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Chronicle

LXIX Open Seminar on Acoustics Karpacz, Poland, September 25 – 29, 2023

On September 25–29, 2023, the LXIX Open Seminar on Acoustics OSA2023 was held in Karpacz. The conference was organized by the Wroclaw Branch of the Polish Acoustical Society (PTA). Simultaneously with the OSA2023 conference two accompanying events were held: Signal Processing Symposium SPSympo23 and 5th Polish-German Structured Conference on Acoustics PGSCA2023. 240 specialists from Poland and abroad took part in the OSA2023, SPSympo23, and PGSCA23 conferences delivering 96 papers and 6 plenary presentations.

Abstracts

Acoustic insulation tests of a multi-layer composite modified with rubber recyclate

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The paper presents acoustic studies of a multilayer composite made on the basis of Synolite 1967-G-1 polyester resin and glass fabric with a three-way arrangement of ±45°, Triaxial type and a weight of 860 g/m^2. As an addition, rubber recyclate created in the process of disposal of car tires was used. The material was made using the vacuum infusion method. By vacuum lamination, composite materials were produced in the form of plates with the addition of rubber recyclate in four variants of the amount of recyclate used in the produced composite – 20%, 30%, 40% and 50%. Each variant contained 6 layers of fabric and five layers of rubber recyclate. The samples were tested in the vibroacoustic laboratory on a dedicated measuring station of the reverberation chamber assembly without lateral transmission, in which the specific acoustic insulation R was determined in accordance with PN-EN ISO 10140-2 and related standards, i.e. PN-EN ISO 10140-1, PN-EN ISO 10140-4, PN-EN ISO 10140-5 and PN-EN ISO 717-1. All manufactured variants of the composite material with the addition of rubber recyclate were characterized by acoustic insulation in the range of Rw = (32.5 ÷ 39.5) dB. High sound insulation parameters for tested panels up to 12 mm thick constitute a barrier to counteracting the spread of unwanted airborne noise. Combined with good mechanical properties such as tensile strength, toughness and hardness, they form the basis for the easy design of all shields in many industries. The use of rubber recyclate obtained in the process of disposal of car tires has a positive impact on improving environmental protection.

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Sound propagation experiments in the western baltic sea

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Sound propagation in the Baltic Sea exhibits special characteristics due to complex oceanographic conditions in this area. In the last two decades experiments on sound propagation in the Baltic sea have been predominately performed east of the Darss Sill. Compared to the central Baltic Sea, the coastal areas of the western Baltic Sea, like the Kiel bay, are much shallower and display differing oceanographic conditions, mainly due to the salinity distribution. The oceanography of the western Baltic Sea gives rise to specific sound propagation conditions. Experiments on the transmission loss, as well as on spatial and temporal variability in the shallow water area of the Kiel bay are presented. In order to examine the sound field properties within the water column, distributed receiver buoys and a vertical hydrophone array were utilized. A stationary, as well as a towed sound source were employed as sound projectors. The sound propagation experiments were conducted with RV ELISABETH MANN BORGESE (Institute for Baltic Sea Research, IOW).

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Diagnosis of acoustic hazards of the environment and its identification problems

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The problems of control and control of the state of acoustic hazards of the environment have a certain unrecognized scientific and application potential. This is because its

identification research dimension has a number of specific properties. They shape the performance peculiarities of the model process, describing the recognized mechanisms: noise generation and propagation, classification of noise hazard states and their forecasts.

Failure to comply with the methodological requirements inherent in identification tasks aimed at: the genesis classification and prognosis of the state of environmental noise hazards – in a manner consistent with their perception by humans – is currently the source of a number of paradoxes and related errors of interpretation.

The speech will review them. The correctness of the decibel algebra will be analyzed, and its corrections will be proposed, opening up new fields of research for the diagnosis of the state of acoustic hazards. The role of proper selection of metrics for decibel comparisons of measurement results, in the process of classifying the state of noise hazards, is outlined. It was found that the currently used Euclidean distance measures in such a process can raise significant objections. Related: methodological, interpretive and application implications are outlined.

The need for new measures for the analysis of comparisons and exceedances of permissible sound levels, free from the limitations of current control practice, was pointed out.

The issues analyzed in the paper were supplemented by an analysis of the problems present in the estimation of the uncertainty of research diagnoses, present in the practice of controlling the state of acoustic hazards of the environment, and the presentation of paths leading to their solution.

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A new, bio-inspired microphone design

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Diverse trending technologies such as the voice control of machines or automatic acoustic condition monitoring are creating an ever-increasing demand for a microphone technology that is well-suited to as many different sound situations as possible. This article presents a novel bio-inspired microphone and uses measurements to estimate its potential, compared to conventional microphones, as an acoustic sensor in future applications.

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The potential of liquid marbles and Pickering droplets as templates for colloidal capsules

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One of the challenges in biomedical applications is the efficient protection of active substances (e.g., drug molecules) and precise delivery to the site of interest when a patient is under treatment or medical diagnostics. Capsules of rigid and dense shells can efficiently preserve the active substances. They can be fabricated from droplets coated with solid particles suspended in a carrier liquid (known as Pickering droplets). Another potential strategy is using so-called liquid marbles, which are droplets covered with particles but suspended in the air.

In the presentation, I will discuss the production of Pickering droplets and liquid marbles based on magnetic fluids. When exposed to a high-frequency alternating magnetic field, these droplets provide the basis for capsule formation. In the tested systems, polymer micro-particles constituting a shell around the droplets change their properties when influenced by generated heat in magnetic hyperthermia. Then, droplets formed in this way can be manipulated using a constant (DC) magnetic field and filled with an active substance, such as an antibiotic suspension. The results from our research will be supplemented with examples from the literature demonstrating the potential of droplets in the transport and release of active substances triggered by, among others, high-intensity ultrasound.

The presentation will also provide further possibilities in this area, including the control of droplet manipulation processes using ultrasound techniques and the active substance release from the droplets by ultrasound and controlled by electron paramagnetic resonance (EPR) techniques.

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Comparison of the acoustic parameters of the commercial ceiling swirl diffusers with the prototype model

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Understanding the behaviour of the airflow in ventilated rooms is essential for architects in order to provide the most efficient ventilation system and also for users of the rooms. In mechanical ventilation, it is necessary to control air quality in the human-occupied zone and this can be achieved by air diffusers of different kinds also called ATD's (air terminal devices) – a general term used to describe supply, exhaust or transfer diffusers and grilles. These units in ventilation systems are important because they create a swirl to supply air to rooms where people are and allow mixing flow ventilation in the comfort zone. But inside buildings fitted with air-conditioning systems, the majority of the noise comes from the air, i.e. caused by the movement and distribution of air between ducts and from the ducts into different areas through vents, diffusers and return grilles. In this work, an aeroacoustic study of four commercial adjustable-blade ceiling swirl diffusers and compare with prototype one was performed. Two positions of adjustable-blade, fully opened and by 45 angles, were performed. The objects were installed on the standard plenum box with a side entry without the regulation damper. The prototype blade was printed by the 3D printer. The aeroacoustics parameters were set out according to ISO 5135 in the reverberation room.

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Evaluation of the impact of a leak on the sound transmission loss of a building partition using sound intensity measurements

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Leaks in building partitions, e.g. at the point of their connection or in the form of poorly filled joints, can significantly affect the resultant sound transmission loss. For partitions in existing buildings with potential leaks, a leak identification method and, above all, a way of assessing the impact of such a leak on their parameters are needed. In this paper, a new method of evaluating the impact of leakage on the resultant sound transmission loss of the partition based on sound intensity distribution measurements was proposed. The tested building element is represented by two-element partition: a tight element and a leak of a certain area and sound insulation. The relationship between the sound transmission loss of a tight partition and the leak is determined on the basis of the measurement of the sound intensity distribution on the surface of the tested element with a leak. Once the relationship is defined, it is possible to predict the recovery of sound transmission loss of the partition as a result of removing the leak.

The paper presents the developed methodology and the results of its verification based on the measurement of sound insulation of a homogeneous partition, with and without leak, using the sound pressure method and the sound intensity method. Measurements were carried out in downscaled reverberation chambers with scale 1:4. A homogeneous MDF board was used with the leakage in the form of holes of a specific diameter. The measurement results were also compared to the values obtained by calculation using well-known Gomperts model of sound transmission loss of the partition with a leak. The measurements and calculations confirmed the possibility of determining the impact of leakage on the resultant sound insulation based only on the measurement of the sound intensity distribution on the surface of the tested partition.

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Objective assessment of the speech signal quality broadcasted by local digital radio in selected locations in Wroclaw

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The development of digital radio, observed in recent years, and the advantages offered by this medium are resulting in the expansion of the audience. In order to ensure the proper quality of broadcasting, it is necessary to monitor this quality. The assessment based on listening tests is very expensive and organizationally inconvenient. The development of methods for objective evaluation of signals makes it possible to monitor the quality of transmitted content, without the need for troublesome procedures associated with subjective evaluation. The good correlation of subjective evaluation results and objective measurements in the transmission of perceptually encoded signals, reported in the literature, may allow for random quality monitoring. The authors decided to test the feasibility of using two objective evaluation methods to assess the quality of the speech signal transmitted on digital radio by comparing the results obtained with the result of subjective evaluation.The paper presents the results of objective measurements of speech quality transmitted via Digital Audio Broadcasting+ in Wroclaw agglomeration. Measurements have been done in various city sites in order to determine the influence of the location on speech quality. The obtained results of the assessment performed by the use of two methods of testing: PESQ and POLQA, allowed to find a correlation between the objective and subjective results of quality evaluations. The method of objective testing may be used for monitoring the quality of signals in Digital Audio Broadcasting networks especially spoken broadcasts.

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Residual convolutional neural network for continuous identification of aircraft noise

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Continuous aircraft noise monitoring systems are the key to a strategic approach to noise management in the vicinity of airports and helipads. They support shaping the spatial distribution of the emitted noise, e.g. by providing data to optimize the use of approach and departure paths, the distribution of aircraft types during the day etc. in the annual perspective, taking into account alterations in the airport operating patterns and the fleet served.

In the single-operation scope noise monitoring systems allow for indicating anomalous aircraft movements which often become an issue from the perspective of a local community, and thus are of interest to airport authorities.

The latter class of problems requires a system to quickly, automatically and accurately identify whether the limit-exceeding noise event is caused by the aircraft operation. Due to the often delayed access to airport operation logs, the system should operate with minimal or no non-acoustic data. The paper proposes the architecture of a noise detection method, meeting the above requirements and attempts to assess its effectiveness.

Proposed approach involves using the residual convolutional neural network for solving the task. The network operates on 1/3 octave noise input data, returning the similarity of the input sound to the aircraft noise.

The accuracy of the proposed method determined for a single data frame using mixture of real-life measurements exceeds 95% for a frame length of at least 30 seconds.

The proposed method gives promising enough results that it can be implemented in a test environment on a larger scale. In parallel, further work is progressing, focusing mainly on improving the quality of training data and fine-tuning the hyperparameters of the network.

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Research in the use of metamaterial sound-absorbing structures in electroacoustics

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The metamaterial structures in sound absorbers' role have increased in popularity in many acoustic applications. However, electroacoustics's most popular absorber type is still porous material such as polyester fibers or acoustic foam. This paper will present the recent finding on the possibility of application for metamaterial acoustic absorbers dedicated to selected features in loudspeaker enclosures, such as standing wave attenuation or absorption of diaphragm backpropagation. The selected applications of metamaterial optimized structure will be demonstrated through numerical simulation and experimental measurements. The optimized structures for the selected application were modeled using COMSOL Multiphysics FEM modeling and Transfer Matrix Method calculation. The selected aspects of sample preparation produced in the 3D printing technique with different technologies of printing will be discussed, as well as the required postprocessing for this type of prototyping technique. We have used the most common rapid prototyping methods, such as FDM, DLP, and SLS, with different mechanical modifications and postprocessing to best match the modeling results in measurements on the impedance tube. The summary will provide feedback on the current stage of metamaterial structures applications in electroacoustics and difficulties in this research topic.

