

## Chronicle

### 40th Winter School on Vibroacoustical HazardsSuppressions Szczyrk, Poland, February 27 – March 2, 2012

Traditionally you are invited to acquaint yourselves with some abstracts of lectures submitted to the 40th Winter School on Vibroacoustical Hazards Suppressions. This national School is traditionally held at the turn of February and March and is organized in different places of Silesian Beskidy Mountains. This year it is again held in Szczyrk.

This year we celebrate the jubilee edition of the School. Because of this anniversary the conference apart from standard organizers, i.e. Upper Silesian Division of the Polish Acoustical Society and Institute of Physics – Science-Didactic Center at the Silesian University of Technology, has also a co-organizer – the Committee on Acoustics of the Polish Academy of Sciences. Moreover there are two splendid honorary patrons – Prof. Zbigniew Engel, president of the Committee on Acoustics of the Polish Academy of Sciences, and Prof. Andrzej Bluszczyk, director of the Institute of Physics – Science-Didactic Center at the Silesian University of Technology.

The conference is a forum for all environmental vibroacoustic fields. Particularly it concerns traffic noise, industry noise, vibroacoustics of machines, room acoustics, noise protection and similar problems. Works which are presented during the School are theoretical, experimental, measuring, technical, applied and normative. The program of the 40th edition of the School is very rich – there are some occasional lectures to celebrate our anniversary and many plenary lectures which recapitulate different achievements in Polish environmental acoustics. It should be mentioned that this year Polish acousticians celebrate the centennial birthday of a famous Polish scientist, Ignacy Malecki.

The School lectures and other conference materials will be published in the “Materials of the XL Winter School on Vibroacoustical Hazards Suppressions” (in Polish) edited by dr. Roman Bukowski. This publication will be intended for participants of the School and for many libraries in Poland.

Other information about the 40th WS on VHS you can find on our website

<http://ogpta.pols.pl/szzzw>

The School is traditionally sponsored by the Ministry of Science and Higher Education.

On behalf of Organizers  
*Roman Bukowski*  
Chairman of the Conference

#### Abstracts

##### **The verification of the accuracy of calculations of acoustic emission due to accepted source modeling way**

BOCZKOWSKI Arkadiusz, arekb@polsl.pl  
KOŹLIK Grzegorz

Silesian University of Technology  
Institute of Production Engineering  
Roosevelta 26, 41-800 Zabrze, Poland

The implementation of the strategic acoustic maps or evaluation of traffic investments interactions entails the necessity of modeling the traffic noise sources and calculating the emission of acoustic source.

The modeling of the traffic noise seems to be the complex matter owing to different methods of modeling the road geometry (e.g. the number of roads and lines) and the possibility of application different methods of calculation. Mentioned factors significantly affect the accuracy in received results.

The article presents the course and the results of the scientific experiment, which main aim was analyzing the impact of different ways of modeling the traffic noise sources and the influence of the applied method of calculation on the accuracy in calculations of road acoustic emission.

With particular precision there were explored the results obtained with the use of French calculating me-

thod NMPB Routes 96 recommended by The Directive 2002/49/WE for traffic noise calculations.

\* \* \*

### **Possibilities of periodical calibrating of the sound level meter realized in B&K PULSE system**

DOBROWOLSKA Danuta, d.dobrowolska@gum.gov.pl  
KACZOROWSKI Bartosz, b.kaczorowski@gum.gov.pl

Central Office of Measures  
Elektoralna 2, 00-139 Warszawa, Poland

The growing number of the users of the B&K PULSE system observed in Poland recently and the awareness of the influence of the measuring equipment on the results of measurements and the associated uncertainty have caused the need of taking up the problem of periodic metrological testing of these devices. The difficulty of such testing results from the great flexibility of this system and consequently from variability of sound level measurement setup parameters in dependence of system configuration. The conventional sound level meter with microphone of specified type, equipped with display device has got characteristics precisely specified and declared by the producer. The calibration of such meter is performed according to the range and using the methods established internationally. In the case of sound level meter based on B&K PULSE system its configuration and characteristics according to the need of the user have to be established before calibration. Additionally there is a need to design the system of windows in the computer being a part of the B&K PULSE system to enable the read out of the results during the measurements. In the paper the method of configuration of the system for its periodic testing is proposed and the results obtained for one specific system under test are presented and discussed.

