

EXPERIMENTAL STUDIES OF THE SYSTEM FOR DETECTING LOW-NOISE UNDERWATER TARGETS IN SHALLOW WATERS

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The article considers materials on underwater situation control in shallow water using underwater acoustic system, equipped with autonomous receiving modules with combined scalar-vector sound receivers. The technology and conditions of the experiment include a system of three receiver modules spaced apart and recording the noise field of the water area when a small-sized underwater vehicle moves in it under conditions of intensive navigation. General information is given on the methods of processing data of receiving modules to obtain calculated information parameters – the energy characteristics of the acoustic field, defined in terms of the square of pressure, and the components of the energy flux vector. These parameters were used to solve problems of detecting and estimating the direction to an underwater vehicle – a source of a broadband noise signal. Estimates of the underwater vehicle location zone are given according to the calculated values of the directions to it from the modules. The paper also presents estimates of increasing the detection range when processing the initial data of receiving modules by the method of holographic interferometry.

Keywords: passive underwater environment monitoring system, underwater acoustic receiving module, scalar-vector receiver, acoustic energy flux vector, detection and direction finding of an underwater maneuverable object, holographic signal interferometry.

References

1. Shurov V.A. Vektornaya akustika okeana. Vladivostok: Dalnauka, 2003. 307 p.
2. Dzyuba V.P. Skalyarno-vektornye metody v akustike. Vladivostok: Dalnauka, 2006. 194 p.
3. Karishnev N.S., Kuznecov G.N., Lun'kov A.A. Obnaruzhenie i ocenka koordinat shumovogo istochnika v melkom more s ispol'zovaniem skalyarno-vektornoj anteny i soglasovannoj fil'tracii. *Gidroakustika*. 2014. N 20. P. 74–80.
4. Gordienko V.A., Gordienko E.L., Krasnopishev N.A., Nekrasov V.N. Pomekhoustojchivost' gidroakusticheskikh priemnykh sistem, registriruyushchih potok akusticheskoy moshchnosti. *Akust. zhurn.* 2008. Vol. 54. N 5. P. 774–785.
5. Seleznev I.A., Glebova G.M., ZHbankov G.A., Mal'cev A.M., Harahash'yan A.M. Veroyatnostnye karakteristiki obnaruzheniya signalov odinochnym skalyarno-vektornym modulem. *Underwater investigations and robotics*. 2016. N 2 (22). P. 44–49.
6. Matvienko Yu.V., Khvorostov Yu.A., Kamornyj A.V. Sposob obnaruzheniya podvodnogo istochnika shirokopolosnogo shuma. Patent 201901778 RF. № 2699923; zayavl. 23.01.2019; opubl. 11.09.2019, byul. N 24.
7. Matvienko Yu.V., Khvorostov Yu.A., Kamornyj A.V. Sposob obnaruzheniya podvodnogo istochnika shirokopolosnogo shuma. Patent 2019121077 RF. № 2715431; zayavl. 03.07.2019; opubl. 28.02.2020, byul. N 4.
8. Matvienko Yu.V., Kamornyj A.V., Khvorostov Yu.A. Ob odnom podhode k resheniyu zadachi obnaruzheniya podvodnogo istochnika shumovykh signalov. *Underwater investigations and robotics*. 2018. N 2 (26). P. 37–43.
9. Khvorostov Yu.A., Matvienko Yu.V. Charakteristiki sobstvennogo shumozlucheniya malogabaritnogo ANPA. *Underwater investigations and robotics*. 2019. N 4 (30). P. 58–53.
10. Kuznecov G.N., Kuz'kin V.M., Peresolkov S.A. Spektrogramma i lokalizatsiya istochnika zvuka v melkom more. *Akust. zhurn.* 2017. Vol. 63. N 4. P. 406–418.
11. Kuznetsov G.N., Kuz'kin V.M., Pereselkov S.A., Kaznacheev I.V. Spectrogram and localization of a sound source in shallow water. *Phys. Wave Phenom.* 2017. Vol. 25. N 2. P. 156–163.
12. Kaznacheev I.V., Kuznecov G.N., Kuz'kin V.M., Peresolkov S.A. Interferometricheskij metod obnaruzheniya dvizhushchegosya istochnika zvuka vektorno-skalyarnym priemnikom. *Akust. zhurn.* 2018. Vol. 64. N 1. P. 33–45.
13. Kuz'kin V.M., Matvienko Yu.V., Pereselkov S.A. Primenenie interferometricheskoy obrabotki dlya lokalizatsii maloshumnykh istochnikov zvuka. *Underwater investigations and robotics*. 2019. N 4 (30). P. 49–57.
14. Kaznacheeva E.S., Kuz'kin V.M., Matvienko Yu.V., Peresolkov S.A., Khvorostov Yu.A. Ocenka dal'nosti obnaruzheniya malogabaritnogo podvodnogo apparata po ego shumovomu polyu. *Underwater investigations and robotics*. 2021. N 4 (38). P. 80–84.
15. Kuznetsov G.N., Kuz'kin V.M., Lyakhov G.A., Pereselkov S.A., Prosovetskij D.Yu. Direction finding of a sound source. *Phys. Wave Phenom.* 2019. Vol. 27. N 3. P. 237–241.

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