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Abstracts

The long-term monitoring of the snapping shrimps acoustical activity in the black sea shallow water

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We carried out close to round-the-clock monitoring of the acoustic activity of snapping shrimps in a fixed point on the Black Sea shelf with coordinates: latitude: $43^\circ\,0.4182'$ N, longitude: $40\circ 59.358'$ E. Registration was carried out in continuous mode with insignificant interruptions. The recorded signal was analysed as a point time process. The existence of daily and seasons variability and fractal features of the process were substantiated. The existence of individual pulses of large amplitude allowed us to set the task of localization of individual clicks.

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Environmental impact on the modeling of the ships hydrodynamic field in shallow water

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The hydrodynamic pressure field (HPF) produced by the flowing ship at the bottom of the shallow sea depends on the shape of the ship's hull, its motion parameters, sea depth, loading method affecting the trim – longitudinal tilt as well as from a wide range of physical and kinematic parameters of the surrounding marine environment – sea current, wind, wind wave, etc. The amplitude and periodic wave characteristics depend in turn on the wind speed, the length of the sea basin and winding time.

The impact of the marine environment may influence the parameters of the ship's motion, such as trimming and rolling the ship, and the sea current may cause an inclined inflow of water to the hull, as well as the yawing of the ship. Achieving too high velocities in shallow water also causes its subsidence – an increase in draft, which in extreme situations leads to contact of the ships bottom with the sea bottom.

The article analyses some of these environmental impacts, which have the greatest impact on the change of HPF according to the obtained research data or the results of numerical calculations.

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The impact of ship's equipment configuration on hydroacoustic frequency response

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A ship moving on the water surface generates disturbances perceived as a noise in the air and underwater space. The underwater space, due to the density of water, is an excellent medium for transmitting acoustic waves over long distances. The recorded disturbances character of the elastic waves depends on the source level, signal frequency and occurrence frequency. Incidental disturbances are difficult to record, therefore the monitoring of underwater noise focuses on long-term sources assigned to the analysed object features.

The article describes the impact of ship machinery settings on the generated noise nature. The data was obtained using an underwater measurement system. The measured object was a ship moving on specific trajectories with given device parameters. The results were calculated to a specified distance from the ship. The comparison was presented in the form of frequency spectra and an RMS value for CPA (Closest Point of Approach).

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Detection of floating objects based on hydroacoustic and hydrodynamic pressure measurements in coastal zone

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The development of coastal infrastructure and related maritime transport forces the intensification of vessel traffic monitoring. Navigation systems used in this research are based on the information transmitted by radio waves.

Marine traffic safety requires constant supervision carried out by dedicated systems, the operation of which may limit the difficult environmental conditions. The possibilities of supporting navigation systems with underwater observation systems have been verified. The research were carried out using the underwater measurement system. Local disturbances of the hydroacoustic and hydrodynamic field from the moving vessels were analysed. The possibility of identifying a moving vessel in the off-shore infrastructure security aspect has been presented in this paper.

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Analysis of the hydrodynamics of the spar platform

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The work presents analyses of the behaviour of a spar platform in marine conditions. The structure is analysed with an innovative shape consisting of a ballast tank located at the bottom of the structure and three columns led out from the top, giving the base for the wind tower. The set loads result from environmental conditions (wave and wind influence) and the structure anchoring system. The wave was modelled using the JONSWAP spectrum with the following parameters: significant height H_s = 9.01 m, peak period T_p = 11.3 s, distribution coefficient γ = 4.12, which corresponds to a 50-year wave on the Baltic Sea. The wind spectrum was modelled using the Ochi spectrum, with a given wind speed v_{10} = 11 m/s at a height of z = 10 m above sea level. The platform was anchored with six elastic ropes with linear characteristics, arranged in the shape of a star.

The calculations were carried out using the ANSYS Aqwa software, based on the boundary element method. The characteristic elements of the program are presented, the input data and the way in which they are defined are described.

The system response was analysed: displacements of the platform with their derivatives, velocities and accelerations, and forces appearing in the anchoring system. Based on the conducted analyses, conclusions were drawn about the validity of the calculation model used, the safety of the construction exploitation and the possible forms of its optimization. The guidelines for further analyses were also presented: strength of the structure and forces needed to anchor it in the ground.

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Flow structure on helicopter rotor blade and effect on acoustic sources

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Rotating and moving bodies generate sound due to the pressure disturbances caused in the surrounding fluid. According to Ffowcs Williams-Hawkings equation, the pressure disturbance can be decomposed into three terms: monopole, dipole and quadrupole. The relevance of each term in various flow cases is taken as the advantage and allows for investigation of flow structure effect on acoustic sources. In case of helicopter rotor, it is believed that impulsive noise, described as a series of intense, low-frequency impulses, be one of the most annoying and loud sounds that can be generated. The high-speed impulsive (HSI) noise phenomenon develops when the advancing tip Mach number is sufficiently high to give rise to transonic conditions and strong compressibility effects in high-speed forward flight. For helicopters operating with the advancing tip Mach numbers in the 0.75–0.85 range, the shape of the signal can be explained by considering only the monopole (thickness) term of the Ffowcs Williams–Hawkings far-field solution. In the paper, numerical simulations for the different configurations are presented: PZL W-3A "Sokół" (Falcon) helicopter main rotor in forward flight and helicopter rotors tested at NASA Ames facility. In the second case, results for Caradonna-Tung rotor in lifting hover and Caradonna-Laub rotor in non-lifting and high-speed forward flight conditions demonstrate the possible gains in terms of the reduction of acoustic pressure fluctuations in the near-field of the blade tip.

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Parametric analysis of the geometry of a three-column spar platform for 6 MW offshore wind turbine to optimize its static stability. Preliminary studies of the platform dynamics

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The dynamic development of the offshore wind energy sector in such countries as the UK, Germany, Denmark, the Netherlands, means that shallow water areas are exhausted (with a depth of 40–50 m), therefore wind farm projects at a depth of 50 m+ are considered. In 2017, the first floating (deep water) mini-farm "Hywind" was launched off the coast of Scotland.

The article presents an innovative concept of a three-column spar floating platform for a 6 MW wind turbine for 65 m+ deep water reservoirs. The key issues related to the use of floating platforms as supporting structures are the stability of platforms and the movement of these platforms on the wave.

