UDC 621

MACHINE LEARNING APPROACH FOR DEFECT DETECTION IN COMPOSITE MATERIALS USING IMPULSE IMPEDANCE METOD

BSc student Roman Motsar,
Ph. D. of Engineering Science Evgeniy Suslov
National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Traditional defect detection workflow looks like: preparing the object for testing, collecting data from sensors and/or visual control, analyzing and concluding, where one of the most significant stages is data analysis because only after this step we can do some conclusions. This stage is also complicated because NDT inspector should have strong domain knowledge about types of defects and how they will effect on signals, analyze the big amount information (impulse signal parameters, output signal form, phase characteristics, etc.) and calculate different metrics to prof conclusion accuracy. To simplify it we suggest applying machine learning techniques on signals data to get the baseline, decrease human mistake factor and found critical defects faster.

For this research, we have prepared the special pattern of a composite material which uses for sensors calibration. This pattern is delimited onto 9 zones with different kinds of defects, and each zone is separated into another 40 zones (20 above the defect and 20 above not) from which we will get 50 signals, which was averaged into new one.

Before model training, each signal was transformed using Hilbert transform formula, and first 5000 points of envelope curve were used as features. After that dataset was separated into a training (67 % of data) and test (33 % of data) dataset for measuring benchmark on data, which wasn't used for training.

Next, we chose Logistic regression, Gaussian Naive Bayes and Support Vector Machine (SVM) with 3 types of kernels: linear, RBF and polynomial models for experiment and comparing on this data. All of these models were tuned using Bayesian Hyperparameters optimization strategy, as performance metric was used F1 score. Results is shown in next table.

Model	Accuracy	Recall	F1 score
Logistic regression	0.8733	**0.8696**	**0.8698**
Gaussian Naive Bayes	0.7391	0.7391	0.7391
SVM with Linear kernel	**0.8898**	**0.8696**	0.8693
SVM with RBF kernel	0.8714	**0.8696**	0.8688
SVM with polynomial kernel	0.8643	0.8587	0.8589

From experiment results, we can conclude that classical machine learning methods as logistic regression and SVM (with linear kernels) can be used as the baseline for NDT inspector because they have good recall and sufficient accuracy.