DOI: 10.37102/1992-4429_2026_57_03_06

ABOUT METHOD OF INCREASING THE ACCURACY FOR AUVS GROUP POSITIONING USING ACOUSTICAL NAVIGATION SYSTEM WITH SHORT BASE LINE

A.F. Scherbatyuk

The paper proposes a cost-effective solution for simultaneously determining the coordinates for a group of inexpensive autonomous underwater vehicles (AUVs). It is assumed that each AUV lacks expensive precision time system and absolute velocity log. The presented method for providing navigation support for a group of AUVs is based on the use of a short-baseline acoustic navigation system (SB ANS). SB ANS implementation is considered, which includes two receiving antennas on board each AUV and one emitting beacon with a known location. To solve the navigation problem, measurements are made of the difference in signal arrival times in each cycle at the SB ANS receiving antennas, the difference in signal arrival times in two consecutive cycles at a single receiving antenna, and measurements of the frequency for the signal received on board the AUV. An algorithm for estimating the AUV's position based on a particle filter is described, designed for operation on board each AUV in real time. The results of the proposed algorithm computer simulation are presented, which confirmed its higher accuracy compared to the version of the algorithm in which measurements of the difference in the arrival time of signals in two consecutive clock cycles to one receiving antenna are not used.

Keywords: short-baseline acoustical navigation, group navigation, autonomous underwater vehicle.

References

1. Ferri G. et al. Cooperative robotic networks for underwater surveillance: an overview // IET Radar, Sonar & Navigation. 2017. Vol. 11, No. 12. P. 1740–1761.

2. Gabriele Ferri, Raffaele Grasso et al. A Hybrid Robotic Network for Maritime Situational Awareness: Results from the INFORE22 Sea Trial. Proceedings of the OCEANS 2022 MTS/IEEE Conference, Hampton, USA.

3. Kim, S.-M. et al. Operational concept and design of multiple AUVs for rapid underwater investigation in case of maritime accidents. Proceedings of the OCEANS 2024 MTS/IEEE Conference, Halifax, USA.

4. McNelly B., Whitcomb L., Brusseau J., Carr S. Evaluating Integration of Autonomous Underwater Vehicles into Port Protection. Proceedings of the OCEANS 2022 MTS/IEEE Conference, Hampton Roads, USA.

5. Pavin A.M., Scherbatyuk A.F. On the search for noise sources by a group of interacting auvs using a genetic algorithm // Underwater Research and Robotics. 2024. No. 2 (48). P. 26–37.

6. Lin Y. et al. A Multi Autonomous Underwater Vehicle System for Autonomous Tracking of Marine Life // J. of Field Robotics. 2017. Vol. 34, No. 4. P. 757–774

7. I. E. Tuphanov and A. F. Scherbatyuk. Designing Group Behavior Algorithms for Autonomous Underwater Vehicles in the Underwater Local Heterogeneities Survey Problem. Automation and Remote Control, 2015, Vol. 76, No. 5, pp. 885-896.

8. Thompson J. at al. Multi-AUV Placement for Coverage Maximization in Underwater Optical Wireless Sensor Networks // Proceedings of the MTS/IEEE International Conference OCEANS 2020 MTS/IEEE San-Diego, USA.

9. Scherbatyuk, A.F. Multiple AUV Navigation without Using Acoustic Beacons // Gyroscopy and Navigation, No. 4, 2022, pp. 106-121.

10. Scherbatyuk, A.F. A Cost-Effective Method of Navigation for Inexpensive AUVs Using a Short-Baseline Acoustic Positioning System. // Gyroscopy and Navigation, No. 4, 2025, pp. 116-129.

11. Atwood D. K., Leonard J.J., Bellingham J.G., Moran B.A. An Acoustic Navigation System for Multiple Vehicles // In Proc. Int. Symp. on Unmanned Untethered Submersible Technology. September, 1995, pp. 202-208.

12. Borodin V., Smirnov G., Tolstyakova N. et al. Hydroacoustic Navigation Aids, Leningrad: Sudostorenie, 1983, 263 p.

13. Krasovskii, A.A., Beloglazov, I.N., and Chigin, G.P. Theory of Correlation-Extreme Navigation Systems, Moscow: Nauka, 1979, 448 p.

14. Stepanov, O.A. Application of the Theory of Nonlinear Filtering in the Problems of Navigation Information Processing, St. Petersburg: Concern CSRI Elektropribor, 1998, 370 p.

15. Vasil'ev, V.A., Isaev, A.M., Stepanov, O.A., and Toropov, A.B., Monte Carlo methods in measurement information processing using resampling procedures, Izvestiya RAN. Teoriya i sistemy upravleniya, 2026, no. 1.

Information about the author

Scherbatyuk Alexander Fedorovich, Doctor of Technical Sciences, corr.-member of RAS, chief scientist
Institute of Automation and Control Processes Far Eastern Branch of the Russian Academy of Sciences
Address: 5, Radio st., Vladivostok, 690041, Russia
Research interests: designing and application of marine robotic systems, positioning of unmanned underwater vehicles
Phone: +7(902)52-38-156. **E-mail**: alex-scherba@yandex.ru
ORCID: 0000-0002-7600-6711. **Scopus Author ID**: 6507204366
Web of Science Researcher ID: K-8737-2017