\* \* \*

### **Damage degree analysis of beam with fuzzy logic application**

DOMINIK Ireneusz, dominik@agh.edu.pl  
IWANIEC Marek, iwaniec@agh.edu.pl

AGH University of Science and Technology  
Department of Process Control  
Al. A. Mickiewicza 30, 30-059 Kraków, Poland

The paper presents an innovative method for calculating the damage degree of beam with fuzzy logic application. Damage changes in constructions manifest themselves in small but detectable variations of frequency. The change of the speed of wave propagation, which is associated with the change of the resonance frequency in the system, is caused by the deformation of the examined material. This phenomenon can be used for an indirect analyse of the construction damage.

The main aim of the article is presentation of the program designed in prospect to analyse the vibration of the electric pylons. The program was created in LabView programming environment with Fuzzy Logic Toolkit. Description of the program, all of its structures and working methods are included.

In the preliminary tests the research were conducted on the simulation data of the virtual beam. The beam was divided into ten parts in which step by step the Young's modulus was decrease. It simulated the damage degree e.g. splitting. The results proved the applicability of the presented method.

\* \* \*

### **Noise reduction inside the building from the compressor room**

FIEBIG Wiesław, wieslaw.fiebig@pwr.wroc.pl  
Wroclaw University of Technology  
Institute of Machine Design I-16  
Łukasiewicza 7/9, 50-371 Wrocław, Poland

In this paper the methods for the noise reduction in the building have been described and investigated. On the first floor of the building in a technical room two compressors for the refrigerators in the shopping center have been installed. The noise from these steady working compressors has been transmitted to the adjacent rooms as air borne noise as well as the structure borne noise. It has been stated that the noise transmitted from the compressor units can be reduced with the vibration and noise isolation measures. To reduce the transmission of structure borne noise from the compressor units the vibration isolation has been introduced. To reduce the air borne noise both compressor units have been equipped with a capsulation. As result the noise levels below 40 dB(A) in all adjacent rooms have been achieved.

\* \* \*

### **The system creating spatial zones of quiet around the wireless microphone**

FILEC Mateusz  
MICHALCZYK Małgorzata I.,  
malgorzata.michalczyk@polsl.pl

Silesian University of Technology  
Institute of Automatic Control  
Akademicka 16, 44-100 Gliwice, Poland

The paper presents results of a research on an active noise control (ANC) system creating a local spatial zone of quiet that can follow the movement of a microphone. Most of implementations of ANC in enclosures are generally systems creating stationary zones of quiet. Then system users may feel discomfort while moving from a zone of quiet to a zone of noise amplification, unless the zone of quiet is global. Creating a local zone of quiet following the user should increase his comfort and safety. The ANC system creating a zone of quiet around a user taking into account his movement is concerned in the paper. The idea is to equip the user with a wireless microphone around which the zone of quiet is created. The movement of the zone of quiet is assured by application of adaptive control algorithm based on FX-LMS algorithm with an additional on-line identification procedure for electro-acoustic plant model estimation. The paper presents results of the laboratory experiments, showing the effectiveness of the system.

\* \* \*

### Research into mechanical systems dynamic properties with the application of ARMA method

HOLEWA Karolina<sup>1</sup>, holewa@agh.edu.pl

DUDZIŃSKA Anna<sup>1</sup>

IWANIEC Joanna<sup>2</sup>, jiwaniec@agh.edu.pl

IWANIEC Marek<sup>1</sup>, MALICKI Łukasz<sup>1</sup>

AGH University of Science and Technology  
Faculty of Mechanical Engineering and Robotics

<sup>1</sup> Department of Process Control

<sup>2</sup> Department of Robotics and Mechatronics

Al. A. Mickiewicza 30, 30-059 Kraków, Poland

The paper concerns application of the autoregressive moving average modal analysis method (ARMA) to research into dynamic properties of mechanical systems. ARMA model is a mathematical model of autocorrelation of time series. ARMA modelling is frequently used for the purposes of prediction of system future behaviour on the basis of time series registered beforehand and provides knowledge concerning physical aspects of system performance by process analysis and simulation. In the paper there are presented the results of the research into dynamic properties of the experimental vibratory machine carried out on the basis of vibration accelerations measured in the vertical direction. At the initial stage of the research linearity of the considered machine body suspension was verified with the application of the restoring force method. System stationarity was investigated with the use of recurrence plots and ADF test methods while modal parameters were estimated by means of the LSCF and LSCE modal methods. In the second stage of the research ARMA method was applied to modelling of the registered vibration acceleration time histories. The authors proposed algorithm for selection of best ARMA model parameters based on the AIC criterion and Ljung-Box test. The last stage of the research consisted in computation of system natural frequencies from the estimated ARMA model and their verification by comparison with the results of spectral analysis.