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The simulation of the influence of the Doppler effect on wideband hydroacoustic signals

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In Underwater Acoustic Communications (UAC) the Doppler effect, that results from the mutual motion of the system's transmitter and receiver, as well as the signal's reflection from the waves forming on the water surface, causes significant distortions of the signal reaching the receiver and reduces the achievable Bit Error Rate (BER) of the data transmission.

The article presents the design and implementation of the simulator of the Doppler effect influence on wideband hydroacoustic signals. The simulator implements two methods of modeling the influence of the Doppler effect. First of which consists of shifting the spectral components of the signal, the second – the compression or expansion of the signal in the time domain. Differences in simulation results obtained with both methods for wideband signals used in UAC systems are presented.

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Sound power level as a means of effectiveness of distributed mode loudspeakers

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Distributed Mode Loudspeakers (DMLs) are characterized by properties, which make them significantly different from – commonly used – conventional electrodynamic loudspeaker with a pistonic diaphragm. Such differences occur due to the design assumptions of the DML, which are totally differing from design principles of conventional loudspeakers. The vibrations of DML consist of bending waves traveling across the rectangular surface of the loudspeaker. That is the cause, why transducers of this type present frequency characteristics with sharp local minima occurring at various frequencies, depending on the angle between the loudspeaker's surface and a measurement microphone. Because of such a property DML produce an acoustic field which is diffusive in the proximity of the loudspeaker. Also, the directivity characteristics of the DML are differing from those related to pistonic loudspeakers. The previous works of these authors have shown that the strongest radiation did not occur at the axis of the transducer, which leads to a conclusion that the Sound Pressure Level measured on the axis of the loudspeaker ought not be conceived as the reference level when normalizing measurement results and calculating directivity specifications.

In this work, a series of sound pressure level measurements of DML in a reverberation chamber has been carried out, which were compared with analogous ones, carried out for a conventional electrodynamic loudspeaker. In further steps – sound power level, according to ISO 3741:2010 standard was determined from the results of conducted measurements for both types of transducers. The sound power level was calculated in 1/3 octave bands, for the filtered pink noise excitation of constant amplitude. It may be concluded, that the sound power level obtained with these two different types of loudspeakers is not significantly differing between each other, despite of various operating principles of transducers.

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Molecular structure and thermophysical properties of ionanofluids

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Investigated ionanofluids are hybrid systems composed of multi-walled carbon nanotubes dispersed in ionic liquids by ultrasonication method. They exhibit a range of desirable properties, including improved thermal conductivity, nonflammability as well as high chemical and thermal stability, making them efficient and safe heat transfer media. In particular, a remarkable increase in thermal conductivity was observed for ionanofluids based on C-sp^2 rich, long, crystalline multi-walled carbon nanotubes. The structural, cryo-transmission electron microscopic studies revealed the existence of subzipping effect of long multi-walled carbon nanotube networks in ionic liquids as a result of interactions

between two neighboring nanotubes which fragmentarily coalescent by the ionic liquid nanolayers, i.e. intertube zipping together with locally unzipped individual pairs of nanotubes and/or longitudinally unzipped nanotubes. The energy of interactions between the carbon nanotube walls and ionic liquids, obtained from the molecular dynamics simulations, indicated that the formation of carbon nanotube networks, separated by a layer of ions, was thermodynamically favorable. Additionally, the correlation between the ID/IG and ID/I2D integrated intensity ratios in the Raman spectra suggested the formation of new covalent bonds between the ultrasonically induced broken nanotubes and the most likely cation. Consequently, the molecular perfection of the multi-walled carbon nanotube structure, along with its supramolecular arrangement and interactions with ionic liquid, significantly contribute to the extraordinary enhancement in thermal conductivity and optimal rheological characteristics.

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Crowd noise spectra for the calculation of the speech transmission index for public address systems

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Knowledge about interfering noise in the area of coverage is necessary for the correct design of a public address system. Acquiring this knowledge for existing buildings is possible, for example, by measurements. In the case of a non-existing or non-operating building, it is possible to obtain data on the basis of similar buildings. In practice, knowledge about interfering noise for design purposes is obtained from the literature, calculated, or using in-house experience. The sound levels of interfering noise can be obtained, for example, from BS 5389-1. It is more difficult to acquire knowledge of the interfering noise spectra, and as presented in the paper, the spectrum is also important for speech intelligibility. For example, for interfering noise with a sound level of 60 dB, in the free field, for large distances from the source, the value of the Speech Transmission Index for Public Address Systems (STIPA) for noise with a male speech spectrum can be as much as 0.15 greater than for noise with a pink noise spectrum. The paper attempts to systematise interference spectra occurring in public buildings where public address systems are most commonly used. As shown in the paper, the error in determining STIPA for appropriately selected normalised interfering noise spectra (speech for adequate vocal effort and white, pink and brown noise), relative to STIPA values for measurement-acquired noise spectra is relatively small. The main focus was on crowd noise, in buildings such as sports arenas and stadiums, waiting rooms, offices, restaurants, stores, airport terminals, etc., and interference on railway platforms. In the study, these analyses were performed by computer simulations using the STIPA statistical model.

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Influence of the laboratory measurement method of the reduction of transmitted impact noise by covering floors on a heavyweight standard floor on the result

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The article presents the results of laboratory measurements of the reduction of transmitted impact noise ΔL by floor coverings on a heavyweight standard floor. The tests were carried out for a floating floor with EPS T insulation in two thicknesses: 43/40 mm and 22/20 mm. Each test was carried out for two types of screed: cement and anhydrite. The tests were repeated for an additional screed load simulating furniture load and without load. An attempt was made to determine the impact of the lack of load on the test result and to check whether a small difference in the weight of the screed significantly affects the result.

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Reconstruction of source components from hydroacoustic time series

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Hydroacoustic time series may contain mixtures of source components originating from natural or artificial sources. We demonstrate that reconstruction of these components can be accomplished by employing the methodology of parametric time series analysis. The core element of the proposed approach is the estimation of models for the prediction of the given time series, such as autoregressive moving-average models or state space models. These models can be generalised for non-stationary situations, such as gradual fading of sources or time-dependent frequencies, e.g., due to Doppler effects. Estimation of states and model parameters is implemented by Kalman filtering and numerical maximisation of the innovation likelihood. As a result of the proposed approach, source components can be detected and reconstructed, also in presence of strong background noise; this is important for the analysis of the hydroacoustic signature of ships. In some cases, additional information regarding the sources can be obtained, such as velocity and distance, or rotation rate of the propeller. As an additional benefit, parametric estimates of the power spectrum can be computed, which have attractive properties, as compared to classical methods for spectral analysis.

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Comparison of the transitional states of singing voice registers depending on the presence of the singer's formant

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This paper provides an in-depth comparison of the transitional states of singing voice registers, specifically focusing

on the influence of the singer's formant. The singer's formant, a spectral characteristic usually found in professionally trained singers, is considered crucial in the projection and resonance of the singing voice. This study examines how the presence or absence of this formant affects the transitions between vocal registers, a critical aspect of vocal performance. By presenting a comprehensive analysis, the paper seeks to broaden understanding of vocal mechanics, potentially informing better training and performance strategies for singers.

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Reducing the impact of fundamental frequency on the HFCC parameters of the speech signal

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The voiced parts of the speech signal are shaped by glottal pulse excitation, the vocal tract, and the speaker's lips. Semantic information contained in speech is shaped mainly by the vocal tract. Unfortunately, the quasiperiodicity of the glottal excitation, in the case of HFCC parameterization, is one of the factors affecting the significant scatter of the feature vector values by introducing ripples into the amplitude spectrum. This paper proposes a method to reduce the effect of the quasiperiodicity of the excitation on the feature vector. For this purpose, blind deconvolution was used to determine the vocal tract transfer function estimator and the corrective function of the amplitude spectrum. Then, based on the obtained HFCC parameters, statistical models of individual Polish speech phonemes were developed in the form of mixtures of Gaussian distributions, and the influence of the correction on the quality of classification of speech frames containing Polish vowels was investigated.

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Investigation of tribological interactions influance on dynamics of optimal surgical robot with DC motor and PID controller taking into account inputs from in vitro experiments on cardiovascular tissue

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Tribological interactions are one of the basic reactions affecting the course of the drive torque in surgical robot joints. It is interesting to test out what is the impact of friction on its dynamics because it gives the possibility to effective control. Inputs from two in vitro experiments on cardiovascular tissue were added to optimization model which include such important physical phenomena as: natural vibrations, linear buckling and history of the deformation. It was assumed that the accuracy of positioning and repeatability of a surgical robot with a serial chain is influenced by such criteria as: first natural frequency, buckling coefficient, mass, dynamic safety factor during transient states and displacement of an end of the effector under the impact of emerging loads. A vector objective function for these four criteria was determined and its optimum with the usage of finite element method, Pareto fronts and the genetic algorithm NSGA-II was specified too. For the optimal obtained geometry, a model of dynamics of driving torques was constructed by using the block diagram method, taking into the account the inertia tensors and the locations of masses centers. The electromechanical DC motor model was added to each joint. PID regulator models were also added to them and step responses with optimal indicators of the regulation quality was received using gradient descent method. For a specific mechatronic system of the surgical robot, dynamic friction model was formulated based on the Lund-Grenoble model equation including the deformation of the cooperating plastic and elastic surfaces, and including the Stribeck effect.

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Magnetic Pickering emulsions characterization by ultrasound attenuation spectroscopy

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A magnetic Pickering emulsion is an emulsion stabilized by magnetic nanoparticles, that accumulate at the droplet interface. However, it is crucial to characterize the stability of Pickering droplets and determine the shell thickness from an application perspective. In this research, the ultrasound attenuation was measured experimentally, and an ultrasound scattering theory based on core–shell model was implemented to analyze the measurement data. The implemented model takes into account the contribution of the shell on the droplet's core during ultrasound wave propagation.

The first part of the results focused on the theoretical calculation of ultrasound attenuation for core–shell model. The change in the ultrasound attenuation values was observed for different core radii, shell sizes, concentrations, and ultrasound frequencies. In the second part of the results, the core–shell model was used to analyze ultrasound attenuation spectra to determine the size of Pickering droplets and shell sizes. We found that the shell thickness varied with various volume concentrations of magnetic particles in the system. Additionally, we investigated the formation of Pickering emulsion under the application of an electric field. The data showed that the thickness of the shell increased compared to samples before electric field treatment.

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Contrast-enhanced magneto-motive ultrasound imaging of sentinel lymph nodes

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A very crucial step in cancer staging is the process of identification of cancerous lymph nodes. The absence of metastases in the sentinel node determines the lower probability of metastasis in other draining nodes and distant organs. Commonly used in clinical practice methods, such as blue dye-, isotope-, and green fluorescence-staining, are lacking accuracy.

As an alternative to generally used sentinel lymph node identification methods, Contrast-Enhanced Magneto-Motive Ultrasound (CE-MMUS) has been proposed. CE-MMUS uses magnetic microbubbles (microbubbles with attached magnetic nanoparticles) as contrast agents. Subsequently, a low-frequency alternating magnetic field induces oscillations of magnetic microbubbles to generate tissue-laden movement. The tissue-laden movement caused by magnetic microbubbles is tracked and recorded with a phase and frequency tracking algorithm.