The authors present the stability analysis of the platform for various sizes of cylindrical buoyancy tanks and using different types of ballast. The authors investigated the influence of these parameters on the tilting of the platform due to the thrust load on the turbine. Based on the results of parametric analysis and based on specific stability criteria, geometrical models of selected variants were created.

For these solutions, a preliminary analysis of platform dynamics was carried out in the conditions of a 50-year storm. Based on calculations of platform on the wave (using a simplified model), the amplitudes of platform movements

and the amplitude of loads resulting from environmental forces and inertia forces were determined.

In the summary, the authors formulated a preliminary assessment of the analysed type of platform.

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A new index of non-periodicity degree of the scattering media structure based on the ultrasonic backscattered RF signals multiresolution analysis

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A numerical approach to the study of non-periodicity in signals by the technique based on the continuous wavelet transform and the wavelet multiresolution analysis is used. The scale index is introduced and interpreted as a measure of the degree of the signal's non-periodicity. The study of the scale index does not require an analytical expression for the signal. We demonstrate how this methodology can be applied to identify the degree of non-periodicity of the scattering structure by multiresolution analysis of ultrasonic backscattered RF signals. The analysed RF signals are obtained in *in vitro* experiment from the specially constructed phantom containing the periodical nylon "threads" immersed in different fluids and, in *in vivo* experiment from different area of human liver containing healthy and cancerous tissues. We show, that the classification of signals into more or less distant from periodicity by the value of the scale index is in agreement with well-defined properties of scattering media. Particularly, we underline the usefulness of this index as the new marker of a liver cancer.

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Reduction of multipath effect in the underwater acoustic channel using filtration in the received signal cepstrum

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Measurement of the propagation channel impulse response plays a very important role both in improving and developing underwater communication systems. Properties of the transmission channel are dependent phenomena occurring in and among them the presence of multipath propagation, caused primarily a reflection, deflection and dispersion of acoustic waves. Above factors make the channel characteristics are not stationary. As a result of these phenomena, any signal from the transmitter reach the receiver in the form of several components of different and time-varying attenuation and delay.

The paper presents results of investigations related to elimination of the echoes in signals transmitted by the hydroacoustic channel. A method of echoes cancellation is based on the cepstral analysis. Results of simulation study and experiments carried out in laboratory conditions are presented. Evaluation of echoes cancellation quality is performed by comparison of the estimation of channel's impulse response before and after echoes cancellation.

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Advances in the multiphase echo sounder

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The article describes research performed in the Gdansk University of Technology in application of high-resolution methods to the multiphase echo sounder, in relation to the state of the art in this area. The article starts with a review of stages of the development of interferometric sonar measurement technology. Acoustic underwater interferometry utilizes less complex receive array than multibeam echo sounder. Modern multiphase differential interferometric echo sounders are capable of successfully operating in multipath environment including shallow waters. For those solution, precise determination of the number of signal echoes present (so called model order identification) is required. The method devised by the authors relies on the singular value decomposition and inter-element coherence to achieve this very purpose. The authors verified the new method using processing of the acquired raw receiving signals in field data. The article presents the results of signal processing achieved using high-resolution methods for direction of arrival determination. Accuracy of various methods is compared as well. High-resolution methods can be successfully applied for multiphase echo sounder owing to the method developed by the authors. The article ends with current trends and perspective for the future development and applications of multiphase echo sounder technology.

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Analysis of the structure of bottom sediments of the Gulf of Gdańsk based on acoustic images obtained with a parametric echosounder

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Bottom sediments and upper layer of the sea bottom have a varied geological structure. It is most often a mixture of commonly found bottom materials such as sand, gravels, mules and clays. Very often we find gas concentrations in these areas. They are usually mixed with the structure of materials from which the seabed is built. The use of nonlinear hydroacoustics achievements, the result of which is, inter alia, the parametric echosounder allows penetration of

the seabed from a few to several dozen meters. This makes it possible to complain about acoustic images of the seabed section with regard to its structure. As a result of geobiological processes, there are areas in which there are gas clusters. The basic element of the paper is the analysis of the seabed structure in terms of detecting its heterogeneity, and in particular the detection of areas in which the concentration of gas bubbles is relatively large.

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Research on underwater sound mitigation due to pile driving noise – a review

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The production of offshore wind energy within Germany's Exclusive Economic Zone (EEZ) as well as the resulting construction activities for offshore wind turbine foundations, normally installed by impact pile driving, lead towards increased underwater noise levels. Satisfying official limiting values that have been introduced by the German government for the protection of marine mammals made the use of sound mitigation systems obligatory. Therefore, since 2000, a straight line of national research projects has continuously improved knowledge in the field of underwater sound measurements and also with respect to the increasing understanding of the physics within different mitigation concepts, like bubble curtains, noise mitigation screens or cofferdams.

The talk intends to give an overview of the scientific achievements in Germany so far and links the results to the international state of the art. It ends with an outlook on future research.

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The single degree-of-freedom SDOF simulation model of underwater explosion impact

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The hulls of naval ships, especially minehunters and minesweepers, are exposed with forces and moments coming from internal and external sources. Usually these are interactions that can be described mathematically by harmonic and polyharmonic functions. The shock of UNDEX type (underwater explosion) works completely differently and its time waveform is difficult to describe with mathematical functions as pressure vs time. The paper presents a simplification of physical and mathematical models of 1-D forces whose aim are performance the simulation of the external force of the detonation wave. The proposed models have been verified and tuned by tests on naval, sea trials. The main goals of the proposed models are to perform simulation calculations of the detonation pressure for different explosion charge weights from different distances of the UNDEX epicenter for the design process of machine foundation. The effects of pressure are transformed as impulses exposed on shock absorber mounted at light shock machine. The main goal of simulation is analysis of optimal damping vs dynamic deflection.

