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METHOD FOR GENERATING PROGRAM CONTROL SIGNALS FOR THE POSITIONING OF A VESSEL SUPPORTING AUV OPERATIONS

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This paper addresses the problem of ensuring stable hydroacoustic communication between an autonomous underwater vehicle (AUV) and support vessel or unmanned surface vessel (USV) supporting its operation during the AUV's underwater missions in open sea conditions using an ultra-short baseline hydroacoustic communication and navigation system. Existing approaches to positioning the vessel relative to an AUV moving along an arbitrary route often lead to degradation or loss of communication due to increasing distance to the vehicle and growing vessel self-noise. To solve this problem, a method for generating program control signals for vessel positioning based on model predictive control is proposed. This method computes the vessel's speed and yaw into account the actual and predicted AUV trajectories, the vessel's dynamic characteristics, and the physical parameters of the hydroacoustic communication channel. In order to maximize the signal-to-noise ratio (SNR), which accounts for signal propagation loss, vessel self-noise level, and sea ambient noise, an optimization objective function is formulated. The vessel's state vector is predicted using its dynamic model incorporating the Nomoto yaw equation. The optimization problem is solved at each computation step by means of quadratic programming in the MATLAB environment. Numerical simulations were performed for an AUV trajectory consisting of successive tacks. Comparison with two alternative approaches demonstrated that the developed method ensures a consistently high SNR level, absence of communication loss, and minimal necessary vessel movements. The research findings confirmed the effectiveness of the proposed method for maintaining a reliable hydroacoustic communication channel with an AUV operating over extended sea areas.

Keywords: hydroacoustic communication channel, signal-to-noise ratio, predictive control modeling, carrier vessel, autonomous underwater vehicle, trajectory optimization, ultra-short baseline hydroacoustic communication and navigation system.

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