Results showed that the functionalization of microbubbles with magnetic nanoparticles does not negatively affect their applicability as contrast agents, and their presence in the sentinel lymph node visibly increased its echogenicity. Derived with the tracking algorithm tissue displacement increased after the addition of magnetic microbubbles compared to displacement caused by magnetic nanoparticles only. Therefore, the CE-MMUS improved lymph node identification. Experiments were conducted on mice models in vivo.

This work was supported by CRUK-grant numbers A23333/24730.

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The impact of infrasound on the level of activation

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The present study provides a comprehensive analysis of research data elucidating the impact of infrasound on human activation levels. The levels of activation were quantified using the Activation-Deactivation Adjective Check List a widely recognized self-assessment questionnaire. Experimental studies were conducted in two independent research scenarios: the experimental study and the control study. The research procedures were uniform, differing only in the acoustic stimulus applied. In the experimental study, an acoustic stimulus with a frequency of f = 13 Hz and a sound pressure level of SPL = 105 dB (Lin) was employed. Statistically significant changes in activation level were obtained.

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Acoustic aspects of the modernization project of the Pomeranian Philharmonic in Bydgoszcz

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The comprehensive modernization of the Pomeranian Philharmonic, planned by the city of Bydgoszcz Ignacy Jan Paderewski will cover the existing part of the building with the well-known concert hall with recognized acoustics and the extension of the building with new rooms. The paper discusses selected acoustic and functional aspects of rooms in the context of acoustic parameters of interiors, construction and testing of acoustic structures and noise protection of rooms. These solutions fit into a very interesting and bold architectural design.

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Acoustic metamaterial design for levelling the impact of double-wall resonance on sound insulation

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This paper presents two solutions employing locally resonant metamaterial to level the mass-air-mass resonance impact on the sound insulation. The first operates on the cantilever beam resonance, and the second uses masses vibrating in flexural mode cut out from the additional panel. Both structures are mounted between two lightweight, honeycomb cardboard panels with a double-wall resonance of 420 Hz. Solutions were analysed numerically for their vibration and acoustic properties and measured in the reverberation chamber, resulting in information about the dispersion curve, effective dynamic mass, and sound insulation. The analytical results of Sound Transmission Loss (STL) and the experimental measurements of diffused-field Sound Reduction Index (SRI) proved the existence of sound-insulation enhancement. The local rise in SRI resulted in an increase of broadband Weighted SRI up to 5 dB.

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Prediction of effects of impact pile driving noise on marine fauna in the PEEZ: A comparison of different scenarios

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The construction of wind power plants in offshore areas is usually associated with the generation of high energy and high sound pressure.

In the Polish Exclusive Economic Zone (PEEZ), the construction of a complete network of wind power generator fields is planned, which will result in an increase in the level of underwater acoustic field both during the construction phase and during the operation of the generators.

The negative and sometimes destructive impact of high amplitude and high energy sounds on marine organisms is

relatively well recognised, at least for some types of animals such as mammals and some fish species.

Hence, the estimation of the values and extent ranges of basic metrics of underwater sound associated with piling is undergoing constant attention from administrative bodies and is an interesting research topic.

This paper presents the results of modelling studies carried out to predict the ranges of impact of sound associated with piling on marine organisms.

Numerical modelling of acoustic wave propagation was carried out using an approximation of the wave equation in the form of the parabolic equation of acoustics.

The sound sources were located in several planned wind power plant areas, mainly located north of Słupsk Bank.

Various scenarios were considered to simulate the range of noise impacts, such as seasonal variations in sound propagation in the basin, pile diameter and/or application of different sound mitigation methods.

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The nature of the variability of the underwater noise field on the Słupsk Bank

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Analysis of underwater noise long term measurements was performed in shallow waters of the Southern Baltic Sea. Measurements were conducted in the course of seasonal changes of sound propagation conditions from typical for winter to early summer (from February to beginning of July). Investigation of similarity between basic noise metrics at two points was aimed to establish proper inference about noise levels in the area. At both sites, broadband (31.5–16 000 Hz) noise spectra and noise level revealed their dependency on ship traffic.

The analysis of the dependence of noise level on wind speed indicated different forms of this dependence in the two frequency ranges. For frequencies above 800 Hz, the spectrum level increases with wind speed, while in the lower frequency range it decreases.

Despite of relatively shallow site of observations occurrence of seasonal trends in the level noise in both anthropogenic and natural sources was established, what confirm and extend earlier reports regarding seasonal changes of the wind driven noise in the Baltic Sea Deeps.

Thought-provoking short-term periodicities in the noise level independent of meteorological conditions, but hypothetically dependent on vertical diel fish migrations, has been identified in some frequency bands.

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Analysis of asthma patients' auscultatory sounds

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Asthma is a global chronic disease that poses a significant burden on public health. The World Health Organization estimates that approximately 300 million people worldwide suffer from asthma, and this number is projected to increase by 100 million by 2025. Childhood asthma is the most prevalent chronic disease, affecting 10–12% of children worldwide and accounting for a significant portion of the childhood health burden. Despite its high prevalence, the current treatment outcomes for childhood asthma remain inadequate, and preventable deaths occur each year. Furthermore, diagnostic challenges contribute to both overdiagnosis and underdiagnosis of childhood asthma.

The current asthma diagnosis is primarily based on the subjective measurement of respiratory symptoms, which are reported by patients or their caregivers during routine clinical visits over an extended period of up to one year. However, this subjective measurement approach introduces a high degree of uncertainty into the input data, making accurate diagnosis challenging.

Objective analysis of respiratory sounds presents a solution for obtaining more precise and reliable diagnostic data. This study proposes an approach for the objective analysis of auscultatory signals in asthma patients. By implementing this approach, physicians can obtain more objective data for asthma diagnosis and improve treatment outcomes, ultimately reducing the burden of asthma on public health.

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The use of psychoacoustic tests and objective methods of hearing examination in the study of Alzheimer's disease patients

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Background: The prodromal phase of Alzheimer's disease (AD) is characterized by the emergence of mild cognitive impairment that falls short of the diagnostic criteria for dementia. During this phase, individuals commonly exhibit subtle memory deficits, word-finding difficulties, challenges in problem-solving, and overall cognitive decline, which often progress to the development of full-blown Alzheimer's dementia. Early identification and intervention during the prodromal phase are crucial for implementing appropriate treatment and support strategies that may potentially slow down disease progression.

Materials and methods: This study employed a comprehensive set of psychoacoustic and objective methods of hearing examination, ie.: temporal gap detection, amplitude modulation detection, interaural time/level difference discrimination thresholds, speech reception threshold in noise, distortion product otoacoustic emissions (DPOAEs), auditory brainstem responses (ABRs), and auditory evoked potentials (P300). A small group of patients in different stages of AD were tested and compared to individuals with normal hearing.

Results: Considering the fact that only a small group of patients have been tested so far, case study analyzes were performed. Overall, when compared to the reference values, the majority of individuals with AD showed elevated speech reception thresholds. Moreover, there were notable elevations observed in temporal gap detection thresholds and binaural parameters, concomitant with a significant prolongation of the P300 wave latency, as indicated by objective measurements.

Conclusions: Although the data collected in this study did not yield conclusive statistical findings regarding changes in the measured psychoacoustical parameters in AD patients, the results are promising. Further research, incorporating speech, visual, and memory tests, will be conducted to deepen our understanding of the auditory preception changes associated with AD.

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Aeroacoustic parameters of the ceiling swirl diffuser with prototype adjustable-blades

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For the major part of our lives we are in the indoor air spend time in artificial climates such as work/home environments and transport vehicles. So, clean air in a room is an essential component for a healthy indoor environment. Ventilation systems are responsible for exchanging air in rooms. Devices controlling the room ventilation are called ATD's (air terminal devices) – a general term used to describe supply, exhaust or transfer diffusers and grilles. The ceiling swirl air diffusers are mechanical devices designed to control the characteristics of fluid at the entrance to a thermodynamic open system. These units in HVAC systems are important because they create a swirl to supply air to rooms where people are and allow mixing flow ventilation in the comfort zone, but also they are the source of the noise. In this work, an aeroacoustic study of ceiling swirl diffusers with prototype manually adjustable air control blades in two positions, fully opened and by 45 angles, was performed. The objects were installed on the plenum box with a side entry without the damper. The prototype blades using the 3D printer were used to find the one with lower noise parameters which are set out by measuring according to ISO 5135.

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Design and practical realization of an amplifier constructed on the basis of Nuvistors used in the preamplifier circuit

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The work aims to show the method of designing, practical realization and measurement of an electroacoustic amplifier constructed on the basis of electron tubes, especially Nuvistors used in the preamplifier circuit. Nuvistor tubes 6N52S were used in the input stage and phase inverter system in the self-symmetry system. The single channel of power amplifier uses a pair of EL84 power pentodes working in a Push-Pull system. The amplifier also uses a passive tone control system in the Baxhandall system.

The paper presents the complete stages of designing, construction and measurements. The realized device and the measurements as well as the subjective tests confirmed the possibility of using Nuvistor lamps in devices working with an acoustic signal. The use of Nuvistors allowed to reduce the anode voltages compared to the traditionally used ECC83 triodes. Also, the reduction of the dimensions of the device and achieving a frequency bandwidth of −2.6 dB/+0.0 dB from 20 Hz to 20 kHz, are available.

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Test stand for study of reverberating plates with adjustable features

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Vibrations of plates can be used for synthesis of artificial reverberation, which is one of the most important signal processors in audio engineering. This paper describes a process of creating a test stand for measurements of reverberating plates. The stand was assumed to have possibilities to modify the output reverberation signal in perceptually significant way by affecting the plate vibrations. The paper contains description of mechanical and signal parts of the stand and their way of working as well as how they can be used in order to achieve differences in the output reverberation signal. The test stand will allow to examine how exactly affecting the vibrating plate will affect features of the reverberation signal.

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Sound insulation performance of cube-shaped enclosures

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The subject of the research described in the article are the sound insulating properties of a cube-shaped enclosures, the walls of which are made of plates of homogeneous materials and double-layer baffles. As an enclosure for an omnidirectional sound source imitating a noisy machine or device, a prototype test stand for testing the acoustic

properties of materials and enclosures was used. The three tested variants were enclosures with walls made of plastic plates, such as polyethylene, solid polycarbonate, and plates in the form of rigid polyethylene foam. The fourth variant was an enclosure with walls made of sandwich baffles in the form of a steel plate with a rubber layer glued on. Calculations of the effectiveness of the enclosure were carried out using the previously developed theoretical calculation model for Insertion loss (IL). The obtained results were related to the IL obtained in the course of experimental tests. The research showed slight discrepancies between the calculations and the measurement results for almost all tested materials in the entire frequency range (100–5000 Hz), with the exception of rigid polyethylene foam, for which the discrepancies were relatively the largest in the lower frequency range, i.e. below 400 Hz.

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Lossy coding and bitrate effects on changes in formant frequencies in Japanese and English speech signals

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Since speaker recognition and verification became heavily used technology, both in professional applications like forensics and more everyday ones, the question arose: what factors can impact results of those processes? One thing that may be important with respect to this subject is lossy coding, as some of the information contained in an original file is lost in the coding process. In the era of globalization, not only native languages or languages of neighboring countries are of interest to researchers, but also those quite far, especially from Asia – the biggest exporter of goods and services to Europe. Those economic relationships are usually connected with the interchange of personnel, which further shortens geographical distance. The article presents the results that are a continuation of research on the behavior of Japanese language formants. Earlier research looked at changes to the trajectories of the first and second formants. This article presents the results of research on the third and fourth formants. The knowledge of these changes is indicated in the process of speaker identification in forensics using the spectrographic method. At the Department of Acoustics and Multimedia, Wrocław University of Science and Technology and in many centers around the world, the auditory-spectrographic method is used, which is a combination of the aural and spectrographic methods. In the spectrographic part, a person is identified on the basis of a comparison of the formants' trajectory.

