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Development of Fuzzy Logic and Neuro-Fuzzy Surface Roughness Prediction Systems Coupled with Cutting Current in Milling Operation

Authors : Joseph C. Chen, Venkata Mohan Kudapa

Abstract : Development of two real-time surface roughness (Ra) prediction systems for milling operations was attempted. The systems used not only cutting parameters, such as feed rate and spindle speed, but also the cutting current generated and corrected by a clamp type energy sensor. Two different approaches were developed. First, a fuzzy inference system (FIS), in which the fuzzy logic rules are generated by experts in the milling processes, was used to conduct prediction modeling using current cutting data. Second, a neuro-fuzzy system (ANFIS) was explored. Neuro-fuzzy systems are adaptive techniques in which data are collected on the network, processed, and rules are generated by the system. The inference system then uses these rules to predict Ra as the output. Experimental results showed that the parameters of spindle speed, feed rate, depth of cut, and input current variation could predict Ra. These two systems enable the prediction of Ra during the milling operation with an average of 91.83% and 94.48% accuracy by FIS and ANFIS systems, respectively. Statistically, the ANFIS system provided better prediction accuracy than that of the FIS system.

Keywords : surface roughness, input current, fuzzy logic, neuro-fuzzy, milling operations
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