ABSTRACTS

Key words: towed antenna module; sonar source of navigation signals; satellite navigation system receiver; carrying coupling cable; sonar navigation system.

Vaulin Yu.V., Kostenko V.V., Mokeyeva I.G., Matviyenko Yu.V., Rylov N.I. TRAITS OF BOTTOM SONAR SOURCES OF NAVIGATION SIGNAL COORDINATION WITH USE OF TOWED ANTENNA MODULE // Underwater Investigation and Robotics. 2018. No. 2 (26). P. 4–11.

A method is proposed for implementing the optimal trajectory of towing an antenna module, which saves time when coordinating bottom sonar beacons without significant loss of accuracy. The designed method evaluates the towed antenna coordinates without using sonar navigation systems. In compliance with the results of flexible inextensible cord simulation the analytic dependences of towed antenna coordinates on communication line length and velocity of travel are determined. The algorithms of evaluation the towed antenna coordinates relative to carrier are developed, based on satellite navigation system data of its velocity of travel, antenna module course and communication line length.

Key words: remotely operated unmanned underwater vehicle, intelligent system, underwater operations, navigation system, software.

Filaretov V.F., Konoplin A.Yu., Konoplin N. Yu. DEVELOPMENT AND FULL-SCALE TESTING OF INTELLECTUAL SUPPORT SYSTEM FOR ROV OPERATORS // Underwater Investigation and Robotics. 2018. No. 2 (26). P. 12–20.

The article deals with the development of the intellectual support system for the ROV operators, as well as the practical implementation of this system for the ROV Comanche 18, which is based on the R/V "Akademik M.A. Lavrentiev". The proposed system implements the controlling algorithms for the coordinated movements of the ROV and its depressor-weight. These algorithms are designed for the simultaneous, accurate, and accident-free ROV movements along the long routes, even in the case when the supporting vessel has no a dynamic positioning system. Proposed system provides operators with visual recommendations and warnings, which are formed in real time on the basis of expert evaluation of the information obtained from various sensors and navigation systems. The abilities for the planning of routes for the ROV and its carrier vessel movements, the entering of target points, as well as the storing of maps, tracks and locations of the detected underwater objects are realized in the developed system. The article presents the results of successful tests performed in the deep-sea scientific research expedition of the National Scientific Center of Marine Biology FEB RAS in the Bering Sea in 2018. The created intellectual support system for the ROV operators significantly expanded the capabilities of ROV in the process of performing many unique works, significantly reducing the time for underwater operations.

Key words: marine robots, group operation, water area surveillance.

Sporyshev M.S., Scherbatyuk A.F. ABOUT USAGE OF MARINE ROBOT GROUPS FOR WATER AREA SURVEILLANCE: BRIEF REVIEW// Underwater Investigation and Robotics. 2018. No. 2 (26). P. 21–27.

Marine surveillance is needed for detection, localization and recognition of strange objects in the specified water area by means of fixed or mobile heterogeneous sensor systems. Strange objects can be mobile or fixed. Different scenarios may be used for port protection or ships and critical infrastructures guarding. Development of marine robotics has led to appearance of surface and underwater robot networks that allow the constant presence and more reliable and low cost solution of the surveillance tasks. The problems and methods of their decision connected with the specified water area guarding by use of underwater robot networks are considered. Some marine robotic complexes intended for group surveillance operations are described and the examples of guarding experiments in the real marine conditions are supplemented.

Key words: autonomous underwater vehicle (AUV), underwater infrastructure inspection, navigation and control system (NCS), high-performance simulation framework, remote investigation of control algorithms.

Inzartsev A.V., Eliseenko G.D., Panin M.A., Pavin A.M., Bobkov V.A., Morozov M.A. INVESTIGATION OF UNDERWATER PIPELINE INSPECTION ALGORITHMS ONBOARD THE AUV VIA REMOTE HIGH-PERFORMANCE MODELING FRAMEWORK // Underwater Investigation and Robotics. 2018. No. 2 (26). P. 28–36.

Automated inspection of the pipeline infrastructure in underwater mining equipment with the help of the AUV requires precise purposeful movement of the robot at a small distance from the inspected object. The exact distance between the pipeline and AUV can be determined on the basis of analysis the visible form of the laser line, with which the robot illuminates the inspected object. This information is then used to organize precise purposeful movement of the robot in the vicinity of inspected object.

The scheme of debugging process and implementation features of the navigation and control algorithms designed for inspection purposes are discussed. Debugging is carried out using a distributed modeling system that includes a remote

high-performance computing cluster, coupled with the software environment of the navigation and control system (NCS) of the real AUV. The tasks of modeling environment and laser line shape analysis are solved on the side of computing cluster. In the NCS environment operate AUV model and control agents that use the recognition data for the inspection organization. This debugging scheme allows for resource-intensive simulations without making any changes to the software architecture of the NCS.

The results of model experiments on the inspection for different placement options of the pipeline on the bottom surface are discussed.

Key words: combined scalar-vector sound receiver, signal arrival direction detection, weak noise signal detector.