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Experimental validation of the asymmetric PZT optimal shape in the active vibration reduction of triangular plates

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In the active vibration reduction of two-dimensional structures, piezoelectric actuators of regular shapes, e.g. rectangular, circular, are commonly used. However, the shape of the transducers can be irregular, asymmetric (a-PZT), and its geometry can be an object for optimization. The paper presents an experimental validation of the application of optimal shaped a-PZT in the active reduction of triangular plate vibrations. Optimization was based on the criterion of the maximum bending moment. This means that the center of a-PZT is located at the point where the bending moment of the plate has reached its absolute maximum. The isosceles right triangular plate with simply supported edges was chosen as the research object. The research confirms the validity of the criterion used for optimization and may be an introduction to considering the use of optimal a-PZT in the active reduction of vibrations for more complex structures.

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Contextual localization bias for a wide range of azimuth and frequency conditions

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The perceived azimuth of a sound source is biased by a preceding source (precursor), typically, towards midline (medial) by a lateral and towards the side (lateral) by a central precursor. Little is known about effects of intermediate precursor azimuths and the contribution of low and high frequency regions. We tested the hypothesis that for a certain intermediate precursor azimuth, lateral and central biases cancel each other out. Ten normal-hearing listeners localized 300-ms targets following 600-ms precursors using a head-pointing task in a virtual audio-visual environment. Both target and precursor azimuths were systematically varied across the azimuth range from left (−90°) to right (+90°). Stimuli were white noises, filtered with listener-specific head-related transfer functions. Low-pass (0.5–2 kHz), high-pass (2.8–16 kHz), and broadband (0.5–16 kHz) conditions were tested to investigate the role of frequency regions dominated by different localization cues: interaural time differences in low-pass, interaural level differences and spectral shape in high-pass, and all three cues in broadband stimuli. Precursor effects were overall strongest for target azimuths of ±70°. Cancellation of lateral and central biases was found only for ±70°-targets, for a mean precursor azimuth of 58.3°. Importantly, the data showed selective spatial contrast enhancement for targets preceded by azimuthally matched Ps. Patterns of precursor effects were relatively similar across frequency regions.

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Infinitesimal volume area of physical space-time in acoustics and electromagnetics

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In practical communication engineering, the mathematics of waves, both acoustic and electromagnetic, deals

usually with vast areas of physical space. The author experience in time-domain analysis of two-aspect fields in amorphous media – fluids and dielectrics has shown a far-reaching affinity of transients in acoustics, on the one hand, and wideband signals in UWB wireless communications, on the other hand.

It is worth noting that the wave relationships and equations themselves are derived by means of formal transformations relating to local interactions taking place "here and now" – in an infinitely small volume, in an infinitely small period of time. In this infinitesimal "space-time" there is an immediate interaction between phenomena. At the same time, the mechanism of this interaction can be very different depending on the physical scale of the space and time involved.

Analysis of phenomena performed in infinitesimal areas of fluids and dielectrics leads to significant results of general importance: A – it indicates the existence in both cases of a space-time with two-aspect physical dynamic properties, B – it gives a practical, engineering insight into the philosophical-practical problem of the "reality" of time/space, C – it gives a tool for determining time (frequency) ranges and linear sizes for the main classes of medium models and phenomena occurring in it – classic (continuous), statistic (granular), and quantum mechanic.

The current physics of the universe struggles with the imbalance of matter and energy. The mass-energy gap problem still needs to be addressed. A return to Lorentz's concept of ether seems potentially useful, perhaps modified by adding a trace energy-mechanical mass content to the space otherwise "endowed with only electric and magnetic properties" (original Lorentz's definition of ether accepted in 1922 by Einstein).

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Selected problems of active plate vibration suppression

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The main aim of the control systems designed for planar flexible structures is to cancel their vibrations and related acoustic radiation as much as possible. This problem is often solved by the application of active methods. This paper presents the derivation of the models for planar structures with surface mounted piezoelectric actuators. The first approach consists in modelling the structural dynamics in the form of the partial differential equations (PDE) derived from physical principles such as the balance of forces and moments. In the second approach, a parametric system identification procedure is employed to establish a mathematical model of the considered system on a basis of the data collected from the measurements. The main objective is to estimate the control-oriented models that are suitable for designing controllers. On the basis of the models derived, the adaptive control algorithms based on solution of Diophantine equation are used to suppress circular plate vibrations. The results of performed simulations and tests are included and discussed.

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First-order ambisonics microphone with MEMS and condenser capsules

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Technologies that produce and deliver immersive VR content are still growing. Ambisonic microphones are available in various types, from the FOA (first-order ambisonics, e.g., Sennheiser AMBEO VR Mic) to HOA (up to fourth-order ambisonics, e.g., MH Acoustics Eigenmike). They are designed with different capsules, from low-cost electret transducers, MEMS (Zylia ZM-1) to high-grade condenser capsules (NEVATON VR). This paper presents two designs of a low-cost FOA microphone based on low-noise MEMS (Infineon IM69D130) and electret capsules (JLI-2590A) in an identical tetrahedral arrangement. This paper details the design, fabrication, and testing of two FOA microphones, including their frequency and directivity response and subjective evaluation compared to commercially available solutions. This study aims to indicate whether the microphone capsule's type affects the recorded sound field's quality and its significance.

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A design of an acoustic coupler for calibration of pressure sensors at ultra low frequencies

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The article aims to present a coupler developed for the calibration of alternating pressure of the pressure sensors at ultra-low frequencies up to 0.1 Hz for the Central Office of Measures (GUM). This study is part of the project "Concept for the construction of metrological infrastructure in the area of underwater acoustics at GUM", which is part of the Polish Metrology program. The growing demand for research of marine objects in the field of infrasonic underwater noise and research of the hydrodynamic field of ships requires ensuring the reliability and repeatability of recorded data and it starts with reliable calibration of pressure sensors. The choice of calibration method was based on a detailed and extensive analysis of calibration methods and similar solutions. The proposed solution is based on an eccentric mechanism driven by a stepper motor. The article contains an analysis of the literature of similar solutions and presents the theoretical basis, describes the designed coupler structure, configuration of the measurement system and a summary.

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Experimental aeroacoustic studies of selected three types of helicoidal resonators

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The paper presents experimental studies of selected three types of helicoidal resonators carried out on an aeroacoustic laboratory stand with the use of pink noise and a duct terminated with a reverberation chamber. The same ratio s/d = 1.976 is considered for three numbers of helicoidal turns n = 0.671, n = 0.695 and n = 1.0. The results of the acoustic attenuation performance depending on the air flow velocity were compared in relation to the numerical test carried out, with resulted in a decrease in resonance frequencies with an increase in the air flow velocity. The measurements were carried out with a high resolution of the FFT spectrum in order to illustrate the changes in the acoustic attenuation performance as accurately as possible. One-third octave bands of flow noise studies were also carried out.

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Investigation of flow features and acoustic radiation of a set of rectangular cavities in a channel

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Due to the widespread use of ventilation and air-conditioning systems in modern buildings, the issue of the generation and propagation of noise generated during the operation of these systems is becoming very important. The source of undesirable sounds have various origins – both directly related to the devices used and related to the flow of the air through the devices, ducts and other elements that are part of these systems.

This article focuses on noise of aerodynamic origin. The paper presents the results of numerical simulations of the air flow in a channel with a set of rectangular cavities. Then, the aeroacoustic wave equation was used to determine the acoustic pressure generated by the flow. Various configurations of the cavities made it possible to study the influence of their reciprocal location on the generated sound.

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Preliminary study: Mobile phone as a phonocardiographic signal recorder

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The aim of this work is to analyze the possibility of using a mobile phone with a voice recorder function as a phonocardiographic signal recorder. Test measurements were carried out by placing the phone at various points on the chest. For one selected point, measurements were carried out for a group of about 100 people, using different models of mobile phones. Data on weight, height and age were collected through a survey. Participants of the study were also asked about potential problems related to the measurement.

Signal quality was assessed using qualitative parameters. It was checked how the selected methods of signal pre-processing (editing of recordings, filtering, noise reduction) affect the values of quality parameters. The obtained recordings were subjected to automatic signal classification.

The result of this work is an extended analysis of the use of mobile phones as electronic stethoscopes and an analysis of the usefulness of signals obtained using this measurement method.

The results of these studies are important for the field of medical diagnostics, especially in situations where access to traditional stethoscopes is limited. If mobile phones prove to be effective recorders of phonocardiographic signals, it will open new possibilities in the field of remote heart monitoring and telemedicine.

However, it should be noted that further research, including validation and comparison of results obtained with mobile phones with those obtained with traditional stethoscopes, is needed before this technology is introduced into clinical practice.

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Modeling human sound-source localization: Current state and future directions

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Spatial hearing allows us to orient ourselves and navigate in a 3D environment. The acoustic basis for 3D spatial hearing is described by the listener-specific head-related transfer functions (HRTFs). While much attention has been put on the aspects along the left/right dimension, spatial hearing goes beyond the lateral dimension, and such investigations often require novel modeling approaches. In this talk, we will focus on the dimensions of sound localization that are particularly sensitive to listener-specific HRTFs, that are, near distances (sound externalization/internalization) and sagittal planes (top/down, front/back). We will discuss recent psychoacoustic findings and computational models aiming at simulating mechanisms underlying the process of sound localization. Further, we will explore the possibility of employing Bayesian inference as a quantitative method to predict 3D human sound localization in dynamic auditory scenes and including self-motion. As outlook, we will describe a unified probabilistic framework potentially able to integrate outcomes from various perceptual experiments to develop functional models of space perception, discussing its advantages and its limits and future directions.

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Infrasound and well-being: A study of wind turbine impact

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Wind turbines serve as a distinctive source of noise, possessing unique attributes such as amplitude modulation,

tonality, and components of infrasound and low frequency. This study explored how these sounds affect human well-being. A total of 129 subjects participated in the study, carrying out attention-focused tests and filling out surveys under three different conditions: normal background noise, artificially created low-frequency noise, and wind turbine-originated infrasound. The test results and the number of discomforts reported post-experiment did not significantly differ among the various conditions for both males and females. However, it was noted that the well-being before the study had a bearing on the complaints reported after the study.

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Analysis of dynamic mechanical properties of composite materials for electric guitar construction

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In recent years, composites have been presented widely as an alternative to traditional materials in many technological applications. Composite materials can be used for manufacturing musical instruments. In the case of an electric guitar, the guitars body, neck and fretboard can be made out of the composite structures. The mechanical properties of composite and epoxy-based materials may determine the final timbre of the instrument. Therefore, analysis of the dynamic response of those materials should be made, to ensure the optimal structural composition. In this paper, three different composite and epoxy-based materials were examined in terms of their dynamic mechanical properties. Firstly, samples of different composite materials were prepared and measured to obtain accurate geometry and mass data. Next, the samples underwent experimental modal impact hammer testing and then obtained output data was analyzed. As preliminary state of research storage modulus was calculated to observe differences in dynamic properties of the evaluated variants of composite materials. Obtained results indicate the possibility of differentiating the variants of composite materials to obtain the best fit for manufacturing the body of an electric guitar.

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Analytical modeling of the harmonic distortion caused by squeeze film damping in MEMS-based acoustic transducers

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Miniaturized microelectromechanical system (MEMS) microspeakers are currently trending in the development of acoustic transducers. When a transducer is scaled down to fit on a microelectronic chip, its physics differ from the macroscopic world, and some common modeling assumptions become invalid. One of the effects observed in MEMS microspeakers is nonlinear squeeze film damping. Understanding this effect is crucial as non-linearities in the speaker can result in harmonic distortion, which is highly regulated in audio applications. In this study, we analyze the influence of squeeze film damping on harmonic distortion using a lumped parameter model of a MEMS microspeaker. This leads to a non-linear ordinary differential equation, and an approximate analytical solution for moderate non-linearities is obtained using homotopy. We present our solution strategy, including the resulting closed-form expression, and verify our findings against numerical solutions.

