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Chronicle

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The Open Seminar on Acoustics is an annual conference, the largest acoustics conference in the country. It has been bringing all Polish acousticians together for over sixty years. It is organized in turns by different divisions of Polish Acoustical Society – in 2019 by the Poznań Division with the Institute of Acoustics, Adam Mickiewicz University in Poznan and Committee on Acoustics of Polish Academy of Science. The conference presents all sections of acoustics, such as: physical acoustics, technical, environmental, speech, hearing, musical, architectural acoustics, etc. The seminar is joined with special session "New trends in psychoacoustics in tribute to professors: Józef Zwisłocki and Andrzej Rakowski" and the Workshop "Noise protection in regulations – current state and directions of changes" (in Polish). We also invite you to the special session "Advances in research in the field of audio acoustics and sound engineering – ISSET 2019".

Abstracts

A computer model for calculating the speech transmission index using the direct STIPA method

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Computer models currently used for the simulation of the speech transmission index (STI) calculate the STI using the statistical method or are based on numerically determined impulse response of the transmission channel. The limitation of both these computational methods is that they do not allow to take into account the non-linear properties of the transmission channel and fluctuating background noise. This paper presents a proposition of MISO (Multiple Input Single Output) model based on the direct method of STIPA. This model allows to computer simulations of STIPA for distributed sound systems, and enables analysis to include both changes in signal dynamics and fluctuating background noise. The work presents the idea of the model and validation of its basic elements – the generator and the analyser. The possibilities of using the model for computer simulation of outdoor public address systems were also discussed.

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A prototype of Chinese aspirated consonants pronunciation training system based on multi-resolution cochleagram

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Mandarin Chinese is considered to be one of the most difficult languages to learn, mostly because of its phonological and tonal systems. Since pronunciation training during formal classes is limited, learners need an alternative which will help them practice pronunciation without teacher's assistance. The solution are computer-assisted pronunciation training (CAPT) systems. I introduce a prototype of CAPT system focusing on pronunciation errors related to aspiration: deaspiration of aspirated consonants and aspiration of voiceless not aspirated consonants. The system incorporates multi-resolution cochleagram (MRCG), a psychoacoustic model of basilar membrane excitation pattern. Mispronounced phonemes detection is performed by recurrent neural network (RNN) trained using MRCG features. Proposed system achieves 96,12% accuracy rate in pronunciation errors detection and 98,58% accuracy rate in determining aspiration length. It may be particularly useful for native speakers of languages in which aspiration does not exist or is non-distinctive feature, e.g. Slavic and Romance languages.

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Advanced methods of breast tissue ultrasound tomography imaging

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Breast cancer is the most common cancer among women. Imaging of breast lesions is currently the primary

method of its detection and malignancy estimation. The success of the breast cancer treatment largely determines its early detection. Commonly used methods of early detection of breast cancer in the general population is the conventional B-mode ultrasound (US), X-ray mammography (MMG) and magnetic resonance imaging (MRI). These methods have their own advantages and shortcomings, so other complementary methods of early detection of breast cancer are being looked for. Completely safe, painless and non-invasive hybrid method, that combines the diagnostic capabilities of MMG, US, and MRI is ultrasound breast tomography (UBT). Innovative ultrasound tomography scanners for acquisition of measurement data of tissue in vivo throughout the whole breast submerged in water are currently being developed and tested in a few centres in the world (i.a. in Poland, by the private investor in cooperation with scientific and research team under the author supervision).In the paper, advanced methods of ultrasound tomography imaging of the breast tissue, which allow to obtain quantitative, quantitative-qualitative and typically qualitative ultrasonic images in volume-structure of a female breast in vivo have been reviewed. The multi-parameter way of the breast structure visualisation that allows an automatic detection of tumours and estimating their malignancy, was presented, as well.

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Aerodynamic noise from circular rod depending on Reynolds number

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The well-known dominant sources of airframe noise are associated with unsteadiness of separated and/or vortical flow regions around the high-lift system (faps, slats) and the aircraft undercarriage (landing gear). Current practical landing gear noise prediction models are individual component-based, what means that the various components are divided into groups according to the frequency range in which they predominantly radiate noise. Since the far-field noise spectra are approximately Strouhal-based, the emitted frequency is assumed to be directly related to their size: the large elements are responsible for the low frequency region of the spectra, and the small components for the high frequency region. On the basis of such understanding of the noise generation mechanism, the special configurations which lead to considerable noise suppression were proposed. One element of these configurations are rods with different shape and cross section. In this work the situation when circular and rectangular rods are in area of laminar-turbulent flow are analysed. The measurements were carried out for single circular rods with different diameter to study the effect of Reynolds number. Complete examination of vortex shedding noise from single cylindrical and rectangular rods were performed. Far field noise for broad range of Reynolds numbers were also examined depending on distance from source of noise.

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Analysis and comparison of vibration signals from internal combustion engine acquired using piezoelectric and MEMS accelerometers

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Condition monitoring of vehicles with internal combustion engine is of immense importance due to high number of vehicles with such engines and their importance to transport and economy. As many persons use a vehicle which is old and inexpensive, a condition monitoring system designed for such vehicles cannot be expensive. Unfortunately, condition monitoring of engines is usually based on the use of vibration signals, which are acquired by accelerometers. Piezoelectric accelerometers are the most commonly used for this purpose, and such accelerometers are not cheap. However, an alternative exists in the form of microelectromechanical systems (MEMS) accelerometers, which are much cheaper, but have narrower frequency characteristics. This paper describes preliminary results of a research on feasibility of use of MEMS accelerometers for condition monitoring and failure detection in internal combustion engines.

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Analysis of acoustic couplers solutions for hydrophone calibration in the low frequency range

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During the calibration process, it is assumed that the hydrophone receiving sensitivity in the low frequency range (1–2000 Hz) is constant up to the first resonance. Meanwhile, long-term cyclic tests of the hydrophone receiving sensitivity have shown that even for the most recognized manufacturers, the results may differ significantly from the values given in the calibration chart. The reason is the change in receiving sensitivity over time, which in addition shows nonlinear properties. The number of acoustic recorders is growing, which, in accordance with Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for Community action in the field of marine environmental policy (Marine Strategy Framework Directive) are used to monitoring underwater noise. The quality of the collected data is very important, therefore, the importance is attached to the calibration of hydrophone or hydroacoustic recorders and the maintenance of traceability between the used hydrophones and underwater noise patterns. Reliable data obtained from underwater noise measurement systems is based on periodic and reliable calibration. The article describes various currently used hydrophones calibration methods for low frequencies and presents acoustic coupler for hydrophone calibration realized in the Central Office of Measures.

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Analysis of Doppler tomography as a novel method of imaging tissue cross-sections *in vivo*

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Currently, methods such as conventional ultrasound B-mode scanner (US), computerized X-ray tomography (CT), magnetic resonance imaging (MRI), standard X-ray diagnostics, radioisotope imaging and thermography are used to visualize the internal structure of tissue *in vivo* and to diagnose the patient. Doppler tomography (DT), otherwise known as continuous wave ultrasound tomography (CWUT), is an innovative method of reconstructing the image of the tissue section using ultrasonic waves and Doppler effect. In contrast to the currently used solutions (US), which use a pulsed wave, this method uses a continuous wave, which, in theory, allows one to operate with higher energy and to detect smaller inclusions within the examined tissue.

This study focuses on the analysis of DT simulation in circular geometry, where a two-transducer ultrasonic probe circulating around the tested object is used to measure the useful signal. Image reconstruction is calculated based on the so-called Doppler signal, determined on the basis of the registered ultrasound reflected wave and using a fast algorithm known as Filtered Back Projection. In this paper, the influence on the tested object's cross-section imaging quality of both the simulated Doppler signal's registration parameters, and the calculation algorithm's parameters, were analysed.

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Analysis of the usefulness of distinctive noise features from rail and wheel in assessing their impact on the overall railway noise level

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The interaction of the wheel and rail is the main source of railway noise over a wide range of speeds, but the relationship between the noise impact of the wheel and rail on the overall level is not constant. It depends on the train speed of travel, with the dominance of noise from the rail at low speeds and the reverse relation at higher speeds. These relations also depend on the type of rolling stock, their technical condition, including the type of brakes as well as on the type and technical condition of the track. Therefore, as part of the work, the issue of analysis of distinctive features of acoustic signal generated on a selected section of the railway line from various units was taken up – freight trains, passenger trains in local and long-distance traffic, and pendolino. The degree of aggregation of permanent features assigned to the track as well as variable features characteristic for individual groups of trains and their usefulness in assessing the impact of noise from wheels and rails on the general railway noise level from the surveyed trains on a given section were analysed.

