C H R O N I C L E

The 54-th Open Seminar on Acoustics OSA 2007

Open Seminar on Acoustics is a significant scientific forum presenting the experience and achievements of both the theoretical and experimental acoustics as well as their applications. The seminar is an overview of the recent, mainly Polish, contribution to the development of research in the field of acoustics. It is also an opportunity for public discussion and exchange of scientific views concerning such an important interdisciplinary science as acoustics. Last but not least, it plays a crucial role in integrating the scientists. The papers presented at the seminar have been divided into plenary papers and papers concerning different areas of acoustics.

The following 4 invited papers will be presented by:

1. Dr hab. inż. Jacek Cieślik,
   AGH University of Science and Technology, Kraków;

2. Dr hab. inż. Tadeusz Pustelny,
   Silesian University of Technology, Gliwice;

3. Prof. dr hab. Andrzej Rakowski,
   Adam Mickiewicz University, Poznań;

4. Dr hab. inż. Wojciech P. Rdzanek,
   University of Rzeszów, Rzeszów.

The 87 contributing papers will be presented during the meeting in the following 13 sessions:

1. General Linear Acoustics (7 papers)
   The papers refer to a linear description of different aspects of an acoustical field, and the problem of energy radiation of sound sources. The research methods are mainly analytical and can be applied in research in other fields of acoustics.

2. Nonlinear Acoustics (3 papers)
   The papers take into consideration a nonlinear description of different phenomena, as well as a number of significant properties of real acoustical systems.

3. Ultrasonics, Quantum Acoustics and Physical Effect of Sound (15 papers)
The papers present methods and applications of ultrasonic technology in: research on physical properties of different substances and components, technological processes in various fields of industry, measurements in the area of medicine and physics, and a precise localization of objects in different media.

4. Biomedical Acoustics (9 papers)
The issues are interdisciplinary in nature and combine such disciplines as acoustics, biology and medicine. The research refers to diagnostics and treatment of diseases with the application of acoustical methods.

5. Acoustooptics (3 paper)
The papers present the diffraction of light (especially infra-red light) by sound (especially by ultrasonic sound).

6. Speech Acoustics (8 papers)
The papers refer to the analysis technique, processing and recognition of speech signal, the analysis of the acoustical modeling of Polish phonemes, as well as the acoustical analysis of lack of fluency in pathological speech.

7. Musical Acoustics (4 papers)
The papers present the results of the research into musical properties of both the hearing organ and musical instruments.

8. Room Acoustics (5 papers)
The issues refer to the research into sound systems, quality of sound, and the level of noise indoors.

9. Structural Acoustics (2 papers)
The papers concern research done on vibration and mechanical values of different physical structures and their vibrations. Vibration attenuation achieved in various ways, and acoustical field generated by vibrating structures are under analysis.

10. Noise, its Effects and Control (20 papers)
The papers take up an important issue of vibroacoustic threats and ways of fighting, minimizing, and preventing them, as well as the issues concerning the elimination of effects, and measurement methods. The research results allow to design, for example work and public places so that they fulfil health and safety requirements determined by the standards.

11. Electroacoustics (3 papers)
The papers deal with properties and quality of signal transmission by electroacoustic measurement and sound transducers. Some of the papers refer to sound power devices.

12. Hydroacoustics (3 papers)

This area comprises a wide range of acoustical issues concerning liquid media. The research done refers to navigation, localization of underwater objects, as well as acoustical properties of various media.

13. Psychoacoustics (5 papers)

The papers concern the research into hearing. The results have a lot of applications, for example processing the sound signals in such a way that the best perception of sound within the range of audibility is assured.

The 54th Open Seminar on Acoustics, OSA 2007 is organized by the Rzeszów Division of the Polish Acoustical Society, Institute of Physics, Institute of Technology, University of Rzeszów.

The Organizing Committee OSA 2007

Invited Lectures

1. Vibration energy balance transmitted in joints of plates

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The structures of vehicles are subjected to external dynamic loading with various excitation frequencies. Plates are the most commonly used built-up structural elements in vehicles and the damage of their connections will result in disintegration of whole system. The method of intensity estimation was based on complex modal analysis elaborated with use of finite elements method. Presented calculation results show distribution of structural intensity (vector field) on the surface of rectangular steel plates connected by the different joints. The models of plates included the linear force excitation and energy damping elements. The changes of finite elements grid density enabled analysis of vibration energy flow in analyzed plates through the joints. Solved problem was intended to show the usability of intensity method in diagnostics of joints specially those typical for the vehicles. The obtained results of calculation give the quantitative information on amount of energy transmitted, reflected and the damped in joints. Results of calculations have been verified experimentally by the scanning Doppler laser vibrometry and infrared thermography used as the method for optical measurements of strain. The results of strain measurements enabled the restitution of stress field on the outer surface of plates as thin constructional elements.

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2. The acoustoelectric method of surface electron parameters determination in semiconductors

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During the past years, the high frequency and nondestructive surface acoustic wave (SAW) measurement technique has been developed and used to characterise the electron and electrical surface properties of

semiconductor materials. Propagated surface acoustic wave in the layered structure: piezoelectric waveguide – semiconductor accompanys an electric field which interacts with the free carriers of the semiconductor.

The reaches of acoustoelectric effects which are results of those interactions have both basic as well as utility meanings.

In the majority of these experiments, the transverse acoustoelectric voltage (TAV) methods are used. By the TAV methods, the important surface semiconductor parameters such as carrier density, type of electrical conductivity in near surface region, electrical surface potential, the lifetime of minority carriers, excess generation and recombination lifetime, deep-levels in bend gap and their activation energy.

Using the TAV method, the wide investigations of near surface region in semiconductors of the III-V groupe were carried out. There were investigated: GaAs, GaP, InAs and GaP. The obtained results are new and original in some cases.

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3. Absolute pitch: The accuracy of performance

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Absolute pitch (AP) is an ability, possessed by some people, to recognize exactly (passive form) or also to reproduce (active form) musical pitch categories without using any reference tone. The accuracy of performance in AP may be assessed considering the following aspects. *Completeness* concerns the division between full AP and partial AP, where less than 12 chromas (usually only 1 or 2) are permanently fixed in a subject's memory. *Infallibility* is expressed as the percentage of correct responses in a "pitch naming test" where 12 chromas are randomly presented with timbre most familiar to subject. *Reaction time*; short is typical of fully developed AP. It may be used as one of the criterions of its quality. *Timbre- or register-change resistance* means stability of results in any AP performance while timbre of sound or pitch register in which chroma appears are different from the most familiar ones. *Precision of internal standards* of AP may be expressed as a reversed measure of dispersion in multiple tunings of a tone to equal pitch with those standards. This test may be applied only to possessors of the active AP.

In the present paper examples will be given for the decrease in effectiveness of AP due to combined effect of limitations in various aspects.

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4. Current investigation areas in the Rzeszów centre of acoustics

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This paper concerns scientific activity in the Rzeszów centre of acoustics. The main topics realized by the individual research groups have been presented. The research groups are located mainly at The University of Rzeszów and at Rzeszów University of Technology.

General Linear Acustics

5. Effect of phase shifts on the sound radiation of acoustic plane sources

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In this work the influence of "phase correction" for surface velocity distribution of considered planar circular sources on acoustic impedance, is analyzed. It has been observed that by turning back a velocity distribution phase by modifying the radiating surface shape in special way, obtaining a more coherent acoustic radiation is possible. This problem has been analyzed during earlier investigations, where attention has been focused on the directivity of some acoustic sources. The aim of present considerations is to calculate the acoustic impedance which allow to examine such a 'phase correction' effect on acoustic radiation of the considered sound sources. Two kinds of sources have been taken into account: a piston with velocity distribution selected on the basis of previous investigations and free vibrating plate clamped at the edge. The result was achieved by numerical calculation with the use Hankel representation of the acoustic impedance.

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6. Computer simulation of acoustic measurements methods in simulated free field

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The anechoic chambers are an example of very expensive equipment of acoustic laboratories. The are few methods that allow free field simulation therefore avoiding the need of huge investments in building anechoic chambers. Among those methods are well known methods using MLS and TDS techniques. Of course simulated free field is not as perfect as the regular one and that brings the question of usefulness of those techniques in laboratory measurements. The author tries to assess simulated free field measurements by conducting computer simulation in Matlab environment and comparing the results gained against the analytical calculations of the quantities characterising the tested object, which are impulse response and spectral-response characteristic. The MLS and TDS techniques are not as exact as the classical anechoic chamber measurements but the simplicity of use and free choice of place where the measurements are taken encourages the attempts to use those techniques also in laboratory measurements.

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7. The Green function for the Neumann boundary value problem at the semiinfinite cylinder and the flat infinite baffle

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The paper presents the Green function for the Neumann boundary value problem at the rigid semiinfinite cylinder and the flat rigid infinite baffle. This function has been expressed as the combination of the

Bessel functions of the first and second kinds, and their derivatives – all n-th order. The acoustic pressure has been presented in the two cases: the time harmonic vibrations of a sector cylinder piston located on the semiinfinite cylinder, and the vibrating annular sector piston located on the flat baffle in the vicinity of the semiinfinite cylinder.

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8. II-order perturbation methods in acoustics – new algebraic methodology

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Theory of perturbations first appeared in one of the oldest branches of applied mathematics: celestial mechanics. Theory of perturbations is now a part of science of the great theoretical and practical meaning.

In the paper special numbers, called further perturbations numbers of the II-order (II-order PN's), similar to perturbation numbers defined in author's earlier papers are used. Recall that they are defined as ordered triples of real numbers $(x, y, z) \in R^3$. The set of II-order PN's with addition $(+_{\varepsilon 2})$ and multiplication $(\bullet_{\varepsilon 2})$ with selected neutral addition element $0_{\varepsilon 2} := (0, 0, 0)$ and neutral multiplication element $1_\varepsilon := (1, 0, 0)$ is a field. Defined in such way field is called a field of II-order perturbation numbers. Perturbation value functions are defined for II-order perturbation arguments as extensions of classical elementary functions. Properties of ε^2-functions are analyzed in details. Calculations with use of new II-order perturbation numbers lead to applications which are mathematically equivalent with II order approximations in classical perturbation methods.

The new technique is used in perturbation ray tracing method based on geometrical optics with II-order perturbations in parameters and is the illustration for estimating higher-order perturbation problems in acoustics. More advanced technical applications cf. Skrzypczyk J., Winkler-Skalna A., Acoustic Waves Propagation Problems in Layered Medium: The New II-Order Perturbation Approach, this conference.