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Short-period internal waves in shallow water (on the example of observations on the shelves of the Black Sea)

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Internal waves play an important role in the dynamics of the sea, especially due to vertical mixing of the water layers. Internal waves are the main cause of the spatial and temporal variability of the sea environment and it is of importance for the propagation of acoustic signals there. In case of intense internal waves, it causes significant changes in vertical sound profiles. In the tidal free Black Sea internal wave amplitudes are on average less than in case of internal waves in the ocean or in the sea with the tides, nevertheless, it manages to register intense internal waves here. We present results of field observations of short-period internal waves at the Caucasian and Crimean shelves of the Black Sea carried out during summer-autumn seasons 2009–2018. Measurements were conducted from the stationary oceanographic platforms with moored thermistor chains as well as from small vessels equipped with ADCP. In the analysed data for all types of the shelf, there was an almost constant presence of short-period internal waves in the area of the thermocline (background oscillations), as well as the episodic appearance of intense internal waves. Examples of intense internal waves as well as internal wave spectra are shown. Trains of internal waves were also identified in the backscattering signal as vertical displacements of the sound-scattering layers. A generalization of internal waves at different shelves is presented. There have been revealed differences of internal waves features which propagate at the narrow and ordinary shelves.

The analysis of data was obtained in the framework of the state assignment of Russia (No. 0149-2019-0011) and was partially supported by RFBR project 19-05-00715.

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Use of vibroacoustic diagnostics to evaluate bridges connecting teeth with implants

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Implant treatment is a proven method in dentistry for partial and complete missing teeth reconstruction. Bridges supported on implants obtain high efficiency of transfer of chewing forces and high acceptability and satisfaction of patients. In some clinical situations it is advisable to limit the number of implants, which can be obtained by making a bridge connecting the patient's own tooth with the implant. So far, the possibility of using safe and permanent connections of teeth with implants has been examined to a small extent due to the dangers resulting from the different mobility of dental implants and teeth.

An attempt was made to use vibro-acoustic techniques to evaluate various combinations of teeth and implants connection. For this purpose, pilot studies were carried out on cadavers with implants which were immobilized in a vise. There were recorded sounds in the immediate vicinity of the mandible formed in response to impulse excitations carried out with a point hit against a tooth or implant before and after their joining with a bridge. The comparison of amplitude spectra allows to see features indicating a high probability of being able to distinguish between the examined configurations and take into account aspects of the physiologically positive mobility of natural teeth in relation to the negative mobility of dental implants.

The results of the research should contribute to a better understanding of the mutual relations between the dental implant and the tooth, which are included in one prosthetic work. In the perspective, it enables to assess the level of safety and to identify clinical situations that allow to obtain dental bridges based on teeth and implants. The possibility of combining implants with teeth in a predictable way shortens the patient's treatment time and the diagnosis with vibroacoustic methods allows to assess the quality of such bridges.

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Ultrasonic detection of the free gas phase

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It is a commonly held opinion that Doppler ultrasonic detection of an intravascular free gas phase is not a procedure that can be particularly useful in decompression research. The main objection is that the detection of the free gas phase in venous vessels is a weak function to predict the presence of the free gas phase in tissues and arterial blood, hence this method is not suitable for assessing the risk of decompression. Only a few countries disagree with this commonly held view and use this method to assess the risk of decompression in decompression studies. France has introduced detection of the free gas phase in venous vessels for diving research and then together with Canada improved this method, and developed it to a standard form.

Based on the published results of the Canadian research, the technique was evaluated at the Naval Academy using statistical methods. The Academy accepted and adopted the results of this research and started to use this method in its own research on decompression over 25 years ago and continues to use it with great effect.

The Bayesian approach is briefly presented for the validation of the Doppler method for intravascular detection of the free gas phase, the organization of diving studies at the Academy and the results achieved in the decompression studies supported by ultrasonic detection of the free gas phase in venous vessels.

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Study of probe signal bandwidth influence on estimation of transmission parameters for underwater acoustic communication channel

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A signal transmitted in a shallow underwater acoustic communication channel suffers from time dispersion due to the multipath propagation and the refraction phenomenon. This causes the intersymbol interference of received signal and frequency-selective fading observed in its spectrum. Delay spread and coherence bandwidth are the key transmission parameters used for designing the physical layer of data transmission system to minimize the influence of time dispersion on the received signal. They can be calculated on the basis of the channel impulse response, measured with the use of the correlation method and frequency modulated signals or pseudorandom binary sequences. Such signals have a narrow, impulse-like autocorrelation function if considered in baseband. However, in the case of bandpass measurements, the influence of the probe signal on the estimate of impulse response, and thus on the estimate of transmission parameters, is no longer negligible. The paper presents the results of simulations and measurements conducted in an inland reservoir.

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Applying distance measures to test the wide sense stationary and uncorrelated scattering (WSSUS) assumption for Underwater Acoustic Communication channel

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Underwater Acoustic Communication (UAC) channels are characterized by a large variety of multipath propagation conditions that can additionally change over time. Designing a reliable communication system requires knowledge of the transmission parameters of the channel.

Wireless channels are often assumed to be wide sense stationary (WSS) with uncorrelated scattering (US). The WSSUS assumption allows for simultaneous modeling of time dispersion and time variability of the channel. However, in the case of shallow water communication channels, especially when system terminals are in movement, the WSSUS assumption may not be fulfilled. In this case, simultaneous analysis of time dispersion and time variability may lead to incorrect values of transmission parameters such as coherence bandwidth or coherence time. Thus, a method is needed to check if the channel meets the WSSUS assumption.

The paper presents a comparison of different distance measures for classification of the UAC channel as being WSS/non-WSS and US/non-US. The results were obtained in simulations performed using impulse responses gathered during the experiment conducted in an inland reservoir.

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Underwater noises of open circuit scuba diver

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Passive acoustic monitoring of scuba divers is promising to ensure the safety of diving and to prevent intrusion of terrorists or poachers from waterside. Respiratory noises and noises of fins emitted by a scuba diver into water may be applicable here.

The respiratory noises of open circuit scuba diver consist of the noise of exhaled air bubble detachment from the breathing apparatus and floating bubbles noise in exhalation, while in inspiration noises are connected to the operation of the high-pressure reducer in scuba apparatus. These powerful quasi-periodic signals have a repetition frequency which corresponds to diver's respiratory rate. Noises of fins are associated with hydrodynamic vortices created by their oscillatory movement.