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Animal mimicry for covert communication with arbitrary output distribution: beyond the assumption of ignorance

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The paper describes a new method of embedding human communication in acoustic sequences mimicking animal communication. This is done to ensure a low probability of detection (LPD) transfer of covert messages. The proposed scheme mimics not only individual sounds, but also the imitated species' communication structure. This paper presents a step forward in animal communication mimicry – from pure vocal imitation without regard for the plausibility of communication's structure, through Zipf's law-preserving scheme, to the mimicry of a known communication structure. Unlike previous methods, the updated scheme does not rely on third parties' ignorance of the imitated species' communication structure beyond Zipf's law – instead, the new method enables one to encode information in a known zeroth-order Markov model. The paper describes a method of encoding an arbitrary message in a syntactically plausible, species-specific sequence of animal sounds through evolutionary means. A comparison with the previous iteration of the method is also presented.

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Assessment of sound absorbing properties of composite made of recycling materials

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In modern world we are searching methods to reuse most of industrial disposals produced during manufacturing. Some kinds of materials, like scraps from acoustic foam, however are not so easily utilized using recycling methods for its primary usage. Disposals produced during the manufacturing process can be compressed and reused as sound absorbing material. The purpose of this article is to examine sound absorbing properties of material made of acoustic foam disposals and compare it with sound protection materials, which are commonly used. Sound absorbing damping were tested using Kundt's tube and reverberation room examination method. Tests were carried out according to standard PN-EN ISO 354:2005, for reverberation room examination, and according to Bruel & Kjaer analyzer type 2010 technical manual for Kundt's tube examination.

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Automatic recognition of artificial reverberation settings in speech recordings

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Artificial reverberation is one of the most common digital audio effect used in sound, music or video production. Reverberation algorithms running as a software plugins are equipped with numerous presets, which are the combination of various reverberation plugins settings. To efficiently create a desired room impression, the sound engineer must be familiar with all these settings. Thus finding the best set of reverberation plugin parameters that identifies desired room acoustic features is time-consuming and non-trivial task. The aim of this study is to create the method for automatic recognition of artificial reverberation settings extracted from a reference speech recordings. The proposed method employs machine-learning techniques to support the sound engineer in finding the ideal settings for artificial reverberation plugin available, i.e. Gaussian Mixture Model (GMM) approach and deep Convolutional Neural Network (CNN) VGG13, which is a novel approach. Training set and data set are 1885 speech signals selected from a EMIME Bilingual Database which were processed with 66 artificial reverberation presets selected from Semantic Audio Labs's SAFE Reverb plugin database. Performance of the proposed automatic recognition method was evaluated using similarity measures between features of reference and analysed speech recordings. Evaluation procedure showed that a classical GMM approach gives 43.8% of recognition accuracy while proposed method with VGG13 gives 99.94% of accuracy.

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Binaural speech segregation system on single board computer

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A pocket-size binaural speech segregation system has been developed and assembled with available consumer hardware. It can enhance a target speech in a certain direction while attenuating interfering sounds from other directions. This system is based on the frequency-domain binaural model (FDBM) and it segregates multiple speeches based on the directivity. This real-time system is implemented on a low-cost single board computer which might be used as a hearing assistance device. Performance of the system is evaluated in a normal laboratory room as well as anechoic chamber. Even in a room with reverberation, the system works well and show the almost same performance obtained in anechoic chamber.

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Classes of tonality in the aspect of active elimination of tonal components

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The aim of this paper is to analyse various types of signals defined as tonal where energy is concentrated in a narrow band of the spectrum. Not all tonal noises could be reduced using narrowband active noise control systems with cancelling signal generated based on source parameters. The author proposes the following classes of tonality: periodical (e.g. sinusoidal) signals, sinusoidal signals modulated by random function, sinusoidal signals with increased/decreasing amplitude and/or frequency, a combination of the two previous ones, and narrowband noises. For each type of the analysed signals active elimination of the tonal component using synthesized cancelling signal was carried out. Depending on the type of the signals different results were obtained which indicates the need to clarify the definition of a tonal signal, or use not one concept of a tonal signal, but several classes discussed above.

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Coding effects on changes in formant frequencies in Japanese speech signals for foreign speaker

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This paper presents results of research on effects of lossy coding on formant frequencies for Japanese speech signals. Additionally changes in pitch of the voice were inspected. For this research four most popular lossy coding standards were chosen, MP3, WMA, AAC and OGG, and compared to original WAVE files. Audio files were created by the author based on ITU-T P.501 recommendation in two sampling frequencies, 16 kHz and 48 kHz, and converted into chosen codecs. To extract the data from audio files, open license software Praat was used. Due to discovered differences in time duration between original and encoded files, that also differed between individual codecs, only OGG and WMA standards were compared directly. MP3 and AAC standards were divided into Japanese syllables, averaged and then compared into also averaged WAVE files. Results were additionally compared to FLAC lossless codec.

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Comparison of the image compounding ways for the multi-angle 3-D ultrasound imaging

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The main goal of the paper is to compare the image compounding methods to minimise the artefacts arising in the Multi-Angle Conventional Ultrasound Imaging (MACUI) due to the system configuration. The MACUI method used for 3-D object imaging and the introduced imaging artefacts are described. Different ways of the image compounding by intensity averaging are presented in the work. Implemented methods of image compounding were tested for different types of objects mimicking soft tissue. The comparison allowed to determine the most appropriate method of intensity averaging in the compounding method to minimise the presence of image artefacts and enhance the quality of the resulting slices which are used to create 3-D volume of an object structure in MACUI method.

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Cyclodextrine *vs* D-glucose in the solutions of the derivative of 1,4-DHP

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Hydrophilic and hydrophobic cyclodextrins (CD) have found a lot of applications in medicine pharmacology, food processing and cosmetology. They can function as a drug carrier material and parent host molecules, increasing drug biocompatibility, optimizing the efficiency of drug activity, and controlling drug release at the desired level. The effectiveness of CD complexation depends on many factors such as the type and the size of both the CD molecule itself and the guest molecule, pH of the solution, and temperature. In aqueous solution of glucose the aggregation of molecules can occur leading to the formation of CD-like structures. In the paper the possibility of the formation of the inclusion complexes of CD and glucose with nimodipine was investigated with the aid of ultrasonic spectroscopy. By comparing the efficiency of industrial saccharides and glucose in the formation of the inclusion complexes the cost effectiveness of the use of glucose as a substitute for CD can be determined.

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Design of control system for active vibration suppression of trapezoidal plate

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An active vibration control system is proposed for suppressing the small amplitude plate vibration. The structure under study is a vibrating trapezoidal plate, having a constant thickness h, to which MFC actuator is bonded. It was assumed, that the plate clamped at one edge is excited by a uniform periodic force generated by a loudspeaker. The control problem lies in using MFC actuator to reduce the plate vibrations. For the system under consideration the mathematical model obtained on the base of parametric identification method is constructed. This part of the research was done with the help of Polytec laser vibrometer. The apparatus is highly advanced tool, that allows measurement of vibration of examined structure. With transfer function model obtained in identification process, using Matlabs Identification Toolbox, feedback control laws was created for changing response of the system in desired way. There are many ways to model controller having mathematical model of the object. In this article, authors proposes approach to design an effective controller for vibration suppression of a trapezoidal plate with the use of the pole placement method in graphical SISOTool environment. This article describes concept, results of simulation tests and implementation for the designed controller.

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Designing acoustic perforated panels using scale model measurements

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In the paper, the authors present an ongoing research on the absorption and measurement uncertainty of perforated panels made at different scales. Knowing the similarity criteria describing the relation between a full-size perforated panel and its scaled equivalent, it is possible to conduct the measurements of the elements of significantly reduced size – with an area not exceeding 0.2 m^2. This procedure notably decreases the costs resulting from the production, transportation and storing the measurement samples. At the same time, the obtained values of sound absorption coefficient measured for the samples at 1:8 scale will characterize their full-size equivalents of geometry changed according to the derived similarity criteria.

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Determination of sound power level by using a spherical microphone array and conventional methods

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Sound power is measured to make objective comparisons between the same type of products but also because legislation requires it. To release a new product, it is often compulsory to certify it according to International Organization for Standardization (ISO) standards, and also with local and regional regulations. Measuring sound power is not a straightforward process. Sound power can be determined either through the measurement of sound pressure (series 3740 methods) or sound intensity (series 9614 methods). As for which of the two is better for a particular application, there is no straightforward answer, because they are

quite different pieces of equipment, used for measuring different things. Selecting one of the above methods depends on the purpose of the test, as well as the available equipment, desired grade of accuracy, background noise level or the test environment. Additional methods, such as microphone arrays are used but the results obtained with acoustic cameras cannot be, for now, used for legislative purposes (are not ISO compliant).

