DOI: 10.37102/1992-4429_2022_40_02_05 https://elibrary.ru/psxaxc

APPROACH TO THE CONTROL SYSTEM DESIGN FOR A HIGHLY MANEUVERABLE UNDERWATER VEHICLE OPERATING ACROSS THE ENTIRE RANGE OF ORIENTATION ANGLES

E.A. Gavrilina

In practice, there is a trend towards increasing the number of tasks that require high maneuverability of unmanned underwater vehicles (UUVs). However, the methodology for constructing control systems for such UUVs has not been sufficiently developed. In particular, the operation of traditional control systems based on Euler angles (yaw, pitch, roll) is limited at critical pitch angles (±90°) due to the degeneration of kinematic equations and the problem of nonuniqueness. At the same time, control systems based on other parameters suffer from the problem of performance deterioration at large angles of inclination (pitch and roll). As a result, the question arises in developing an approach that ensures the required quality of UUV operation over the entire range of orientation angles. To solve the problem, the paper proposes an approach to control system design based on Euler angles, and algorithms that ensure the system's operability at any orientation angles. The operability of the approach was tested on the non-linear model of the Aqua-MO ROV on special test movements that check the operation of the system at critical pitch inclinations, as well as when performing large angle maneuvers. The obtained results confirm the efficiency of the proposed approach. In addition, performed experiment confirmed that, in some cases, the approach based on Euler angles has an advantage over the approach based on quaternions. The results obtained in the work contribute to improving the quality of the control systems of highly maneuverable UUVs, using the accumulated experience in the development of new systems, as well as expanding the operating angles of already developed control systems.

Keywords: AUV, ROV, H-inf, hybrid control systems, attitude control systems, Euler angles, quaternions, high maneuverability, robust control.

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About the author

GAVRILINA Ekaterina, Researcher
Bauman Moscow State Technical University
Address: 141006, Mytishchi, Olympic Ave, 23, apt. 179
E-mail: Ekaterina.a.gavrilina@gmail.com
Area of scientific interests: control systems, underwater robotics, autonomous systems
ORCID: 0000-0002-9919-5287

Recommended citation:

Gavrilina E.A. APPROACH TO THE CONTROL SYSTEM DESIGN FOR A HIGHLY MANEUVERABLE UNDERWATER VEHICLE OPERATING ACROSS THE ENTIRE RANGE OF ORIENTATION ANGLES. Underwater investigation and robotics. 2022. No. 2 (40). P. 39–53. DOI: 10.37102/1992-4429_2022_40_02_05. EDN: PSXAXC.