\* \* \*

### Identification of Ancient Frescos Inner Structures

IWANIEC Marek, iwaniec@agh.edu.pl

AGH University of Science and Technology  
Faculty of Mechanical Engineering and Robotics  
Department of Process Control

Al. A. Mickiewicza 30, 30-059 Kraków, Poland

Circular plates are the subsystems that are relatively often used in machine constructions, buildings, means of transport, etc. Circular, clamped plate with different boundary conditions excited with acoustical pressure proves to be a very efficient model of delaminations appearing in multilayered materials as a result of lack of adhesive forces. As a particular example of such a structure the ancient fresco structure can be considered. The inner structure of fresco consists of a few layers of plaster successively made of dissimilar mortar. Each layer has been made one after another in different condition of humidity, surface roughness and chemical properties of the mortar. In the course of centuries the adhesive forces between layers are weaken which results in unrecoverable destructions of ancient monuments of art.

The paper concerns analysis of physical phenomena which appears and can be measured with non destructive methods. The theoretical analysis focuses on changes in dynamical responses and modal parameters resulting from changes in the boundary conditions and growth of delaminations. The known, non-invasive methods dedicated to ancient frescos structural health monitoring as well as the new methods developed by the author are presented. The theoretical results are compared with the results of measurements carried out on the specially prepared samples.

\* \* \*

### Beam condition assessment on the basis of MDLAC criterion

IWANIEC Marek, iwaniec@agh.edu.pl

SZOPA Krystian, kszopa@agh.edu.pl

AGH University of Science and Technology  
Faculty of Mechanical Engineering and Robotics  
Al. A. Mickiewicza 30, 30-059 Kraków, Poland

Dynamic properties of mechanical structures are the basis of condition assessment of these technical objects. The analysis of natural frequencies and mode shapes, gives the possibility to detect damage location in the individual elements of structure. This paper concerns MDLAC (multiple damage location assurance criterion), that allows to determine the level of correlation between measured and predicted (obtained from numerical model) natural frequencies. This criterion allows to adjust numerical model to real construction, and thus to find the locations and levels of damage, without the need of using the mode shapes in calculations. This paper presents the experiment conducted on steel, unilaterally restrained beam with a damage in the form of reduced cross-sectional area at a specific location along its length. The MDLAC criterion was determined for the beam and its numerical models, and thus the damage locations were possible to detect. We also described further steps of research towards increased use and efficiency of discussed method.

\* \* \*

### Measuring environmental noise and sound power level for wind turbine

KACZOROWSKI Bartosz, b.kaczorowski@gum.gov.pl

Central Office of Measures  
Elektoralna 2, 00-139 Warszawa, Poland

In recent years a growing number of investments aimed at generating energy from renewable sources can be noticed. One way of obtaining ecologically clean energy are wind farms.

Devices of this type, in addition to shadow flicker or interfering with the natural landscape, are a source of noise. One way to predict the extent to which wind turbines interfere with the area in terms of noise, computer simulations are performed using appropriate software. In such programs sound power level supplied by the manufacturer of wind turbines are inserted. The result is a map of sound levels, which exceeds the permissible limits.

This paper presents the results of the thesis done by Bartosz Kaczorowski and Michał Romanowicz within the

postgraduate study “*Environmental identification of acoustic and vibration threats*” in the faculty of Automotive and Construction Machinery Engineering at the Warsaw University of Technology. The work sets the sound power level according to the standard IEC 61400-11:2004 and on this basis, verifies the data from the manufacturer. Within the thesis sound levels were also measured at a far distance from wind farm and the results were compared with values obtained using WindPRO, whose computational model is based on the standard ISO 9613-2:2002.