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9. Acoustic waves propagation problems in layered medium: the new II-order perturbation approach

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The study of acoustic wave propagation in the nonhomogeneous medium has attracted considerable attention in the past. This has been motivated by the need to understand signal detection in acoustics and seismology. In the paper we use special numbers, called perturbations numbers of the II-order, defined as ordered triples of real numbers $(x, y, z) \in R^3$ with specially defined algebra. The eigenvalue of the problem corresponds to the sound speed, which can vary due to variation in the temperature, humidity, salinity, location etc.

We consider the medium of height h consisting of two layers of uniform height, the upper layer has height d so that the lower layer has height h-d. The boundary conditions are considered to be at $z = 0$, $z = d$ and $z = h$. In our studies the bottom of the cylindrical domain is conveniently assumed to be rigid

– I case, absorbing or impedance mixed-type conditions – II case. Physically, it means that the part of the acoustic field is reflected while a part of it is absorbed.

The model can be simply generalized to more layers than two. The new methodology can be applied to any complicated boundary problems with different types of boundary conditions. We have considered the effects of height dependent perturbed density on the eigenfunctions and eigenvalues resulting from the Helmholtz equation.

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10. Unified description of sound and electromagnetic waves in ducts

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The paper presents a unified approach to the problem of propagation of sound and electromagnetic waves in ducts by means of potentials. The description of the acoustic field is carried out by means of velocity potential, while the electromagnetic waves in ducts are expressed by means of Hertz potentials electric and magnetic. The propagation of the sound waves in hard and soft duct and the electromagnetic waves in conducting duct are considered. As a result the wave equation with Dirichlet boundary condition is obtained for velocity potential in soft duct and the electric Hertz potential for the TM electromagnetic waves in conducting duct, while the velocity potential in hard duct and the Hertz magnetic potential for the TE waves satisfy the Neumann boundary condition. It points out on possibility of extending solutions obtained for one kind of waves to the other and establishes analogies between physical quantities. The acousto-electromagnetic analogies, derived for potentials of wave modes could be extended on the cut-off frequencies, the waveguide impedance and the power transmitted along the duct. The results of waveguide theory are important also for practical reasons because, besides waveguides constructed for wave transmission duct-like elements are met frequently in different machines, devices, acoustical systems etc.

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11. The sound pressure radiated into the far field by a circular piston located in the vicinity of the two-wall corner and the three-wall corner

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This paper focuses on the far field approximation of the steady state sound pressure radiated by a flat circular piston into the region bounded by some flat rigid baffles. The two Neumann boundary value problems have been considered – the region of the two-wall corner and the region of the three-wall corner. The Green function in its Fourier representation has been used together with the Sommerfeld radiation condition which has given the sound pressure approximation in the form of some useful elementary formulations. The boundary value problems often appear in the situation when the sound source is located in the vicinity of the Earth and some vertical walls, e.g. the sound barriers, the building walls, etc.

Nonlinear Acoustics

12. Dependence of harmonic generation on primary wave pressure distribution

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The wave distortion is observed during finite amplitude wave propagation in water. The waveform change is equivalent with spectrum change. The aim of this paper was theoretical analysis of harmonic generation during finite amplitude wave propagation. The problem was considered as an axial symmetric one. The mathematical model and some results of numerical calculations are presented. The mathematical model was built on the basis of Khokhlov–Zabolotskaya–Kuznetsov (KZK) equation. To solve the problem the Fourier series expansion and finite-difference method were applied. The calculations were carried out for different pressure distributions on the circular source and different values of medium parameters. Especially even and polynomial pressure amplitudes of primary waves were considered. The harmonic pressure amplitudes as a function of axial distance and their transverse distributions at fixed distances from the source were examined. The pressure amplitudes distribution at horizontal section were also investigated.

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13. Acoustic streaming induced by the non-periodic sound in a viscous medium

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Instantaneous radiation force of acoustic streaming in a thermoviscous fluid is the subject of investigation. Dynamic equation governing the velocity of acoustic streaming is a result of splitting of the conservative differential equations basing on the features of all possible types of a fluid motion. The procedure of deriving does not need averaging over sound period. It is shown that the radiation force consists of three parts, one corresponding to the classic result (while averaged over sound period), the second being a small negative term caused by diffraction, and the third one. This last term equals exactly zero for periodic sound (after averaging) and differs from zero for other types of sound. Sound itself must satisfy the well-known Khokhlov–Zabolotskaya–Kuznetsov equation for the weakly diffracting nonlinear acoustic beam propagating over attenuative fluid. The effects relating to the sound aperiodicity are illustrated and discussed.

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14. Wawes with finite amplitude in acoustic horns

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This paper presents an approximate solution for weak nonlinear waves in the interior of an acoustic horn. An analytical approach is chosen assuming one-dimensional wave propagation in a lossless fluid within a conical horn. The wave reflected from the open end and boundary layer effects are neglected. The equation of the sound wave propagation in the horn is formulated. The analysis is given in Lagrangian coordinates.

Ultrasonics, Quantum Acoustics and Physical Effect of Sound

15. Frequencies of localized acoustic modes in dependence on mutual relation of components of Au/V nanolayers

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The paper presents the study of frequencies of the acoustic localized modes in metallic Au/V nanolayers. On the basis of Rytov model describing acoustic wave propagation in periodic layered medium and Djafari-Rouhani formula the frequencies of localized modes were numerically calculated. Dependencies of localized modes frequencies were presented graphically as a function of b/L nanolayer parameter (b-thickness of Au sublayer, L-thickness of Au/V bilayer) for first and second fononic stop bands. Obtained experimentally frequencies of localized modes for Au/V nanolayers were compared with calculated values. Accordance between experimental and theoretical results is satisfactory.

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16. Acoustic wave velocity in Ag/Fe nanolayers

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The paper presents the results of acoustic wave velocity investigation in metallic Ag/Fe nanolayers deposited on GaAs substrate. Measurements of velocity were performed using femtosecond technique. Ag/Fe samples were characterized by different thickness of bilayers. On the basis of experimental results of velocities, effective elastic constants c_{11} were evaluated. In the range of bilayers thickness above 80 Å the c_{11} values are in agreement with those calculated from the elastic constants of bulk materials (Rytov model). For lower values of bilayer thickness elastic constants exhibit large decrease. Grimsditch's model was applied to interpret changes of elastic constants dependence for low bilayer thickness. This model contains an additional interlayer treated as the parameter. Comparison the values of theoretical elastic constants obtained by applying of Grimsditch model with those calculated from experiment shows qualitative accordance in the range of small bilayer thickness.

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17. Ultrasonic chemical sensor for detection of aliphatic and aromatic hydrocarbons in air

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The reaction of the organic monomolecular, Langmuir-Blodgett layer, deposited on the sensor delay line using surface acoustic wave, on the presence of vapors of some aliphatic and aromatic hydrocarbons in

air has been investigated. The chemical composition of this layer is an equimolar mixture of 5-[[1,3-dioxo-3- [4- (1-oxooctadecyl) phenyl] propyl] amino] - 1,3 - benzenedicarboxylic acid (DA) and cetylamine (CA). Time of sensor reaction is less than 2 seconds. Decrease of the differential frequency after contact with the vapor-air mixture and decrease of this frequency in time are different for various hydrocarbons; a length of the chain is important for aliphatic ones and a presence or not of side chains – for aromatic ones. The reaction of the sensor on the hydrocarbon vapors in air is reversible.

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18. Dielectric and piezoelectric properties of PZT type ceramics obtained by the sol-gel method

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The sol-gel process is a chemical method of fabrication inorganic and inmetalic materials. The ceramics samples were obtained by conventional ceramics sintering method (CCS) and hot pressing method (HP) from powders with Zr/Ti ratio 35/65, which were obtained, by the sol-gel method. The temperature dependences of dielectric permittivity and tangent of dielectric loss of angle were determined for all samples.

This work presents the detailed description of technological process and connected dielectric and piezoelectric parameters. The PZT type ceramics samples has an application as a sensors, transducers electro-acoustic, piezoelectric amplifier, loudspeaker and microphone.

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19. Three-dimensional imaging in ultrasonic microscopy

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Advances in modern technology increases requirements for nondestructive characterization of material and biological properties in the μm range.

The acoustic microscope presented in this paper combines C-scan and B-scan modes. The data collected during single XY scan allow to present transversal and horizontal cross-sections of the sample as well as real tree dimensional images of the sample interior.

The whole system is build from several components: step motor driven mechanical scanner, transmitter/receiver device, ADC 1GHz board, ultrasonic heads, PC-class computer and image processing and visualisation software.

Image processing software is used for initial 3D image analysis of whole image or its fragments, and preparing it this way for vectorisation. To achieve vectorisation we used VTK (Visualization Tool Kit) library from Kitware Inc., which is the open source software, designed for 3D graphics and image processing. Finally iso-surface is constructed and presented as 3D scene in interactive GUI.

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20. Ultrasonic characterization of low concentrated ionic ferrofluid

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Ferrofluid is a stable suspension of monodomain magnetic nanoparticles in organic or inorganic liquid carrier. Ionic ferrofluid is an electrostatically stabilized composed of charged magnetite particles dispersed in water. Aggregation process in ionic ferrofluid under the influence of magnetic field has been monitored by ultrasonic attenuation spectroscopy, a technique which is sensitive to changes in the spatial distribution of magnetic particles within suspension. The results have shown that columbic repulsion is a very effective method preventing aggregate formation in low concentrated ionic ferrofluid.

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21. Imaging of the mean frequency of the ultrasonic echoes

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A standard USG image is in fact a visualization of a distribution of the reflexion coefficients. There is an increasing interest in imaging of the different parameters, which might characterize another physical properties of a tissue. The attenuation coefficient is one of such parameters and theoretically it can be estimated using frequency shift of the RF signal. The frequency shift results from dispersive character of the attenuation in tissue and is a function of attenuation along the propagate path. In this work authors use echo's mean frequency as an imaging modality. The results of measurement of tissue phantom using 10 MHz linear array are presented. The preliminary results are encouraging being the first attempt towards mapping of the attenuation in tissue.