In this work the differences in the determination of sound power level by using conventional methods and microphone arrays are determined. System composed of a loudspeaker and a fan were used as a sound source of noise. Sound power levels according to ISO 3746 and ISO 9614-1 were determined and were compared with the new methodology by using microphone arrays techniques.

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Development of predictive model for vibro-acoustic protections in industrial hall

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The paper presents an analysis of the impact of a highly noisy active machine on the working environment in an industrial hall. The glass hardening furnace has been installed in a modern, fairly quiet hall. It generates vibroacoustic problems at its workstations and at workstations at other machines located in this hall and adjacent hall. These problems are mainly due to the errors during in the preparation of the place space for the furnace, embodiment of the foundation for the machine, as well as the assembly errors of the machine and accessories. The conducted research allowed diagnosing problems and shown appropriate ways to minimize the risk of noise and vibrations. The basic research tool we used to recognize problems was to create an acoustic model of a hall. Modelling the effectiveness of each noise reduction component allowed optimizing the solution in terms of acoustic effectiveness and approximate application costs. The measurements are performed, according to standards procedures, in order to describe the internal acoustic climate, to characterize the noise sources and to have reference values to be used in the tuning of the model. With the sources acoustic characterization, the simulations are performed and compared with measured levels. Analysis of vibration and noise propagation paths, indication of structural faults is a recommendation to formulate vibroacoustic requirements for new installed devices.

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Diagnostics of the RIAA equalizer in a turntable using artificial intelligence methods

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The article presents the methodology of RIAA equalizer condition analysis based on measurements of its amplitude and phase characteristics. The RIAA equalizer is an integral part of modern turntables and its parameters determine the quality of the music being played. The task is to determine the critical values of electronic components (capacitors) based on the characteristics of signals observed at the circuit's output. It is considered difficult due to the presence of noise, elements' tolerances, and simultaneous drift of several system's parameters. The presented methodology uses the Artificial Intelligence module that implements the task of parameter identification. The knowledge exploited by the AI-based module is extracted during machine learning, based on the dataset obtained during the simulations of a equalizer's computer model. For the decision-making module the RBF-type artificial neural network was used. It is the standard tool for the regression tasks. The obtained results allow for considering the potentially high usefulness of the presented approach for the parameters identification in electronic circuits used in audio technology.

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Dimensional analysis and similarity criteria for the acoustic model tests

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The aim of this work is to conduct a dimensional analysis and to determine the similarity criteria for the use in acoustic tests of sound propagation in open and closed spaces. Moreover, the authors present a system of wave equations describing the phenomenon of sound propagation in an elastic medium together with boundary conditions in a dimensionless form. Based on the presented theoretical analyses, it will be possible to plan and conduct acoustic experiments on small-scale models that will significantly reduce the cost and availability of this type of research.

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Effect of tonal noise on work performance – psychological assessment using the Vienna Test System

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Tonal noise can cause unpleasant user experiences in spaces and, in turn, lead to increased complaints. The annoyance thresholds experienced by the general population with regards to the degree of tones in noise is a significant piece of knowledge that has not been well-established. Thus, this paper addresses the relationship between work performance and noises with tones in the typical office environment. The study involved 50 people (25 male and 25 female) fulfilling the audiometric qualification criteria. The research method used both the questionnaire studies concerning noise sensitivity (NoiseQ), work load (NASA TLX), noise annoyance (ISO 15666) and computer psychological

tests (Vienna Test System) assessing work performance, attention and concentration. Four types of generated test signals were developed (filtered noise – A, and three signals with tonal components 125 Hz, 1600 Hz, and 8000 Hz – B, C, and D) at the same sound level A of 55 dB. Results of the statistical analysis based on the questionnaire studies, as well as for the psychological tests, did not show a statistically significant variation between individual signals.

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Effectiveness of acoustic banners depending on the distribution in the concert hall

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One of the most frequently used methods of adjusting the room acoustics of concert halls is the temporary introduction of additional acoustic absorption in the form of acoustic banners. Banners are implemented in the form of fabric surfaces entered vertically or horizontally along the walls of concert halls. In practice, one or two layers of heavyweight fabrics are used, characterized by a high value of the sound absorption coefficient. Simplified methods of designing acoustic banners assume estimating the effectiveness of adjusting the reverberation time on the basis of static theory. More advanced methods use geometric methods to estimate the effectiveness of acoustic banners. The paper presents the results of measuring the effectiveness of acoustic banners carried out in the concert hall. The possibility of tuning the interior acoustics was verified depending on the position of the banner in the room as well as depending on the degree of its opening. The paper was summarized by a discussion of the results obtained.

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Estimating the population exposed to noise: a case study of a city in Poland

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European Union Directive 2002/49/EC relating to the assessment and management of environmental noise (named as END) in article 6 paragraph 3 states that "harmful effects may be assessed by means of dose-effect relations referred to in ANNEX III". In this still unfinished ANNEX III there are formulas which present how to calculate the number of people affected by a given noise. The dose-effect relations have been recently presented in WHO document "Environmental Noise Guidelines for the European Region". These Guidelines allow to predict the percentage of people who will be affected by a specific kind of noise, e.g. it is shown how to calculate the percentage of highly annoyed people for a given value of noise index, L_{den}. In our paper we propose how to calculate the total number of people affected by noise in their living conditions and discuss the implementation of methods recommended in ANNEX III in Poland.

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Evaluation of the acoustic background level in assessing industrial noise in the environment – problems and good practices

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Assessing the acoustic impact of an industrial plant that works near other noise sources is a difficult problem. The measurement of the acoustic background becomes the key measurement. The quality of this measurement is decisive for the correct determination of the actual impact. The paper presents the problem of acoustic background measurement for various ambient systems and its influence on the final result, along with the presentation of good practices of correct assessment.

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Evaluation of the transmission and the scattering matrix applicability to the mufflers analysis

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The analysis of the acoustical systems can be carried out based on a number of different formalisms, of which applied frequently are the transfer matrix formalism, in which the chosen state variables are the sound pressure p and the sound velocity v, and the scattering matrix formalism adopting the sound pressures p^+ and p^- and the sound velocities v^+ and v^- of waves propagating through an element in both directions. Even though, they are mathematically equivalent, i.e. there exists the unequivocal transformation from one to another there are some advantages and disadvantages in applying one or the other to analyse mufflers or other acoustic system, especially when the propagation of a multimode wave is assumed and numerical calculations are indispensable. In the paper the transformation between the formalisms has been derived and applied to analyse the phenomena at a junction between the tail pipe and the chamber and also in mufflers composed of one or two chambers. The more flexible for numerical calculations seems the scattering matrix formalism, especially when the number of propagating modes differs on both sides of a junction. On the other hand the transmission matrix formalism is suitable for analysing systems constituting a cascade. The sources of the advantages and disadvantages of both formalisms are explained. The results obtained can be helpful in the effective design of silencers with specific properties.

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Fluid-fluid phononic crystal with elastic coat working in audible frequencies

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Phononic Crystals are receiving rising attention in the field of modern acoustic materials. PCs are artificial structures of periodically arranged scatterers. Such a structure enables creating a band gap in which, due to the Bragg diffraction phenomenon, vibrations are restrained or even forbidden. In this paperwork, the fluid-fluid PC is tested and simulated – the scatterers are constructed of water cylinders with a hyperelastic EPDM rubber coat and embedded in air. The band gap is calculated to emerge in the audible range of frequency. Every simulation is performed with the use of the finite element method.

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Honoring Jozef Zwislocki: the interplay between psychology, physiology, and modelling in hearing science

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Josef Zwislocki (1922–2018) started his scientific career in hearing with extensive work on modeling of the cochlea. His doctoral dissertation, finished in 1948, developed a mathematical description of sound propagation in the inner ear, which allowed to describe the observational data by von Békésy not only qualitatively, but even quantitatively. In his later work, he emphasized experimental work in both audiology and psychoacoustics, with one of the goals to have experimental confirmation of his cochlea modeling work via impedance measurements of the middle ear. He also took up physiological work on live cochleae, by for instance measuring the resonant properties of the tectorial membrane and its role in frequency tuning of the input to the auditory nerve. In his psychoacoustic work, he took up problems which are closely related to cochlear and hair cell function, pitch perception and loudness. This close exchange between psychological and physiological experiments in hearing, put into mutual relation with the help of computational models, is characteristic for modern hearing science. Therefore, in my talk I want to honor Jozef Zwislocki not only by mentioning his own work, but also show how in present-day research, the various underlying disciplines enrich each other.