Experimental study in shallow-water regions demonstrated that recording respiratory noises of a scuba diver associated with the noise of floating bubbles in spectrograms provided tracing acoustic signs and evaluation of respiratory rate at distances up to 200 m. The same acoustic signs provided monitoring displacement of the scuba diver by determining time delays of maxima of cross-correlation function at 2 hydrophones. Trails of such delays in correlograms may be traced at distances up to 300 m.

The main sources of scuba diver noises have small wave size and can be theoretically considered as the point multipole emitters. The respiratory noises source is closer to monopole one. While noises of fins movement are predominantly characterized by dipole and quadrupole emitters having powerful near-field components of radial and tangential vibrational velocity. Thus in accordance with higher susceptibility of pressure gradient (vector) sensors to near-field components of the vibrational velocity, the registration of noises of fins in the near field with these transducers should be more promising than with commonly used hydrophones.

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Propagation of underwater acoustic disturbances generated by moving marine objects in the shallow sea – basic problems

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The issue of propagation of acoustic waves in limited media, e.g. shallow sea, is associated with multipath propagation. This is due to multiple reflections from the free surface of the sea and from the bottom. Considering the ecological acoustic aspects related to current trends prevailing in the policy on the protection of the underwater environment (European Union Directive on Good Environmental Status – descriptive indicator 11 – noise), as well as factors related to security problems associated to asymmetrical threats (e.g. terroristic threat where underwater transport is used), these factors gain additional weight.

The paper presents the theoretical issue of the propagation of acoustic waves associated with the source of waves moving underwater. The problem's solution is a series of wave modes, which at a suitable distance from the source are a description of the acoustic field. A significant influence on the propagation range has the boundary condition at the sea – water bottom border, which is connected with the penetration of acoustic energy into the bottom. The final part of the paper is the projection of the prediction acoustic wave coverage for the experimentally measured disturbance, e.g. the noise of the submarine as a source, taking into account selected components of the spectrum. Using the theory of wave propagation in the form of wave modes, transmission losses is determined.

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Transverse stability of a hydrofoil running near the free surface

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Most modern hydrofoil crafts have foils that piercing the free surface. In this case, transverse stability in foil-borne mode is achieved by changing the wetted area of the hydrofoil on both sides due to the heel angle. The main rules of the IMO High Speed Code, concerning hydrofoil craft transverse stability, using this phenomenon only. However, the hydrofoils usually have a flat part in the middle part of them. If it is sufficiently submerged, it also produces a righting moment. In this paper, the influence of flat part of hydrofoil on its transverse stability is discussed. Results are compared with some experimental data obtained from measurement the lift force of a flat hydrofoil with variable submergence. Furthermore, a measurement of transverse stability carried on a hydrofoil craft model is used to verify calculations. Finally, some conclusions useful for practice are presented.

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Applications of ultrasound in gynecology

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Ultrasonic waves in gynecology and obstetrics have been used since the 1950s when Ian Donald created the first ultrasonograph of a fetus in the womb.

The 1980s and 1990s saw the rapid development of new medical technologies, including technically advanced ultrasound scanners and probes using piezoelectric crystals. For the first time, the transvaginal probe was used, and in time, this became the gold standard of ultrasound examination due to its high resolution up to 14 Mhz. The advantage of the transvaginal probe is that the ultrasound waves bypass a number of underlying tissues, so as to obtain images beyond the vaginal wall with high resolution. In addition, ultrasound has been further extended to map blood vessels (Color Doppler, Power Doppler), which increases diagnostic sensitivity and specificity.

Technological progress in ultrasonography during the first decade of the twenty first century led to the development of spatial imaging cameras (3D and real-time 4D), which are used for imaging ovarian tumours, genital malformations and fetal defects.

Currently, transvaginal examination is used for evaluating the risk of ovarian cancer (criteria IOTA), assessing endometrial hyperplasia and carcinoma (criteria IETA), observing the fetus in the first trimester of pregnancy (for risk assessment of fetal genetic malformations), examining patients with suspected ectopic pregnancy, and monitoring of ovulation and assisted reproduction procedures.

Recent technological developments that have increased the accuracy of ultrasonography include elastography, which is used mainly in assessing the degree of liver fibrosis. The ultrasound method is rapidly developing in gynecology, for instance, for evaluating endometrial and uterine muscle pathology.

At the present time, ultrasonography is an indispensable method for diagnosing and supporting the treatment of diseases in women, and its applications are finding new places in gynecology.

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The statistical characteristics of underwater noise of ships on the Gdynia Port Approach Zone

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With the development of shipping, ports and marine infrastructure, such as oil platform and wind farms, the importance of underwater noise monitoring is increasing. In the approach zone to the port it is difficult to estimate and predict the underwater noise level of ships due to the variable parameters of the ship's engine operation related to manoeuvres. A characteristic feature of these environmental conditions is the large dispersion of underwater noise parameters. The work is focused on developing a method for calculating the average noise parameters and its characteristic spreads. It allows to set up appropriate Radiated Noise Level levels to develop noise maps and forecasts for a given water area e.g. for the Gulf of Gdansk. The statistics analysis is not only limited to the RNL but also includes many other hydroacoustics parameters such as the distribution of energy in the underwater noise spectrum depending on length, draft, Gross Tonnage and class of the ships. The underwater noise measurement database of merchant ships was collected by Hydroacoustic Team of the Polish Naval Academy during the realization in the years 2012–2015 the SIRAMIS project of the European Defence Agency and includes measurements of more than dozens of ships of various sizes and classes.

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Design of a modern port protection system for the near zone

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Ports serve as key hubs for the present-day commerce more than ever since around 90% of global trade involves seaborne shipping and the total ship's capacity increased by more than 250% over the last 15 years. This makes ports and harbours a valuable target for a terrorist group or a nation practicing hybrid warfare.

Many proven methods exist for providing security of ports over their land boundaries but securing it from seaside is still a challenge and an open problem. Based on OBR CTM S.A.'s 20-year experience in this field, beginning with introduction of KRYL system, we have found that a successful solution utilizes a multitude of sensors that detect, track and classify threats in the air, surface and underwater domains. Integration of data from different sources provides port security with a clear picture and allows them to precisely respond to threats. A variety of effectors allow to counter threats in a scalable manner, securing certain "red zone" areas, projecting their effects towards intruders or being delivered towards threats by unmanned vehicles. Sensor and effector packs could provide means for small utility boats and unmanned surface vehicles to identify and counter threats at a greater distance from the protected zone.