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22. Universal coded ultrasound imaging system with software processing

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Coded transmission is a technique to solve the inherent compromise between penetration and resolution required in ultrasound imaging. Our aim was to examine the performance of the coded excitation in HF (20–35 MHz) ultrasound imaging. For this purpose a novel real-time imaging system has been developed. The digital programmable coder-digitizer module supports arbitrary coded waveform generation and RF echoes sampling up to 200 MSPS. All digital RF and image processing was implemented in software. The system performance was evaluated with a single thick-film transducer (focused 25 MHz, 75% bandwidth) scanning head. The RF echoes were acquired from a perfect reflector located with 1 cm of tissue mimicking material. Single sinus burst and 16-bits Golay codes excitations were evaluated. SNR gain for the Golay codes (referenced to single burst) of 15 dB for 20 MHz and 16 dB for 35 MHz were obtained.

The axial resolution measured at half maximum was 35 ns for 20 MHz and 25 ns for 35 MHz for both single burst and the Golay codes. It clearly shows that the Golay codes can perfectly restore the resolution while giving respectable SNR gain.

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23. Acoustic emission and the Portevin–Le Châtelier effect in tensile tested Al alloys processed by ARB technique

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The paper presents the investigations of the relation between the acoustic emission (AE) and the Portevin-Le Châtelier (PL) phenomena occurring in tensile tested two kinds of aluminium alloys: not-predeformed and predeformed earlier using the technique of accumulative rolling banding (ARB). There have been found essential correlations between AE and PL effects in ARB not-predeformed alloys. The tensile tests for ARB predeformed alloys were performed on a series of samples of various degree of work hardening and it has been observed that the correlations between the AE and PL effects are not so pronounced as in the case of ARB not-predeformed alloys. The results of AE measurements obtained using a new software allowed additionally to carry out the spectral analysis of AE signals and, in consequence, to determine the acoustic maps (acoustograms) and the spectral characteristics which are very useful in the discussion of the relations between the non-homogeneous strain mechanisms of the PL effect and the mechanisms of AE events generation. The results are discussed in the context of the existing dislocation models of the PL effect and the theoretical concepts of AE sources.

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24. Acoustic emission in compressed Mg-Li and Al alloys processed by ECAP, HPT and ARB methods

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In the paper there are presented the results of investigations of the relations between acoustic emission (AE) and the plastic strain mechanisms during channel-die compression of materials, based on both Mg-Li

and Al alloys, having ultra fine-grained (UFG) or nanocrystalline structure obtained using the technique of equal channel (of both quadratic and circular section) angular pressing (ECAP) as well as the technique of high pressure torsion (HPT). Also the AE in compression and tensile tests of UFG (nanocrystalline) Al alloys obtained by accumulative roll-bonding (ARB) method have been investigated. The results obtained using a new generation AE analyzer are compared with those obtained for similar materials but not subjected to ECAP, HPT and ARB processing. Moreover, the wavelet analysis of the detected AE signals based on the acoustic maps (acoustograms) and spectral characteristics has been carried out and the AE behaviour is discussed in the dislocation aspects of both plastic strain mechanisms and possible superplastic flow in UFG or nanocrystalline materials.

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25. Acoustic-mechanical and microscopic investigation of corundum material

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This paper presents the results of acoustic emission (AE) measurements of samples under compressive stress. Additional research, concerning structure and parameters of the material, were performed using microscopic and ultrasonic methods. The object of investigation was samples of corundum material C 799 type. The content of alumina in investigated material was equal to 99.7%. The corundum materials demonstrate high mechanical, thermomechanical as well as grindability resistance and find wide application in production of modern technical devices. The aim of study was recognition of stages of degradation processes of the corundum structure. The analysis of AE results pointed out diversified strength and mechanical-acoustic characteristics of particular samples. It was stated during microscopic investigation that the main reason for this effect is due to different grains size and their spatial distribution. The authors consider the abnormal grain growth (AGG) phenomenon as a reason of inhomogeneities of the corundum structures in particular samples. This effect occurs at longer sintering term, especially for fast temperature growth. AGG phenomenon has random character and up to now is not explained in satisfying way.

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26. Anisotropy of ultrasound attenuation in APG-832 magnetic liquid

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Ferrofluids are stable colloidal suspensions of nano-sized magnetic particles in a carrier liquid. Their stability is achieved by coating them with the surfactant layer that produces entropic repulsion. However, the break in the balance between the Van der Waals attractive forces and the steric repulsive forces causes certain amount of colloidal particles to join into quasispherical and chain-like aggregates.

In the external magnetic field the anisotropy of a sound attenuation is observed. This effect is attributed to the translational and rotational motions of the clusters of the colloidal magnetic particles dispersed in the

carrier fluid. The ultrasound anisotropy in APG832 magnetic fluid was studied using broadband ultrasonic spectroscopy. In this approach a broadband ultrasonic pulse is used, i.e. a single pulse which contains a wide range of different frequencies. After the pulse has traveled through the sample, it is analyzed using a Fourier transform algorithm to determine the values of velocity and attenuation as a function of frequency.

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27. The influence of the transducer bandwidth on the efficient Golay codes compression

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The maximization of penetration depth with concurrent retaining or enhancement of image resolution constitutes one of the time invariant challenges in ultrasound imaging. To solve this problem a pulse compression technique employing long coded sequences is now under intensive investigation and in fact some of the corresponding techniques were already implemented in commercial scanning machines. This paper investigates the influence of the effective bandwidth of the transducer on the behaviour of the encoding/compression technique and its potential influence on the axial resolution. We have investigated two different bits lengths – one and two periods – in the Golay sequences resulting in substantial difference of the bandwidth of the transmitted sequences. Three transducers with different fractional bandwidths were used in the experiments: 6 MHz focused transducer with 25% fractional bandwidth, 4.4 MHz flat transducer with 58% fractional bandwidth and 6 MHz flat, composite transducer with 80% fractional bandwidth. The experimental results are clearly showing that the elongation of the Golay single bit length (doubled in our case) compensates for the limited transducer bandwidth. For 25% bandwidth peak-to-peak echo increased by 1.89 times; for 58% bandwidth peak-to-peak echo increased by 1.62 times, and for 80% bandwidth peak-to-peak echo increased by 1.47 times.

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28. $Pb(Fe_{0.5}Nb_{0.5})O_3$ ferroelectric ceramics as a material for electroacoustics

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The mixed perovskite-type oxide lead iron niobate $Pb(Fe_{0.5}Nb_{0.5})O_3$ (PFN) is known to be as a typical ferroelectric with magnetic ordering. The material is an optimal for multilayered ceramic capacitors (MLCCs). Owing to their large capacitance, highly compact design and reliability, these capacitors have become promising candidates for electronic devices. In this compound, ferroelectric state is a result of the structural phase transition from the high-temperature paraelectric of regular structure into the low-temperature ferroelectric of rhombohedral structure at the Curie temperature T_C and antiferromagnetic spin ordering takes place below the Neel temperature. These phenomena cause that ceramics of the PFN type is an interesting object for a detailed analysis.

In this work, the results of investigations of electric and mechanical properties such as: Young's modulus E, electric permittivity ε and tangent of dielectric loss of angle $\tan \delta$ of the $Pb(Fe_{0.5}Nb_{0.5})O_3$ ceramics obtained are presented.

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29. The ferroelectric PLZT type ceramics as a material for transducers

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Modification of the PZT system by the addition La^{3+} ions has marked beneficial effect on several the basic parameters, such as squerness of the hysteresis loop, decreased coercive filed, increased dielectric constant, maximum coupling coefficients, increased mechanical compliance, and enhanced optical transparency.

The mechanical and electrical properties in lanthanum modified lead zirconate-titanate ceramics of 5/50/50 and 10/50/50 were studied by electric permittivity ε and tangent of dielectric loss of angle $\tan\delta$ measurements. The temperature dependences of $\varepsilon = f(T)$ and $\tan\delta = f(T)$ were determinate in temperature range from 300 K to 730 K. The values of T_C obtained during ε and $\tan\delta$ measurements were respectively: 560 K for 5/50/50 and 419 K for 10/50/50.

Biomedical Acoustics

30. The effects of low-frequency noise on the levels of activation
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The paper summarises the research data showing how low frequency noise affects the level of activation in humans. Activation levels were measured with the use of the self-assessment questionnaire, known as the Activation-Deactivation Adjective Check List (AD ACL). The research program involved three independent stages and three types of acoustic stimuli were applied. The acoustic wave applied in the first stage had frequency $f =$ Hz, acoustic pressure level Spl = 120 dB (HP). In the second stage participants were exposed to an acoustic wave $f = 18$ Hz, acoustic pressure Spl = 120 dB. In the third stage a low-pressure wave was applied $f = 40$ Hz, acoustic pressure Spl = 110 dB. The exposure time in each experiment was constant (20 min). Results indicate a statistically significant increase of the deactivation – sleep effect following the low-frequency sound exposure.

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31. Phase-sensitive method in studies of Corti organ
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The phase-sensitive method is used to detect and measure very small AC signals. Precise measurements may be made even when the small signal is hidden by noise and other disturbed signals. The authors

use the method to measure changes of the electric function of the Corti organ influenced by different external factors (e.g. ototoxic medicine and vibrations). Different experimental setups used by authors have been described.

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32. Use of double-phase sensitive detection to measure DPOAE signals

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This paper presents a new method of measuring distortion product otoacoustic emissions (DPOAE) induced by a two-tone acoustic wave. The method is based on double phase-sensitive detection whereby it is possible to precisely measure DPOAE signals whose acoustic pressure level is even below -15 dB. Exemplary experimental results for guinea pigs are given.

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33. The changes of acoustics parameters of teeth under of influence of Coca-Cola

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The research was done on extracted human moral teeth. The time of propagation of ultrasonic waves (0.1 MHz) through teeth crown was measured in two transverse sections (side and cheek-tongue direction) using a Tester CT-1 (Unipan-Ultrasonic). Diameters of teeth were determinated by a slide caliper. Vaseline was coupling medium. The mean ultrasonic velocity was $3407 \div 5667$ m/s. The teeth densities were determinated by the hydrostatic method. The mean density of teeth was $2012 \div 2279$ kg/m^3. The teeth (15) were divided into three groups (5). The first and the second groups of teeth were immersed in Coca-Cola for various spans of time. Third group of teeth was soaked in orthophosforic acid (10 %) at temperature 37 °C, for 20 minutes. Measurements of teeth have been repeated. The concluding measurements gave the following results: densities of teeth decreased on average, by 5 % and ultrasonic velocities decreased on average, by 7 %. Acoustic impedance of teeth decreased on average, by 10 %. The Young's modulus decreased on average, by 15 %. The graphs illustrating the changes have been prepared: densities, ultrasonic velocities, acoustic impedances and Young's modulus depending on time. Teeth enamel was observed by the SEM microscope with a microprobe.

