Neural-Network-Based Simulation and Empirical Metamodelling of Centreless Grinding Process

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Abstract

The enhancement of the centreless grinding process efficiency and understanding can be achieved by a process simulation. Suppose that the performance of a centreless grinding system mainly depends on chosen levels of controllable factors and that this system is of such complexity that it is necessary to use simulation to estimate its performance for each set of factor levels. The empirical methodology utilizes multiple layer perceptron artificial neural network for modelling and predictive simulation of surface roughness in plunge centreless grinding. The results of conducted experiments were transferred into a deterministic simulation model that was used in predicting surface roughness within the region of experimental interest. Response surface methodology treats the simulation model as a black box and requires the development of approximative metamodels. The approximation technique consists of design of experiments, in which a simulation input set is selected, predictive output simulation, and metamodel fitting. The first metamodel is based on a Taylor series approximation, which employs D-optimal design of experiments and regression analysis. The second metamodel is an exact interpolator, based on a weighted linear combination, which employs latin hypercube sampling of experiments. To validate predictions based on a metamodel, it is necessary to perform sensitivity analysis to ascertain how a given metamodel output depends upon the inputs. This is an important method for checking the quality of a given metamodel, as well as a powerful tool for checking the reliability of its analysis.