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DYNAMIC AMPLIFICATION OF OSCILLATIONS IN THE ELECTRIC DRIVE OF DEEP-SEA MANIPULATORS BASED ON ELECTRIC MOTORS OF OSCILLATORY MOTION

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Currently, technologies for the development of mineral resources of the world's oceans are being used with the help of robotic mining systems moving along the bottom. Underwater manipulators can be used to collect solid minerals dispersed along the seabed. High-speed manipulators are necessary for efficient operation. In manipulators, the speed of the links is limited by high energy consumption to overcome the forces of inertia in each cycle of movement. The purpose of the work is to study the dynamics of a high–speed manipulator based on electric motors of oscillatory motion of a resonant type. The resonant tuning ensures the recovery of energy spent on overcoming the forces of inertia. In deep-sea conditions, the electrical part of such a vibration drive can be easily isolated from the external environment. A simulation of the dynamics of the manipulator drive based on oscillatory motion electric motors with a rotary anchor is carried out. Lagrange-Maxwell equations were used in the development of the mathematical model of the drive. The simulation showed that due to the positional dependence of the electromagnetic driving torque, the electric motors in question cannot provide sufficiently large oscillation amplitudes. The possibility of amplification of oscillations by dynamic control methods was considered. It is shown that the amplification of vibrations can be achieved by introducing an additional degree of freedom into the electromechanical system "electric motor – actuator". It is proposed to connect the grip of the manipulator with the armature of the electric motor by means of an elastic element forming, together with the mass of the grip, an inertial dynamic vibration damper of the armature. Due to dynamic damping, the vibrational energy is redistributed from the armature to the actuator. As a result, the amplitude of the vibrations of the grip increases, and the amplitude of the vibrations of the armature, on the contrary, tends to zero. Moreover, it is possible to achieve dynamic stabilization of the armature oscillations in the zone with maximum values of the positional dependence of the driving electromagnetic moment. Numerical simulation has shown that in this way it is possible to increase the oscillation amplitude of the actuator tenfold.

Keywords: underwater robotic systems, robots moving along the bottom, resonant type manipulators, electric motors of oscillatory motion, vibrations of electromechanical systems, dynamic vibration control.

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