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Important role of temporal amplitude envelope: perception of speaker individuality and vocal emotion for noise-vocoded speech

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This paper investigates the importance of temporal cues in the perception of non-linguistic information such as speaker individuality and vocal emotions. Experiments of speaker and vocal-emotion recognition were carried out using an analysis/synthesis technique of noise-vocoded speech (NVS). The temporal amplitude envelope (TAE) of NVS was controlled by varying the upper limits of the modulation frequency (0, 0.5, 1, 2, 4, 8, 16, 32, and 64 Hz). In addition, the role of TAE in the different spectral-resolution conditions was also investigated by varying the number of channels (4, 8, and 16). The results demonstrated that the TAE contributes to the recognition of speaker and vocal emotion. Therefore, temporal cues are found to be important for the perception of not only linguistic but also non-linguistic information. In addition, the important modulation frequency in the TAE for the perception of non-linguistic information was suggested to be higher than that of linguistic information.

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Improvements in the signal subspace separation method in multi-phase echo sounder

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The article presents the new results of the search for the improvement in the subspace separation method. The authors have previously proposed a new method for subspace separation. This method allows the application of model-based methods, such as modified Prony method, to the processing of the signal acquired by the multi-phase echo sounder. The threshold is calculated using a modified matrix perturbation method and the notion of equivalent noise which is the result of the inter-element coherence loss inherent in underwater signal echoes. Although the proposed method indeed improved accuracy of bottom depth determination in relation to standard forward-backward least squares method, it struggled with sporadic under-modeling issues. This source of this behavior has been attributed to high signal variability characteristic for Rayleigh-like scattering. This negative effect might be counteracted, to a certain degree, by lowering the subspace division threshold proposed by the authors. The aim of this article is to verify the conditions for which lowering the threshold used by the previously proposed method actually increases accuracy for low signal to noise ratio. The article ends with general conclusions regarding applicability of the new method to various high-resolution methods.

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Influence of noise on children's sense of hearing

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Children are at risk of developing hearing problems due to their exposure to high sound pressure levels for excessive

amounts of time. The aim of this project was to establish the relationship between sound levels in the most hazardous fields and their effect on children's sense of hearing. Measuring sound pressure levels in schools, analysing earphone and headphone usage, and comparing them to audiometry results, enabled basic dependencies to be found. Some of the examined students fall outside the safe exposure times to certain sound pressure levels (according to WHO directives). The results analysed in frequency bands show that there is a clear correlation between a shift in hearing threshold and intensity levels in music. Noise during lessons is not very high, but the noise during breaks and of bell rings can influence children's' hearing to a certain extent. Due to improper usage of earphones and headphones, the young people we examined may develop hearing loss at an early age.

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Intonation as the voice quality and experience indicator among choral singers

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The ability to correctly reproduce notes by the voice is one of the essential features of the singing task and called intonation. In combination with other parameters like timbre, formants and sound attack it affects the reception of listening impressions. In this paper, we present results of the examination concerning the automatic evaluation of intonation among the nonsingers, untrained and trained choral singers. We used Zero Band Filtering method to determine fundamental frequency from the singing signal. We noticed significant differences between studied groups and the possibility to assess and classify the level of advancement of the singer by using intonation characteristic.

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Investigations of the sound diffusing panel based on acoustic metamaterial

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The paper presents the results of research on a sound diffuser based on an acoustic metamaterial. This sound diffuser is a slotted panel, with each slit being loaded by Helmholtz resonators. Such structure allows the scattering of acoustic waves with lengths many times greater than the thickness of the panel. The article presents the possibilities of shaping the sound diffusion characteristics by adjusting the geometrical dimensions of the resonators. Also, the effect of geometry inaccuracy on sound scattering was investigated. Obtained results of calculations were compared with Schroeder diffusers. The prediction of sound diffusion coefficient was carried out using numerical methods.

The obtained results allowed to assess the usefulness of acoustic metamaterials for the construction of sound diffusers used for acoustic treatments.

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Isobaric speaker directivity measurements for small acoustic omnidirectional source development

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Acoustic monopole construction is unsolved task, which engineers try to solve for many years. In the past they constructed many innovative solutions, such as spark or laser-gap sound sources, but those concepts caused many equipment troubles. It is impossible to select type of the measurements signal for this kind of sound sources, also any sparks and laser beams can provide strong electromagnetic distortions around the operation zone. In current state of art we are trying to provide non-standard solutions while traditional omnidirectional sound source, based on spatial configuration of electroacoustic transducers, is not described correctly and can be expanded.

Paper presents concept of acoustic monopole source based on isobaric configuration for electrodynamic loudspeakers. By using FEM modeling we will present directivity patterns and project ideas, describing how overall results corresponds with geometrical parameters of speaker configuration and parameters. Presentation summary contain results of prototype device directivity patterns measurements. Received characteristics shows big potential in using cone-to-cone speaker isobaric setup to reach acoustic monopole in frequency range defined by distance between transducers. Achieved knowledge allows to provide broadband, easy to build and small acoustic monopole with many possible applications.

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Magneto-ultrasonic hyperthermia

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Hyperthermia is an anti-cancer medical treatment that involves an increase in tissue temperature up to 41–45°C. Such generated heat leads to several changes in the tumor tissues. Weaken by the heat, cells are more susceptible to radiotherapy or chemotherapy. The temperature increase in the tissues can be induced by ultrasounds or alternating magnetic field. Magnetic nanoparticles due to sensitivity to the magnetic field are the source of heat in the magnetic hyperthermia. Moreover, magnetic nanoparticles can be used as a sonosensitizing material in ultrasound hyperthermia. They are the cause of additional scattering of ultrasound wave which becomes the source of supplementary ultrasound attenuation. The novelty of our research concerns combining the ultrasound sonication with magnetic hyperthermia. To investigate the magneto-ultrasonic ther-

mal effect tissue-mimicking phantoms, doped with magnetic nanoparticles, are simultaneously irradiated with the focused ultrasonic wave and the alternating magnetic field. During this magneto-ultrasonic heating, the thermal effect of magnetic hyperthermia will be improved due to ultrasound sonication.

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Model of multipath propagation of ultrasonic pulses in soft tissue using divergent beam tomography method

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The paper presents the model of calculating the waveform of ultrasound beam emitted inside the ultrasonic transducer ring array and propagated through a biological medium submerged in water. Each elementary transducer emits a burst signal, which then propagates through a medium and is received by a number of transducers on the opposite side of the ring array. The method allows for calculating runtime and amplitude of ultrasonic bursts while traveling from an emitter to a receiver through a specified soft tissue section geometry, having regard to the refraction and attenuation effects and directivity pattern of transducers. The soft tissue section geometry is constructed using circular shapes with given ultrasound speed and attenuation distribution. The elaborated software creates a set of received waveforms for each transmitting transducer. The presented results produced by the software can be used as a basis for further research on inverse problems in ultrasound waveform tomography.

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Multidisciplinary aspects of sound timbre research

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The timbre of sound is a complicated phenomenon that has interested researchers since Helmholtz's time. Careful considerations on the need to introduce an objective and subjective definition of timbre were given in one of the last papers by Marianna Sankiewicz and Gustaw Budzyński published in the Archives of Acoustics in 2007. The Authors have shown, that the distinction between these two approaches carries many practical implications. The objective definition of the timbre allows statistical analysis of measurable parameters characterizing sound sources, while the subjective definition introduces modifications resulting from the properties of the sound perception process. This important difference was reflected in the multidisciplinary research carried out over the last decade. In this paper, a brief review of these studies is performed, starting from the objective research within the Music Information Retrieval domain, through the investigation of semantic descriptions of timbre, to the exploration of the neurophysiological response to the sound in a human cortex using modern imaging methods.

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Musicians' daily sound exposure assessed by full-day dosimetry

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In day-to-day life student musicians are often exposed to high-level sounds, that may be damaging for their hearing. At music universities, there are various obligatory activities, such as playing in the symphony or wind orchestra, playing in chamber ensembles or a Big Band. Many hours of individual practice is also mandatory. In every one of these activities, sound levels are often high and the daily noise exposure levels often exceed the permissible limit of 85 dB(A). In this study, the exemplary results of the daily exposure are shown for a group of music students. In contrast to other studies, the measurements were carried out throughout the entire duration of the typical workday, so the calculated daily exposure values ($L_{\mathrm{EX,8h}}$) are based on factual data, not estimations. Data concerning the sound level in the function of time are presented for musicians playing the flute, clarinet, double-bass, percussion, trombone, trumpet and French horn. Equivalent sound levels are presented for every activity (e.g. lesson, rehearsal, concert) and daily noise exposure levels $L_{\mathrm{EX,8h}}$ are determined for each instrument.

