Chapter 37
Application of ANN and PSO Swarm Optimization for Optimization in Advanced Manufacturing: A Case With CNC Lathe

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ABSTRACT

CNC lathe is one of the best machining techniques which provides us with better accuracy and precision. Considering speed, feed and depth of cut as inputs and among all possible outputs, in the present work Material Removal Rate and Surface Roughness would be considered as the factors those affect the quality, machining time and cost of machining. Design of experiments (DOE) would be carried out in order to minimize the number of experiments. In the later stages application of Artificial Neural Network (ANN) and Particle Swarm Optimization (PSO) would be used for the Optimization in the advanced manufacturing considering CNC lathe. The obtained output would be minimized (for surface roughness) and maximized (for MRR) using Artificial Neural Network (ANN) and Particle Swarm Optimization (PSO). The combination of various input parameters for the same would be identified and a comparison would be drawn with the various above methods.

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INTRODUCTION

Computer Aided Numerical Controlled (CNC) machining has become an essential piece of machining industry in the present scenario. By applying various conventional machining techniques the exactness, precision and accuracy could not be obtained as accomplished through CNC. Yet at the same time there is a space for blunders in a CNC machine and essentially the expertise and experience of the labourer matters to get the measurements right. Also the machine execution and item attributes obtained by CNC machining are not ensured to be adequate in all cases. From different parameters which could be considered as the output of the machining operations, the material removal rate (MRR) and Surface roughness (SR) were considered for this work as the factors specifically influences the quality, machining cost and the machining hour rate.

Conventionally in all cases for any machining techniques an operator decides the input parameters like speed, feed and depth of cut, depending upon type of job and the sliding controls are controlled by hand. In a CNC machine the controls and sliding movements are controlled by motors using computer programs. CNC machine consists of machine control unit (MCU) which decides the various factors like speed, feed, depth of cut, coolant on and off, selection of tools etc. In the form of numerical data commands are issued by MCU to the motors that position the slides and tool according to the input provided.

CNC machining no doubt is one of the finest machining techniques still there are room of errors in this. These errors can be avoided by using skilled and experienced workers. In the present work Material Removal Rate (MRR) and Surface Roughness (SR) are considered as the most influencing factors for the quality of machining, cost of machining and the rate of machining.

Finding the optimized set of inputs for obtaining the relevant outputs has always been a challenge for researchers since years. Aggarwal et al. (2008); Asilturk et al. (2016); Liu et al. (2010); Dutta and Majumdar (2010) and Singh and Kumar (2006) are some of the researchers who have tried to optimize the machining parameters incorporating various methods like Genetic Algorithm, Simulated Annealing method, Multi objective Evolutionary Algorithm etc. Cayda (2010) evaluated the machining of AISI 4340 steel by varying cutting tool and Negrete et al. (2013) tried to optimize the cutting parameters minimizing the cutting power.

Machining is broadly classified as Conventional and Non Conventional machining. Conventional machining has a direct contact of tool and the work piece. It involves physical contact between the cutting tool and the material to be processed. Non Conventional Machining uses modern and advanced technology for processing of materials. Tools such as laser beams, electric beams, electric arc, infrared beam, plasma cutting etc are used in Non conventional machining processes. Non conventional tool are more accurate than the conventional machining tools, with a better tool life and also doesn't lead to any noise pollution. Although they are having a complex setup and spare machining parts are difficult to avail in case of breakdown.

In this work the authors have performed the multi-objective optimization of Material Removal Rate and Surface Roughness using Artificial Neural Network and Particle Swarm Optimization, where in the fundamental objective functions (Regression Equations) of MRR and SR are used in for minimizing and maximizing SR and MRR respectively. On application of these Optimization techniques it was very suitable for the mass production of components of machines where there is a fast movement of consumer goods. In some cases these optimal values developed using PSO in this work can be adopted or the regression equation can be used for the cases that are having some variation in the levels of input parameters for prediction of output parameters.