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34. A preliminary analysis of possibilities of compensating for the faults of laser technology and ultrasonic technology in surgery

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The active applications of ultrasounds and lasers in surgery are similar. Both technologies complement each other and allow us to obtain desired effects eliminating the limitations of each of them. Therefore

what happens very often during a medical procedure is the simultaneous use of these two methods from separate standard devices. Having proved the possibility of acoustic wave propagation through optical fibers, the combination of laser and ultrasounds in one device and one tip using an optical fiber seems more effective. What is obtained in this way is an opportunity to use ultrasounds for endoscope and laparoscope operations. A comparative analysis of both systems shows that combining the advantages of ultrasounds and laser in one device allows us to compensate for the faults of each of the technologies and improve the effectiveness of surgical operations. The combined method is safer and it lessens the risk of complications. The preliminary tests of the operation of the laser-ultrasonic cutter produced positive and encouraging results. The combined technology allowed us to decrease the power of laser and consequently lessen the risk of burning the quartz tip and the optical fiber. A precise selection of the optical fiber seems to be crucial to obtaining an effective laser-ultrasonic surgical device. What is equally important is the appropriate way the light and ultrasonic energies affect interact. The acoustic wave causes a change of the light refraction coefficient, and it is possible to modulate the laser radiation.

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35. Modeling of artery wall thickness examinations

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The developed solver of acoustic field was used for simulation of the artery wall thickness examination. It would be capable of describing spatial and time-dependent distribution of an ultrasonic beam that is emitted by a piezoelectric ring transducer and then backscattered on cylindrical surfaces of the walls in artery models. The calculated electrical received signal pretty well corresponds with the actual RF signal that is obtained during measurements at the output of the ultrasonic VED apparatus. The theoretical model of the artery for the creating the simulated ultrasonic reflected echoes was used. The internal radius of the artery model was 3 mm for the diastolic pressure and 3.3 mm for the systolic pressure. The intima-media thickness (IMT) of the artery wall was changed from 0.48 mm to 0.44 mm respectively. The echoes tracking solver based on zero-crossing and correlation methods was used for detecting changes of the IMT.

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36. Ultrasonic examinations of IMT in common carotid artery wall

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The paper describes the initial results of examinations of the intima-media thickness (IMT) in the common carotid artery wall. The examinations of IMT permit for assessment of elastic properties of the arterial wall. The ultrasonic examinations were carried out on healthy volunteers using the VED apparatus designed by authors to measure the elasticity of arteries. Applying the PDA-14 PC-card (Signatec) permitted for acquisition the ultrasonic RF signal from the output of VED apparatus and further analysis of dynamic changes of IMT during hart cycle. The changing of IMT during time as a difference between instant position of two tracking slopes of RF echoes was obtained. For this purpose the zero-crossing method for tracking the phase changing of the rising two slopes of RF ultrasonic echo was used.

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37. The acoustic and electroglottographic methods of determination the vocal folds vibration fundamental frequency

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There are many methods of measuring the course of vocal folds vibrations fundamental frequency. This function can be estimated in several ways i.e. internal measurements (optical methods), external measurements (the acoustic analysis of the voice, electric method). Electric methods (EGG – based on analysis of the electroglottographic signal) are often applied. Still developing professional methods of registration and processing speech signals are permit to apply the acoustic methods. A number of authors' research proves that maximum information on phonetic action of larynx can be assembled by delimitation of the fundamental frequency parameters. Thus the exact determination of pitch function makes a priority in the glottal area research. The spectrum character of speech wave is connected with the fundamental frequency (F_0) of human vocal folds vibration. As it is considered, F_0 of the source during voicing contains an abundance of information on the larynx pathology, individual trait, the emotional state and ethnographical origin of speaker. The literature demonstrates non numerous researches have conducted simultaneous measurement of fundamental frequency by the EGG and with the acoustics methods. The present paper presents results of such research. The analysis of the F_0 function exactitude delimitation and the usefulness of these methods were executed too.

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38. Acoustic analysis of esophageal speech in patients after total laryngectomy

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Laryngeal cancer is one of the most frequent types of malignant tumor in male patients and it is located at position 5 among all the malignant tumors. The primary method of laryngeal carcinoma treatment for the cases with advanced cancer stages is the surgical treatment. In such a treatment the most frequent version is the total extraction of the organ. An effective postoperative therapy leads to the extension of the patients life-time, but the price is a serious disability, considerably impairing the patients communication with other persons. Therefore there is a problem of creation of a substitute voice and speech for those patients. The creation mechanism of the esophageal speech is the formation of vibration generator in the upper part of oesophagus. The substitute air container is formed by the oesophagus itself and the air vibrations in the upper part of oesophagus, generated during the anti-peristaltic motion of the air removed from oesophagus, create the primary pitch. The modulation of the fundamental pitch is obtained by the unchanged articulation organs and resonance cavities of the body. In the present paper an acoustic study of esophageal speech is described. An attempt has been made to determine the acoustic signal parameters, which can be useful in evaluation of esophageal speech quality.

Acustooptics

39. Acousto-optic interaction with the use of cylindrical ultrasonic waves in the laser cavity

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Recent advances in acousto-optics have been stimulated by applications of the phenomenon of light interaction with either bulk or surface ultrasound in laser technology. Implementation of piezoelectric ceramics made it possible to produce more complicated shapes of transducers. Circular cylindrical piezoelectric shells belong to the group of transducers that are able to concentrate the energy of elastic wave. Due to this fact, one can generate quite a high intensity of ultrasound at the axis of cylindrical transducer, thereby leading to the efficient light diffraction.

In this report we present a review of recent results concerning theoretical and experimental studies of interaction between light and ultrasonic wave of axial symmetry. Theoretical investigations of this phenomenon need numerical analyses to be used. Experimental findings of various acousto-optic configurations revealed a very good agreement with numerical calculations. Due to unique resonance properties of proposed acousto-optic system, it makes achieving extremely high values of Raman-Nath parameter at the axis of symmetry possible. The piezoelectric cylindrical shell can generate the ultrasound of quite a high intensity, especially at the axis of the transducer, and thus permits observation and investigation of efficient light diffraction by ultrasound propagating in gases.

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40. Photoacoustical method of research of physical properties of a thin liquid film on solid surface (numerical modeling)

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Noncontact photoacoustical method for measuring of physical properties of a thin liquid film on solid surface has been considered. The numerical modelling of excitation of acoustic waves by the laser pulse and of propagation of these waves in liquid film has been carried out. A 2-D case was considered in this model. Finite elements method was used to solve the problem and explicit scheme was applied. The acoustical field on surface of liquid has been calculated depend on optical, thermal, acoustical properties and thickness of liquid. Inverse problem was considered. Physical properties are being determined from information about acoustic field. Inverse problem is being solved by multiparametric minimization of acoustic signals that were measured in several points of liquid. The optimal conditions for precise measurements were considered. The optimal conditions of measurements and influence of different factors on their precision have been studied. The method was considered for liquid thickness in the region of 50–500 μm.

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41. The analysis of transformer insulation oil properties using optoacoustic phenomena

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Sonoluminescence is a process by which light is emitted from collapsing ultrasound-driven gas bubbles in a liquid. The light intensity and emitted light spectra depends mainly on the fluid and dissolved gases properties. These features indicate the possibility of estimating the amount of dissolved chemical compounds in liquids. The objective of this work is to point out the possibility of using sonoluminescence phenomenon as a diagnostic tool for power transformer life-time prediction. During the long time of energetic transformer operation the losses of insulation properties of used transformer oils can't be avoided. The essential factor in transformer oil degradation is the amount of chemical compounds i.e. oxygen, nitrogen, hydrogen and simple hydrocarbons. An important factor is the humidity content as a result of insulation paper oxidation. All of the factors have also influence on the sonoluminescence phenomenon. Mathematical and statistical analysis of obtained measurements data in form of sonoluminescence spectra from spectrometer and light intensities for different types of gas-liquid mixtures can verify the possibility of using the sonoluminescence as a diagnostic tool for insulating oils.

Speech Acoustics

42. Automation of the logatom intelligibility measurements in rooms

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Speech intelligibility is one of basic quality parameters of speech transmission in rooms. The methods for assessment of speech quality fall into two classes: subjective and objective methods. This paper includes an overview of selected methods of subjective listening measurements (ACR, DCR, speech intelligibility) recommended by ITU-T, ISO and Polish Standard and the method of speech transmission quality evaluation called "modified intelligibility test with forced choice" (MIT-FC). The MIT-FC method provides fully automatized measurement of speech intelligibility in rooms. The experiments carried out in finding the relations between logatom intelligibility measured with traditional and the MIT-FC methods for the rooms have shown that there exists the multivalue and repetitive relation between them.

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43. Identification of the phonemes don't consist basic periods

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This article describes method of phonemes without basic periods analyses. First finding the beginning and the end of the phoneme is necessary. Here different methods could be used. One of these is grid method where finding to long grid means finding phoneme without basic periods. After finding the borders the mathematic analyses could be done. To identify phonemes three parameters have been used. First is the difference between mean value of the signal and mean value of the noise, next is the quotient of the number of samples over the mean noise level to number of samples under mean noise level. Last is the quotient number of extremum minimum to numbers of the extremum maximum of the signal.

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44. Identification of the phonemes consist basic periods

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This article describes speech recognition method based on the image recognition. This method has two different algorithms. One for phonemes consisting basic periods and another for the rest phonemes. The article shows that for recognizing phonemes with basic periods, grids algorithm is very useful. Some steps of recognition and some resolved problems was described too. Also examples of decoding phonemes are included. During the research for testing of the recognition method the data base called "CORPORA" was used. There were recorded 45 persons, who said names, digits and different phrases. The results of this research for different phonemes was showed. They show that speech recognition based on the phonemes recognition could be apply for speaker independent recognizing isolated words.

