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THE 20TH INTERNATIONAL CONFERENCE ON PHOTOACOUSTIC AND PHOTOTHERMAL PHENOMENA

JULY 7-12, 2019, MOSCOW, RUSSIA

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Deep neural network applied in calibration of transmission frequency gas-microphone photoacoustic

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Calibration in gas-microphone photoacoustics is not easily achieved, mainly due to the impossibility of finding two identical microphones needed for the differential set-up (each of them introducing non-linear influence on the recorded PA response).

In this work, the methodology is developed which determines the influence of the used microphone, manifested through five characteristic frequencies which are functionally bonded to electronic and geometrical properties of the device. This is accomplished with the implementation of two-layer deep neural networks (fig. 1), enabling the filtration of the measured signal and thus removing the influence of the measurement chain on the photoacoustic response.

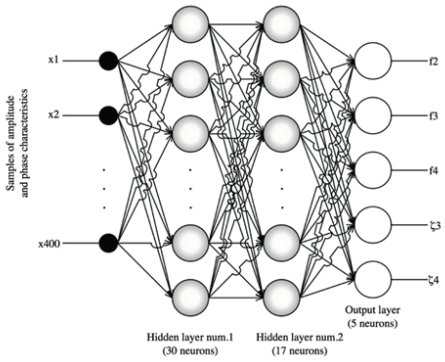

Fig. 1. An MLP with two hidden layers

Case study is done on PA measurements of laser-sintered polyamide (PA12), calibrated onto PA response of aluminum. Analysis of the obtained regression model for the prediction of the microphone parameters of PA response of aluminum is given in table 1.

Table 1. Analysis of the regression model for the prediction of the microphone parameters

	Accuracy		Cost		Numbers of epochs
Model 1	98.59%		0.000001		5000
Average deviation from the accurate value expressed in the percentage of the accurate value on the training set					
Parameter	f_2	f_3	f_4	ξ_3	ξ_4
Model 1	0.02025029	0.08571574	0.03485037	1.0117933	0.59135133
Average deviation from the accurate value expressed in the percentage of the accurate value on the validation set					
Parameter	f_2	f_3	f_4	ξ_3	ξ_4
Model 1	0.2028082	0.08540299	0.03530468	0.998583	0.60733956
Average deviation from the accurate value expressed in the percentage of the accurate value on the test set					
Parameter	f_2	f_3	f_4	ξ_3	ξ_4
Model 1	0.02026834	0.0861348	0.0351213	0.9855594	0.5777709
Prediction time					
	CPU time		Computation_time		
Model 1	14 ms		31 ms		

It is proven that this methodology successfully calibrates the measurement of examined samples onto a reference sample response, also filtrated from the measurement chain influence. It is also demonstrated that this procedure expands the frequency range for inverse solving of the PA problem, aiming at the estimation of thermal and optical sample properties, as well as improving their accuracy.

Acknowledgements

Authors wish to acknowledge the support of the Ministry of Education and Science of the Republic of Serbia for their support throughout the research projects III 45005 and OI 171016.