Chapter 6
A Statistical Scrutiny of Three Prominent Machine-Learning Techniques to Forecast Machining Performance Parameters of Inconel 690

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ABSTRACT

Computational approaches like "Black box" predictive modeling approaches are extensively used technique applied in machine learning operations of today. Considering the latest trends, present study compares capabilities of two different "Black box" predictive model like ANFIS and ANN with a population-based evolutionary algorithm GEP for forecasting machining parameters of Inconel 690 material, machined in a CNC-assisted 3-axis milling machine. The aims of this article are to represent considerable data showing, every techniques performance under the criteria of root mean square error (RSME), Correlational coefficient R and Mean absolute percentage error (MAPE). In this chapter, we vigorously demonstrate that the performance of the GEP model is far superior to ANFIS and ANN model.

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1. INTRODUCTION

Amongst the various technological advancement adopted in defining premeditated pathways to meet up the cutting force-surface roughness-cutting temperature trade off in a milling machine, CNC systems with its unique capability to concurrently provide a significantly abridged cutting force-surface roughness-cutting temperature footprint as compared to a conventional milling machine. A greater dedication of CNC machine manufacturer to appreciably reduced cutting force, surface roughness and cutting temperature dilemma has greatly augmented.

Inconel alloys are the most extensively used super alloys especially used in aerospace industries. Due to its incredible strength and hardness, it posses very dumpy machinability. Therefore, machinability of Inconel materials has turn out to be a very decisive subject for exploration. Considering machinability of Inconel some noteworthy studies were found in the precedent literature. But the gigantic majority of the accessible literature focuses on Inconel 718 (Obikawa et al 2008; Ezugwu et al 2005; Dudzinski et al 2004; Coelho et al 204; Narutaki 1993).

On the other hand, Predictive models are advantageous, as they curtail the need for experiments, which are typically costly and time-consuming. Machine learning techniques offer a feasible solution where the pertinent machine behavior is emulated by appropriate plant model embodying the underlying physics of the problem.

Even though a significant number of Artificial Intelligence based predictive methods have been projected previously by different authors for modeling machining performance parameters, but ANN strategies have been extensively subjugated in the field of simulations of machining performance parameters. But still, now modeling of machining parameters is one of the prime fascinating topics in engineering research. Therefore, it is desirable to build up some new predictive models of machining parameters.

Hence, the current chapter endeavors to launch three predictive models of machining parameters of Inconel 690 alloy based on four draw frame variables, namely, speed, feed, depth of cut and width of cut. To explore the reliability of the developed models, they have been comprehensively compared with themselves to address the identical objectives as in the present study.

2. THE MOTIVATION OF THE PRESENT STUDY

Due to the wide usage of heat resistive alloys, the machining of Inconel materials has turn out to be a very crucial subject for investigation in the arena of manufacturing. In this chapter, a tentative inquiry was carried out to recognize the machinability behavior of Inconel 690. Generally, Inconel alloys are portrayed by excellent oxidation, high strength, creep resistance at elevated temperature. These properties are accountable for low machinability, high tool wear, high cutting temperature, and high cutting force. Thus, it is very demanding to machined Inconel alloys in the industrial ambiances.However, computational systems with its unique capability to concurrently get across an appreciably reduced surface roughness, resultant cutting force and cutting temperature footmark as paralleled to conventional milling have been correctly considered to be an imperative technical revolution to grace the milling machines of today.

Numerous alternatives crop up as a solution to these machinability problems; the use of novel tool materials with special cutting geometry, new lubrication strategies and use of refrigerant fluids. In fact, to advance the process efficiency, latest tool materials such as coated carbide tools, coated CBN, PCBN and whisker reinforced ceramics cutting tool are regularly used as cutting tools for machining of Inconel

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