

between actuator driving signals, vibration responses on the touch surface, and radiated sound power. Proper actuator driving signals are derived from the optimization problem formulated using the relationship. The proposed method was demonstrated through vibration rendering experiments on a touch surface comprising an acrylic plate and voice coil actuators. The results showed that the proposed method could shape the acoustic radiation while rendering target vibration patterns at desired positions on the touch surface. This study's proposed method could allow haptic engineers to design vibrotactile feedback and sound radiation simultaneously for a more compelling haptic experience.

**Session: 04.00 Signal Processing, Measurements, Sound Reproduction, Diagnostics for Noise and Vibration  
Engineering, General, Part 2  
Channel 2**

2:40 PM 02-Aug-2021 [IN21\\_1035.pdf](#) DOI: <https://doi.org/10.3397/IN-2021-1035>

***Research on the Layout Optimization of Acoustic Radiation Power Flow Reinforcement Based on Weight-Guide method***

Xiaoyan Teng, Qiang Li, Xudong Jiang, Zhihua Yan

In order to reduce the noise radiation of the plate and shell structure, the Weight-Guide method is used to optimize the layout of stiffeners for acoustic radiation power flow. Firstly, Rayleigh integral method and Helmholtz equation are used to derive the acoustic radiation power flow, and the sensitivity is calculated by using explicit approximation technique, which takes the acoustic power flow as the objective function. Secondly, the guide weight method is used to update the design variables to optimize the layout of stiffeners and change the shape of the vibration structure, so as to transform the structure into a weak radiator to reduce the radiated sound power. Finally, the optimized structure can optimize the frequency of the partial frequency band reduction by the analysis of numerical examples, and at the same time, the full band optimization of the sound power spectrum can be achieved by changing the number and position of the peaks.

3:00 PM 02-Aug-2021 [IN21\\_1950.pdf](#) DOI: <https://doi.org/10.3397/IN-2021-1950>

***Determination of tonal signal parameters based on zero crossing detection***

Michal Luczynski, Stefan Brachmanski, Andrzej Dobrucki

This paper presents a method for identifying tonal signal parameters using zero crossing detection. The signal parameters: frequency, amplitude and phase can change slowly in time. The described method allows to obtain accurate detection using possibly small number of signal samples. The detection algorithm consists of the following steps: frequency filtering, zero crossing detection and parameter reading. Filtering of the input signal is aimed at obtaining a signal consisting of a single tonal component. Zero crossing detection allows the elimination of multiple random zero crossings, which do not occur in a pure sine wave signal. The frequency is based on the frequency of transitions through zero, the amplitude is the largest value of the signal in the analysed time interval, and the initial phase is derived from the moment at which the transition through zero occurs. The obtained parameters were used to synthesise a compensation signal in an active tonal component reduction algorithm. The results of the algorithm confirmed the high efficiency of the method.

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***Sound power and sound energy measurements using an ellipsoidal measurement surface***

Edward Zechmann

To support purchasing low noise products, sound power and sound energy measurements of sufficient quality need to be routinely made by consumers on a global scale. Sound power measurements using ISO 3744, 3745, and 3746 are conducted in a free field using an acoustic far-field approximation of the intensity integrated over an enveloping measurement surface. Sound power and sound energy measurements generally use a hemispherical, parallelepiped, or cylindrical measurement surface. Those measurement surfaces have limitations and assume that the measurement points lie on the measurement surface often in preferred positions. An alternative approach is to choose microphone positions that optimally satisfy the assumptions of the measurement. The measurement surface should then be fit to the chosen microphone positions. Regression methodologies are available for fitting ellipsoids. The number of microphone positions can be as few as three to fit an ellipsoid. An ellipsoidal measurement surfaces can abut zero, one, two, or three orthogonal reflecting planes. Correction equations for the microphone locations and the angle errors for the microphone orientation and wave propagation direction are shown. This paper will present simulations of sound power, sound energy, and corrections for environmental reflections for ISO 3745 and other measurement surfaces.

3:40 PM 02-Aug-2021 [IN21\\_3510.pdf](#) DOI: <https://doi.org/10.3397/IN-2021-3510>

***Experimental determination of the acoustical effects of face masks on speech effort***

Noah Schumaker, Andrew Barnard

The COVID-19 pandemic has led to a global trend in mask wearing. This study investigates how wearing face masks influence the output levels of the human vocal range. Masks were equipped onto a test fixture to evaluate acoustic insertion loss over whole-octave bands important for vocal transmission. With the exception of face shield, tested masks showed less than 2 dB of insertion loss at frequencies less than 2 kHz and up to 5 dB of attenuation at frequencies above 2 kHz. The face shield showed insertion loss of more than 10 dB in the 4 and 8 kHz octave bands.

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**Session Number 04.00 Signal Processing, Measurements, Sound Reproduction, Diagnostics for Noise and Vibration Engineering, General, Part 1 - Channel 1**

6:40 AM 01-Aug-2021 [IN21\\_1136.pdf](#) DOI: <https://doi.org/10.3397/IN-2021-1136>

***Distortion measurements of sound pressure level generated by a pistonphone***

Thiago Antônio Bacelar Milhomem, Zemar Martins Defilippo Soares, Gustavo Palmeira Ripper, Peter Hanes, Adrian Solano Mena, Federico Ariel Serrano, Giancarlos Miguel Guevara Chuquillanqui, Juan Pablo Ayala Breña

A supplementary interlaboratory comparison on pistonphone calibration was performed between 2018 and 2020 under the auspices of the Inter-American Metrology System. Seven national metrology institutes took part in this comparison. One pistonphone was circulated among the participants for measurement of the generated sound pressure level, frequency, total distortion + noise and total harmonic distortion. This paper presents the results of distortion measurements and analyzes them. From the stability check, notable variances with respect to reported measurement uncertainty were observed. From reported results, a large difference between the estimated uncertainties by the participants was noted. Convergence between results was found when measurements were performed using one-inch microphone while some divergence between results was found when measurements were performed using half-inch microphone. In addition, these results (using one-inch and half-inch microphones), even when obtained by the same institute, sometimes were different. Reasons for these findings are discussed and suggestions for future comparisons are presented.

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***MEMS digital microphone and Arduino compatible microcontroller: an embedded system for noise monitoring***

Felipe Ramos de Mello, William D'Andrea Fonseca, Paulo Henrique Mareze

Noise assessment and monitoring are essential parts of an acoustician's work since it helps to understand the environment and propose better solutions for noise control and urban noise management. Traditionally, equipment to carry out this task is standardized, and, eventually, expensive for the early career professional. This work develops a high-quality (and cost-effective) prototype for an embedded noise monitoring device based upon a digital I2S MEMS microphone and an Arduino compatible microcontroller, named Teensy. Its small size and low power consumption are also advantages designed for the project. The system captures and processes sound in real-time, computes A and C frequency-weighted equivalent sound levels, along with time-weighted instant levels with a logging interval of 125 ms. Part of the software handles the audio environment, while the biquadratic IIR filters present in the Cortex Microcontroller library are responsible for the frequency-