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The influence of diffusing elements arrangement in a reverberation room on the results of airborne sound insulation measurements

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The primary issue in evaluating airborne sound insulation lies in quantifying the sound energy emitted by the barrier. This is typically accomplished by measuring sound pressure levels and acoustic absorption within the receiving chamber. When significant fluctuations in sound pressure levels occur within a reverberation room, it indicates the presence of standing waves, necessitating the incorporation of diffusing elements. ISO 10140 has established specific thresholds that dictate the inclusion of reverberation time for frequencies equal to or surpassing 100 Hz. Nevertheless, there are instances, particularly in spacious rooms, where acquiring the requisite parameters becomes arduous and, at times, unfeasible. Under such circumstances, it becomes imperative to ascertain whether the measured sound insulation is contingent upon the reverberation time.

The presentation presents the measurement results of various diffusing elements configurations in a reverberation room. These diffusers aim to improve the uniformity of the acoustic field in terms of acoustic pressure and reverberation time. Therefore, the focus was on these two parameters. The ultimate goal was to assess the impact of changes in the arrangement of diffusers on the results of sound insulation measurements.

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Investigating the restorative properties of natural soundscapes

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With the increasing levels of stress and the challenges associated with psychological restoration, natural soundscapes have gained attention for their therapeutic qualities. However, there is a need for an objective classification system to facilitate psychoacoustical research in this area. This paper focuses on analyzing the restorative properties

of diverse natural soundscapes. By examining acoustic, ecoacoustic, and psychoacoustic parameters, as well as conducting psychoacoustic tests utilizing virtual reality tools, this study aims to provide a comprehensive understanding of the factors that contribute to the restorative effects of these soundscapes. The research results and their analysis have led to the creation of a classification of soundscape parameters that significantly affect the ratings of their restorative properties. In the future, further analyses will allow for the development of a guide that describes which soundscape parameters and their values are crucial for their positive restorative evaluation.

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Acoustic classification with the descriptor of the weighted standardized level difference $D_{nT,w}$ and of the weighted apparent sound reduction index R'_w. Are the classes the same?

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Building regulations specifies technical requirements to sound insulation performance. This will be often done by using a single number rating like the weighted apparent sound reduction index R'_w or the weighted standardized level difference $D_{nT,w}$. A better description of the quality of sound insulation would be the formation of classes. If acoustic classes are provided, the question arises to what extent are R'_w and $D_{nT,w}$ the same. Can a sound insulation class be equal with both descriptors R'_w and $D_{nT,w}$? This paper compares the two parameters and presents the class formation of both descriptors.

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Micro-perforated stretched ceilings for acoustic, lighting and climate design

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Stretched foils used as ceilings, wall coverings and other set-ups have been applied for more than 30 years. By introducing a nearly invisible micro-perforation into the stretched material the foil becomes highly sound absorptive. The classical set-up of a micro-perforated sound absorber consists of a micro-perforated panel in front of an air cavity. The sound absorption coefficient of these set-ups can easily calculated with a high accuracy according to the well-known approximation of D.-Y. Maa if all defining geometrical parameters (diameter of microperforation, distance between orifices, panel thickness and air cavity depth) are known. Measurements in the reverberation chamber are presented for several set-ups.

These materials are applied in architectural design. Here the combination of acoustic absorption, lighting design and climatization is most interesting – three functions in one ceiling set-up. Furthermore optically transparent sound absorbers are available to cover glass surfaces.

Different applications in rooms will be presented from various projects.

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New draft DEGA guideline 103-1 in sound protection classes

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The DEGA recommendation 103 (DEGA-Empfehlung – Schallschutz im Wohnungsbau und Schallschutzausweis) has been introduced in the year 2009 and includes a classification scheme for dwellings. Seven classes are defined. The classification is based on different criteria for air borne noise, impact noise and other quantities. In 2018 a revised version has been published. Both version relied on classical quantities such as air born sound insulation R'_w and impact sound insulation $L'_{n,w}$.

A new version has recently published as a draft DEGA guideline 103-1 (Entwurf zur DEGA-Richtlinie 103-1 "Schallschutz im Wohnungsbau, Teil 1"). In this new draft the idea of seven classes have been taken over. The classification is based on traditional values such as R'_w and $L'_{n,w}$ but also offers the use of the weighed sound level differences $D_{nT,w}$ and weighed standardizes impact sound pressure level $L'_{nT,w}$. It is suggested to use the later quantities. This dual track approach allows a better design and will lead to a higher acceptance among acousticians and other users.

The new draft is presented and will be discussed in relation to other approaches for sound protection in dwellings.

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Simulation of acoustic lens influence on wavefront shaping

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The main objective of presented study is to examine the influence of an acoustic lens on shape of the wavefront. To conveniently illustrate the difference between acoustic pressure wave propagation with and without the lens, an isodynamic transducer was chosen as a source. This kind of loudspeaker generates flat wavefront as a result of approximately uniform distribution of speed and phase on the entire diaphragm. The designed lens consisted of a matrix of individual waveguides. Manipulation of size and position of output matrix in relation to input matrix allowed for achieving the desired waveguide length distribution. Differences in lengths of lens's channels resulted in wavefront delay distribution at the output matrix. A numerical model of transducer and waveguide matrix was created to evaluate the behaviour of acoustic pressure wave propagation trough the designed lens. With stationary study, a spatial pressure distribution was calculated, in the near field and far field, in hemisphere in front of the lens as well as in hemisphere in front of just the transducer. The differences in wavefront shapes between the two cases were clearly visible in comparisons, confirming the expected pressure wave delay distribution of the lens. The resulting wavefront curvature was compared to the assumed one in theoretical design. Results of those comparisons proved the possibility of influencing the wavefront shape, by manipulating the output matrix

with some caveats discussed in the paper. The data from numerical calculation of pressure propagation allowed for visualizing calculated sound pressure level distribution, adding the directivity evaluation to the comparisons.

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Assessment of acoustic quality of residential buildings in Poland – case study

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The requirements of people in relation acoustic comfort are very diverse. They depend on many factors. With regard to residential buildings notion of "satisfactory acoustic conditions" must take into account the need to provide a sense of intimacy, peace and security. Taking care of the appropriate acoustic quality of buildings, should result from compliance with applicable laws and be the responsibility of all participants in the construction process.

The article discusses the acoustic classification of residential buildings with a better acoustic quality, introduced in Poland in 2017. Also the overall legislative problem will be discussed.

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Acoustic adaptation of ventilation system prototypes dedicated to individual classrooms

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The prototypes of innovative ventilation systems dedicated to individual classrooms are designed to solve the problem of poor air quality in schools while reducing the need for the energy necessary for heating. At the same time, the working ventilation system must meet the acoustic requirements. These requirements specify the permissible value of the L_{Aeq} of the sound level = 40 dB as the average value of six measurement points. For this purpose, several studies have been carried out. First, a room was prepared that mimics a real-scale classroom with equipment and models of students. Calibration of such a room model was carried out by means of reverberation time measurements in octave dogs of the frequencies 125 Hz, 250 Hz, 500 Hz, 1000 Hz, 2000 Hz, 4000 Hz. In the calibrated room, The prototypes of innovative ventilation prototypes were successively installed and the noise level in the room was tested. In the event of failure to meet the requirements, acoustic adaptations were made, and measurements were made again. The task was successful when the sound level at each measurement point and the average sound level did not exceed 40 dB.

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Estimation of the improvement of the impact sound insulation of a carpet floor covering on a wooden floor based on the results of tests carried out on a massive floor

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This paper presents the relationship between the sound insulation properties of carpet floor coverings on the massive and lightweight reference floor structures. Most floor covering impact sound insulation tests are performed on a massive reference floor. There is actually no data on lightweight floor, which means that the possibilities of damping the impact sounds of floors on such structures are unknown. It turns out that it is achievable to estimate the parameters of impact sound insulation of carpet coverings installed on a wooden floor on the basis of tests performed on a massive reference floor. The proposed method uses the mobility parameters of the elements involved in the acoustic test. The use of this method allows to reduce the number of tests necessary to select the appropriate solution for damping the impact sound energy in the lightweight floor structures.

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Validation of Adaptive Categorical Listening Effort Scaling (ACALES) for Polish language

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Introduction: Considering the complexity of perceiving and properly processing speech signals, it is important in audiological diagnostics to assess not only intelligibility itself but also the so-called auditory effort, understood as a mental load needed to understand acoustic information in speech signals.

Purpose: The aim of the study was to prepare and validate in terms of the accuracy and repeatability of results (test-retest) the Polish version of the Adaptive Categorical Listening Effort Scaling (ACALES) test. The speech material used was the Polish Matrix Sentence Test. 60 listeners participated in the measurements – 20 younger and 20 older individuals with normal hearing, as well as 20 individuals with sensorineural or mixed hearing loss of varying degrees. Using the Oldenburg Measurement Application (OMA) software listening effort was assessed using a 13-point scale in various acoustic conditions including stationary, modulated, and cafeteria noises. In addition, speech recognition thresholds (SRT) and slope were determined adaptively under the same masking conditions.

Results: Similar to speech intelligibility, the influence of the masker type on the measured listening effort was observed – it was usually greater in the case of stationary noise compared to modulated signals. Listening effort decreased as the signal-to-noise ratio (SNR) value increased. At unfavourable SNR values, listening effort ratings depended on measured intelligibility to a greater extent than at higher SNR values. Older, normal-hearing listeners and people with hearing loss rated their listening effort higher compared to young, normal-hearing listeners.

Conclusion: It has been shown that the Polish version of the ACALES is a reliable, repeatable, and simple tool characterized by a small variability between test/re-test values

and can provide complementary information to the value of speech intelligibility, supporting the multi-faceted assessment of the patient's ability to effectively hear in the context of communication situations.

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Identification of errors in the digital transmission paths of radio stations

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Radio stations currently use a hybrid method of broadcasting. The transmission between the studio and the transmitter is digital. In the transmitter, the digital signal is converted to analog form and transmitted using AM or FM modulation.

The identified problem are transmission errors in the digital path. Single cases of transmission errors are not uncommon and happen in most systems. However, repeated errors occurring in clusters are usually a sign of damage to the transmission path and require intervention.

The article presents an exemplary solution that allows automatic detection of some errors that manifest themselves in the identified way. In order to identify transmission errors, basic statistical methods were used that allowed the creation of a reference data set on the basis of which it is possible to identify the fact of an error based on patterns and algorithms from the machine learning area.

People associated with the radio industry are keenly interested in studying this phenomenon because there are currently no reliable solutions that would allow automatic detection and identification of such problems.

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Practical aspects of diffuse reflection and sound diffraction modeling in room acoustics simulations

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Most modern programs for modeling room acoustics contain implementations of algorithms that enable modeling of diffuse reflection and diffraction of sound inside rooms. However, these algorithms are often based on different mathematical models, require different sets of input data, and also differ significantly in computational complexity and precision of the calculation results. The use of these capabilities of simulation programs is possible provided access to data on the characteristics of the sound scattering coefficients of the materials used. The most commonly used coefficients are these obtained in a diffuse field.

The presented paper discusses the implementation of diffuse reflection and sound diffraction modeling algorithms in the most popular simulation programs.

In addition, the influence of modeling these phenomena on the accuracy of the obtained results was analyzed on exemplary room models.

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Acoustic screen as a practical anti-noise protection

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Acoustic screens are commonly used in Poland and in many countries as the only protection of noise-prone areas. They are used both in the outdoor environment and in the working environment in industrial rooms and offices. The history of the use of acoustic screens dates back to the second half of the 20th century. Since then, they have been used to reduce noise from roads, railways, airports, manufacturing plants, and municipal noise, as well as for many other noise sources. The effectiveness of an acoustic screen is a function of many factors that must be considered in the design process. The article presents the multi-variant application of acoustic screens, discusses the methods of testing acoustic parameters of screens in laboratory and in situ conditions.

