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BUCUREȘTI

PhD THESIS

CONTRIBUTIONS TO THE ANALISYS OF MOVEMENT FOR UNDERWATHER TOWED VEHICLES

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The doctoral thesis is structured in eight chapters, as follows.

In chapter one, the relevance of the theme is presented. Lately, the towed systems for the prospecting of the marine environment have been imposed, where the basic element of the system - the one that performs the conversion of acoustic pressure - electrical signal and/or vice versa - can be immersed at the optimal depth in terms of the propagation of acoustic waves. These systems are increasingly used in the geological - geophysical research of the bottom of the planetary ocean in order to discover the areas with hydrocarbon resources and mineral deposits, in the seismographic prospecting of the submarine soil, in the exploitation of the large submarine oil and gas pipelines, in the scanning the seabed for locating wrecks or other objects, in detecting schools of fish and also in the military field of submarine detection.

Various systems are presented, their common characteristic in a general configuration could be: the tugboat, the launch-recovery installation consisting of winches and crane, the shock absorbing device, the towing cable, the underwater device, in which it is mounted part of the environmental prospecting equipment, the rest of the equipment being mounted on the ship.

At the end of the chapter, the specific objectives of the research are defined.

In the second chapter - "Differential equations of the movement of marine bodies" the toretic aspects of the specific dynamics of bodies immersed in water are addressed. In the beginning, the reference systems used in the management of bodies moving in water are presented. The kinematic parameters of the translational movement are determined, expressed in the bound reference system and in the basic reference system.

The equations of the dynamics of the immersed body are written, highlighting the hydrodynamic forces and moments, the weight and the buoyant force, the forces and moments of the driving installations.

Simplification, by linearizing the differential equations, opens the way to solving the problems of controlling the movement and steering of the ship.

Chapter three - "Behavior of marine cables in non-stationary regime" presents the differential equations of the dynamics of stranded cables. By specialization, the equilibrium configuration of the marine cable can be deduced. The mathematical model is composed of the differential equations of the cable movement that can be used in a large number of specific situations: simple or combined moored systems (composed of cables, chains, submerged or surface bodies, buoys, weights and docks); the distinct boundary conditions both at the bottom end and at the top end; different loads, both concentrated and distributed; different continuity conditions at the points where bodies are attached, or at the points where separate cables are connected; distinct two-dimensional and three-dimensional geometric configurations; various water depths; diverse topography of the water bottom; simple and compound traction systems.

In chapter four, "Stability of the motion of a towed submarine vehicle", the equations of motion of the submarine vehicle, compared to the semi-linked system and the mobile linked system, are presented. The terms on the right side of the equations contain the projections of the forces and moments acting on the vehicle. Of these, the hydrodynamic forces and moments are usually expressed with the help of experimentally determined coefficients.

The constitution of the linear movement model is based on the hypothesis of a stationary, equilibrium movement regime, around which small changes in the kinematic variables take place. It is thus assumed, in addition, that the disturbances that take the vehicle out of the stationary motion regime are small.

In the fifth chapter - "Experimental determination of the hydrodynamic characteristics of the immersed vehicle on reduced-scale models", an experimental study is presented on a physical scale model. Experimental results obtained in the aerodynamic tunnel of the ICEPRONAV Galati measurement base are presented on a fixed model and in the case of the mobile model, towed in a water tank.

Chapter six - "Numerical determination of the hydrodynamic characteristics of the immersed vehicle on a real scale", presents the determination of the hydrodynamic characteristics of the vehicle for the case of vertical movement. Two cases of movement are considered: translational movement in the vertical plane (with two degrees of freedom: horizontal movement and vertical movement) and rotational movement around a normal axis in the vertical plane (with one degree of freedom).

In chapter seven, "Numerical simulation of the movement of a towed submarine vehicle", the modeling of the dynamics of the towed underwather vehicle is presented, considering a movement in the vertical plane, both of the submerged vehicle and of the cable.

The modeling of the wire was made with rigid bar-type elements articulated between them, with cylindrical joints with the axis perpendicular to the plane of movement. The last segment is articulated by the underwather vehicle, with the presented geometric and mass characteristics. Several study cases were considered: total cable lengths of 50 and 100 m. For the forward speed of the towing vessel, speeds of 2 m/s, 4 m/s and 8 m/s were considered respectively.

Chapter eight, "Original contributions and possible directions for future research" contains the general conclusions, contributions and further directions for research development.