This article provides an overview of available sensors and effectors that should form an integrated and complete solution for protection of ports from threats from a maritime domain in the near zone – the inner harbour and immediate surroundings.

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Fishlike shaped robot for underwater surveillance and reconnaissance – design and study of selected parameters

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Undulating propulsion is a new and promising solution for underwater vehicles used for subsea security systems, especially due to its potential low noise, better energetic efficiency, low water turbulence and living animals mimicry. Selected results of the international project concerning biomimetic autonomous underwater vehicles (BAUVs) for intelligence surveillance and reconnaissance are described in the paper. Shape of the vehicle's hull was inspired by

living fish. Key aspects of the design and construction of BAUV are presented focusing on tasks required to perform by the robot. Physical parameters such as vehicle's velocity, drag, and generated noise were investigated. Forces acting on BAUV's hull were calculated using CFD analysis and compared with the results of experimental research. Noise generated by the vehicle was measured for two types of propeller's drives in order to select those with lower sound pressure level.

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Lung ultrasound and heart failure

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Lung ultrasound can be easily obtained during standard echocardiography, providing additional information about heart failure status. B-lines appear in the second stage of lung water cascade, as a symptom of increased extra-vascular fluid in the lung, before crackles and dyspnea are clinically evident. The number of B-lines has been shown to be correlated with BNP and E/e' in acute dyspnea and during stress test. B-lines can be used as a marker of the pulmonary congestion severity and response to standard decongestion therapy, i.e. diuretics, both in heart failure with preserved or reduced ejection fraction. It has been shown that lung ultrasound response to treatment is an independent 6-month survival predicting factor for all-causes mortality and acute heart failure re-hospitalizations. Lung ultrasound is proposed as a part of integrated quadruple stress echocardiography that includes the assessment of regional wall motion abnormalities, lung water, contractile reserve and coronary flow velocity reserve. Different variants of chest wall acquisition points are proposed in supine or prone position in different studies, with the view to obtain simplicity, feasibility and time reduction. There are evidences that passive leg rise is helpful tool to predict impaired exercise diastolic function in patients with heart failure with preserved ejection fraction. In our preliminary study we show that in some patients preload increase caused by leg rise can provoke emerging or boost of B-lines.

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Errors in underwater navigation system based on the Doppler shifts

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A new solution of an acoustic navigation system was developed to determine the position and speed of moving underwater objects such as divers or underwater vehicles. The tract of the object and its speed are determined on the basis of Doppler shifts of acoustic signals emitted by the transmitter placed on the object and received by four hydrophones installed on the periphery of the observed reservoir. The position and velocity measurements are affected by errors mainly caused by acoustic reflections from the tank boundaries and the surface reverberations. The article describes sources of disturbances, presents the results of simulation tests and measurements. It has been shown that the errors magnitude can be accepted in most of the potential applications of the system.

* * *

Validation of model test method for propeller cavitation noise prediction

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The propeller cavitation noise of commercial vessels has been predicted from experimental results obtained at the large cavitation tunnel in KRISO (Korea Research Institute of Ships & Ocean engineering). The model tests were performed in accordance with the KRISO standard procedure, published as ISO 20233-1:2018(E). The procedure is composed of reproduction of noise source (propeller cavitation), noise measurement, post processing and scaling. The validation of the scaling method is very important to estimate the full-scale source levels accurately from the model scale results. A series of measurements were carried out under the test conditions according to the different flow speeds. The scaled results have the good agreement over the entire frequency range. The full-scale noise measurements have been carried out for the same full-scale vessels to validate the standard scaling method. This paper shows that the predicted results from the model test agree quite closely with the results from full-scale measurement.

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Diel vertical migration of biological objects in the Puck Bay (Southern Baltic Sea)

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Over the years, unique ecosystem of the Puck Bay and its special sensitivity to anthropogenic impact, attracted researchers' attention. Hydroacoustic techniques have been also applied to support the study of its biotic and abiotic elements. However, much of the potential of these techniques has not yet been fully used in the biological research in this area.

The main objective of the presented interdisciplinary study was to improve the understanding of the Diel Vertical Migration (DVM) of marine organisms in the Puck Bay, using the broaden possibilities of modern hydroacoustic equipment, mounted on board of the newly built research vessel r/v Oceanograf.

Hydroacoustic measurements were performed on the selected transects in a wide range of acoustic frequencies, using three broadband split-beam echosounders with central frequencies of 38, 120 and 333 kHz and acoustic Doppler current profiler (ADCP) with frequency of 600 kHz. To interpret the backscattering, the data on salinity, temperature and horizontal component of sea currents were collected. Visual remotely operated underwater vehicle (ROV) inspection was conducted. Meteorological data were acquired.

The magnitude of diel vertical migration, its typical time, migrators' velocities have been defined. The characteristic features of the temporal variability of biological aggregation internal structure during the migration, have been specified. The dependence of the DVM characteristics on the type of biological objects has been demonstrated. The variation of DVM characteristics for different seasons of year has been considered.

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Basal cell carcinoma lesions assessment using 30 MHz ultrasound

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There is a growing interest in application of the high frequency ultrasounds for the skin lesions classification and theirs size assessment. The quantitative ultrasound can provide information helpful in skin cancer lesion diagnosing. The goal of this study was to find the quantitative measure of the skin tissue backscattering properties that could be used for differentiating the changes of tissue structure induced by Basal Cell Carcinoma (BCC) and precancerous lesions – Actinic Keratosis (AK). 35 patients with diagnosed AK and BCC have been examined by physicians from the Dermatology Clinic using a specially designed 30 MHz ultrasound scanner. The collected ultrasound RF-data has been processed to find parameters of the ultrasound backscatter statistics. The study showed statistically significant differences between the shape parameters of the Nakagami, K and homodyned K distribution calculated from ultrasound echoes scattered in BCC and AK skin lesions. AK and BCC changes revealed increased attenuation compared to healthy skin. Classification of skin lesions based on shape parameters of the considered statistical distributions allowed distinguishing these changes with AUC equal to 0.996, 0.983 and 1.0 respectively, for K-homodyne, Nakagami and K distribution. Ultrasound attenuation differed skin changes from healthy skin with AUC = 0.993.

