Abstract

Cutting tools generally ultimately fail by gradual wear, but often may fail prematurely which is random and catastrophic in nature. For maximum utilisation of the tools and avoidance of catastrophic failure and its consequential losses, the tools need to be withdrawn or changed in appropriate time through continuous monitoring of the tool condition while machining is going on. This is very essential particularly for sophisticated and expensive machining systems. Operations like face milling is characterised by interrupted cutting, varying chip load and shocks at the entry and exit and hence needs special care and method of tool condition monitoring. There are various possible strategies and decision systems for tool condition monitoring. By evaluating their relative performances, the appropriate one should be identified and used for effective and economic tool condition monitoring for face milling.

The study, conducted both in single and multi tooth milling, has been made for prediction of wear of the face milling inserts by on-line monitoring of the machining responses given as inputs to the three different decision systems viz. multi layer perceptron type (MLP) neural network with backpropagation learning algorithm (BPNN), modified BPNN (MBPNN) and fuzzy controlled BPNN (FBPNN) for faster convergence. In single tooth milling, it was found that measured forces may be used to monitor the tool condition effectively rather than by its transformed force features. Sensor fusion of force and vibration leads to comparable results, but often with low prediction accuracy. Chip characteristics represented by colour and shape provide excellent opportunity for determining tool condition in conjunction with measured forces with or without vibration. However, inclusion of hardness of jobs produced premature overlearning in the decision systems with comparatively larger prediction error. Employing the features of fast convergence, MBPNN and FBPNN took less computational time as compared to BPNN. Multi tooth milling also revealed similar results. The measured average forces are more affected by the tool wear process, rather than the peak forces as they are predominantly governed by only entry and exit phenomena. Thus in multi tooth milling as well,

measured forces used as inputs to decision systems provided better performance of the TCM system. Inclusion of chip characteristics as input to the decision systems along with average forces proved more effective in monitoring tool wear. However, non-recurrent ANN, as used in single tooth milling, failed to provide reasonable prediction accuracy in multi tooth milling for which recurrent ANNs have been used. Here also, FBPNN showed faster convergence with comparable performance of MBPNN.