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New standards in building acoustics – state: June 2019

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The basic aim of standardization in the field of building acoustics is to create the conditions to meet the basic requirement No. 5 "Noise protection" contained in the European Parliament Regulation 305/2011 on construction products and in the Polish Construction Law. The level of acoustic requirements for buildings and the external environment is determined by the individual countries and is quite varied depending on the economic possibilities. The evaluation parameters and methods of their designation are normalized at global or European level, within the framework of the work of the ISO/TC 43/SC2 "Building Acoustics" and CEN/TC 126 "Acoustic properties of building products and of buildings". Implementation of the EN/ISO norms for Polish standardization is dealt with by PKN Technical Committee No. 253 "Architectural Acoustics", which co-operates with the aforementioned. Committees.

The scope and status of standardization in the field of building acoustics is discussed in that presentation. The

examples of topics which will be discussed refer to new standards concerning:

- measurement of speech level reduction of furniture ensembles and enclosures used in open-offices,
- acoustic criteria for rooms and spaces for music rehearsal,
- determination and application of measurement uncertainties in building acoustics in sound absorption coefficients.

Future changes to other current standards will be also discussed.

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Noise pollution of soundscape of Kapp Linné in Svalbard

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Paper presents analysis of ambient noise influence on soundscape of Kapp Linné Bird Sanctuary. Kapp Linné is reserve located at the south side of the outlet of Isfjorden on Spitsbergen in Svalbard. The reserve covers also the sea and surrounding islands up to 300 m from the shore with low tide. It is known that soundscape interacts with landscape perception and affects the sense of place and its cultural significance. Soundscape quality is important for wildlife wellbeing. Kapp Linné Bird Sanctuary borders on the Isfjord Radio. Radio, that was built in 1933, is used for tourist purposes. A noise of generator that powers the Isfjord Radio and the hotel influence the protected area. Therefore, during research expedition to Svalbard in July 2018 SPL measurements and ambisonic recordings were made in Isfjord Radio and nearby. Based on results of measurement noise maps have been drawn. The aim of the analysis is to illustrate that in nature reserve not only landscape with wildlife, flora, fauna or features of geological but also soundscape should be protected. Soundscape of Kapp Linné Bird Sanctuary should be considered natural resources worthy of management and conservation.

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Numerical analyses of the effectiveness of an integrated disc based piezoelectric sensor-actuator

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This paper deals with numerical analyses of plates vibration reduction effectiveness of an integrated disc based piezoelectric sensor-actuator compared to standard type disc based piezoelectric actuator. For that purpose $400 \times 400 \times 2$ mm plate clamped on all sides was modelled with 2 piezo elements attached to it. One of them was a standard square based piezoelectric actuator used to excite the plate. The second one is disc based and can be either a standard element or an integrated sensor-actuator and is used for vibration reduction. The harmonic analyses were performed for the 1st, 2nd, 4th and 5th mode. Voltage used for plates excitation was always set to 100 V. The amplitude of voltage applied to the actuator was selected using internal ANSYS optimization procedures. The goal function for this was the minimum of the displacement vector sum of n modes of the plate, where depending on the case n could have 3 possible values.

Each run of the optimisation procedure consisted of no more than 30 steps with initial voltage range was 0–500 V. Best voltage value was then used in subsequent runs with the voltage range being narrowed. For the final range the voltage range was ± 2.5 V. As for the phase of the applied voltage – previous works shown that depending on the mode its either 0° or 180°. Results include the differences between vibration reduction obtained using both types of actuators, and the effectiveness of the sensor part of the sensor-actuator.

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Numerical investigations of underwater noise produced by the ship propeller

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The paper is aimed to present results of numerical simulation of the hydrodynamic noise generated by the flow around a non-cavitating underwater propeller. A numerical code was based on the solution of the continuity and momentum equations. It was used for the study of propeller functioning in off- design conditions. The main focus was on hydrodynamic forces and moments applied to marine propeller. This effect was analysed for acting on a single blade. The method of Green's function was used for the analysis of the propeller's noise. The far field sound of the propeller was estimated. Marine propeller is one of the dominant sources of noise of marine vessel. Unfortunately the noise produced by the propeller pollutes the underwater environment. This aspect is becoming of interest in European Parliament and the Council of the European Union because of its crucial significance on Good Environmental Status (GES). This paper deals with the modelling and analysis of propellers for reducing the underwater noise level.

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Objective and subjective evaluation of musical and speech recordings transmitted by DAB+ system

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Maurycy Kin

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The results of research on the sound quality of various kinds of music as well as speech signals transmitted via Digital Audio Broadcasting Plus system are presented. The results showed that bit-rate values significantly influence the results of quality assessment, i.e. the overall audio

quality as well as a timbre are dependent on the bit-rate. The additional conclusion is that the CCR method is more accurate for sound assessment for higher bit-rate values and this fact has been verified by standard deviation values of obtained results. The speech signals were additionally examined with PESQ method. The results have shown that the assumed quality of 4 MOS for speech could be achieved at 48 kbit/s. This fact was confirmed by both: subjective and objective research.

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Optimization based validation of room acoustic models

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Results obtained in a numerical modeling are biased with reasonable errors, which are connected mainly with the simplifications of both: modeled physics phenomenon and geometry of modeled object. Not precise material parameters are also a source of uncertainty of results. Reduction of uncertainty of results is possible in cases, when there is a physical representation of object at least similar to a modeled one. Validation of a numerical model using measurement results let to choose the best calculation methods and to narrow down the range of input parameters range. Both benefits are important in geometrical acoustics (GA) methods, where a significant error is inherent with the sound absorption coefficients. Errors arise mainly from a different acoustic field both in a laboratory and *in situ* conditions. In the paper, a validation method of a geometrical acoustics model was proposed. The procedure of selection of key simulation parameters was proposed (number of rays and ray tracing time), as well as a range of variation of input parameters and a similarity criterion between a model and a measurements results. Basing on simulation and measurement results of five acoustically different interiors, it was proved, that optimization based material parameters search, let to decrease the difference between model and measurement results by over five times.

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Performance of coherent modulation scheme used in acoustic underwater communication system

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The development of an acoustic underwater communication system for shallow waters is still a big scientific and construction challenge. Currently, non-coherent modulations in combination with strong channel coding are used to achieve reliable communication with low rate in such a channel. To obtain transmission with a higher transmission rate, it is required to use coherent modulation. This paper presents the assumptions of such a transmission system and the results of data transmission carried out by this system in the channel with the Rician and Rayleigh fading. A digital version of the carrier phase modulation known as Phase-Shift Keying was selected for simulation. In addition, the idea of improving the transmission quality based on the channel equalizer was included.

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Prediction of acoustic parameters in orchestra pit based on Barron and Lee revised theory

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Musicians in the orchestra pit often report problems with too high sound levels during performances. At the same time, numerous surveys indicate frequent problems with the mutual hearing of musicians with each other, as well as themselves or a singer from the stage. The structure of the orchestra pit causes the musicians to be exposed to strong reflections with low delay, which increases the overall sound pressure level. In the literature, one can find recommendations that the space of the orchestra pit should be treated with sound absorbing materials in a wide range and with sound-scattering materials without indicating their quantity or localization.

This paper focuses on the development of tools for assessing and predicting the value of energetic parameters such as sound strength G or clarity C80 in the orchestra pit based on its acoustic absorption and the volume of the hall. The sound propagation model in concert halls proposed by Barron and Lee was adapted for this purpose. The sound strength G can be used to predict the acoustic conditions in the orchestra pit, such as the sound pressure level, the mutual audibility of the musicians, and how the room supports playing musicians. The analysis covers several existing halls of different geometry and size, as well as the design of the barrier of the orchestra pit with the proposed modifications.

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Prediction of low-frequency sound field in rooms with complex-valued boundary conditions on walls

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A modal representation of a room impulse response has been used to formulate expressions for low-frequency sound field in rooms of arbitrary shape. Based on theoretical results, a simulation program has been developed to predict a sound pressure distribution and a room transfer function inside rectangular enclosure having walls covered by a material of complex impedance. Damping properties of the material have been described by the random-incident absorption coefficient. Calculation results have shown that a wall reactance strongly influences a sound absorption inside a room and an increase in the absolute value of the reactance leads to a drop of a sound attenuation. Furthermore, it was found that changes in the wall reactance entail

a substantial modification of a sound pressure distribution. Finally, an influence of wall reactance on the room transfer function was investigated and it was discovered that a change in a reactance sign causes a shift in frequencies of modal vibrations excited in the room.