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Detection of wavy sea surface oil-derivative contamination with forward specular high-frequency scattering

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A spectrum of low-frequency (20–30 Hz) amplitude fluctuations of the ultrasonic (10 MHz) signal specularly scattered from water surfaces covered with monomolecular and thicker crude oil origin films of well-defined, oceanographically relevant viscoelastic properties was examined in laboratory and at-sea conditions. At high-frequency scattering systems, the intensity of the scattered signal depends on the slope of the wavy surface, for which fine, capillary waves are responsible under natural conditions. The relationship between the surface water wave (30 Hz) damping coefficient and the oil layer thickness was established, and compared to the one predicted by the classical Stokes' theory. The depression of the spectral energy density of wind-driven waves by surface films (the relative spectra, so-called contrast K) was inferred from the ratio of acoustic signal fluctuations spectra with/without films, and compared to that resulting from the Marangoni damping theory applicable to monolayers of particular surface viscoelasticity (determined in a separate measurement), and the self-agreement between the theory and experimental data was satisfactory. As shown in at-sea experiments performed with a free-floating, buoy-like acoustic system, and an artificial oil slick spread over the Baltic Sea surface, the film rheological surface properties (elasticity modulus) can be recovered from the acoustic surface probing, as well as the oil spill edge detection. Simultaneous statistical analyses of the scattered signal amplitude distribution parameters (mean, fluctuation coefficient, skewness and kurtosis) turned out to be unequivocally related to the oil substance fraction weight, oil layer thickness, and the form of oil contamination (monolayer, thick layer or individual dispersed oil spots covering a variable area). The described acoustic system in a form of lightweight free-drifting buoy can be successfully for remote sensing of oil slicks properties and evolution at sea.

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The concept of underwater communication using the direct sequence spread spectrum technique in hydroacustic channel

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Military wireless control systems for underwater vehicles or weapons require solutions that ensure safe, reliable and fast data transfer via the hydroacoustic channel. One

of the possible method that meet these assumptions is modulation technique called Direct Sequence Spread Spectrum (DSSS). The article discusses the principle of DSSS technique, where spreads signals has the form of pseudo-random sequences. In this special solution named Direct Sequence Code Division Multiple Access (DS-CDMA) the same physical channel may be use to simultaneous independent transmission by different date streams. In addition, high confidentiality of transmitted data is guaranteed, because for non-authorized users they have the form of noise. Information sent this technique is resistant to the phenomenon of multipath in the communication channel. All these properties make this solution have a lot of potential to use it in military underwater communication systems.

The article presents the DS-CDMA technique, configured to work in a hydroacoustic channel. The proposed solution was checked in simulation and model tests. The results of these tests are included in this document.

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Hydroacoustic suite for an automatic mine disposal vehicle

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Hydroacoustic suite required for mine disposal vehicle operating in an automatic mode is defined with reference to the Gluptak mine countermeasure vehicle system. The Gluptak mine counter vehicle system use a single task (disposable) remotely operated vehicle The vehicle is described as a physical platform that is outfitted for very particular task. It contains several hydroacoustic subsystem. These subsystems assure navigation, identification of a target and its consequent destruction. The complement of the hydroacoustic equipments is very comprehensive and defined by the task, not by the size of the vehicle. While the Gluptak vehicle is comparatively small and generates its own noises, the acoustic "problems" are extremely dense. The equipments used are indicated and shortly characterised with reference to requirements and limitations of particular application considered.

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Application of computed unified device architecture devices for sonar digital signals processing

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Acoustic processor of sonar system is a very complex and expensive device. Many solutions of this type of devices are based on multicomputer systems. The article presents research work related to possibilities of use Computed Unified Device Architecture (CUDA) processors for these systems. Application of modern graphic processor units (GPUs) can significantly reduce the costs of an acoustic processor, without limiting its performance. The basic task of classic GPUs is an image processing. The development of technology and especially new GPU architectures using CUDA units, allowed a significant extension of the scope of GPU's application. One of areas in which these devices are commonly used is digital signal processing. Presented type of modern GPUs greatly improve a system performance. In contrast to classic processors, the use of CUDA units requires a different approach to describing signal processing algorithms. The paper presents in detail the modifications of the signal processing algorithms dedicated to the CUDA processors, as well as results of the research for sonar applications.

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Use of space-time block codes for acoustic underwater communication in shallow waters

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The realization of an underwater acoustic communication is limited due to adverse propagation conditions in the communication channel. To improve the reliability of the data transmission system, the multiple-antenna technique was chosen. The paper presents an implementation method of the multiple-antenna technique based on the Space-Time Block Code and its optimal case in the form of Alamouti coding. The results of simulation tests in a channel with flat Rayleigh fading were included.

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ADCP as a powerful tool of modern acoustical oceanography

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Acoustical Oceanography – the science of ocean exploration using acoustic measurements, which appeared with the invention of the echo sounder, continues to evolve actively in the present time. In the early 1980s, acoustic Doppler current profilers (ADCP) appeared. These devices measure the currents of the sea environment by the acoustic method, successfully replacing traditional contact current meters. The paper shows that ADCP, developed as a current meter, actually has a much wider range of functions, which makes it a powerful multidisciplinary instrument of modern acoustical oceanography. In combination with background current monitoring, ADCP simultaneously measures the intensity of the backscattered signal, which allows monitoring and studying various processes in the water column. The capabilities of the instrument are demonstrated on the basis of our 15-year research cycle using ADCP "Rio Grande 600 kHz" in the shelf zones of the Russian seas.

At the confluence of large rivers into the sea, spatial survey with ADCP allows to collect detailed information on the dynamics of the plumes of freshened waters. With the help of a spatial survey, it is possible to investigate the dynamics of submesoscale eddies on the shelf. The use of

ADCP is useful when conducting sub-satellite marine experiments, since it allows one to associate the features that appear on the sea surface and seen by remote sensing with the currents causing them. ADCP allows significant progress in the experimental study of internal waves, both in terms of their generation, and of various important effects that accompany internal waves. ADCP can be used for solving problems of marine geology and marine biology for measuring the concentration of suspended matter and the distribution of plankton in the marine column.