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45. Detection and removal of 'smacking' noise from lector speech records

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In the following paper, analysis of "smacking" noise, introduced to the speech signal by a lector, was shown. We demonstrate a working algorithm to reduce amount of "smacking" noise in the speech tract. This particular type of noise arise mainly from saliva snapping in the speaker's mouth. It is not only decreasing the quality of the signal but it can also annoy the listener, making it hard to focus on the record's content. Currently, processing of the records degradated by "smacking" noise is made manually in sound editors. The operator locates smacks by first listening to the audio segment and then zooming in on the suspected area. Then the smack is usually replaced with a tiny bit of the waveform that comes immediately before or after it. This is very time-consuming process, mainly because distortions tend to occur in numerous groups at random positions in the waveform. The job also requires a lot of experience as the artefacts frequently have low amplitude and very short duration. Our algorithm performs detection of distortions in the time domain using differentiation of the signal. The removal routine is based on discrete wavelet transform (DWT) and inverse discrete wavelet transform (IDWT).

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46. Polish Digit Triplet test for auditory screening: development and initial evaluation

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The objective of this study was to develop and evaluate the Polish digit triplet test for speech intelligibility screening. The first stage of the work deals with the preparation of the test and the recording procedure. The second part presents results of the digit triplets scoring measurement and a test retest data. The test consists of 4 statistically equivalent and phonemically balanced lists, each containing 25 different triplets. The triplets were presented to the subjects at 7 SNR values: -14.5; -13.0; -11.5; -10.0; -8.5; -7.0 and -5.5 dB. The order of the triplets and the SNR presentation were randomized. The constant stimuli paradigm was used to determine the digit triplet psychometric functions. 50 otologically normal subjects took part in the measurements. The obtained results showed that for the Polish digit triplets, the

mean speech reception threshold (SRT) was equal to -9.4 dB and corresponded to SRT$= -9.3$ dB obtained for German language. The mean slope of the psychometric function (S50) for the Polish digit triplets was equal to 20.6%/dB and was comparable to Swedish, 19.3%/dB. The Polish triplet test evaluated in test-retest experiments showed high reliability and accuracy for a fast intelligibility screening.

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47. Tests of robustness of GMM speaker verification in VoIP telephony

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The paper presents the scores of the GMM (Gaussian Mixture Models) based speaker verification system for speech signal transmitted in VoIP (Voice over IP) telephony conditions. The speaker verification problem was partly solved over traditional PSTN networks (Public Switched Telephone Network), however nowadays it is also important to assess how specific distortions of VoIP transmission influence the speaker verification scores. As a reference database XM2VTS (Extended multi Modal Verification for Teleservices and Security appliations Data Base) containing English speech (strings of digits) was applied. Three coder degradations (PCM, G.711A and G.723.1) and three network conditions were examined in various configurations to estimate the influence of each, coding and transmission degradation for the final verification scores.

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48. Acoustic investigations of persons with phonation disorders

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The lack of unification in objective evaluation of phonation disorders enforces explorers to search for an optimal form of acoustic investigations of vocal organ supporting a subjective aural diagnostics. The condition is to process a huge number of data contained in a spectrum of human speech, which is possible with the computer systems administering suitable computational power. However, it was one should create suitable method, based on typical analytic operations, which we can use as diagnostic tool.

This study is a continuation of investigations of vocal organ and its illnesses, with use of an analyser SVAN 912 AE (Svantek). 80 persons (in total) were examined: 40 persons with organic illnesses in area of glottis (Oedema Reincke or Larynx Polyps) and 40 healthy persons from control group. The analysis of harmonic frequencies decisive for structure of spectrum showed existence of factors disturbing phonation in the group of ills. It is an effect of connections between the laryngeal stimulation and the acoustic properties of vocal duct. The analysis of individual features of speech signal showed the convergence of value of studied parameters. This made possible differentiating of changes of source (laryngeal stimulation) profile, caused by different kind of pathologies.

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49. Comparison of subjective and objective speaker recognition under voice disguise conditions

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An experiment was performed in order to compare the results of subjective and objective speaker recognition under voice disguise conditions. The experimental material consisted of the key sentence "To jest akustyka" (Eng. "This is acoustics") spoken several times by Polish male speakers in a natural mode

and under voice disguise conditions. In the subjective method the utterances were grouped in pairs and presented to the listeners, whose task was to make a decision whether a given pair of speech samples was produced by one speaker or by two different speakers. In the objective method two parametrical representations of speech (LPC coefficients and Km reflection coefficients) were utilized and a computer program for automatic speaker verification was applied. For normal speech both method exhibited a very good effectiveness of speaker recognition and the results for the subjective method were a bit lower (98.9% in comparison to 99.4% for the objective method). Under voice disguise conditions, however, the results for the subjective method (92%) were substantially better than for the objective one (77 %).

Musical Acoustics

50. Case studies on Absolute Pitch

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Absolute Pitch (AP) seems to be one of the most remarkable phenomenons of the long-term auditory memory. AP-possessors can identify or also produce musical pitches (e.g. C, C#, D, etc.) without using an external reference tone. The aim of the present investigation was to find the occurrence of AP in the students of Polish music schools. In the first part the pitch-naming test with piano tones was applied to about 1100 subjects. The test was accompanied by the questionnaire including questions about details of musical education, familial aggregation of AP and the features of musical hearing. In the second part of investigation the test with the tones of various timbre was applied to 31 students who previously identified more than 50 % pitch values. In the present paper reports on the individual cases of various forms of AP are presented.

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51. Short-term auditory memory in musicians with absolute pitch

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Musicians possessing absolute pitch (AP) can recognize musical pitch values (e.g. C, C#, D, etc.) without using any external standard for comparison, because 12 corresponding pitch values are permanently stored in their LTM as internal standards. Musicians who do not have absolute pitch (more than 90 %) cannot keep exact values of musical pitch in LTM, however have very exact short-term memory (STM) for pitch and usually can repeat the exact pitch values after the delay not exceeding 2-4 minutes. So far it was not known whether the short-term memory for pitch in AP possessors is the same, better or worse as that of musicians not having AP. In the present experiment 5 subjects were used: 2 musicians, AP possessors, 2 non-musicians, and 1 musician not having AP but a well-trained relative pitch. The subjects were given the tasks of tuning frequency of a pure tone to equal pitch with a standard tone. In each task standard tone was presented only once and tuning could have started after a definite time delay. 4 different standard tones and 6 different time delays were used ranging from 1 sec. to 6 min. As a result it appears that STM for pitch in musicians does not depend on having or not AP, however it strongly differs between musicians and non-musicians.

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52. Musical activity and hearing thresholds in applicants to the Department of Sound Engineering

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A survey about musical activity (e.g. years of practice to play on the musical instruments, exposure to loud music, use of the portable music players) was conducted among a group of young musicians – applicants to the Department of Sound Engineering at the Chopin Academy of Music. Hearing thresholds in quiet were measured in all subjects. The measurements were performed with the use of tonal audiometry in an extended frequency range from 125 Hz to 16 kHz. Audiometric patterns were analyzed in order to select musicians with hearing losses of various kinds and depths. The audiometric data were correlated with the information about musical activity. A statistical method of correspondence analysis was applied. The present findings indicate that certain kinds of exposure to music cause a decrease in the sensitivity of the hearing system. All kinds of bilateral hearing losses were observed in the groups of older subjects: percussion players, persons who frequently attended disco and rock concert and intensive users of home audio equipment. A weaker, but still clear relationship between hearing loss and musical activity was found in a group of younger musicians who played on electric instruments (guitars, keyboards).

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53. A method of detecting the C4 violin mode in the energy spectra of chromatic scales

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This article presents a method of detecting the frequency of the C4 mode of the violin in the energy spectra of the chromatic scales. The work makes use of the recordings from the AMATI multimedia database, which includes recorded sounds of violins used in the 10th Henryk Wieniawski International Violin Making Competition in Poznań.

The method is based on the search for the part of the energy spectra of recorded chromatic scales which is common for these spectra. The recordings were made in the near field, separately for each string. The analysis of the spectra was made in the 650 to 796 Hz band, with the 0.5 Hz resolution. All the instruments in the AMATI database were tuned with $a' = 443$ Hz. The frequencies of the strings were as follows: the g string: 196.89 Hz, the d string 295.34 Hz, the a string: 443 Hz, the e string: 664.5 Hz. This method was developed in accordance with the results of the latest research.

Room Acoustics

54. Optimal value of an absorption coefficient selection and material distribution on the room's boundaries

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In this paper a problem of optimization of an acoustic absorption materials application on the room's boundaries has been presented. A harmonic, monochromatic sound source has been placed inside a room. A pressure distribution was described using modal analysis assumption. For sufficiently enough high

boundaries' impedance the modal coupling can be neglected. Then modal amplitudes values of a steady-state pressure distribution can be obtained. Amplitudes are dependent of eigenfrequencies ω_n, damping coefficients r_n and a source function. Conducting analysis of the modal amplitude function, in relation to ω_n and r_n, an optimal damping can be obtained. For each eigenfrequency, there is the value of a damping coefficient, which is a limit of a decrease in amplitude value. Take this criterion into consideration, a material with the specific normal-absorption coefficient, distributed on boundaries has been found. In that case, the sum of differences between material damping coefficient and optimal damping coefficient, counted for all eigenfrequencies, achieves minimal value. Consideration was limited by low frequency range.

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55. Digital inverse equalizer assisted active sound control

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The article presents digital inverse equalizers, allowing active control of sound in the restricted areas. The theoretical foundations of the systems are based on the inverse filtrations theory (deconvolution). The systems described have been implemented on the card with the TM320C31 signal processor, manufactured by Texas Instruments, as well as on the popular soundcard. The report presents the mathematical models of the aforesaid equalizers, as well as the results of experimental testing, confirming the efficiency of their operation. The apparatus designed and constructed may be applied to the active sound reduction systems, the segments of the electroacoustic or transportation systems serving echo cancel, as well as to the creation of acoustic climate of the selected interior.

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56. Analysis of non-exponential sound decay in an enclosure composed of two connected rectangular subrooms

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Acoustically coupled rooms have recently been drawing more and more attention in the architectural acoustics community. Determination of decay times in these coupled rooms from computer-based models has become increasingly significant. In computationally modelling of coupled enclosures the geometrical acoustics methods do not apply at lower frequencies, and models must account for the wave-nature of sound fields, especially modal effects. In this investigation a combination of modal analysis with finite-difference algorithm was used to predict a decay in the sound field energy in an enclosure composed of two connected rectangular subrooms. Random incidence absorption coefficients inside subrooms have been modified in this study to create different configurations of absorbing materials on subrooms walls. When one of these subrooms was much more absorbent than the other one, calculation results have showed that, at any frequencies, there existed both the initial sudden and the late slow decrease in the sound field energy. This effect was characterized by two metrics: early reverberation time (EDT) and late reverberation time (LDT) determined from a sound level decay from -45 to -50 dB. The analysis of numerical data confirmed that the most influential factor in realizing the non-exponential sound decay is a phenomenon of eigenmodes localization.