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Azimuth and elevation errors in binaural reproduction of ambisonic sound

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Binaural decoding of an ambisonic sound is reproducing the information about a soundfield over headphones. It is done based on the spherical harmonics representation of the spatial sound and on the use of Head Related Transfer Function (HRTF). Inaccuracies in the decoding process, which can be caused for example by using non-personalized HRTF, may lead to difficulties in localizing the sound source by the listener. Especially in the elevation plane, localization errors can be significant. In this study, listening tests were conducted in order compare azimuth and elevation errors for different binaural decoders. It is discussed how azimuth and elevation errors vary depending on the type of the binaural decoder used, for 1st and 3rd order ambisonic recordings of pink noise bursts.

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Optimisation of the model for the numerical determination of the HRTF

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Recently, the issue of numerically determining the Head Related Transfer Function has been still considered. The HRFT is the basis for creating individualised sound experiences in metaverse solutions.

This paper presents an analysis of different variants of the numerical model of an artificial head. Optimisation was carried out considering the upper limit frequency of the model, the size of the elements and their size distribution, the size and the enclosure properties of the head model.

The numerical model obtained as a result of the work is characterised by a short computation time with a sufficiently high upper limit frequency. The results obtained were compared with measurements of the real object, which confirmed the correctness of the designed model.

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Control of spectral components in additive resynthesis as a means to alter sensation of consonance in chords

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A prior study presented a possibility to impact the sensation of consonance by controlling spectral components of simultaneous pitches consisting a chord in sound synthesis using the additive method. It involves considering spectral components in all simultaneously sounding pitches consisting a chord. Components within the range of beating and roughness are modified to gradually strengthen or weaken both phenomena. So far, the idea and method had been implemented in a basic additive synthesizer producing simple, abstract, time-invariant timbres. The current study carries out the research further, and discusses problems of implementing aforementioned consonance-altering mechanism in a more complex additive synthesizer, applied to resynthesize sound of selected acoustic instruments. The study deals with natural independent evolution of spectral components, where consonance gradually varies with time. Moreover, it presents a solution to mitigate impact of the mechanism on a total signal level, caused by attenuation of selected components.

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Acoustic model for the classification of Polish vowels

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The study explored the performance of vowel recognition using an acoustic model built on Audio Fingerprint techniques. The research compares the performance of Support Vector Machines (SVMs), Hidden Markov Models (HMMs), Artificial Neural Networks (ANNs) and K-Nearest Neighbors (k-NN) classifiers in the recognition of isolated and within-word vowels and investigates the importance of different types of acoustic speech features in this process. Temporal, spectral, cepstral, formant, LPC and perceptual features of speech were examined. Importance of features was tested using a random forest classifier. Vowel classification was tested at three confidence levels for feature importance: 90%, 95% and 99%. Two author databases consisting of a total of 1,200 samples from 20 speakers, recorded under household conditions, were used. The classifiers were evaluated by confusion matrix, accuracy, precision, sensitivity and F1 score. A segmentation of words into speech sounds was carried out using a tool based on BiLSTM recurrent neural networks and the BIC criterion. Three most important features were determined: power spectral density, spectral cut-off and Power-Normalised Cepstral Coefficients. In the isolated vowel recognition task, the SVM classifier was the most effective with a feature significance confidence level of 95% obtaining accuracy = 81%, precision = 81%, sensitivity = 81%, F1 score = 80%. In the task of recognising a vowel within a word, it was verified if the algorithm detected the presence of vowels in the correct segment and if it recognised the correct vowel within it. The best results were obtained by the k-NN classifier (statistical confidence level of feature importance of 99.9%). However, these results were low, correct recognition of the vowel in the word: A, E, U: 20%, I, O: 7%, Y: 23%. This indicates strong influence of the neighbourhood of other speech sounds in speech on the acoustic model of vowels and their recognition.

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The effect of ultrasonic noise on a worker's ability to perform their basic tasks

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Noise, defined as the presence of undesirable sound, has been extensively documented in the context of its impact on human health. Exposure to elevated levels of acoustic pressure can result in adverse health outcomes such as hearing impairment, the perception of tinnitus, and various other health-related issues. In recent times, there has been a growing concern surrounding the potential health ramifications of exposure to ultrasonic noise. A number of countries have officially recognized ultrasonic noise as a health hazard within occupational settings. Despite ongoing investigations into the frequency range above 20 kHz, there remains a deficiency in comprehensive data pertaining to its effects on the human organism. Furthermore, there is a notable absence of internationally accepted standards for the assessment of ultrasonic noise within workplace environments. While recent research endeavors have contributed to the expansion of our understanding in this domain, there remains a substantial gap in knowledge. This deficiency encompasses inquiries into potential health consequences and the development of enhanced dosimetry methods. Moreover, this knowledge gap is particularly significant within the context of workplaces and the welfare of employees, underscoring the critical need to establish comprehensive measures that safeguard them against potential adverse health effects.

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Electrodynamic pick-up for electric string instruments

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The most important elements in electric musical string instruments are pick-ups. They convert vibration of strings into electric signal. Usually, two types of pick-ups are used: electromagnetic and piezoelectric. Electromagnetic pick-up, called also a pick-up with moving armature, converts vibration of string into an electric signal using change of magnetic flux in the magnetic circuit by the vibration of the string made of magnetic material. Vibrating string causes change of the air gap between the string (which is a moving armature) and rest of magnetic circuit. A variable electromotive force is generated in the stationary winding. In order for it to be proportional to the speed of vibration,

polarization is needed, which is achieved by using a permanent magnet in the magnetic circuit. In a piezoelectric transducer, an electric current is generated due to the deformation of the piezoelectric material under the influence of a vibrating string. The subject of this paper is a stringed instrument with a electrodynamic transducer, which converts mechanical vibration of strings into an electromotive force which is produced between the ends of moving wire placed in the permanent magnetic field. This transducer is also called a transducer with moving wire. A wire (string) is made of a conductive material, but not necessarily a magnetic material. The principle of operation is similar to that of a ribbon microphone. The electromotive force induced at the ends of the string is very small and must be strongly amplified. It's a novel technique which is applicable in electric stringed instruments such as guitar, violin, viola, cello, double bass, and others. It has already been described in form of the patent application registered by Polish Patent Office and it is now designated to the further patent actions abroad based upon this priority document.

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A tool for designing water tanks for measuring hydroacoustic transducers

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Special water tanks are commonly used to measure the parameters of underwater acoustic systems. They must meet specific requirements, the fulfilment of which ensures very small but acceptable measurement errors. These requirements define the size of the tank and its shape as well as the strong damping of reflected waves. At the design stage, it is necessary to determine the impact of the tank structure on the measurement errors and to adapt it to the expected measurement methodology. The article presents a mathematical tool for designing such water tanks using the impulse response method. Contrary to the use of this method in architectural design, the presented method is here used to determine the measurement signals emitted by ultrasonic transmitting transducers and received by receiving transducers (hydrophones). The relationships are given between the parameters of the pulse response and the design parameters of the tank and the measurement system, as well as its transfer functions and sample measurement signals.

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Thermodynamic properties of 1-allyl-3-methylimidazolium dicyanamide and 1-vinyl-3-methylimidazolium bis(trifluoromethylsulfonyl)imide

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Ionic liquids (ILs) have emerged as promising alternatives to traditional organic solvents due to their unique properties, such as low volatility, high thermal stability, and remarkable tunability. Understanding the thermodynamic properties of ILs is crucial for their application in various fields, including energy storage, separation processes, and catalysis. In this study, we experimentally investigate the thermodynamic properties of two ILs, namely 1-allyl-3-methylimidazolium dicyanamide ([AMim][DCA]) and 1-vinyl-3-methylimidazolium bis(trifluoromethylsulfonyl)imide ([VMim][NTf2]), which have not been previously studied.

The speed of sound and isobaric heat capacity were measured in the temperature range from 293.15 to 323.15 K at atmospheric pressure. The density was measured in the temperature range from 278.15 to 363.15 K at ambient pressure. From the experimental data the related thermodynamic properties were calculated, i.e. isentropic and isothermal compressibility coefficients as well as the isobaric thermal expansion coefficients.

The results reveal that [AMim][DCA] exhibits higher values of speed of sound and isobaric heat capacity compared to [VMim][NTf2]. On the other hand, [VMim][NTf2] demonstrates higher density values and calculated coefficients compared to [AMim][DCA]. It was found that for that for [AMim][DCA] the temperature dependence of the isobaric coefficient of thermal expansion is stronger and negative – contrary to [VMim][NTf2], where this dependence is smaller and positive.

The data obtained in this study contribute to the development of reliable thermodynamic databases for ILs and a comprehensive understanding of their thermodynamic properties. The acquired knowledge enhances our understanding of IL behavior and facilitates the advancement of IL-based technologies.

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Experimental tests of selected sound-absorbing materials dedicated for a hydroacoustic measuring basin

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Several scientific institutions from the Gdańsk community participate in the implementation of the grant from the Ministry of Education and Science "Concept of building metrological infrastructure in the area of underwater acoustics at the Central Office of Measures". In practice, the concept includes, among other things, the design of two measurement basins: a large-size one for measurements in the range of possibly low ultrasound frequencies (from several dozen kHz) and a small-size one (from several hundred kHz). One of the basic conditions for the proper implementation of measurements is to obtain minimum sound reflec-

tions from the water surface, walls and bottom in basins. This is possible by covering these surfaces with sound-dispersing materials or so-called acoustic absorbers. The frequency characteristics of these properties are decisive here, but also the price, ease of assembly, cleaning and slow aging. The article presents the results of the measurements of the signal attenuation after passing through the tested materials, the values of the levels of attenuated echoes and the calculated of the absorption coefficients of currently available and promising layers of "synthetic grass" with different lengths of blades, plates made of various plastics and, for comparison, curtains made of dispersing brushes, damping the measuring basin of the Department of Sonar Systems for several decades. The obtained characteristics were compared with those presented by the manufacturer of commercial absorbent panels.

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Low-power underwater modem for shallow water communications

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The low-power underwater acoustic modem is usually an important component of the Underwater Wireless Sensor Network (UWSN). Network nodes have predetermined energy resources that will not be replenished during the life of the node. In shallow waters, multipath propagation is constantly occurring and for the modem to work effectively, solutions to overcome them must be used, which will also meet the important criterion of energy efficiency. The article presents the concept of a low-power underwater modem using BFSK modulation and the fast frequency-hopping spread spectrum (FFHSS) technique. The results of simulation and experimental tests, which were carried out to determine the performance of the modem, are included. Simulation tests were performed using a Watermark simulator, and experimental tests in a model pool.

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Experimental setup design to evaluate acoustical privacy protection in small enclosed compartments

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Privacy protection is an upcoming topic in our society caused by increased individual mobility and forced availability by telephone. Acoustic communication in small, closed compartments exhibits a challenge to establish a private sphere for a single user without heavily affecting the acoustical surrounding, e.g. in a quiet environment, for other persons. For a specific use-case in car compartments a recently developed approach will be examined within a listening test. To ensure control over several conditions of the experimental setting while still providing the listeners a comfortable situation mimicking real conditions a specific real-time capable setup in an anechoic room is used.

