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Doctoral Dissertation Summary

„Neural modeling in feedforward active noise control systems with nonlinear primary path”

The doctoral dissertation undertakes the problem of nonlinear phenomena in active noise reduction systems. Noise is the most common harmful agent in the working environment. Reducing noise exposure of workers is the subject of many studies. Increasingly important direction of research is employment of technical solutions in the form of active noise control systems. These systems are based on the destructive interference of acoustic waves which results in a reduction of sound pressure in an area of interest. The subject of research in this PhD thesis are non-linear phenomena in the primary path of feedforward active noise control system. Result of nonlinear behavior of the primary path is higher harmonics in the spectrum of the compensated signal that compensation using the controllers for linear structure is difficult to achieve. Aim of this study is to investigate the possibility of using neural models for control the secondary path for improvement the effectiveness of such systems. The dissertation presents the concept of the application of neural model of NARMAX (Nonlinear Autoregressive Moving Average with exogenous input) as an adaptive controller for active noise control system. The controller is based on a structure of a feedforward sigmoidal multilayer neural network. The paper also proposes a method for learning neural network using error back propagation algorithm, which takes into account the secondary path influence. The study assumed that the secondary signal path can be modeled with sufficient using non-recursive structure in the form of a linear digital filter with finite impulse response.

The proposed concept of using neural NARMAX model has been verified by numerical simulations of the system and experimental studies of active noise control. In both stages of the verification sinusoidal reference signals were used. During numerical simulations the primary signal path was modeled by the Wiener structure. In laboratory studies nonlinear phenomena were obtained by placing into the acoustic waveguide acoustic baffle made of brass sheet. The results of numerical simulations are consistent with the results of laboratory tests to confirm the first thesis.

During the research the analysis of adaptive controller based on the ra-

dial basis function neural network trained by the algorithm employing direct Lyapunov method was conducted. As the result of the analysis the modification of investigated algorithm was proposed.

The modification is based on the limitation of gain factor responsible for speed of convergence.Efficiency of the proposed algorithm and its modification were compared by performing numerical simulations in which the primary and secondary signal path were modeled with finite impulse response filters. Numerical simulations were carried out using a stochastic process signals. The results of numerical simulations confirm the second thesis.