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Problem of placing the organ pipes on the windchest

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This paper presents research showing the problem occurring in the construction of a pipe organ, related to the placement of the organ pipes on the windchest. The close location of the organ pipes to each other influences the parameters of the sound generated by the pipes. It causes an intonation problem, namely the detuning of the organ pipes if they are located too close to each other on the windchest. The presented measurements show the influence of a distance between pipes of various types on basic sound parameters, such as frequency or volume level. The research carried out shows that in extreme cases the detuning reaches a temperate halftone. This has undoubtedly an impact on the tuning of organ pipes, especially in the case of a table organ or pipe organ built in a small space. In the future, the outcomes of the presented research can be applied in the windchest design.

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Program loudness on different media type

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The paper presents a comparison of the values of acoustic parameters related to the program loudness of broadcasting program distributed on various media type. The purpose of the work is to observe the acoustic parameters of measured program depending on the type of media. The following parameters were measured: the actual peak TPL (True Peak Level), loudness (in LUFS), RMS value and DR (Dynamic Range). For analysis, program distributed by an analogue media (eg. FM), a digital media (DAB+), and from different internet services (streaming) were used.

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Remembrance about Marianna Sankiewicz and Gustaw Budzyński – our teachers and scientific mentors

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Doc. Dr. Eng. Marianna Sankiewicz-Budzyńska (who passed away on 29 May 2018) was a co-organizer of the Laboratory of Electrophone and Sound Engineering at Gdansk University of Technology, author and co-author of over 130 scientific publications, supervisor of numerous master and doctoral theses in the field of studio techniques in radio and television. She had an outstanding contribution to the development of sound recording technologies and their practical use in Polish Radio.

Doc. Dr. Eng. G.K.E. Budzyński (who passed away on 29 July 2018), half a century earlier, in 1968, together with his wife and research associate, Doc. dr inż. Marianna Sankiewicz-Budzyńska founded the Electrophone Laboratory, which was part of the Telecommunications Institute. In 1982, he took over the management of this laboratory, and at the same time changed its name to the Department of Sound Engineering. Doc. Budzyński chaired this department for nine consecutive years, creating the program of the first in the country and for many years the only specialty under the name Sound Engineering.

Their achievements have been repeatedly presented at scientific conferences in Poland and abroad, including many editions of Open Seminar on Acoustics. In the domestic and foreign academic centers (Gdańsk, Wrocław, Kraków, Thessaloniki, St. Petersburg, Aalborg), the research and didactic program initiated by them are still in use in a regularly updated form.

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Required attenuation of aircraft noise in buildings in the light of data from the Chopin Airport monitoring

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The minimum attenuations of aircraft noise required by the Polish Standards concerning acoustic insulation and noise levels inside buildings have been compared. Data from the noise monitoring system of the Chopin Airport were used.

The minimum attenuation required by PN-B-02151-02: 1987 differs from that required by PN-B-02151-3: 2015-10. The highest required attenuation occurs when taking into account the maximum sound level $L_{A\max}$ of aircraft noise. The requirements related to $L_{A\max}$ are 2.0 to 7.8 dB higher than those associated with the equivalent sound level L_{Aeq}.

If the flight operations number will approach the maximum number of forty ones at night, the requirements related to L_{Aeq} may be decisive.

The requirements connected with L_{Aeq} according to PN-B-02151-02: 1987 are 0.6 to 2.6 dB higher than coming from PN-B-02151-3: 2015-10.

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Scientific legacy of professor Andrzej Rakowski in current studies of pitch discrimination in music

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This paper is an overview of experimental studies of pitch discrimination and pitch strength in music conducted in recent years at the Chopin University of Music. The studies were inspired by Professor Andrzej Rakowski's findings and ideas on the foundations of pitch perception in music. The measurements of pitch discrimination show that the ability to hear pitch differences markedly decreases below 200-Hz frequency so that the pitch discrimination threshold increases to about a semitone at very low frequencies. The auditory system's relatively poor ability of pitch discrimination of low-frequency tones also manifests itself in much less accurate identification of musical intervals and melodic patterns in the lowest octaves of the musical scale, comparing with higher octaves. The paper also discusses the results of an experiment which indicate that some percussion instruments of the indefinite pitch family produce a sensation of pitch strength comparable with melodic instruments.

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Simulation of a single mode wave generation in cylindrical systems applying numerical methods

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The paper presents simulations of a selected single mode generation in systems containing duct-like elements applying the finite element method (FEM). Simulations were carried out for values of the Helmholtz number exceeding the plane-wave propagation, i.e. for a multimode wave. The systems in a form of a cascade will be analysed and the first step is to simulate generation of a selected single mode in a rigid and infinite cylindrical duct. Propagation of the incident wave in the form of a single mode greatly simplifies solutions of many problems, to mention only derivation of the transmission or the scattering matrices. The results obtained can be applied to analyse the effectiveness of attenuation of acoustic silencers or elements of heating, ventilation and air conditioning systems (HVAC) at the design stage.

Results of simulations are compared with already published experimental data obtained in a measurement set-up containing the self-designed single mode synthesizer.

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Simulation of direct-sequence spread spectrum data transmission system for reliable underwater acoustic communications

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Underwater acoustic communication (UAC) system designers tend to transmit as much information as possible, per unit of time, at as low as possible error rate. It is a particularly difficult task in a shallow underwater channel in which the signal suffers from strong time dispersion due to multipath propagation and refraction phenomena. The direct-sequence spread spectrum technique (DSSS) applied successfully in the latest standards of wireless communications, gives the chance of reliable data transmission with an acceptable error rate in a shallow underwater channel. It utilizes pseudo-random sequences to modulate data signals, and thus increases the transmitted signal resilience against the inter symbol interference (ISI) caused by multipath propagation. This paper presents the results of simulation tests of DSSS data transmission in multipath propagation channel using binary spreading sequences with different autocorrelation and cross-correlation properties.

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Software package for running psychoacoustic experiments

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Most of current research in the field of psychoacoustics is nowadays carried out using a computer. It is used to generate and present the stimuli and to collect the responses of the subject. However, writing such a computer software for running such type of experiments requires a lot of time and some technical knowledge. A software package that allows to set up and conduct a wide variety of experiments in psychoacoustics is proposed here. So running nearly any basic experiment in this field is easy and does not need time-consuming programming. A full experimental setup, except the software, requires a PC computer, sound card and quality headphones. Once the calibration of the set is done a variety of experiment to be carried out. This includes measurement of the absolute threshold, simultaneous and forward masking, auditory filter shape determination, comodulation masking release, intensity and frequency discrimination, amplitude-modulation detection and discrimination, gap detection, discrimination of interaural time and level differences, measurement of sensitivity to temporal fine structure and measurement of the binaural masking level difference. Moreover it also enables the determination of the psychophysical tuning curves using sweeping noise method (SWPTC) as well as measurement of the speech intelligibility (in Polish only so far).

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Sound absorbing elements in office furniture pieces

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Current construction law specifies requirements regarding reverberant conditions inside public utility spaces, such as offices, classrooms, etc. On the other hand, modern designs and designers visions of the designed interiors are often in opposition to the visual possibilities of the acoustic solutions provided by the producers. For this reason, in order to meet the demand of the market, it is necessary to introduce acoustic solutions which can be possibly invisible but yet improve the acoustic conditions of an interior. In the paper, the authors present the analysis of possibilities of assembling sound absorbing materials to the elements of the furniture of open-space offices, such as desks and chairs. The analyses were performed using computer models and scale model measurements. The measurements of sound absorption coefficients of pieces of furniture with differently distributed sound absorbing materials were conducted at 1:8 scale. The results open a possibility for further investigation of this topic.

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Sound engineering as our commitment to its creators in Poland

Bożena Kostek, Andrzej Czyżewski

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Sound engineering is an interdisciplinary and rapidly expanding domain. It covers many aspects, such as sound perception, studio and sound mastering technology, music information retrieval including content-based search systems and automatic music transcription frameworks, sound synthesis, sound restoration, electroacoustics, and other ones constituting multimedia technology. Moreover, machine learning methods applied to the topics mentioned above become a substantial part of sound engineering. The state-of-the-art of these topics is shortly covered by this talk. History of the development of sound engineering within the last decades is briefly outlined. A contribution of Gdańsk University of Technology (GUT) pioneering researchers to the development of sound engineering is shortly characterized. A decisive influence of Professors Sankiewicz's and Budzyński's initiative and achievements on the growth of the Multimedia Systems Department and Audio Acoustics Laboratory of Gdańsk University of Technology is demonstrated. Some key events concerning founding the Polish Section of the Audio Engineering Society are also recalled.