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Influence of the current velocity variability on the channel response fluctuations in shallow water under autumn conditions

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In shallow water multipath propagation patterns with rays reflecting off the surface and fine-scale fluctuations of the sound speed profile yield short-term variability of sparse impulse responses that must be accounted for when estimating the effectiveness of algorithms for underwater acoustic communication. Since direct modeling of this type of variability is computationally demanding an approach based on representation of the ray arrival amplitudes and phases as random variables is usually implemented. We present results of an experiment aimed to estimate the probability distributions of such random variables under calm sea state conditions with nearly constant vertical profiles of temperature and salinity. For this type of environment, we consider the vertical profile of the current velocity to be the main factor contributing to the temporal variability of probability distributions of ray arrival characteristics. Two autonomous bottom-mounted hydroacoustic stations were deployed ~1 km apart at ~35 m depth with receivers and transmitters mounted in tripods ~50 cm above the seafloor and exchanged BPSK modulated signals at 2 kbit/s data rate. Vertical profiles of the current velocity were measured with an ADCP deployed ~600 m from the track between transceivers. Two events presumably associated with passages of submesoscale eddies were registered during the experiment. We analyse the statistics of ray arrival amplitudes and phases during these events in comparison to ambient conditions. A ~4 dB decrease in the main arrival amplitude led to a ~8 dB increase in the demodulation error and increase in bit error ratio from almost 0 to ~0.07 at the time intervals when the current velocity heterogeneities reached the surface.

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New approach to the hydrographic modeling

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Recording of the bottom of the channel/river/lake etc. by means of the echo sounder leads to a very large number of measuring points. They are the basis for the development of various final products, e.g.: cross sections, bathymetric maps, 3D model. They are obtained after the measurement and development of acquired data.

In this article, authors propose that the development of measurement data in order to obtain a 3D model of the channel bottom was carried out in a sequential manner, and thus took place in the pseudo-real time (almost in the moment of data acquisition). After the measurement by echo sounder conducted on a specific section of the channel, the obtained data is reduced and then a partial 3D model M_i is generated on their basis. Following measurement at the next section is again reduced and modelled, another model M_{i+1} is generated. Analysis are focus on the way how the partial models can be combined.

Proposed approach, due to very short time of model's acquisition, might be very useful in the case of watercourses characterized by a dynamic change of the bottom or in those cases where time of obtaining model is, for various reasons, a key issues.

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Analysis of the strength of the rescue seat and the hull of the Kobben submarine during the docking of the rescue vehicle

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The paper presents an analysis of the stress state and deformation of the rescue seat of the Kobben class submarine (project 207) loaded with the pressure of a rescue vehicle that docks on the seat surface. The sea current and hydrostatic pressure were considered depending on the immersion depth in the range of 100–500 m. The effect of docking the vehicle on the ship's hull was checked. The Finite Element Method was used to accomplish the task with which the static equation of equilibrium was considered, taking into account nonlinearities related to material description and large deformations. A description of Jonson-plastic plastic characteristic for steel was presented. The load of seats caused by thrust of hydrostatic pressure, thrust of rescue vehicle and induced by sea current in accordance with STANAG 1297 requirements is described. The results of the stress state and deformation in the rescue seat of the Kobben class submarine, obtained from FEM simulation, for immersion depth of 200 m have been presented.

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The forces driving streaming in presence of scatterers mimicking the blood cells or the contrast agents

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In lossy homogenous fluid streaming velocity is generated by Acoustical Driving Force (ADF) which depends only on absorption and intensity of ultrasound. In suspension of solid or fluid inclusions and in some cases, such as ultrasound scattered on blood cells at high frequencies, or the presence of ultrasound contrast agents, scattering generate additional components to ADF and affects the streaming speed. Using the scattering theory, the single particle (inclusion) ADF was calculated as the integral of the momentum density tensor components over the heterogeneity volume. The possibility of negative ADF was indicated. Then, the total ADF acting on inclusions only was determined as a function of its concentration. The formula for the relative increase in ADF, resulting from increased concentration was derived. Numerical ADF calculations are presented.

In experiments the streaming velocities in a blood-mimicking starch suspension in water and Bracco BR14 contrast agent (SF6 gas capsules) were measured. The source of the streaming was a plane 2 mm diameter 20 MHz ultrasonic transducer. Velocity was estimated from the averaged Doppler spectrum. For different starch concentrations, the streaming velocity increased from 7.9 mm/s measured in reference homogenous liquid to 12.5 mm/s. This corresponds to a constant 14% velocity increase for a $4 \times 20\,000$ l/mm^3 concentration rise. For BR14, its streaming velocity remained constant at 7.2 mm/s, is relatively negative in relation to the speed of the reference liquid and was independent of the concentration. This indicates that it is the speed of the inclusions, not the surrounding fluid. It results from the balance of Stokes drag force and negative ADF. Numerical calculations showed a 16% increase in streaming velocity for 20 000 particles/mm^3 starch concentration rise, very similar to the experimental results. The theory has also shown the ability to reduce the streaming velocity by low-density scatterers, as was experimentally proved using the BR14 contrast agent.

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A toolbox for simulations of acoustic propagation in tissue mimicking structures

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Optimization of ultrasound applications in medical diagnostics as well as in nondestructive testing requires accurate simulations of acoustic waves propagation in nonhomogeneous media. Several attempts were made and few different simulations methods were proposed as a publicly available software toolboxes.

A new, freely available third party toolbox for the simulation of acoustic wave fields is presented and described. The toolbox *USim* is designed to make an acoustic modeling of ultrasound propagation in tissues reliable and fast, with interface similar to the *field II* software. The forward simulations of the wave fields are based on the Born-Neumann single scattering approximation of the solution of Sturm-Liouville equation.

The toolbox allows simulating the ultrasound wave propagation in nonhomogeneous media containing geometrical scatterers similar to those existing in a real tissues. The approach of calculations conducted in Fourier space increases the efficiency of the calculations and allows taking into account the absorption and density of the medium. The construction of an efficient simulator in the time-space domain would be impossible due to the large relative size of the phantom models.