Within the experiment different positions for both speaker and would-be listener are examined under multiple driving conditions. Psychoacoustic principles like spectral and spatial auditory masking of signal-dependent broadband noise as well as signal-dependent temporal distractors are evident and adjustable components of the evaluated approach. Therefore, in the proposed experimental setup the listening subjects initially have to adjust the level of the broadband component individually to the point of perfect masking of presented speech signals. However, while these levels should guarantee complete unintelligibility, they will cause the most affecting loudness increase in the car cabin potentially causing increased passenger annoyance. Therefore, these levels will provide the anchors to start an individual adaptive adjustment procedure. Subjects presented with masked spoken sentences will echo the recognized parts immediately. Their responses will be evaluated by an automatic speech recognition system in real-time to guarantee sufficient masking. Within this procedure the broadband noise levels will be readjusted by additionally applying temporal compact distractors. Thus, the overall loudness will be reduced while preventing listening in.

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Validation of the measurement data for different heights of a microphone position in outdoor environment

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One of the major problems when performing measurements of noise generated in outdoor environment is assessment of the influence of the microphone position (height). For measurement of noise generated by wind turbines it is important as in EN 61400 standard the measurement technique specifies mounting of the microphone on a mounting board on the ground level. So for the other microphone positions, practically demanded especially for long term monitoring, it should be carefully analysed and transfer function should be evaluated. Other problem which is under investigations is the influence of wind and the correction due to wind speed ought to be estimated.

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Subjective tests of speaker recognition for selected voice disguise techniques

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Research work on the effectiveness of voice disguise techniques is important for the development of biometric systems (surveillance) as well as phonoscopic research (forensics). A speaker recognition system or a listener can be deliberately or non-deliberately misled by technical or

natural methods. It is important to determine the impact of these techniques on both automatic systems and live listeners. This paper presents the results of listening tests conducted on a group of 40 people. The effectiveness of speaker recognition was investigated using selected natural (chosen from four groups of deliberate natural techniques: phonation, phonemic, prosodic and deformation) and technical (pitch shifting, GSM coding) voice desguise techniques. The results were related to the previously obtained outcomes for the automatic method of verification carried out using a classical speaker recognition system based on MFCC (Mel Frequency Cepstral Coefficients) parameterisation and GMM (Gaussian Mixture Models) classification.

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Acoustic aspects of the Goseck Circle area

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Goseck Circle is an example of monumental buildings from the Neolithic period called rondels. The object was discovered in the 1990s, then archaeologically reconstructed and opened to the public in 2005. Currently, it is considered to be the oldest known object of this type, and its creation is estimated at around 4900 BC. The object is roughly circular in shape. It has one ditch and two palisade rings. There are three entrances leading to the interior of these structure, two of which are located on the south side and coincide with the places of sunrise and sunset during the winter solstice. Therefore, the Goseck Circle is considered as the oldest solar observatory, as a worship or ritual place.

A number of studies on both contemporary and archaeological objects indicate that the objects display the characteristic features depending on their intended use. Therefore, it can be assumed that if the Goseck Circle structure was to be a place of worship, then in terms of acoustics it should be characterized by such values of acoustic parameters that will also prove this. This concept was the reason for carrying out a series of numerical calculations that allowed for the determining of the selected parameters characterizing the acoustic field inside the analyzed object. The article presents and discusses the results of these numerical analyses.

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Cloning the voice and speech of Piotr Fronczewski for Polish speech synthesis

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The quality of synthetically generated speech has improved significantly in recent years, largely due to the technological development of speech synthesis systems, in particular those based on deep neural networks (DNN). However, the problem of emotion in speech synthesis still remains a challenge. Most of the existing speech synthesis systems do not convey the pervasive emotional contexts in human-human interaction. The lack of expression limits the emotional intelligence of current speech synthesis systems. This work aimed to develop a recording method for preparing a balanced corpus of emotional recordings in the Polish language for use in speech synthesis based on artificial intelligence (AI) algorithms. An essential aspect of the work was the selection of a voice-over artist who would allow the recording of the spectrum of an actor's voice, emphasizing the actor's interpretations and emotions derived from the content. Outstanding actor Piotr Fronczewski was chosen for the role.

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Wind turbine noise annoyance prediction in the low-frequency range

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Currently, wind turbine noise is modelled using commonly used calculation methods such as ISO 9613-2, CNOSSOS-EU, and NORD 2000. The ISO 9613-2 and CNOSSOS-EU methods allow calculations in octave bands from 63 Hz to 8 kHz, while NORD 2000 allows calculations in one-third octave bands from 25 Hz to 10 kHz. Neither of these computational models takes into account the additional physical phenomena occurring in the low-frequency range (tonality, frequency modulation) that increase the annoyance of the noise generated by these devices. This paper presents the results of calculations using the aforementioned computational methods for modelling low-frequency noise generated by wind turbines, taking into account tonality and signal modulation determined experimentally. The suitability of the presented approach was verified by comparing the obtained calculation results with measurements taken around the wind farm.

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Effect on imaging quality of ultrasound probe parameters in Doppler tomography method

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Doppler tomography (DT) is a method that allows the reconstruction of 2D or 3D images of the interior of the examined object. For this purpose, a two-transducer ultrasound probe is used. In this method, the Doppler phenomenon and the so-called Doppler signal are used to obtain an image. Therefore, the probe is one of the most important components of the measurement system of this method.

It should be noted that Doppler tomography differs significantly from the well-known Doppler method of measuring blood flow in blood vessels. In the DT method, stationary cross-sectional images of the object under examination are obtained. In order to produce the Doppler effect in this

case, the probe can move around or along the object being imaged.

This paper will present a simulation of the effect of the frequency of the ultrasound probe on the imaging quality of a single inclusion.

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Selected acoustic structures for effective sound absorption at low frequencies

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The article presents a summary of the results of absorption tests for selected sound-absorbing-insulating materials: commonly used acoustical systems and composite materials of specially composed composition. In addition, we propose a new type of metamaterial in the form of a multi-layered acoustic system, which consists of an insulating material and a core in the form of a profiled steel plate loaded with a point mass, vibrating in an air gap environment. The research aims to evaluate the sound absorption performance of selected materials in the low frequency range. The results confirmed the very good absorption properties of the developed composite materials. In addition, promising absorption coefficient values were also obtained for the acoustic metamaterial in the case of matching the point mass to the local resonance.

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Impact of changes in the shape of sensor part of sensor-actuator hybrid on its effectiveness in plates' vibroacoustic reduction

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This work is a continuation of authors previous works on modelling a piezo electric sensor-actuator hybrid. For these models a change in sensor shape will be introduced to determine how it impacts the results. In order to preserve continuity with previous and future work a steel plate with 2 piezo elements and a half sphere of air was modelled using ANSYS software. One was used to excite plate's vibration, the other one for the purpose of vibration reduction. The first piezo element is a standard square based piezoactuator which will be used to excite the plates' vibrations. The second one can be either a standard square based piezoactuator or a sensor-actuator hybrid with a square based actuator part and either disc or square based sensor part with different sizes. Harmonic analyses were performed for the 1st, 2nd, 4th and 5th mode shapes using internal ANSYS optimization functions with the goal function being the minimization of displacement vector sum of a number of nodes with 3 possible cases. 1st case – all nodes making the back of the plate used as sensor, 2nd case – "virtual" sensor placed on diagonal of the plate, 3rd case – sensor placed where the sensor part of a hybrid is placed. Results presented obtained reduction for the plate and the differences between standard actuators and proposed sensor-actuator hybrids.

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Annoyance of noise penetrating partitions in multi-family and multi-function buildings

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Multi-family residential buildings often combine residential and commercial functions. At the same time, the amount of time spent in the home is increasing, partly due to the increasing prevalence of remote working. In such a situation, the problem of providing suitable acoustic conditions for work and rest becomes particularly important. Many works indicate that standard – single – number methods for assessing the acoustics of partitions are insufficient to determine whether occupants are adequately protected from noise. The main purpose of this study is to assess the annoyance of noise penetrating different types of partitions. The spectral waveforms of exemplary noises penetrating into living spaces were analysed, and the results obtained were related to indices for assessing noise annoyance. This indicates the need for further work on methods for assessing the building envelope in residential and commercial buildings.

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Sound insulation – comparison of standard vs. real world situations

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Standardized sound insulation metrics are essential for testing of building elements and for field measurements in order to ensure comparability of data. When it comes to a real-world situation, however, the source and receiver positions and the source directivities might differ from those in the standard setting. An auralization framework based on ISO 12354-1 is briefly described. In an application of the framework, a study on the impact of specific source positions and orientations on the effective sound level difference is discussed in a few examples.

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The influence of the use of a system of resonators in the structure of a sonic crystal on its effectiveness

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This paper concerns the topic of layered structures of sonic crystals. Sonic crystals are periodic systems of acoustic scatterers placed in a homogeneous medium. They achieve effectiveness through the impedance difference between the medium and the scatterer. These structures are characterized by the ability to tune the system to the selected frequency band, as well as the possibility of free air flow. The paper discusses the impact of replacing the scatterers in the sonic crystal structure with a system of resonators (by making holes in the cylinders) on their effectiveness in the selected frequency band. The transmission drop was calculated analytically and then verified by measurements performed in free field conditions. The analysis

of the effectiveness of the solution was confirmed by measurements using a directional loudspeaker as a sound source and two configurations of sonic crystals. The first one, made of scatterers, and the second one, made of Helmholtz resonators, obtained by making holes in the cylinders building the crystal.

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Comparative analysis of selected voice parameters of patients with obstructive pulmonary disease and dysphonia

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A quality of voice is an important matter in communication, and can determine self-esteem and relationship quality. Speech pathologies can be a serious disability of the accusation, leading in extreme cases to social exclusion. Voice problems are similar both among people working with professional voice and patients with respiratory disease, including chronic obstructive pulmonary disease.

The purpose of the work was a comparative analysis of selected voice parameters of patients with obstructive pulmonary disease and dysphonia.

Research material: Research tests were taken on a group of 61 people: 30 healthy people (mean age 25.1 years), 16 patients with COPD (mean age 67.4 years) and 15 patients with dysphonia (56.4 years).

In order to obtain changes in the acoustic signal, characteristic for dysphonia and obstructive pulmonary disease, it was necessary to verify according to: body position and selected voice parameters.

Body position was assessed using the photogrammetric method. The three-plane position of the body in space was established. In order to study the acoustic signal of speech, an analysis was carried out in the time and frequency domain of the collected voice recordings. In contrast to the "classical" methods of speech signal assessment and analysis, the directions of research mentioned and conducted by many authors bring little when it comes to speech pathologies. The acoustic signal of pathological speech should be justified from the three-point source of this signal: the process of articulation – the process of origin – the stage of deformation of one and the other process by determination.

As a result of the research, the parameters of the speech acoustic signal were obtained, which provide additional information about changes in the sound source, which manifest themselves in the form of deformation of the sound signal.

The research method presented in the article will provide the patient with comprehensive and necessary diagnostics, as well as the process of treatment and rehabilitation.

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Questionnaires and acoustic measurements in Longyearbyen Area, Svalbard

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Svalbard is a Norwegian province in the Arctic, covering the Svalbard archipelago and islands within 71°–81°N and 10°–35°E. The largest town on the island of Spitsbergen is Longyearbyen, with a population of around 2 100. It is the main centre of administration with the governor's office, and there are many public buildings, a housing estate, a harbour and an airport. This paper presents selected results from a survey on the quality of environment and soundscape of Spitsbergen. The results of acoustic measurements of selected sites near Longyearbyen are also presented. Based on the responses, three groups of tourist activity were identified: (1) Longyearbyen activity: a round trip of town, visit to the museum, mine no, 3 and UNIS visits, (2) Snowmobile trips: to Barenstburg, East Cost and Elveneset, (3) Nature hikes: trips to the summits of the Sarkofagen and Trollsteinen peak, hiking on the Larsbreen, Longyearbreen and Tellbreen glaciers and visits to glacier caves. Of these sites, acoustic analyses (SPL – time and frequency characteristics) were conducted at the following locations: Longyeardalen: Unis area and city centre, Adventalen: dog sleds and snowmobiles rides, Nature hike: to Sarkofagen peak and caves in Larsbreen and Longyearbreen glaciers.

