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Chapter 18

Development of an Artificial Neural Network Algorithm for Predicting the Cutting Force in End Milling of Inconel 718 Alloy

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1.0 INTRODUCTION

To predict the required cutting force is necessary to realize the potentials of difficult-to-cut materials and get better efficiency. Cutting force is a critical and important target while machining because the change of it will affect surface finish, tool wear, vibration etc. The forces that are developed during the milling process can directly or indirectly measure/estimate process parameters of end milling such as, tool life, tool wear, surface finish etc. For the instance, excessive cutting forces generally result in low product quality while small cutting forces often indicate low machining efficiency [1]. Therefore controlling these forces is of vital importance.

Because of its paramount significance, researchers have been trying to develop mathematical models that would predict the cutting forces based on the geometry and physical characteristics of the process. A.S. Mohruni et al [2] developed the cutting force models where the primary machining parameters such as cutting speed, feed and radial rake angle were used as independent variables for factorial design of experiment coupled with response surface methodology (RSM). Kuang-hua fuh et al proposed a predicted milling force model for the end milling operation. In that study, the spindle rotation, feed, axial and redial depth of cut are considered as the affecting factors and an orthogonal rotatable central composite design and the response surface methodology were used to construct the model [3]. Such prediction could then be used to optimize the process. Nonetheless, due to its complexity, the milling process still poses a challenge to the modeling and simulation research effort. In fact, most of the research works reported pertained to this are based on either analytical or semi-empirical approaches, has in general shown only limited levels of accuracy and/or generality.

ANN offers an alternative way to simulate complex and ill defined problems. As the machining process is nonlinear and time-dependent, it is difficult for the traditional identification methods to provide an accurate model. Compared to traditional computing methods, the artificial neural network (ANN) is robust and global. ANN has the characteristics of universal approximation, parallel distributed processing, hardware implementation, learning and adaptation, and multivariable systems. Because of this, ANN is