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57. Acoustic field in an industrial hall

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Either wave methods or geometric ones are used for the description of acoustic field in industrial halls. The acoustic field distribution in such halls is not uniform, thus the applied in an acoustics of interiors assumption of field diffusivity is often not fulfilled. The room forms amplitude and phase characteristics of the signal, introducing additionally effects related to space development, which are decisive for the acoustic pattern in the observation point. The analysis of an acoustic field inside an industrial room, when one machine of not large dimensions is operating – is presented in the paper. The measurement results and computer simulations related to the acoustic field distribution are given.

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58. Analysis of sound field in Dominicans' church in Cracow

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Analysis of the sound field is a good base for acoustic adaptation of space. Reverberation time and impulse response are two of the most important parameters in sound evaluation. Simulation methods allow us to build models of existing rooms, but also of those which are still in project. Geometrical methods result in good effects above Schröder's frequency. Under border frequency dominate wave phenomena, which are not taken under consideration in these simulations. Application of finite element method for low-pass band allows to achieve results without miscounts. Measurement of real acoustic parameters permits correctness assessment of the model. We present results of such an analysis: simulation using radius method, finite element model below 200 Hz and real measurements, executed in Domincans' church in Cracow.

Structural Acoustics

59. Influence of connection type on the way of vibrational energy transmission

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The analyses of energy balance in the mechanical systems are done by the quantitative and qualitative assessment. The qualitative assessment is possibly by the use of energy flow descriptors and observation of energy density distribution in the mechanical structure. The work presents the results of investigation of welded connections of rectangular steel plates. The aim of the analysis was the quantitative estimation of vibrational energy transmitted though the welded connection depending on the inclination angle of plates. The structural intensity was used as the parameter for the analysis. The method of structural intensity evaluation enabled the elaboration of intensity vector field. Unification of shape and size of finite elements made possible the summation of only the magnitude of intensity. The summation was performed in the plate's cross-sections perpendicular to the main direction of energy flow, far from the places of excitation

and the damping. As the result the detailed information on vibration energy flow was achieved. The obtained results of calculation give the quantitative information on amount of energy transmitted, reflected and the damped in welded joints of plates. The analyzed case was intentional to show the utility of intensity method in diagnostics of joints in mechanical constructions.

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60. Application a new sound intensity probe Microflown in the acoustic insulation measurements

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Excessive noise that is transported into the rooms affects destructive for a human life, health and work. One of the ways minimize noise is applied a partitions that have a high acoustic insulation. Therefore are applied besides the heavy partitions also light multilayer partitions. In this paper is investigated the experimental results of the acoustic insulation of light multilayer walls measurement in situ by two methods: KL-classical (only a sound pressure) and SI- sound intensity.

The sound pressure is a scalar quantity and will give insufficient information about the direction and size of the sound energy flux of a radiating field.

The sound intensity is a vector quantity. Acoustic power flow could be directly obtained from near field measurements (for example in a receiving room) and to perfect the measurement of the acoustic parameters of structures.

In this article made investigation a new intensity probe Microflown applied of building acoustics. The experimental results the airborne sound insulation by means of Microflown was compared with Norsonic probe. The acoustic characteristic of insulations was measured Micrflown is the same like other probe. The conclusion of this article is that Miroflown probe could be used in the acoustic measurements.

Noise, its Effects and Control

61. Analysis of stochastic acoustical hazards in environment

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Acoustical assessment of environment, realized on the basis of changes observation held as part of national environment monitoring for the need of long term noise protection policy in environment, demands long term average noise level LDEN and LN estimation. The estimation is based on noise measurement results from all the days in the year, taking into account day, evening and night times. The basis for correct statistical estimation when the data is incomplete (time limited monitoring of acoustic environment) is a choice of time sample so that results gained reflect the mechanism of noise hazard changes that works throughout the year. It should provide identification of particular event occurring frequency and time relations between events, e.g. sound extreme value appearance or recognition of periodical changes of important parameters in uncertainty assessment. Such process demands assumption of particular statis-

tical techniques related to the assumed model of noise level changes where the random factor is important and always present. That problem is part of the article. The paper presents basic analysis of monitored phenomenon by usage of models framing its stochastic volatility. Important elements of modeling are described, illustrated by examples of yearly noise data analysis gathered at one of main streets in Kraków. Attention is paid to the analysis problem with the process periodicity, measurement uncertainty related to the measurement conditions volatility or time uniformity of the monitored noise processes in view of its internal causality relations.

They are loaded with random factor whether we assign randomness to noise source volatility, whole year measurement conduct inability or distortions related to proper sampling of given field of noise hazards.

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62. Integrated control system for acoustic and non-acoustic data measurement devices

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The article presents technical solution for integration and control of measurement device such as sonometer, weather station and road traffic intensity meter. The presented solution is universal, allows remote configuration and is fully automated. Also the device is able to work stand-alone or in networking mode, and cooperates with the data transfer system.

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63. Acoustic field layout in the area of PKE Siersza Electric Plant in Trzebinia

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The paper presents results from sound field simulations around Siersza Power Station in Trzebinia. These results are necessary for investments decisions in order to meet the noise emission standards in daytime and at night. The cooling towers are the most significant noise sources which should be reduced. First experiments were connected with changes of the number and configuration of working towers. Next an acoustic screen was also considered. Values of required noise level reductions of all significant sources are the main result of research. SoundPlan software was used for simulations especially its ability to 3D terrain model which seems the most significant in such investigations.

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**64. A concept of an actuator for positioning of elements
of a measurement system in an anechoic chamber**

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Automation of acoustic measurements in an anechoic chamber poses a considerable challenge to designers. On the one hand, the special character of such measurements requires designs that minimize disturbances to the acoustic field; on the other hand, automation always involves the introduction of additional mechanical elements, which disturb the free acoustic field of the anechoic chamber. The authors of this paper attempt to reconcile these conflicting demands by designing a mechatronics measurement system. On the basis of known solutions and current measurement needs, a number of concepts has been proposed, and a design has been identified that can be implemented in the chamber under study.

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65. Assessment of exposure to impulsive noise of policemen who worn ear-muffs at rifle-range

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According to noise directive 2003/10/EC employers are obliged to "assess and, if necessary, measure the levels of noise to which workers are exposed". When workers use hearing protectors the assessing of noise levels is done by dint of the methods recommended by standard EN 458. The measurements of exposure to noise of policemen were carried on with the use of the sound analyzers SVAN 948 and SVAN 945. The two microphones were placed under the both ear-muff cups and the one microphone was placed about 20 cm from the policeman head. The results of measurements revealed that for the thirteen of the sixty four tested cases the peak C weighted sound pressure level was higher than exposure limit value of 135 dB(C). For the nineteen cases the levels of noise measured under the right and left cups differed by more than 3 dB. For the 89 % cases the measured levels were higher than assessed. The maximum observed difference between measured and calculated values was 10.6 dB(C). The main reasons for the lack of the expected protection were bad cushion fitting caused by an incorrect way of wearing and bad condition of the ear-muffs caused by the duration of their usage.

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66. Acoustic attenuation performance of round silencer with spiral duct on the inlet

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The acoustic attenuation performance of round silencer with spiral duct on the inlet is investigated. Finite Element Method was used for three-dimensional numerical computations in COMSOL Multiphysics

application. Time-harmonic analysis without airflow was used for frequency range from 10 Hz to 2 kHz. The results show that spiral duct on the inlet can improve the acoustic attenuation performance of round silencer. Sound attenuation depends on spiral lead, absorbing material and frequency. Transmission loss of investigated acoustic system with spiral ducts is related to initial acoustic system with circular pipe. The results are shown as the growth of transmission loss ΔTL given by insertion of spiral ducts. Specific parameter given by relation of spiral lead s to constant circular duct diameter d is presented as s/d ratio. The value of ΔTL is determined by s/d ratio and increases in specific frequencies. Acoustic wave in those frequencies is divided on the outlet of spiral duct and the major acoustic energy goes aside, directly to absorptive material, and minor acoustic energy goes axially to the silencers outlet. This is the damping effect of spiral ducts.

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67. Theoretical and experimental models of circular plate for active vibration control

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The problem of confidence in enough fidelity of dynamic models of structures is very important for vibration control. Derivation of the models for structures can be guided into two ways. The first manner is commonly referred to as system identification. In this case a model of the system can be inferred from a set of data collected during a practical experiment. The second approach consists of modeling the structural dynamics in the form of the partial differential equations (PDE) derived from physical principles such as forces and moments' balance and it is also considered here. The aim of this work is the comparison of the results obtained by both methods for a thin circular plate with surface mounted piezoelectric elements. The choice of structure is motivated by its simplicity and its representative nature. For the considered system the high order linear discrete models obtained by parametric identification method have been constructed. Experimental data have been acquire with sampling time 0.0001 sec. on the multi-channel system working under LinuxRT with Master-Slave architecture.

On the other hand the PDE-based model of plate in question has been derived as well. This model has been reduced by BST (Balanced Stochastic Truncation) method and discretized with bilinear transformation. The frequency range of enough agreement for both obtained models has been determined.

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68. Modeling of torsional vibration in harmonic drives

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Harmonic Drives (HD) play important rule in industrial applications and precise medical equipments. They offer unique features, such as high gear ratios, high torque capacities, compact geometry, zero back-slash and high efficiency. However, the torsional flexibility, friction and nonlinear hysteresis enhance to the system the complex dynamic behavior, which reveals as torsional vibrations. In consequence, to improve the performance of new machines, the transmission compliance and internal friction mechanism must be analyzed.

This paper is concerned with precise mathematical modeling of HD. The proposed model consists of three components: hysteresis, friction and torsion flexibility. The hysteresis has been modeled as weighted combination of individual Preisach cells to form global operator, which generates adequate hysteresis curve due to measured data. Friction model includes a lubricated contact force and dynamic behavior developed by Bliman & Sorine. The last component of the HD model describes the flexspline (the flexspline is a flexible cylinder made of steel with outer teeth) flexibility, that produces substantial transmission torsion. Original proposition assumes that the flexspline can be modeled as cylindrical shell FEM model ($n \times m$ degree

of freedom mass-spring-damper system.), based on 16 directional mesh (four nearest-stretch springs, four diagonal-shear springs and eight next-nearest neighbors, nonlinear bend spring). The flexspline is loaded on both sides by the various forces which are tangent to the flexspline surface. The friction torques has been taken into account on both sides of HD: one in the input side, another on the output side.

