

## CALIBRATION FOR UNDERWATER ROBOTIC VEHICLES NAVIGATION

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### ABSTRACT

Calibration for acoustic and on-board navigation systems of underwater robotic vehicles is based on precise range-only measurements in the underwater medium. Calibration is carried out on the specially equipped area with the coordinates being estimated by using geodetic methods with inaccuracy less than 1 meter. A complex navigation system including a set of hydrophones / transponders and acoustic antenna with known coordinates is used for determination and better control of signals propagation speed within the area. The paper presents both the results of calibration for complex navigation system based on estimation and changing of estimated coordinates by data obtained from acoustic navigation system and inaccuracy sources for coordinate estimations. The consideration of inaccuracy sources for coordinate estimations provides significant decrease of total navigation error during long lasting mission of underwater robotic vehicle along the cyclic trajectory.

**Keywords:** underwater robotic vehicles, navigation systems, calibration for acoustic navigation system, Doppler log, acoustic ranging.

### REFERENCES

1. Ageev M.D., Kasatkin B.A., Kiselev L.V., Molokov Yu.G., Nikiforov V.V., Rylov N.I. *Avtomaticheskie podvodnye apparaty* [Automatic submersibles]. Leningrad, Sudostroenie Publ., 1981. 248 p.
2. Ageev M.D., Kiselev L.V., Matvienko Yu.V. et al. *Avtonomnye podvodnye roboty. Sistemy i tekhnologii* [Independent underwater robots. Systems and technologies]. Moscow, Nauka Publ., 2005, 400 p.
3. Zlobina N.V., Kasatkin B.A., Matvienko Yu.V., Rylov R.N. *Fizicheskie osnovy i metrologicheskoe obespechenie gidroakusticheskoy dal'nometrii v melkom more* [Basic physics and measurement assurance of hydroacoustic range finding in shallow sea]. *Pribory - Instruments*, 2006, no. 11, pp. 55–60.
4. Matvienko Yu.V. *Navigatsiya podvodnogo robota. Gidroakusticheskie sistemy s ul'trakorotkoy bazoy* [Navigation of an underwater robot. Hydroacoustic systems with ultra-short base]. Saarbrucken, Palmarium Publ. (Germany), 2013, 199 p.
5. Matvienko Yu.V., Rylov N.I., Rylov R.N. *Sposob opredeleniya gorizonta'nykh koordinat nepodvizhnogo podvodnogo istochnika navigatsionnykh signalov* [Method of determining the horizontal coordinate of the stationary underwater source of navigation signals]. Patent RF, no. 2378663, 2008
6. Matvienko Yu.V., Rylov R.N., Burenin A.V., Voytenko E.A., Morgunov Yu.N. Experimental studies of underwater ranging features in the East Japan Sea shelf zone. *Podvodnye issledovaniya i robototekhnika – Underwater Investigations and Robotics*, 2009, no. 2(8), pp. 44–49.