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C H R O N I C L E

DISSERTATIONS

Inverse problems in fish target strength estimation [in Polish]
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Fish target strength estimation constitutes one of the main problem in the hydroacoustic methods of fish populations assessment and monitoring. Knowledge of target strength and its equivalent value in absolute units – backscattering cross-section – is needed for proper scaling of measurements data from echo integration surveys. In the thesis the hydroacoustic methods of fish abundance estimation are analyzed. Particularly the *in situ* target strength estimation methods based on acoustic measurements of fish in natural environment are described in the context of statistical removing of beam pattern effect in a indirect way by processing of the collection of fish echoes. These indirect methods solves the inverse problem under question in which the unknown function represents target strength probability distribution function (PDF).

Newly introduced by the author fish target strength estimation methods, particularly the method based on Discrete Mellin Transformation (DMT) with singular value decomposition (SVD) and regularization techniques of Fredholm integral equation, reduces shortages if methods in use and guarantees obtaining more reliable target strength PDF estimates less susceptible to artifacts and other deformations.

The acoustic system for measurement of the nonlinearity parameter of the water medium using parabolic model [in Polish]

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The thesis deals with the finite amplitude method for the determination of the acoustic nonlinearity parameter for liquids, especially for water medium. Parameter is determined by fitting the theoretical model of the acoustic system to the results of measurements of the nonlinear distortions which are carried out in the nearfield of a circular ultrasonic transducer with sinusoidal excitation. These distortions are studied as a function of the distance from the source using a planar receiving transducer with a diameter equal to that of the source. The existing acoustic methods employ measurements of the fundamental and second harmonic components of the acoustic pressure and the quasilinear theoretical models. The low accuracy of these models and necessity of the assumption that the transducers are pistonlike lead to significant errors in the estimates. The theoretical model developed for the proposed method involves parabolic approximation of nonlinear wave equation. Direct numerical solutions of the KZK equation are used to determine the averaged acoustic pressure on the receiving transducer (obtained by the integration over the receiver aperture). The parabolic model enables the higher excitation levels, thus allowing to consider the additional harmonic components and to increase the dynamic range of the measurements. The developed method allows also to take into account the actual source characteristics for radiating transducer those are reconstructed by the backward projection of the measured acoustic pressure field (for the fundamental harmonic component).

The ability of the introduced method to precisely determine of the parameter B/A is demonstrated *via* comparison with experiments conducted in distilled water and ethylene glycol. Some results of performed calculations and measurements for the first four harmonic components of the averaged pressure are given to illustrate the capability of the method and to estimate its accuracy. The results obtained confirm the better accuracy of the method that uses the parabolic model.

Composite ultrasonic transducers for medical application [in Polish]
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The purpose and manner of conducting the process of asymptotic homogenization of a type 1–3 type composite structure are presented. The formulation of the homogenization process was reduced to numerical static analysis of an elementary symmetry cell of the composite with generalised forces applied at the boundaries of material phases. It was demonstrated that the effective values of the material tensors of the composite depended not only on the tensors of the component materials, but also on variability course of the aforementioned tensors over the volume of the solid of an elementary symmetry unit of the composite. The acoustic parameters of composite transducers were calculated using finite element method including the homogenisation process. The results of experimental measurement were close to hose obtained theoretically. These transducers utilising the complementary properties of a piezoelectric ceramic and piezopolymer. Coupling constant can be 20% larger than those of the piezoceramic, while the acoustic impedance almost reaching the range of the piezopolymers. Acoustic impedance of composite is close to tissue so it recommends them for using in medical ultrasonic imaging. Composites are also over 50% much broadband than conventional piezoceramic. It is very important in many ultrasonic system when high-frequency pulses of short duration are frequently used. The manufacturing process of 2–5 MHz composite transducers were presented.