Matviyenko Yu.V., Kamornyy A.V., Khvorostov Yu.A. ON ONE APPROACH TO SOLVING THE PROBLEM OF UNDERWATER SOURCE DETECTION OF NOISE SIGNALS // Underwater Investigation and Robotics. 2018. No. 2 (26). P. 37–44.

Determining angular position and detecting a moving source of broadband noise data processing model based on stable angular characteristics of source generated energy flow for receiving systems with combined scalar-vector sound receivers is presented. The model is based on angular distribution calculations of total levels of energy flows from narrow horizontal sector. The energy detector determines the angular sectors where energy level exceeds the average (noise) value over the whole horizon. Under low signal-interference ratio the model conducts initial normalizing of high levels spectral components of pickup signal and its temporal averaging.

The model is presented as (software) computer program. Authors give the examples of data processing for the broadband noise source under different different signal-interference ratio as well.

Key words: acoustic field, autonomous underwater vehicle, underwater sound system.

Chupin V.A., Dolgikh G.I., Shcherbatyuk A.F. RESEARCH OF THE TIME-SPACE DISTRIBUTION OF THE ACOUSTIC FIELD IN THE COASTAL AREA OF THE SEA // Underwater Investigation and Robotics. 2018. No. 2 (26). P. 44–48.

The results of experimental studies of the space-time distribution of hydro-acoustic pressure field are described in a wedge-shaped shelf created by low-frequency hydroacoustic emitter with a central emission frequency of 33 Hz, and was hardware and software sonar system based on Autonomous underwater vehicle MARK and highly sensitive sonar receiving system. During the processing of experimental data, the space-time distribution of the hydroacoustic field in the coastal zone of Vityaz Bay was obtained.

Key words: underwater navigation, sound speed, satellite oceanology, AUV, underwater sound channel.

Morgunov Yu.N., Golov A.A., Dubina V.A., Luchin V.A. METHODOLOGY OF THE OCEANOLOGICAL DATA APPLICATION IN HIGH ACCURACY OBSERVATION OF UNDERWATER OBJECTS AT LONG DISTANCES // Underwater Investigation and Robotics. 2018. No. 2 (26). P. 49–54.

Providing the positioning of autonomous underwater vehicles (AUV) at large distances from the control centers is connected with the solution of the problems of underwater ranging in complex hydrological and bathymetric conditions for the propagation of navigation signals. The article is devoted to the development of a methodology for solving one of the main problems of effective observance of AUV at large water areas. The main aspect of the methodology is the correct forecast and control of the oceanological situation and its changes in the navigation support area with the possibility of transmitting information about changes to the AUV board. Particular attention is paid to methodical and technical means of monitoring the main characteristics of underwater sound channels of various origins in the summer and winter seasons by the example of the north-eastern part of the Sea of Japan. An analysis is given of the possibility of applying long-term climatic data of hydrological measurements in a given area, on specified acoustic paths to ensure high-precision observation of underwater objects over a long range. For winter conditions of near-surface propagation of acoustic energy, the possibilities of immediate measurement and control of effective sound velocities at given paths using the data of satellite infrared images of surface temperature are considered.

Key words: remotely operated unmanned underwater vehicle, intelligent system, underwater operations, navigation system, software.

Kasatkin B.A., Zlobina N.V., Kasatkin S.B. FEATURES OF THE SPATIAL-FREQUENCY STRUCTURE OF THE SOUND FIELDS CREATED BY BOUNDARY WAVES OF RAYLEIGH-SHOLTE // Underwater Investigation and Robotics. 2018. No. 2 (26). P. 55–62.

Calculation of the sound field in a type wave guide a water layer – a firm half-space of sedimentary type for a case when the speed of a shift wave in a half-space is less than acoustic speed in a water layer is executed. Special attention is paid to the interfaced couple of normal waves of a zero order (fundamental fashion) which in limit cases of low or high frequencies degenerates in a boundary wave of Rayleigh or in boundary waves of Rayleigh–Sholte, regular and generalized, respectively. Options of implementation of boundary waves of Rayleigh–Sholte in the interferential structures registered by the combined receiver in case of low frequencies when boundary waves of Rayleigh–Sholte make the dominating contribution to the total sound field are considered.

Key words: underwater acoustics, processing of experimental data, discrete variable representation, vertical hydrophone array, waveguide.

Makarov D.V. ALGORITHM FOR RECONSTRUCTION OF AN ACOUSTIC WAVEFIELD PROFILE BY MEANS OF POINTWISE MEASUREMENTS // Underwater Investigation and Robotics. 2018. No. 2 (26). P. 63–68.

A method for calculation of a continuous acoustic-wavefield profile by means of pointwise measurements via a vertical hydrophone array is developed. The method is based on the usage of discrete variable representation functions. It is shown that this method provides almost exact reconstruction of the acoustic-wavefield profile if vertical sound wavelength exceeds double spacing between the nearest hydrophones. If an acoustic wavefield is localized in depth due to presence of a near-surface or near-bottom sound channel, then the array length needed for the reconstruction can be diminished.