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Sound insulation of double frameless glass walls

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Frameless glass walls are mostly used in office building. They divide interior into small rooms but preserve impression of space, make possible visual communication and provide good flood of natural lighting. The sound insulation of such walls depends on their structure, in the case of double partitions it may be higher than for traditional massive walls of the same thickness. An empirical study on the acoustic effects of different glazing used for the frameless glass walls is presented. Monolithic tempered panes and laminated glass of different bending stiffness were considered. Double structures with various combinations of panes and different distance between them were investigated. Besides, the influence of absorption inserted into the space between panes on the perimeter was examined, as well as additional vertical absorbers dividing the whole plenum into smaller chambers. The sound insulation measurements have been carried out according to ISO 10140 in the laboratory test facilities with suppressed flanking transmission, full-size samples representative of real construction were tested.

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Speed of sound in ionic liquids – phase and group velocity

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Ionic liquids are very interesting compounds with many fascinating properties and many potential applications. However, due to ionic character, their properties are different from the properties of molecular liquids. Ionic liquids are dissipative or even strongly dissipative systems because of their high and very high viscosity, which is two-three orders of magnitude larger than viscosity of typical molecular organic solvents at room temperature. Therefore, the shear contribution can be appeared in ultrasonic wave propagation. Based on the temperature dependence of the viscosity, density and speed of sound, the classical absorption coefficient can be calculated and the absorption can be estimated at the low frequency range. It allows to select a speed of sound measurement method based on group or phase velocity as well as measurement conditions.

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Standing wave – frozen image of dynamics acoustic flow

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The acoustic phenomenon known to acoustics as "standing wave", is a conventional term for a resonant phenomenon occurring in limited acoustic flows. In its didactic simplicity, this characteristic phenomenon is discussed on the example of field distribution in pipes and ducts which represent acoustic waveguides. Although the name "standing wave" is commonly and unequivocally understood by acoustics, the logic name is not completely correct. Physically, a wave is an element of motion, so it cannot "stand". The aim of the paper is to show the structure and dynamics of wave motion represented by the conventional name of

a standing wave. In the form of 2D and 3D vector images the results of experimental studies of the internal structure of a standing wave with an open-ended acoustic waveguide stretched along its entire length will be presented. Special attention will be paid to the illustration of events in three characteristic regions of the standing wave where deeply nonlinear phenomena dominate: in the near field close to the forcing source, in the area of the wave node and in the region of the end of the waveguide (end correction). Spatial images of acoustic energy distribution distributions will be obtained from sound intensity measurements and non-invasive measurements of acoustic particle movement using laser PIV/LDA techniques. The distribution of disturbed flow fields will be performed with the use of our own method of acoustic orthogonal decomposition AOD.

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Suppression of otoacoustic emissions in studies of the efferent part of the auditory system

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Measurements of otoacoustic emissions (OAEs) enable to assess the functioning of the cochlea, in particular the outer hair cells (OHCs). Changes in the OAE level caused by additional contralateral stimulation (CS) are an objective measure of the functioning of the olivocochlear system.

Measurements of distortion product otoacoustic emissions (DPOAEs) were carried out in the investigations. A contralaterally presented wideband noise caused the maximum suppression of the DPOAE level for f_2 frequency of 1.5–2.5 kHz. Different types of contralateral signals were used in the study: speech presented against babble masking noise for different signal-to-noise ratios (SNRs) and babble noise without a speech signal. It was found that processes combined with the focusing of auditory attention and identification of speech sounds were responsible for a significant reduction of the suppression of the DPOAE level. These findings have proven that higher-level auditory regions have an influence on the olivocochlear system.

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Tests of basic voice stress detection techniques

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The modern speech processing techniques enable new possibilities of potential applications. Besides speech and speaker recognition, also the information about speakers' physical condition, emotional state or stress can be detected in speech signal. Since emotional stress can occur during the deception, its detection in speech could be used for law or security services. The paper presents the comparative tests of two voice stress detection techniques: one based on trials of microtremors detection relying on an iterative EMD method (Empirical Mode Decomposition) and the second one based on the statistical analysis of fundamental frequency and MFCC parameters. The preliminary tests were carried on the group of 12 speakers (6 males and 6 females) answering yes/no to the list of a few dozen personal questions. The presented research revealed the speakers' very high personal influence on the obtained results.

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The effect of dynamic focusing of the beam on the acoustic field distribution inside the ultrasonic ring array

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This paper presents the analysis of readings acquired from the ultrasonic ring array used in tomography for the diagnosis of female breast tissue. In addition, this paper also presents the results for the acoustic field distribution simulation, acquired through a method of summing up all acoustic fields generated by each of the elementary transducers of the ring array. The change in acoustic field pressure level when changing activation frequency (2 MHz, 3 MHz, 4 MHz) of the elementary ultrasonic transducers for the sector consisting of 32 and 64 ultrasonic transducers was studied. By changing the time of activation of individual transducers, a change in the natural position of the focus inside the ultrasonic ring array was observed. For the sector consisting of 32 ultrasonic transducers the relation between the echo coming from the wires of the wire pattern and the level of noise and distortion on the ultrasonographic image for different locations of the focus of the central transducers was studied. The results were compared with the simulations of the acoustic field, which were conducted using MATLAB software. This research is the continuation of studies aimed at choosing the optimal focus and number of transducers in ultrasonic ring array with the goal of receiving the best possible quality of images of cross-sections of the female breast.

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The effect of tissue-mimicking phantom compressibility on magnetic heating

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During hyperthermia, magnetic nanoparticles placed in an alternating magnetic field become a source of heat. It has been shown that in water suspensions magnetic particles move freely and generate heat easily. However, in tissues of different mechanical properties, nanoparticles

movement is limited and leads to the small temperature rise on tissue. Therefore, it is crucial to conduct magnetic hyperthermia studies in similar conditions to the human body. The effect of tissue-mimicking phantom compressibility on effectiveness of magnetic hyperthermia was investigated on agar phantoms with particles (single and cluster nanoparticles). The mechanical properties of prepared phantoms were controlled by acoustic technique that allows to obtain the compressibility. Results show that tissue-mimicking phantom compressibility decreases with the concentration of agar. Moreover, the lower the compressibility, the lower the thermal effect of magnetic hyperthermia.

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The impact of the damper blade position on the generated noise and pressure losses in plenum box with swirl diffusers

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The article presents the effect of setting the throttle in the plenum box with swirl diffuser on the generated noise and the pressure losses. The sound power levels of the source was determined using the precision method in the reverberation room in accordance with the PN-EN ISO 3741:2011 standard. The examination was carried out for damper blade position set vertically and horizontally for full opening and at a 45 degree angle in both directions. In order to confirm the universality of the conducted experiment, the tests were carried out for two different face swirl diffuser with different shapes of air control blades and holes in the plate and for different flow rates. The multi-criteria optimization methods were used to select the best throttle position.

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The impacts of infrasounds on humans – selected aspects

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Infrasounds are acoustic waves of the frequency below 20 Hz, they are inaudible to humans and yet they impact on humans on the physiological and functional level. On account of their physical properties, they tend to propagate over large distances whilst the high acoustic pressure levels negatively impact on humans. The effects of infrasound exposure at work are perceived as nuisance, subjectively described as the feeling of excessive fatigue, discomfort, sleepiness and, objectively, they affect the central nervous system, producing the effects similar to those experienced during the reduced waking state. This study summarises the major aspects of infrasound exposure, focusing on the impacts of infrasounds on the activation levels and the bioelectric pattern of brain activity. Experiments revealed that the impacts produced by infrasounds of high pressure levels on humans are found to be statistically significant.

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The problem of minimum sample size in determining the uncertainty of long-term road traffic noise indicators

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In the estimation process of long-term noise indicators L_d, L_w, L_n, L_{dwn} there is the problem of selecting the measurement sample size. On the one hand, increasing the size of the measurement sample is beneficial in terms of obtaining uncertainty ranges for noise indicators with the desired statistical properties – adequate coverage and length. On the other hand, it is economically unjustified. Most of the classical algorithms for determining the measurement uncertainty are based on the assumptions of the Central Limit Theorem, allowing to assign average energy levels or average sound levels of normal distribution. Such assumptions enable the construction of uncertainty intervals. When using the CLT the minimum sample size is not strictly defined. Although there are formulas that allow to determine the minimum sample size so that the CLT can be used (e.g. Cochran's formula). However, this formula does not take into account, for example, the problem of rounding measurement data and their accuracy. It may be the case that the minimum sample size calculated from Cochran's formula is several dozen elements whereas for a dozen or so measurement samples the ends of the uncertainty intervals do not differ significantly (as to the magnitude of the measurement error) from the range determined by classical methods. The article presents the problem of determining the minimum size of the measurement sample of long-term noise indicators. It is also presented how the uncertainty intervals.

