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Discipline of Information and Communication Technology

SUMMARY OF THE DOCTORAL DISSERTATION

APPLICATION OF COMPUTATIONAL INTELLIGENCE METHODS IN DIAGNOSTICS OF CNC MACHINES AND SELECTED TECHNOLOGICAL PROCESSES

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The dissertation describes the author's contribution to research on the issue of diagnosing the state of technological processes and selected elements of CNC machines using artificial intelligence algorithms. The thesis conducts an extensive analysis of literature, divided according to the discussed issues. The CI methods used and assessing their quality and the procedure for dealing with data sets are described, indicating at the same time the most common problems. The idea of an intelligent system for diagnostic tasks both in the software and hardware and measurement layers was presented.

The main part of the work describes 3 diagnostic problems, which were solved by classification and regression methods: estimation of the life the cutting tool in the milling process, diagnosing the unbalance of the drive system and diagnosing the extrusion process. Each time, the author designed and conducted research experiments on his own, made a measuring station, prepared a software data logger, collected and processed the database and tested CI methods offline.

For the diagnosis of the drive system, a complete laboratory station was prepared from scratch and an online perceptron neural network classifier was additionally tested using the rapid prototyping method. The author solved production problems using CI methods. For the problem of estimating the life tool, a unique measurement database was collected for 13 tools from novelty to their damage. For estimation, an algorithm for selecting the weights of the logistic function using the method of least squares was used. To diagnose the extrusion process, an innovative method based on data obtained from the distance sensor through polynomial approximation and classification with a decision tree was proposed and described.

The thesis uses a number of IT tools, including: Matlab & Simulink environment for data integration and preparation, feature extraction and selection and testing of shallow and deep learning algorithms, Python language for searching for the most discriminatory fragments of time series and TwinCAT3 for data recording and communication with the PAC controller, inverter and HMI panel (the software has been prepared in the ST language).