ICPPP21 International Conference on Photoacoustic and Photothermal Phenomena

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BOOK OF ABSTRACTS

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Abtracts of the ICPPP21 Conference 2022

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19 – 24 June 2022, Bled, Slovenia

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The reduction of neural network input vector for efficient optimization of photoacoustic calibration

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The research presented in this paper is part of an effort to improve the process of calibration procedure optimization of model - dependent diagnostic techniques (transmission frequency photoacoustics) using a machine learning approach. A regression model for recognizing the characteristics of a microphone as a photoacoustic detector has already been developed and significant results have been obtained, first in reducing the influence of measuring instruments, then in significantly reducing the processing time of measured data, reaching the so-called work in real time, while maintaining the basic requirements - to make measurements reliable and accurate. Testing the model under different conditions (theoretical or experimental signals, with and without noise, different types of microphones, different samples) we found that the accuracy of the model is high and that the processing speed of measured data does not change significantly by reducing the input vector dimension of the machine learning algorithm. The question is how far can the reduction go without losing the quality of measurements? Computational intelligence algorithms - artificial neural networks and principal component analysis of main characteristics (amplitude and phase), supplemented by discussion of their correlations and expert knowledge can indicate a solution: the data set can be reduced to 10 characteristics, which means that the measurement procedure is reduced to 5 measuring points. We confirmed this assumption in this paper with satisfactory accuracy and reliability by a regression model for the characterization of three types of microphones. It has been shown that the procedure of measuring and characterizing a microphone can be performed simply and quickly by measuring at 5 defined points. At the same time, the problem of different number of measuring points is generalized by a new reduced set of characteristics.

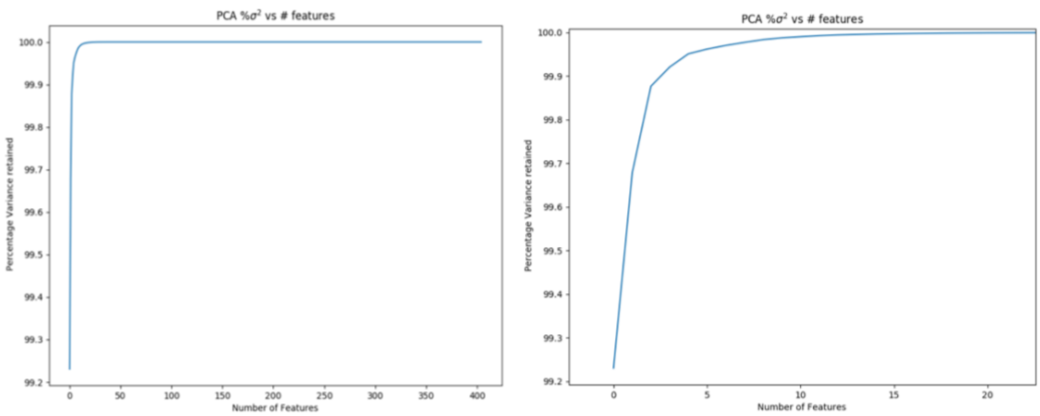

Fig. 1. a. Reduced dataset variance depending of number of features, analyzed for microphone ECM30B (dataset original dimension: 400 x 67 500), b. zoom of diagram a. to lower number of features

Table 1. Regression model performance on reduced data set for three types of microphones

Average deviation from the accurate value expressed in percentage of the accurate value on the test set, microphone ECM30B, accuracy of the regression model 97.8 %					
Parameter	f_2	f_3	f_4	ξ_3	ξ_4
Average deviation	0.05664359	0.13738047	0.0719733	1.290471	1.2778711
Average deviation from the accurate value expressed in percentage of the accurate value on the test set, microphone ECM60, accuracy of the regression model 98.32 %					
Parameter	f_2	f_3	f_4	ξ_3	ξ_4
Average deviation	0.06761368	0.08670316	0.05289495	0.85380656	1.0646605
Average deviation from the accurate value expressed in percentage of the accurate value on the test set, microphone WM66, accuracy of the regression model 98.02 %					
Parameter	f_2	f_3	f_4	ξ_3	ξ_4
Average deviation	0.0737425	0.13992077	0.08633012	1.1550651	1.2725114

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