\* \* \*

### Noise barriers as the source of the low-frequency noise in the external environment

KOMPALA Janusz, jkompala@gig.eu

Central Mining Institute

Laboratory of Technical Acoustics

Pl. Gwarków 1, 40-166 Katowice, Poland

In recent years more and more attention has been paid to the low-frequency noise nuisance. This noise in the range of 10 Hz up to 200 Hz has been regarded as one of the important problems in the protection of human living standards against excessive noise. In accordance with the recommendations of the European Commission “less noise before 2020” the ideas have been created, with the necessity of creating a basis for assessment and mitigation of low-frequency noise in the environment.

Traditional methods of noise assessing, based on the measurements of equivalent noise level with the correction A, have been found insufficient for the low-frequency source.

The experiments that have been carried out proved that noise emitted at 40–100 dB (depending on the specific frequency) would not cause health problems but might cause many nuisances. As an example, results of the tests, carried out in the external environment and in the living quarters located in the direct neighbourhood of the noise barrier – crucial source of such problems, could be stated.

\* \* \*

### Problems of index assessment of vibroacoustic hazard at workstation in open pit mines

KOSAŁA Krzysztof<sup>1,2</sup>, kosala@agh.edu.pl  
ZAWIESKA Wiktor<sup>2</sup>

<sup>1</sup>AGH University of Science and Technology  
Faculty of Mechanical Engineering and Robotics  
Al. A. Mickiewicza 30, 30-059 Kraków, Poland

<sup>2</sup> Central Institute for Labour Protection  
– National Research Institute  
Czerniakowska 16, 00-701 Warszawa, Poland

Problems concerned with proposition of index method of vibroacoustic hazard assessment at workstations in open pit mines of rock raw materials were shown in the paper. There are many indices in vibroacoustic processes investigations, single number ones too. One of them is the vibroacoustic global index of sustainable development, which has been recently defined. This index is a function of several partial indices of assessment, which are dependent on many acoustic parameters as well as geometrical and construction of investigated environment ones.

Proposition of index assessment of hazard of work environment on open pit mine example was shown in the paper. The hazard assessment index at workstation – crusher, after making additional vibroacoustic investigations and verification, will be the part of the global index of sustainable development.

\* \* \*

### Application of decision supporting tools in management of the acoustic environment

KUBOSZEK Artur, KAŻMIERCZAK Jan

KOMONIEWSKI Marek, PASZKOWSKI Waldemar

BOCZKOWSKI Arkadiusz, DĄBROWSKI Marcin

Silesian University of Technology

Institute of Production Engineering

Roosevelta 26, 41-800 Zabrze, Poland

The article presents the results of research done in the Institute of Production Engineering on the Faculty of Organization and Management at the Silesian University of Technology within the development project “Network consultation and advisory system for the processes of creation and exploitation of strategic acoustic maps”. The objective of the project is creation of complex computer system integrating a range of internet and multimedia tools, which enable their users to constant access to information related with creation and exploitation of the maps. The system uses advanced computer techniques such as expert systems, e-learning, virtual consultant and hardware tools (i.e. videoconference equipment).

\* \* \*

### Damage location of lattice construction based on modification of elements of stiffness matrix

ŁUKASZ Lech, llech@agh.edu.pl

IWANIEC Marek, iwaniec@agh.edu.pl

AGH University of Science and Technology

Department of Process Control

Al. A. Mickiewicza 30, 30-059 Kraków, Poland

The need for quantitative global damage detection methods that can be applied to complex structures has led to the development and continued research of methods that examine changes in the vibration characteristics of the structure. Thus, since couple last years vibration-based identification methods play important role in assessment of mechanical condition in physical systems because they are few techniques that monitor changes in the structure on a global basis. They allow to detect and localize damage in very complex structures with high confidence level so they are eagerly applied in intelligent monitoring systems in structures such as: aerospace, civil and mechanical engineering infrastructure.

Presented method is based on stiffness matrix update in conjunction with a powerful tool to simulate dynamics in physical systems i.e. finite element method. In modelling stage a different level of damage of particular elements are considered. In the next step, eigenvalue problem is solved so that eigenvalues can be extracted. In this way a database of natural frequencies of considered cases is created and thus a minimum of the objective function in the form of

difference between measured and simulated frequencies can be calculated.

An analysis was carried out for double circuit suspension straight tower of 110 kV. It was considered damage of for both stiffened elements and load-bearing elements. It was shown sensitivity of the method according to number of natural frequencies and according to center frequency in octave-band.

