical surfaces, as well as color, texture and other features. According to the proposed methodology, direct identification of the detected object with the adoption of decisions on subsequent actions will be carried out by the operator in offline mode based on the analysis of the received images and data from automatic algorithmic processing on board the AUV. The computational experiments performed with model data confirmed the prospects of the proposed method for detecting underwater objects.

Keywords: artificial object, recognition, stereo images, autonomous unmanned underwater vehicle, 3D point cloud, geometric elements

References

1. Gomes, D., Saif, A.F., & Nandi, D. Robust Underwater Object Detection with Autonomous Underwater Vehicle: A Comprehensive Study. Proceedings of the International Conference on Computing Advancements. 2020.

2. Yibo, S., Zhe S., Weitong Ch. The evolution of object detection methods. Engineering Applications of Artificial Intelligence Vol.133(1):108458. July 2024.

3. Dujmić, H., Papić, V., Turić, H. A New Method for Detection of Artificial Objects and Materials from Long Distance Environmental Images. International Journal of Mathematical, Physical and Engineering Sciences, No.4. 2010, ; P.22-26

4. Fei, C., Chen, H., & Ma, J. Man-made Object Detection Based on Texture Visual Perception. International Journal of Engineering and Manufacturing, No.2,P. 01-08. 2012.

5. Borodulin V.V., Chemeris D.S., Saj S.V., Sorokin N. Yu. Algoritm poiska i raspoznavaniya iskusstvennyh ob"ektov podvodnyh izobrazhenij. Vestnik TOGU. 2012. No. 3 Vol. 26. P.67-74.

6. Guili, X., Wang, Z., Cheng, Y., Tian, Y., & Zhang, C. 2017. A man-made object detection algorithm based on contour complexity evaluation. Chinese Journal of Aeronautics, No.30, P.1931-1940.

7. Kuz'menko A.V. Identifikaciya podvodnyh ob"ektov po opticheskomu izobrazheniyu. Morskie intellektual'nye tekhnologii. No. 2-2. Vol.48. 2020.

8. Himri, K., Ridao, P., Gracias, N. 3D Object Recognition Based on Point Clouds in Underwater Environment with Global Descriptors: A Survey. Sensors. 2019, No.19, 4451.

9. Himri, K.; Ridao, P.; Gracias, N. Underwater Object Recognition Using Point-Features, Bayesian Estimation and Semantic Information. Sensors 2021, No.21, Vol.1807.

10. Kabanov A. A., Kramar' V. A., Kramar' O. A. Sistema 3D-zreniya dlya podvodnogo robototekhnicheskogo kompleksa. Prikaspijskij zhurnal: upravlenie i vysokie tekhnologii, No.2 Vol.54, P. 113-125. 2021.

11. Kramar, V.; Kabanov, A.; Kramar, O.; Fateev, S.; Karapetian, V. Detection and Recognition of the Underwater Object with Designated Features Using the Technical Stereo Vision System. Fluids 2023, No.8, Vol. 92.

12. Roberts, P., Helmholz, P., Parnum, I., Krishna, A. Image feature extraction methods for structure detection from underwater imagery. The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences. XLVIII-1/W2-2023. P. 1067-1074. 2023.

13. Chen, Zh., Zhang, Zh., Dai, F., Bu, Y., Wang, H.. Monocular Vision-Based Underwater Object Detection. Sensors. No.17. Vol.1784. 2017.

14. Bobkov V., Melman S., Kudrashov A., Scherbatyuk A. Vision-based navigation method for a local maneuvering of the autonomous underwater vehicle. IEEE OES International Symposium on Underwater Technology. 2017. Busan. South Korea. February 21-24.

15. Melman S., Bobkov V., Inzartsev A., Pavin A. Distributed Simulation Framework for Investigation of Autonomous Underwater Vehicles' Real-Time Behavior. Proceedings of the OCEANS'15 MTS/IEEE Washington DC, October 19-22, 2015.