The presented *USim* simulation software uses Single Instruction Multiple Data architectures of heterogeneous computers to make efficient computations through massively parallel computing.

The validation of the simulations' results is done by the comparison with the results of the other ultrasound simulation software.

Student Presentations

The practice of gynecologists-obstetricians working in different reference level centers regarding the examination of the mammary gland

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Background. In recent years breast cancer has become more frequent among young women, who initially inform their gynecologist about first signs of the disease. It is therefore natural that we increasingly wonder whether this subject is included in the spectrum of interests of obstetrics and gynecology specialists (OB&GYN). In addition, it is important for the early detection of breast lesions in young patients to be possible thanks to physical examination and ultrasonography.

Objective. To check the OB&GYN awareness of breast diseases and their diagnostics through examination and ultrasonography.

Materials and methods. Anonymous questionnaires conducted on a group of 55 physicians in centers with different level of reference in the Pomorskie voivodship and Warminsko-Mazurskie voivodship as a control group. The questionnaire contained 13 multiple-choice, single-answer questions. The subject mainly concerned cancer diseases history taking, physical examination and mammary gland ultrasonography usage and professional experience.

Results. 95% of respondents do not routinely examine mammary glands of a patient during a gynecological

visit. 75% of respondents do not perform ultrasonography of the mammary gland at all. 40% of respondents were not interested in the availability of literature on breast disease diagnostics. In the institution with the same level of reference from the Pomorskie and Warminsko-Mazurskie voivodships, no differences were found.

Conclusions. There is a need to rise OB&GYN specialists' awareness of the importance of diagnosing breast changes, especially by improving their practical education in the mammary gland ultrasonography, so that they can respond to the needs of patients visiting them with breasts lesions.

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Model tests of suction caisson as the foundations of offshore wind farms

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Offshore wind farms are located further and further away from the shore, on waters with unfavorable ground conditions. The location of drilling platforms and offshore wind farms on such water bodies is possible due to the use of appropriate technical solutions, which are also economically advantageous.

An alternative to this type of offshore construction is a new type of underwater foundations called suction caissons or suction buckets. These are modern, foundation geotechnical structures that are used on an increasingly large scale in marine engineering. Currently, they are used in the offshore industry as anchoring elements and foundations, including offshore wind farms and drilling platforms. They are also used for other deep-water underwater constructions and for anchoring single buoys and floating sea fish farms.

The suction ceilings are large, up to a dozen or so meters in diameter and several meters high, cylindrical structures closed at the top. They are usually made of steel. It looks like an inverted mug. The advantage of the caisson foundations, decisive for their superiority over traditional foundations, is the quick installation on the site of the construction foundation and dismantling from the seabed in the event of a need to change location or renovation.

The main advantage of the caisson foundations is the possibility of transferring the load pressing the foundation to the ground and the load that pulls the structure out of the ground. The loading pressure is initially resisted by the friction resistance of the ground, which occurs on the side of the caisson.

Complex phenomena occurring in the caisson ceilings are not yet accurately and completely recognized and described. The extraction process and the phenomenon of suction of the structure to the seabed during the start of extraction are not fully tested. The generation of underpressure inside the caisson also requires testing when it is extracted from the ground substrate at different speeds.

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The use of ultrasound in the sentinel lymph node assessment in early-stage cervical cancer – a systematic review

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While breast cancer remains the most frequent gynaecological cancer in the world, uterine cervical cancer takes the second place. To detect lymph node metastases in the field of gynecology, different imaging modalities are in use. One modality which may exceptionally assess lymph nodes is ultrasonography. As a part of a regular visit to a gynecologist, it is often used to exclude various pathologies. It also plays an important role in early-stage uterine cervical cancer (CUC), where proper staging of the malignancy is the prerequisite for the adequate treatment; how it should be planned and executed. First tumor draining nodes (sentinel lymph nodes) that could have metastases are crucial in terms of prediction and prognosis of patients with early-stage CUC. This review article was aimed at literature search on the subject of ultrasound techniques for assessing sentinel lymph nodes in early-stage CUC.

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Protecting bottom from erosion – classical and modern solutions

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The aim of my diploma and presented poster is the characteristic and analysis of nowadays knowledge and practical solutions connected with protecting the sea bottom from erosion. I presented reasons according to places of occurrence of erosion and results of demersal erosion, taking into account demersal currents generated in an area of chosen hydrotechnical constructions of objects such as: harbours, marinas, places of testing tethered ships propulsion, where currents affects the same parts of bottom for long time. In those places the main reason of erosion are currents generated by the main propeller jet or bow thrusters of moving ships. Other places taken into consideration are: foundations of sea electric plant, oil rigs or even bridges, where the reason for erosion is simply natural waves and currents. I characterized classical and modern constructional solutions of bottom munitions. Starting with classical rock filling, trough blocks of concrete to mattress filled with concrete. There were considered the main rules of designing and calculating the solution based on soil suction forces, as a modern and the most efficient way of protecting the bottom from erosion. The presented examples of practical use of classical and modern solutions – are my input into the presented issue.

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The purpose of the work was to investigate changing of inclination angle of the wind turbine blade in order to increase the efficiency based on the concept of palm tree wind turbine

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The project presents wind generation phenomena, the principles of wind turbines, the types of wind turbines and their construction, their impact on the environment, and the comparison between onshore and offshore installations. The palm tree wind turbine concept has been quoted and the related principle work and construction is described. The turbine achieves 50 MW. The cutting edges of wind are open when there is a low-speed wind. When the speed is getting higher blades are bending on the inside. It happens because of load need to be offset and the production of energy has to be optimized. When the extreme condition occurs the blades are completely folded on like a palm frond. By this kind of solution, they dodge the damage of the rotor and reduce tensions of the tower. The change of the inclination angle of the wind turbine blades is the core of the calculation of the project. Next, the nominal parameters for further calculations of turbine performance are selected. The subsequent calculations concern the change of the inclination angle of the blade in order to increase the turbine efficiency. To conclude, there is a comparison between a conventional and a palm tree wind turbine operation performances. The study is accomplished by delivering a summary and the final remarks.

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