\* \* \*

### **Active Noise Control of sound transmission through vibrating plate with a virtual microphone**

MAZUR Krzysztof, Krzysztof.Jan.Mazur@polsl.pl  
PAWELCZYK Marek

Silesian University of Technology  
Institute of Automatic Control  
Akademicka 16, 44-100 Gliwice, Poland

The active control of sound transmission through vibrating plates is of great scientific interest because of a number of potential applications. Such systems can achieve much higher noise reduction for low frequencies than passive systems. They are resistant to difficult environmental conditions including dust and humidity.

Because of this they are very attractive for industrial applications, where difficult environmental conditions can cause problems with loudspeakers in classical Active Noise Control systems.

There are many possible goals of active control of sound transmission including reduction of sound radiation from a vibrating plate or reduction of sound pressure level at specified points.

Reduction of sound pressure level at specified points can provide higher reduction levels at those points at cost of lower reduction at other points and need of measurement of sound pressure level at those points.

In this paper an adaptive feed-forward system for reducing sound pressure level at a given area is investigated. For that purpose a virtual microphone control system is applied. It is experimentally verified and obtained results are reported.

\* \* \*

### **Reverberation time and speech transmission index in primary school classrooms**

MIKULSKI Witold, wimik@ciop.pl

Central Institute for Labour Protection  
– National Research Institute  
Czerniakowska 16, 00-701 Warszawa, Poland

Acoustic quality of the classrooms in terms of speech intelligibility can be described using the following parameters: the reverberation time and the speech transmission index STI. The second one more accurately determine these properties, however, is rarely used in practice, because the method of its determination is more complicated and requires more complicated measuring equipment than the measuring equipment for determining the reverberation time. An analysis of determination of the estimated value of speech transmission index on the basis of the reverbera-

tion time was conducted in selected frequency bands. The paper presents a synthesis of the results of these studies.

\* \* \*

### **Frame plasterboard walls of high sound insulation**

NURZYŃSKI Jacek, j.nurzynski@itb.pl

Building Research Institute  
Filtrowa 1, 00-611 Warszawa, Poland

The interest in lightweight partitions and lightweight structures use in a building is continuously increasing. The tendency to reduce total weight of a building and to use more modern lightweight structural solutions will certainly remain as such solutions fit well into the sustainable development scheme and the general concept of the transformation of a present building industry image. Nowadays the most known and most developed are dry partition systems where pivotal role plays frame plasterboard walls. Such solutions are already typical in the case of office buildings, where the acoustical requirements are not very demanding, but are also used in another type of buildings.

Frame plasterboard walls of the structure that may assure high sound insulation are discussed in the paper as well as the structural details crucial for possible achievement of a good acoustical performance. The analysis is performed on the basis of the sound insulation laboratory test carried out in the facilities of Acoustic Department of Building Research Institute. Frame walls of a proper structure may obtain very good sound insulation but it largely depends on the structural details.

\* \* \*

### **Shaping soundscapes in the design of acoustic environment of cities**

PASZKOWSKI Waldemar, wpaszkowski@polsl.pl

Silesian University of Technology  
Institute of Management Production  
Roosevelta 26-28, 41-800 Zabrze, Poland

This article presents a new approach to designing the acoustic climate of cities. Based on a review of literature a currently developing trend has been shown to shape soundscapes for the needs of designing the acoustic environment of cities.

The assumptions and guidelines for shaping city soundscapes as a systemic approach has been described; an approach which puts special emphasis on the perceptive context of the subjective acoustic sensations of the inhabitants. The new approach in this research area requires the methods of identifying noise threat or assessing the degree of noise nuisance to be elaborated anew.

Later in the paper it is discussed how the tasks of spatial planning can be used as an instrument for the local authorities to shape the acoustic environment. In particular, spatial planning can be an effective tool used to 'implement' city soundscapes at the stage of creating new functional and utility structures and of modernizing the existing ones.

The development of the conception of shaping soundscapes may help find another approach to implementing noise protection schemes in cities.