Simulation results show that the developed model has satisfactory features and accuracy and can be used in ongoing research to develop variant of MRAC-type controllers for vibration cancellation.

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69. The road traffic noise attenuation by external wall of office building in standard work condition

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The methods to estimate the road traffic noise at workplaces in the office buildings are based on the results of noise assessment in the surrounding and sound *insulation of external wall* when the windows are closed. The value of this parameter is quite this same as the value of the windows. But in standard work conditions the windows are often open, half-open, or untight (variants of the "open" window). Therefore in order to predict SPL at the workplace in standard work conditions, it is necessary to take into account how the sound insulation of the external wall depends on the opening of the window. In this article are results of measurement in 30 rooms. In order to estimate the number of office rooms in which the windows are not tightly closed, a number of random examinations was carried out – the position of window was checked in 1296 office rooms.

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70. Effect of measurement method on an earmuff's frequency response

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Light, medium and heavy earmuffs' amplitude frequency response was measured using insertion loss technique with a microphone placed in subject's ear (MIRE – microphone in real ear) and on an artificial test fixture (ATF). Measurements were conducted in frequency range up to 9 kHz employing maximum length sequence (MLS) method. This method shows details of earmuffs' amplitude frequency response, in contrast to sound attenuation data obtained in octave bands according to the EN-ISO 4869-1 standard. The study compared the ATF data with results measured on a person when soft tissues influenced the ripples of the obtained frequency response. Results were also judged against the sound attenuation data of the REAT method used in certification of hearing protectors.

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71. The acoustic properties of the lightweight structures

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On the construction, polish market light panels begin to be very often used materials by investors and contractors of industrial buildings. They are very willingly used as façades or internal partitions with regard

to their easiness and fast mounting as well as low mass of elements. The typical examples of this type of systems are sandwich panels or two - layer system produced during building mounting.

In the paper the measurement results of different structures and their sound insulation and sound absorption properties are discussed. One took an attitude to this problems, having the use of the researches of the ITB Department of Acoustics within the confines of approval procedures and principles of the acoustical designing of the buildings, as well as the synthesis of the measurement results of different material and construction solutions of the lightweight structures.

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72. A two-stage wiener filter based multi-channel feedback virtual microphone acoustic noise reducing system

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The aim of Virtual-Microphone Control systems is to generate zones of quiet at desired locations. The system considered in this paper does not require identification of the virtual paths, usually time-variant. It is, however, assumed that corresponding disturbances at the real and virtual microphones can be considered equivalent.

The system has two stages of operation. In the first stage physical microphones are placed at positions of corresponding virtual microphones. At the same time a filter matrix is designed so that a particular vector signal is minimised. In the second stage the virtual-microphone signals are not used for control. The filter matrix is employed to work out command signals for the real-microphone signals. For both stages the estimates of the disturbances are the control filter inputs. Although the system is of feedback structure the design problem is reformulated so that the Wiener filter approach can be applied. A polynomial technique is used. Due to non-minimum phase character of the plant including delays it requires performing the inner-outer factorization of a polynomial matrix and the causal-anticausal decomposition. The system has successfully been applied for noise control in an active headrest system.

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73. Investigations of sound absorbing properties of selected granular materials

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The results of investigations of sound absorption coefficients for selected granular materials (polypropylene, polystyrene and "keramzyt" granulates, high-silica sand) being often applied as sound absorbing cores in double-wall partitions are presented in the paper. Tests were performed for samples of two thicknesses of layers: 20 and 50 mm. The results confirmed good sound absorbing properties of granular materials, which placed them in the group of sound absorbing materials applicable in constructions limiting noises of machines and devices. The authors of the paper have already for several years been performing research on application of granular materials in sound absorbing and insulating partitions being applied in integrated enclosures for machines and devices, which require continuous and direct servicing. Such machines cannot be placed in the classic sound absorbing insulated housings, which any access to the machine render difficult. Granular materials can also be successfully applied in modifications of machine frames in such a way as to increase their resistance to sound transmission. The positive results of an acoustic effectiveness of prototype solutions with granular materials – worked out by the authors – created the need of verification their ability for sound absorption, especially since no information on this problem can be found in the scientific and technological references.

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74. Method the preliminary of identification of ultrasonic noise at workstations

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Ultrasonic noise at workplaces in Poland is defined as the broadband noise containing high audible and low ultrasonic frequencies. In Poland, the assessment of ultrasonic noise exposure is based on (equivalent and maximum) sound pressure level in the 1/3 octave band (the central frequencies are from 10 kHz to 40 kHz). The best method for determine the current level of ultrasonic noise exposure at workplaces is measurement method. It is not possible to use it in every case.

This article presents the method allows for a preliminary identification of workplaces at which an ultrasonic noise exposure occurs. The method takes into account two logical indicators. The first one is based on the awareness of ultrasonic sources (eg. ultrasonic washers, ultrasonic welders, ultrasonic drills, soldering tools, galvanizing pots). The second one takes into account the aural perception of high-frequency noise, which in many cases, occurs concurrently with ultrasonic noise (e.g. wheezing, whistling, squeaky). These logical indicators are implemented in a questionnaire (based on the subjective assessments of workers). This method was verified on the results from the 200 questioners' answers.

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75. Application of the inverse method in the estimation of noise emission from industrial plants

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Methods of determination of the acoustic model parameters of industrial plants are presented in the paper. Such determination is related to an identification of noise sources in the factory, their localisation and acoustic parameters. In order to determine the source parameters correctly, it is necessary to utilise the whole available knowledge, the one obtained due to acoustic measurements as well as the one given *a priori* (e.g on the basis of catalogues of devices). The inverse acoustic method with the utilisation of the algorithm of the highest likelihood was applied in the solution. The theoretical assumptions of the method, adjustment to the industrial conditions as well the examples of computer simulations are presented in the paper. The paper is of an introductory character and the problem will be developed further.

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76. Evaluation of the active plate vibration reduction via the parameter of the acoustic field

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Effectiveness of the active vibration reduction of triangular plate is evaluated by way of the analysis of acoustical field. The active vibration reduction is performed with actuators. But the effect is measured

via the analysis of the acoustical field both far distance and near one from the plate. As the measure any difference between acoustical pressures is considered. The first pressure and the second one are emitted by the plate without and with the vibration reduction, respectively. The measure is calculated for two reduction cases. First case, when actuators are attached at so called quasi-optimal places and second one, when they are somewhat shifted.

The numerical calculations show that the acoustical field is sensitive to change of the plate vibration. It records even little changes of the plate vibrations in both active reduction cases mentioned above. So that it is handy indirect measure of the active vibration reduction.

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77. Algorithms of acoustic signal filtering

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In the article, there are described three methods of acoustic signals filtering, which are based on time-frequency analysis: Short Time Fourier Transform (STFT), Wigner Distribution and S-method. There are presented a individual conceptions of this method and showed a examples of their realizations. Short Time Fourier Transform makes a complex spectrum of signal variable in time. It is a simple extension of the FT, where the FT is repeatedly evaluated for a running windowed version of the time domain signal. Each FT gives a frequency domain "slice" associated with the time value at the window center. In Wigner Distribution for individual moments of time, we estimate the autocorrelation function by means of individual sample products. When we apply a Fast Fourier Transform, we get power spectrum of signal in each moment. Basic property of the S-method is that it can produce time-frequency representation of a multicomponent signal equal to the sum of the WD of each component, avoiding cross-terms. The autocorrelation function is multiplied by window in each time interval.

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78. Statistical analysis of a noise measurements for the series of ro-ro ships

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The importance of noise and vibration measurements during the sea trials is significant, especially now when noise limits are getting more restrictive and ship-owners demand to obey those noise limits. For a new-built vessels the normal procedure is to perform noise forecast at design stage. Taking into account weight limiting the passive noise insulation becomes a very important issue, therefore in order to avoid solutions which are not effective one should base on a realistic data. Noise forecasts are mostly based on initial documentation and characteristics of main sources e.g. engines, generator sets, propellers etc, which are provided (measured or calculated) by manufacturers. Ship noise prediction might differ from real on-board noise situation. The question is what is a standard deviation between forecast and noise measurement. Normally for noise prediction analysis the worst case scenario is taken into account, so one can expect that real on-board noise levels will be lower then forecasted. However, when weight limits are taken into account in standard work case scenario the real on-board noise levels are more or less the same as forecasted The question is how much is it "more or less"? Conducting the measurements onboard of a series of ships creates the convenient opportunity to perform statistical analysis of the results. The paper focuses on statistical analysis of noise measurements performed for the series of ro-ro ships.

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79. Uncertainty of industrial noise measurement at distant locations from the source

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Methodologies for industry noise measurement usually include the range of weather conditions in which the measurements must be taken. Among them a large spread of permissible temperature, humidity, atmospheric pressure and wind speed (up to 5 m/s) in particularly, might be a cause of relevant spread of measurement results at distant locations from the source. The effects of meteorological conditions on sound propagation are small for short distances, and larger for longer distances at greater receiver and source heights.

One can find some algorithms in ISO 9613-1,2 for calculation of weather conditions impact on community noise, so called Cmet, but especially wind correction, is rather poor, limited to only two cases; moderate downwind and a variety of meteorological conditions as they exist over months or years. The problem begins in calculating long-term average A-weighted level using short-term data with unknown detail weather conditions on the path of sound propagation.

The paper deals with some real word data of partial uncertainties of noise prediction and measurement from large industry and impulse sound sources, taken in different meteorological conditions. It has been shown that in some cases maximum spread of the data exceeds 20 dB with the same state of industry running and completely similar weather conditions. In case of the impulse sources it has been shown uncertainty analysis for the impulse sound power and sound exposure level at reference distance of 1 km.

