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RADAR-ACOUSTIC SYSTEM FOR BIOLOGICAL MONITORING OF MARINE SPECIES ACCUMULATIONS LOCATION IN THE COASTAL ZONE

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Abstract: Possibility of detecting, recognizing and monitoring the location of marine biological species accumulations in the coastal zone using radar-acoustic system which includes parametrical sounding and receiving arrays, autonomous acoustical and hydrophysical transducers transmitting data through radio-communication channels, and coastal sector scan radars as well is considered.

Specialists have been in recent years giving intent attention to problem of biological monitoring the location of marine species (MBS) accumulations in the coastal zone.

The potentialities of active hydrolocation tools are restricted by reverberational interference, involving the required long-range detection handicap, and also by significant effect of sound and infra-sound radiation on behavioral description of MBS and on a whole ecological system.

The possibility of detecting, recognizing and monitoring the MBS location by passive hydrolocation tools are restricted by high level of sea noise in the sea straits and shelf areas. The authors of numerous articles (for example, [1 - 3]), showed that the movement of MBS accumulations in water medium produced considerable changes in its structure: there were turbulent streams, its stratification discontinuity resulted from. In other words, the structure of moving MBS is contrastly inhomogeneous for acoustic (primary, secondary and combination frequencies), electromagnetic and other physical fields.

The base of developed unit including: parametrical sounding (PSA) and receiving reverberational arrays (RRA) and also coastal sector scan radars are the basis of the developed system. In this case, biological monitoring of the location of MBS carried out by their acoustic (primary, secondary and combination frequencies), hydrodynamic and electromagnetic fields.

The main features of the method that based on operating the developed system are:

- using PSA and RRA for distant-reading spectroscopy of sound scatters to determine their acoustic characteristics (resonance frequencies, layers strength and other), and a choice of the best (in terms of the most effect of acoustic wave energy transformation) parameters of the stimulated signals;
- using the parametrical transducer (source) to form directional sounding a broadband wave of difference frequency and to sail directions of object to be find on the hydrodynamic formations induced by MBS movement.
- using RRA to take the bearings of a noise source in a wide frequency band and also PSA sounding signal reflected from MBS accumulations.
- applying the spatial-spaced parametric sounding and receiving hydrophones to implement the method of bistatical hydrolocation.

Presented in the figure is a structural diagram of the stationary hydroacoustical system for detecting MBS accumulations the system composing, in the simplest case, an active and passive sonar set, two spatial-spaced RRA and two coastal sectors scan radars.

Using the PCA for transmitting the broadband signals in a narrow-solid angle and also spatial RRA the directional characteristics of which are oriented, by certain way, in vertical flatness, permits to use data more effectively (if compared with the linear hydrophones).

The data above mentioned are presented in primary and secondary acoustical fields and also in the hydrodynamic field of moving MBS accumulations.

Besides that the monitored area of sea waters is by an order or more greater than to be explored by linear hydrophones at the coast of using low band frequencies and directing PSA and RRA in vertical and horizontal planes.

In common, the active and passive parametrical sonar set contains the following channels: PA calibration channel, high frequency (HF) waves of the close frequencies to perform the distant-reading acoustical spectroscopy of sound scatterers and to select the optimal (for example, in frequency) pumping parameters for PSA; channel of pulse radiation of intensive HF pumping waves of close frequencies intended to implement the method of parametrical sounding of the broadband hydroacoustical signals; RRA calibration channel; channel continuos radiation of HF pumping waves for sonic spectroscopy of sound scatterers and selection of the RRA pumping signal parameters; continuos emission channel (higher frequency than that in PSA) of RRA pumping signal; channel of the signal frequency processing; document and data retention channel.

Combined parametrical sonar operates as follows, the distant-reading spectroscopy of sound scatterers to determine their acoustical characteristics is carried out by PSA and RRA.

Selection of pumping HF signal parameters for PA and RRA (frequency, sound pressure level, etc.) is made in terms of data obtained, formed, amplified and emitted into the nonlinear water medium in the channel of emission is the pulse HF pumping signal at the near frequencies f_1 and f_2. In the nonlinear field of the medium a difference frequency $\Omega = f_1 - f_2$ sound wave is shaped by means of which MBS accumulations, subject of search at the same time, forming, amplifying and emitting in the emission channel of RRA pumping signal is the continuos, more high-frequency and less intensive than in PSA, tone-signal on a frequency ω_n.

Scattering on water medium inhomogeneities, HF pumping waves of a frequency of ω_n interaction with low frequency (LF) waves on frequencies of echo-signal Ω' and MBS emitted noise, which the waves being formed at combination frequencies $\omega_n \pm \Omega'$, $\omega_n \pm \Omega''$. Nonlinear transformation occurs more intensively in a narrow solid angle, where the collinear condition, of HF pumping waves and those of LF signals are kept.

The waves of combination frequencies with a high space selectivity ate received by RRA, and marked in the processor are LF signals from the modulation process by detection method.

This system could be applied with a good result to solve monitoring problems of sea medium in the straits and shelf regions as well.

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