\* \* \*

**Active noise control – solutions and challenges**

PAWELCZYK Marek, Marek.Pawelczyk@polsl.pl

Silesian University of Technology  
Institute of Automatic Control  
Akademicka 16, 44-100 Gliwice, Poland

Active control has been gaining an increasing role in protecting humans against excessive exposure to low-frequency acoustic noise. They are designed as supplements to passive isolation techniques or autonomous solutions. Rapid development of technology including smart materials, electronics, control theory and signal processing algorithms widens areas of active noise control applications. The lecture summarizes current state of the art in the field and main involved research centers in the world. It presents applications from simple personal hearing protection solutions to complex large scale systems with emphasis to noise control in industrial halls. Ideas behind classical and modern control structures and techniques along with guidelines for their choice are demonstrated. Emerging problems are also addressed. They are related to complex coupled physical and control related phenomena. Some of them have already been approached and heuristic solutions seem promising, although full examination and theoretical justification still require extensive research. Perspectives for active noise control are tried to be predicted. The work has been financed from the Polish budget for science in 2009–2012, as a research project no. N N514 232037.

\* \* \*

**Determination of sound absorption properties of materials in frequency range above 4 kHz**

PLEBAN Dariusz, daple@ciop.pl

Central Institute for Labour Protection  
– National Research Institute  
Czerniakowska 16, 00-701 Warszawa, Poland

Measurements of the sound absorption coefficients of materials were carried out in a free field by means of a tone-burst technique in the frequency range from 4 to 40 kHz at angles of incidence varying from 0 to 60°. The absorption coefficients of four materials were calculated from the reflection coefficients obtained by reflecting the tone-burst from both a perfectly reflecting panel and a combination of this panel and the sample of the tested material.

\* \* \*

**Measurement method influence on the acoustical pressure value determined at workplaces in the range 10–40 kHz**

RADOSZ Jan, jarad@ciop.pl

Central Institute for Labour Protection  
– National Research Institute  
Czerniakowska 16, 00-701 Warszawa, Poland

Giving the measured physical quantity, it is necessary to provide quantitative information about the quality of the measurement result to estimate its reliability. One of the elements influencing the quality of the result is a measurement method. The paper presents a study on the impact of the measurement method on the determined values of

sound pressure level at selected workstations in the range 10–40 kHz.

\* \* \*

**Sources of ultrasonic noise in the work environment**

SMAGOWSKA Bożena, bosma@ciop.pl

Central Institute for Labour Protection  
– National Research Institute  
Czerniakowska 16, 00-701 Warszawa, Poland

According to the most advanced knowledge, the influence of industrial noise on human body in the work environment confirmed that this type of noise exerts adverse effects on the hearing organ. It has been determined that faster and greater changes of hearing threshold level occur in the range audiometry of high frequency i.e. in the frequency range 8–20 kHz. Therefore it is important to determine the machines and other devices that are responsible for the emission of ultrasonic noise (10–40 kHz) as harmful and annoying hazard in the work environment. In this paper ultrasonic noise sources that are frequently used in industry have been determined and preventive measures to reduce the exposure to ultrasonic noise have been described. Two types of ultrasonic noise sources have been distinguished: the machines and other devices used to carry out or improve the production processes, so-called technological sources and the sources in which ultrasonic noise exists as unintentional result of work of many devices, so-called non-technological sources of ultrasonic noise. The emission of SPL has been defined for each of the groups of devices, based on literature review and measurements.

\* \* \*

**Switching secondary sources in an active noise control system**WATRAS Piotr, piotr.watras@polsl.pl  
PAWELCZYK Marek, marek.pawelczyk@polsl.plSilesian University of Technology  
Institute of Automatic Control  
Akademicka 16, 44-100 Gliwice, Poland

Active noise control (ANC) systems may use one or more secondary sources to create local zones of quiet around the heads of the persons (users) inside the room in which the system operates. When the users move inside the room, the corresponding zones of quiet should be relocated as well. However, as the user moves away from the secondary source, at first the energy required to control that secondary source increases significantly and, as the user moves further, the effective noise reduction level in a given zone of quiet decreases. The use of all the available secondary sources to create a zone of quiet for one user is not effective due to the computational load and technical requirements for a such ANC system. It is therefore beneficial to use a single secondary source closest to the location of the user and switching between the secondary sources as the user moves.

The aim of this paper is to present a proposed solution for switching secondary sources assuming that the location of the user is known all the time. Furthermore, it is assumed that the immediate change of noise level creates unpleasant experience for the users and ANC system should aim at minimizing the rate at which the noise level changes.