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80. Uncertainty of sound insulation measurement in laboratory conditions

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Protection against noise is one of the six essentials requirements of the European Union directive. In buildings, airborne sound insulation is used to define the acoustical quality between rooms. But the assessment of a sound insulation makes same difficulties in field measurements but in laboratory measurements as well, even tough there are existing some uniform ISO 140 methods. One can find some obstacles with reproducibility and repeatability of the measurement results. Some other difficulties might be caused by non diffuse acoustic field, non uniform reverberation time and an error of the reverberation time measurements. A little less important is flanking transmission and the S/N ratio.

The paper includes some analysis of the partial uncertainty of the above mentioned components and its influence on the combine uncertainty in 1/3 octave frequency bands and the sound reduction index determined according to ISO 140-3, using the uncertainty propagation law.

All of the analysis and calculations performed in the paper concern the conjugated reverberation rooms and measurement set-up in AGH-UST Department of Mechanics and Vibroacoustics in Kraków.

Electroacoustics

81. Investigation of the acoustic pressure distribution occurring around an aerial substation adjacent to apartment buildings

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The subject matter of the research work presented in this paper refers to the measurements of the values of the acoustic pressure levels (noise) occurring around a main feeding-point aerial substation adjacent to apartment buildings. The paper presents the values of the noise accompanying the particular power devices, mainly transformers, during their regular operation. The main aim of this research work was the comparison and assessment of the acoustic pressure values measured with the permissible values defined by environmental standards binding in Poland. The experiment results obtained made it possible to determine graphic areas of acoustic pressure, based on which it was possible to determine a zone for which the values obtained assume permissible parameters.

The research analysis carried out proved that during a long-term operation of power appliances installed in substations the acoustic pressure level that they emit into the environment is not constant but is subject to changes. Thus the increase of the noise level above the permissible values can be the cause of violation of environmental standards. Due to a significant increase of people's awareness and readiness to claim their rights, the main consequence of violating the standards is a growing number of claims. Therefore it is imperative that the level of the acoustic pressure be monitored during routine tests, especially around high-power transformers.

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82. Comparative analysis of the AE signals generated by partial single- and multi-source discharges

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Within the research work carried out, the results of which are presented in this paper, a comparative analysis of the acoustic emission (AE) signals generated by partial single- and multi-source discharges (PDs) was carried out. The investigations were carried out in a model system, in which PDs were generated with two identical spark-gaps. In the work, spark-gaps in the surface system were used, due to the fact that this is the PD form occurring most often in power transformers. The AE signals were registered with a contact transducer placed on the external part of the tub. For the AE signals generated by both single-source PDs and multi-source PDs, a frequency analysis using a fast Fourier transform (FFT) and an analysis in the time-frequency domain using a short-time Fourier transform (STFT) were carried out. The results of the frequency analysis are presented in the form of power density spectra, and the time-frequency analysis results in the form of spectrograms. Analyzing the research results the signals registered were compared from the point of view of identification possibilities of the particular PD forms. The aim of the research

work carried out is also proving the usefulness of the AE method for diagnosing the condition of high-voltage power appliance insulation, in which multi-source discharges occur.

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83. Comparative calibrations – in a free field – of measuring microphones

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Comparison of calibrations of measuring microphones obtained in two laboratories – Laboratory of Physikalisch-Technische Bundesanstalt in Braunschweig (Germany) and Laboratory of Vibroacoustics at the AGH University of Science and Technology in Kraków (Poland) is presented in the paper. However, the performed calibrations were not the official InterLaboratory Comparisons (ILC), since those comparisons in the field of *Calibrations of reference microphones in a free field* are still at the preparatory stage.

The paper contains comparisons of the calibration results (together with uncertainty of measurements) obtained in both laboratories for exactly the same devices as well as the traceability of the results. According to the guidelines of the Polish Centre for Accreditation – given in the DA-05 document – the index E_n constitutes the assessment criterion.

The selected problems related to calibrations and influencing their results – are discussed by the authors. They have drawn a special attention to comparisons of the calibration results obtained in various laboratories. Those problems are connected – among others – with the lack of basic data in the Calibration Certificates concerning e.g. traceability of the results, reference microphones, methods of measurements and uncertainty of measurements assessments. The paper contains suggestions concerning further co-operation of laboratories in this field.

Hydroacoustics

84. Modeling of narrow and wideband signals scattering by randomly distributed scattering points

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Presented in the paper issue of surface and volume scattering of acoustic wave in marine environment is fundamental problem related to mono-, bi- and multistatic acoustic systems operating in littoral sea. Reverberation creating as a result of the scattering has a significantly influence on the small target detection. Modeling of narrow and wideband signal scattering has been carried out using MATLAB. To solve the issue we accepted that scattering occurred on randomly distributed points which generated scattering waves received and summed in receiver. Density and arrangement of the points is a measure of environment scattering property. The analyses, by signal processing in matched filter, were made for LFM, HFM and CW signals (for comparison). The effect of signal parameters on scattering was investigated also.

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85. Application of time reversal technique in shallow water environment

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Underwater acoustic communications in shallow water environment is a challenging problem due to the intersymbol interference caused by time-varying dispersive multipath channel. This paper describes the time reversal technique and its spatial and temporal focal properties to reduce dispersion, channel fading and intersymbol interference which causes serve distortion on the communication signals. In a strong multipath environment the time reversal process offers unique opportunity for solving the multipath problem and recovers the original signal at the focus. Communication systems can be divided into incoherent or coherent modulation systems. In this article coherent underwater acoustic communication method was presented by using phase conjugation technique. Recently time reversal communications is a method introduced to the underwater acoustic communication and presented results confirm the potential utility of the phase conjugation in shallow water environment to underwater communications.

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86. Visualisation forms in long range sonar with cylindrical transducer array

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This paper presents forms of visualisation used in long range sonar modernised at the Department of Marine Electronics Systems. The introduction gives an overview of the design of the sonar and the type of signals transmitted, received, processed and used for imagining. The article then describes the other factors, which are important for how images are organised, i.e. the operators' tasks, the settings and how they are presented, other data from additional sonar sensors, how the systems works with the other onboard systems (gyro, GPS, ECDIS, sound velocity meter), operator training and ergonomics. Examples of images for active and passive operating mode are included.

Psychoacoustics

87. Perceptual consequences of change in parameters of vocoded speech for various reverberation conditions

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The perceptual consequence of change in parameters of vocoded speech for various reverberation conditions has been examined. The three controlled variables were: number of bands, instantaneous frequency changes rate and reverberation conditions. The effects were quantified in terms of: (a) non-words'

recognition scores for young normal-hearing listeners, (b) 'ease of listening' based on the time of reaction (response delay) and (c) the subjective measure of difficulty (ten-degree scale). The results have shown that the fine structure information is a relevant cue in speech perception in reverberation conditions. It has also been observed that only the slow variations of instantaneous frequency are critical in perception. A good correlation was found between all subjective measures considered in this study.

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88. Modulation masking phenomenon for masking signals of different statistical and spectral properties

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Modulation masking effect for modulation maskers of different spectral and statistical properties was investigated in this study. Three noisebands centred at 16 Hz were used as modulation maskers, namely: 1) 32 Hz wide Gaussian noise (GN 32 Hz); 2) 32 Hz wide low-noise noise (LNN 32 Hz) and 3) 4 Hz wide low-noise noise (LNN 4 Hz). The GN 32 Hz and LNN 32 Hz were characterized by the same power spectrum density and different probability density functions, i.e. GN 32 Hz revealed a typical normal distribution, while LNN 32 Hz was characterized by "U-shaped" (subgaussian) probability density function. Conversely, the LNN 32 Hz and LNN 4 Hz had the same probability density functions, but different power spectra. The results of the measurements indicated that modulation masking was mainly determined by power density spectrum of the modulation masker, however, probably due to peripheral compression, temporal properties of the masker might play also some role in the modulation masking.

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89. Efficiency of blind source separation in a real room

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The present study is concerned with the effectiveness of the blind source separation (BSS) in real acoustical environment measured by means of a speech reception threshold, SRT. BSS is a multisensoral method that leads to a signal extraction from a mixture of sounds. The performance of such algorithms are most often describe by means of the increase in signal-to-noise ratio, SNR. However, the SNR is not an appropriate measure for speech enhancement, since increase in SNR does not lead directly to the improvement of the speech intelligibility. Thus, the relationship between an increase in SNR and speech intelligibility is not straightforward.

This work shows some experiments in which the speech masked by a babble noise, music or concurrent speech was separated out using algorithm for convolutive BSS. The SRT before and after the separation was measured for subjects with audiologically normal hearing.

All recordings were carried out in a small office room using an array of two microphones. Two spatially separated loudspeakers were used as sources of signals: target speech and disturbances.

The results of the experiment revealed a marked improvement in the speech intelligibility: the decrease in SRT reached about 10 to 15 dB in individual cases.

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90. Acoustical model of the head for HRTF calculation

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In this paper numerical model of a dummy head is presented. This model is used for calculations of Head-Related Transfer Function (HRTF). The model allows to determine the value of HRTF without the measurements making. The model includes both geometrical and acoustical parameters. The model consists of a set of triangles placed in 3D space. The dependence of precision of the real model projecting geometric shapes on the polygons amount is presented. It is pointed out which parts of the model have to be projected with more accuracy (using a bigger amount of elements for a surface unit) and which may be projected with a less accuracy. The resolution of the model to gain proper numerical calculation results is discussed. The consequences of utilisation unproportional projecting precision on the results of the simulation are explained. The other material parameters connected with acoustical properties of artificial head are presented, especially acoustical impedance.

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91. Implementation of the FAST-PTC measurement method on a PC platform

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Dead regions (DRs) are areas in the cochlea where the Inner Hair Cells (IHCs) or/and neurons innervating them are damage or not functioning and the information from these areas is not transmitted to the higher stages of the auditory system. Diagnose of the dead region is very important especially in hearing aid fitting, as a gain applied to a frequency area coinciding with the region deteriorates speech intelligibility. Measurement of the Psychophysical Tuning Curve (PTC) turned out to be the best method for determining the frequency limit(s) of the dead region, especially its fast version (FAST-PTC) proposed by Sęk *et al.* [International Journal of Audiology, **44**, 408-420 (2005)]. The FAST-PTC enables measurement of a single PTC during merely 4 minutes while the traditional method, based on 2AFC procedure takes about 2 hours. So far, to use the FAST-PTC method it was necessary to use TDT system which is not widely available. As a quality of sound cards in PCs has been markedly improved it was possible to implement the FAST-PTC on a PC computer. Therefore this paper presents details of the FAST-PTC method implemented on a PC computer as well as some initial results gathered by means of this application.