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The reception of acoustic environment in visually impaired persons in the context of social communication

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The problem of hearing in blind persons has been thoroughly analysed and described in scientific literature. It turns out that blind listeners, because of the lack of one sense, are able to compensate for it by the sharpening of other senses, i.e. auditory or tactile. It is possible due to some changes in neuronal connections that occur in a cerebral cortex, mainly in areas responsible for the reception of external stimuli. If the visual deprivation is only partial, minor neuronal changes might occur. This problem is related to visually impaired persons whose vision is constrained to the point that it inhibits their everyday social existence. Therefore, the question arises to what extent these persons are able to use acoustic signals in spatial orientation and, above all, how does it influence their communication?

To answer these questions, the set of experiments will be presented that have been created to possess information about spatial perception of speech signals in visually impaired persons. The experiments include speech detection and reception in noise, spatial localisation of the talker and synergy of the abovementioned factors. The main purpose is to find the differences in hearing abilities of visually impaired persons and persons with normal visual acuity. If obtained results are similar for both groups, no sense compensation will be proven and the outcome will enable to create facilities for visually impaired persons to help them in everyday social existence.

* * *

The use of ultrasonic homogenization, electrocoalescence and magnetic field in formation of colloidal capsules

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Nowadays, novel manners of providing nutritional and therapeutic ingredients to the human body have gained scientific interest. One of the prospective ways is to produce small capsules based on colloidal systems (so-called colloidosomes). These objects have a potential to be used in pharmacotherapy or the food industry, especially due to their abilities to react on external stimuli e.g. magnetic field, change in pH or temperature rise. Colloidosomes can be produced by using the particle-stabilized emulsions (Pickering emulsions) as templates. The shell of particles formed during sintering can protect efficiently encapsulated materials.

Here, we propose the potential manner of sintering particle-covered droplets using magnetic heating. Magnetite particles were used along with polystyrene particles as stabilizers of oil-in-oil emulsions produced as the output of a consecutive action of ultrasound and electric field. Because of the presence of magnetic particles, in the external alternating magnetic field the temperature rise occurred. The high enough local temperature on the droplet surface may induce melting of polystyrene particles and lead to form a solid shell around the droplet as it is for capsules. In the presentation, the effectiveness of the magnetic heating of Pickering emulsions will be presented and discussed. We also will show the results on magnetic sintering as a potential approach to form colloidal capsules.

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Timbre Solfege and auditory profile analysis

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A course in auditory evaluation of sound, called Timbre Solfege, was developed at the Music Acoustics Laboratory, Chopin University of Music, by a team of researchers headed by Professor Andrzej Rakowski. A large part of the course, taught at the Department of Sound Engineering, has been focused on the detection and identification of timbre changes produced by formants and by other kind of sound spectrum modifications. Detecting formants in sound recordings is an auditory task that has much in common with auditory profile analysis, an area of research initiated and developed in psychoacoustics by Professor David M. Green, exploring the fundamentals of detection of changes in the sound spectrum envelope shape, independently of the differences in loudness between the sounds,. The purpose of this study is an attempt to relate the results of the Timbre Solfege sound evaluation drills to the theory of the auditory profile analysis.

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Toys noise measurements. Comparison between standardised method and alternative "real-life conditions of use" approach

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The problem of sound generated by toys seems to remain underestimated. In this research we are going to measure the level of sound generated by the most popular toys, according to the results obtained in conducted survey, used by children less than 6 years of age. The procedure is going to take into account not only existing standards but also real conditions of use. Examination will be performed in an anechoic chamber using sound analyser and dummy head, to reflect the impact of head shadow effect on acoustic perception. Discrepancies in the values of sound level obtained during measurements performed in the way specified by suitable standards and conducted in real-life terms are being expected. Those could suggest insufficient accuracy of existing standards and point out the need of development of more appropriate ways enabling to evaluate the noise of most commonly used toys that better reflect the real conditions of use.

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Tuning the selected acoustic helicoidal resonator with a short flat bar – numerical analysis

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This paper describes the possible way of tuning the selected acoustical helicoidal resonator placed in straight cylindrical duct by the use of a short flat bar. The acoustic attenuation performance (transmission loss) of helicoidal resonator has emphatically changed with the change of the length and the degree of rotation of a short flat bar placed close to the resonator. The finite element numerical calculations of the acoustical systems were made in COMSOL Multiphysics computational environment. The results show that the change of length and rotation of short flat bar can

widely change the resonance frequencies of helicoidal resonator. So in this work were presented the possible simple tuning options for the acoustic helicoidal resonator applied in ducted systems.

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Ultrasound tomography imaging: results of breast phantom study and resolution estimation

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In order to improve breast cancer detection rates, new and better imaging methods are required. Currently, the ultrasound tomography (UT) as non-invasive and safe hybrid method may contribute to achieving a new standard for breast cancer diagnostics. The aim of the paper was to analyse the imaging ability of tissue-like media structure found in female breast using the developed novel ultrasound computer-assisted tomographic scanner. Measurements was performed on commercial breast biopsy phantoms due to their well-defined structure with inclusions mimicking glandular tissue with lesions, as well as on the simple agar phantom. Obtained magnetic resonance images (MRI), conventional ultrasound images (US) or X-ray computed tomography (CT) images of the measured media sections were used for comparison. The analysis of the obtained results and carried out theoretical considerations have allowed to estimate the resolution of soft tissue UT imaging.

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Validation of the polish sentence matrix test: sensitivity, specificity, and discrimination accuracy in different masking conditions

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Speech recognition in hearing impaired listeners is affected mainly in noisy conditions and can be only partially explained by the elevated pure tone threshold. The goal of this study is to validate the Polish matrix sentence test (PMST) for reliable assessment of speech recognition in different acoustic conditions. 35 normal-hearing listeners (NH) and 58 hearing-impaired (HI) listeners with mild to severe hearing loss participated in the experiment. Speech reception threshold (SRT) was measured adaptively with the PMST in quiet, test-specific stationary noise (TSN), modulated noise ICRA5-250 and IFFM, and in realistic noise of cafeteria ambience. SRT in quiet was highly correlated with the PTA and showed high sensitivity (97%). Weaker correlation with PTA but high test sensitivity and specificity was observed in the TSN condition. SRTs in modulated noises and cafeteria noise were well correlated with the PTA but also with the stationary noise. No differences in SRT were found between two modulated noises. Significant SRT differences between HI groups were found in all considered conditions. Older NH performed comparable to mild HI group in quiet, TSN and cafeteria noise and to young NH in quiet and TSN. In the modulated noises, they differed significantly from all listener groups. The PMST with its high sensitivity, specificity, and discriminative power is a reliable tool for diagnostics and research.

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Why acoustics and its subsequent use in the study of physical and chemical properties of liquids

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The presented work is divided into three parts:

1) First, it is a study of relaxation of the Kneser type, that is, the transfer of energy between translational and vibrational degrees of freedom.
2) The second one is the so-called isomeric relaxation caused by the isomeric transformation of compounds.
3) The third is the process of creating complex compounds of the so-called "guest-host" between water and dissolved nonelectrolytes.

All these studies were carried out using the following methods: photoacoustic and ultrasonic. Especially these two first studies in a very wide frequency range.

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"The training course of organbuilder" by Marek Kwiek – a unique handbook of the construction of pipe organs

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The subject of the presentation is a discussion of the unique work of the outstanding acoustician and an expert in the theory and practice of organ building – Marek Kwiek. The work, conceived as a handbook for students in the profession of organbuilder, is the most

comprehensive script in Polish literature, containing knowledge about the construction of pipe organs. It was written and published using the mimeograph in 1939. This book is a significant valuable scientific source, which should be a must-read for all organ-makers who study in Poland mainly through the process of termination in organbuilder workshops. Marek Kwiek, on almost 300 pages, discusses both theoretical foundations of the functioning of organs as a technical device and technological aspects of their components. The author created a coherent system of transferring knowledge about the creation of all parts of organs – from pipes, through action, an air system, to an external structure. By supporting technical drawings and graphs as well as documenting the lectures by calculations, he prepares the student to perform this complex profession. The advantages of the script are very numerous examples of purely technological activities, e.g., the entire section about soldering, making pipes or woodworking. Those chapters indicate the author's knowledge of organ build practice. Marek Kwiek's script is probably the only surviving copy. It contains handwritten additions and marginalia from the author.

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