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Beamforming in nearfield – metaheuristic approach and speech intelligibility tests

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A set of microphones spatially arranged in space in a specific pattern is called a microphone array. Such an array has many applications, inter alia: sonars, radars, or speech processing. It can be used to extract and enhance the signal of interest from its observation corrupted by other interfering signals, such as noise or to estimate the direction of arrival of a source. Since the microphones are in different places in space, the phase of the signal components that arrive to each of the microphone can be different and some frequencies can be attenuated. Therefore, the array can be perceived as a spatial filter that consolidates the acoustic signals received by individual microphones to form a bean. Such process is called beamforming.

In this paper we focus on a problem in which the desired signal (speech signal) is interfered by other signal with partially overlapping band but with different localization. Our goal is to attenuate the interfering signal. We experimentally study the method in which microphones do not have to be equally spaced and all information regarding signal phase is hidden in a transfer function of the microphone. We focus on determining the microphones positions to minimize and FIR filter coefficients so that the actual output the beamformer is as close as possible to the desired one in the sense of l_2 norm. To solve this problem, we

use a metaheuristic algorithm. Since the interfering signals, i.e. background noise reduce speech intelligibility (SI), we study how the proposed microphone matrix influences this parameter (SI) – a variable, being an index of the comprehensibility of speech signals. SI is defined as the average percentage of words or phonetic units that human listeners can recognize.

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Noise testing of multi-disc fan

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The impeller of a multi-disc fan was made of rotating smooth discs spaced close together. The concept of such machine came from Nikola Tesla in 1909. The fluid, based on the principle of friction against the rotating surfaces of the discs, flows outwards from the disc pack into an outlet. According to the literature, such a design is characterized by low noise emissions. Based on calculations, a prototype of a multi-disc fan was designed and then manufactured. Tests were carried out for the sound power level emitted from the fan's outlet. The examination was performed in a reverberation chamber according to ISO 3741:2010 standard. The noise source was visualized using an acoustic camera. The aerodynamic characteristics were also determined experimentally according to ISO 5801:2017 standard. The acoustic and aerodynamic characteristics of the multi-disc fan were determined.

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Algorithm for detection of wave packets in a circular waveguide

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This paper presents an algorithm for detecting wave packets in a circular waveguide. The waveguide terminated with a concrete plug was used to test the method. The concrete was made in accordance with the Eurocode standard. During the tests, a significant difference was observed between the behavior of the speaker and the concrete plug. The pulse reflected from the plug maintained its shape regardless of the sound level. The reflection of the pulse from the speaker's diaphragm resulted in a significant change in the form and duration of the wave packet. These changes were dependent on the sound level of the wave packet. As a result of these modifications was a significant difference between the measurement uncertainty of detecting a pulse reflected from the concrete and the speaker. In the case of reflection from the concrete plug, an uncertainty of 0.036% was obtained. The smallest measurement error value for the pulse reflected from the speaker was 2.5%.

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Measurement verification of model calculations results of noise distribution around large industrial plants

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Noise mapping of large industrial plants is typically carried out in preparing Integrated Pollution Prevention and Control (IPPC), environmental impact assessments and as part of strategic noise mapping. The construction of an acoustic model of a large plant at the development stage is similar to the modelling of other facilities. Essential differences arise at the calibration and verification stage of such a model. In an industrial plant, noise sources are distributed over a large area and noise emissions are usually measured at the plant boundary, at varying distances from the noise sources. Noise sources in large cities are distributed over an even larger area, but the calculations can be verified directly in their surroundings (e.g. next to a road), with the influence from other sources eliminated. In addition, the layout of the sources is repeatable (roads, railways, etc.). These are features that increase the accuracy of the modelling. In the case of an industrial plant, which is often seen as a black box, the points for calibrating the model are outside. Then the calibrated (measured) level is not the emission from an individual source but the summed emission level from all sources on the site. The noise emission from noise sources at the measurement point strongly depends on the attenuation along the propagation path. The magnitude of this attenuation for each source is different, as it depends on the location of the source relative to the measurement point and the obstacles between the source and the measurement point. As the EU recommended computational models (ISO 9613-2 and CNOSSOS) allow calculations to be performed under specific weather conditions, the problem of measurement verification of the model becomes even more important.

The paper focuses on the consistency of weather conditions and measurement verification and their influence on the result of noise prediction in the surroundings of a large industrial plant. The results of control point calculations using ISO 9613-2, CNOSSOS algorithms and the Nord 2000 model, which allows calculations under practically any weather conditions, are shown. The results of the analyses were compared with the measured results at the control points under "real" weather conditions.

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Tests of windshields for wind turbines noise measurements

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Measuring noise from wind turbines is a problematic metrological task due to the significant interference caused by the wind, especially in the low-frequency range. In the

audible band, especially A-weighted, the impact of interference from wind is significantly less than in the low-frequency and infrasound bands. For this reason, methods are still being sought to reduce interference from wind in the lowest frequency bands effectively. Experimental tests within the scope of the work were carried out using several windshields: with a single standard spherical windscreen (90 mm diameter) at 1.5 m and 4 m height above ground level; with an additional microphone's shield (tent); with a set of the double-shell type consisting of a standard spherical windscreen made of polyurethane foam and a second shield covered with a double thin fabric (included 90% nylon with 10% admixture of polyurethane/cotton, which is often used in pop-filters) with high flexibility and a 300 mm diameter placed at the height of 1.5 m above ground level; on the board with a double windscreen at a ground level according to IEC 61400-11. An effectiveness analysis of the proposed measurement methods was carried out on the wind farm in various wind condition. Performed research indicates that the best of the tested variants, when measuring wind turbine noise especially in the low-frequency range, is to place the microphone on the board with a double windscreen according to IEC 61400-11. It is also acceptable to use a double spherical cover.

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Effect of phase modification of sound components on spatial impression in 2 and 3-component signals

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Spatial perception of sounds is one of the fundamental properties of the auditory system, allowing for the localization of sound sources in space or the evaluation of room size. However, the mechanisms responsible for this phenomenon have not been fully understood and described yet. Research in this area indicates the existence of mechanisms in the higher levels of the auditory system that are responsible for creating the impression of spatiality. On the other hand, other studies have shown that the auditory system is sensitive to phase coherence between the components of complex signals, suggesting a relationship between these phenomena. Preliminary informal listening tests suggested that continuous phase shifts introduced into components of complex sounds evoke an impression of spatiality of these sounds.

The subject of this paper is the investigation of the influence of phase modifications on the perception of sound spatiality and the presentation of its results. Harmonic signals composed of 2 or 3 pure tones at specific fundamental frequencies were used in the study. The signal components were then phase-modified using specially designed algorithms and various parameters of phase change. The listening test involved a dozen participants, mostly students without specialized listening training, who were asked to compare the spatial impressions of sounds with phase modifications to those without them. The research was conducted in an audiometric cabin using headphones.

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Evaluation of hydroacoustic channel stationarity for reciprocal movement of transmitter and receiver

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For shallow water areas, the hydroacoustic channel is characterized by strong multipath and at the same time long memory times. In the case of reciprocal movement of the transmitter relative to the receiver, coherence times should be expected to be extremely short. Classical methods of assessing the stationarity of a channel, for example, proposed on the recommendations of ITU-R P.1407-7, in the case of hydroacoustic channels do not allow the determination of coherence times primarily due to the long memory time of the channel. In view of this, the paper proposes a method for assessing channel stationarity based on simultaneously transmitted chirp signals of increasing and decreasing frequency. The study was carried out in a laboratory pool for different rates of movement of the transmitter relative to the receiver. In the pool there was strong multipath i.e. very difficult propagation conditions for data transmission. The paper evaluates the stationarity of the channel as a function of the speed of movement of the transmitter, the bandwidth occupied by the measurement signal and its duration. The study shows that the hydroacoustic channel is not always stationary for the duration of the symbol and this assumption is often made in simulation studies of data transmission in the hydroacoustic channel.

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Profile analysis: A framework for the study of auditory sound spectrum analysis

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Profile Analysis (PA) is a research approach in measuring the listeners' ability to discern the changes in the spectral envelope shape of complex tones. PA is based on a specific experimental design in which the listener is forced to perform across-frequency spectral comparisons. This is achieved by using a procedure of signal level roving to prevent the subjects from responding on the basis of their ability of detecting the change of level in a single frequency channel. The studies, initiated by D.M. Green and his coworkers in 1980s, explored the topic of PA in a thorough, systematic way. The experiments concerned the detection of amplitude increment (or decrement) of a single component in a multicomponent logarithmic complex, detection of multicomponent spectral changes, tilted spectra, or using a pedestal. The use of logarithmically spaced components accounted for the auditory filter bandwidths (ERBs) as in such spectra the same number of components fall in each and every auditory filter along a wide frequency range.

Later experiments included harmonic spectra more typical of music. A novel approach in PA was to separate across-frequency spectral envelope shape comparisons in a complex tone and across-time level comparisons in given particular frequency channel. This procedure has brought new insight into timbre perception explorations in real-life conditions of sound perception, such as differentiating timbre changes in musical sounds during which both across frequency and along time comparisons are made. PA offered a new approach to the study of auditory sound spectrum analysis but was followed by only few researchers. The paper recalls results of the PA studies and provides discussion of some links between the PA and the results of listening tests conducted during a course aimed at the development of timbre evaluation skills among the students at the Chopin University of Music in Warsaw.

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Assessment of the impact of road traffic noise based on post-realization analysis of a project

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The article presents the issue of post-implementation analysis of the road in terms of noise generated by road traffic, which affects the quality of life of residents and requires effective remedial actions. The post-implementation analysis allows for the assessment of the actual effects of road noise, the identification of areas requiring protection against noise and the monitoring of the effectiveness of the applied noise solutions based on field studies. It presents factors influencing the acoustic climate, such as traffic intensity, type of vehicles, road surface and applied acoustic protection. Presented is the current land development, such as the location of the road, its infrastructure and surroundings in the form of data obtained on the basis of the conducted terrain scanning. The conducted analysis of the measurement results was the basis for additional tests of the acoustic parameters of the existing acoustic screens. In addition, computer simulations were carried out, which allowed the assessment of the current acoustic climate along the entire length of the road and were the basis for developing a repair program to the extent required.

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The influence of composite material manufacturing technology on the change of insulation from impact sounds

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The paper shows the influence of the composite material manufacturing technology on the change of the insulation parameter from impact sounds and the ability to dampen structural vibrations by modifying the structure of the composite material with the addition of rubber recyclate. Tests of acoustic insulation from impact sounds were carried out on a sandwich composite made on the basis of Synolite 1967-G-1 polyester resin and glass mat with a random arrangement of fibers and a weight of 350 g/m^2. As an additive modifying improving damping efficiency, rubber recyclate created in the process of disposal of car tires was used. The material was made using the vacuum infusion method. Composite materials were tested in three variants of the arrangement of recyclate in the produced composite in the form of 1, 2 and 3 sandwich layers. In the field of "in-situ" field tests, the reduction of the impact sound level by the ceiling with the tested plate made of composite material in relation to the ceiling without $\Delta L'$ plate was determined in accordance with PN-EN ISO 16283-2 and PN-EN ISO 717-2. The best insulation from impact sounds was obtained for a board made of material with 3 sandwich layers, which is $\Delta L' = 20.6$ dB. A decrease in the impact sound level of the board with 3 sandwich layers in relation to the composite board without the addition of recyclate was also determined, demonstrating the effect of rubber recyclate additives on the attenuation of structural sounds in the tested material. The use of rubber recyclate obtained in the process of disposal of car tires has an impact on improving environmental protection.

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