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Short Communication

APPLICATION OF NEURAL NETWORK TO REDUCE THE MACHINING OPTIMIZATION

Ashim Mukherjee, Amit Kachawaha

Department of Mechanical Engineering
Dr. C V Raman University Kota Bilaspur, India

Abstract

For efficient use of machine tools, selection of machining process and determination of optimal cutting parameters (speed, feed and depth of cut) are required. The aim of this paper is to discover the role of these parameters is to prediction in milling operations by using artificial neural networks and Taguchi design of experiment. The study was conducted by using milling machine with fine type carbide tool with twin cutting edge. The experimental data is later used to predict output data by using artificial neural network.

Key Words:- Machining, Neural Network, Milling Operation.

Introduction

The quality of the surface plays a very important role in the performance of the milling as a good quality milled surface significantly improves fatigue strength, corrosion resistance or creep life. Therefore the desired finish surface is usually specified and the appropriate processes are selected to reach the desired surface quality. Unlike turning, face milling or flat end milling operations, predicting surface roughness for ball end milling by mathematical models is very difficult. A neural network with their learning capabilities can be used to learn the fuzzy decision rules, thus creating a hybrid intelligent system. A scientific approach to plan the experiments is a necessity for efficient conduct of experiments. When the problem involves data that are subjected to experimental error, statistical methodology is the only objective approach to analysis. Thus, there are two aspects of an experimental problem: the design of the experiments and the statistical analysis of the data. These two points are closely related since the method of analysis depends directly on the design of experiments employed. Modern rotating machines are susceptible to equipment malfunction and ambient disturbances because of their complexity and high speed. The complexity hampers the operator's ability to diagnose and eliminate equipment failures before their

For Correspondence:
ashimrace007@gmail.com
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occurrence Fault diagnosis of rotating machinery has been done by analyses the external condition with the help of vibration signals to determine the internal fault in machines. Furthermore, the structural and functional organization of the linear chromosomes allows the unconstrained operation of important genetic operators such as selection, mutation transposition, and recombination. Predictive models of machining processes and tool life can be applied to help businesses gain a competitive edge. In this time of expanding global markets, it has become essential for manufacturers to improve process efficiencies, maintain stricter part tolerances, and enhance part quality. Furthermore, the motivation for using analytical tools for process optimization, rather than costly trial and error, has perhaps never been greater. The application of the Artificial Neural Networks (ANN) model for the modeling purpose in various different areas including machining is used varies widely by researchers.

Hossain *et al.* studied the average surface roughness Ra (value) for Aluminum after ball end milling operation has been measured. 84 experiments have been conducted varying cutter axis inclination angle (φ degree), spindle speed (S rpm), feed rate (fy mm/min), radial depth of cut (feed fx mm), axial depth of cut (t mm) in order to find Ra. This data has been divided into two sets on a random basis; 68 training data set and 16 testing data set.The comparison shows that selected ANFIS model gives better result for training and testing data. So, this ANFIS model can be used further for predicting surface roughness of Aluminum for three dimensional end milling operation [1]. **Bajic *et al.*** improves and examines the influence of three cutting parameters on surface roughness, tool wear and cutting force components in face milling as part of the off-line process control. The experiments were carried out in order to define a model for process planning. Cutting speed, feed per tooth and depth of cut were taken as influential factors. Advantages of off-line process control which utilizes process models by using these two modeling methodologies are explained in theory [2]. **Bondade *et al.*** presents a technique to find the different conditions of rotating machinery through data obtained by vibration analyses. The various earlier researchers work is also elaborated in this paper. The results will be also going to test by FEM and MATLAB codes. It is general thinking at this stage that comparisons of MATLAB result, FEM analysis and experiment result give better solution for faults occur in rotating machinery [4]. **Rawangwong *et al.*** investigate the effect of the main factors on the surface roughness in semi-solid AA 7075 face milling. The results of the research could be applied in the manufacture of automotive components and mold industry. When the equation was used to confirm the research results, it was found that the mean absolute percentage error (MAPE) of the surface roughness obtained from the predictive comparing to the value of the experiment was 3.62 percent, which was less than the specified error it was acceptable [7]. Snyder *et al*. developed the Birl is an electronic wind instrument, which uses artificial neural nets for the mapping of fingering systems and embouchure position. The design features of the instrument are described, and the selected machine-learning mapping strategy is discussed.[8]

Objective of Work

The main objective of this work is to predict the total output parameter in face-milling operation. ANN model outperforms the prediction accuracy obtained by the ANN to best knowledge, the multiple-input multiple-output (MIMO) nonlinear relationship with back propagation-based ANN model. In this thesis, some experimental results are also given to make the comparison of effectiveness with those obtained by the Matlab toolbox in terms of prediction accuracy model with back propagation (BP) algorithm given by the Matlab toolbox. Experiments were conducted through the established Taguchi's design method. In this work, the machining characteristics are investigated based on surface roughness and tool wear. The most appropriate strategy available to the manufacturers and researchers to reduce the possibility of such failures is to introduce some form of feedback representing the quality of machining and state of the tool during the machining process.

Materials and Method

Artificial Neural Network is a capable computation model for a weight diversity of problems. For manufacturing process where no satisfactory analytic model exist or a low order empirical polynomial model is inappropriate, Neural networks offer a good alternative approach. Until today many different neural network models have been developed. Among the various neural network models Back Propagation (BP) is the best general purpose model and probably the best at generalization. The typical neural networks architecture is shown in the Fig 1.

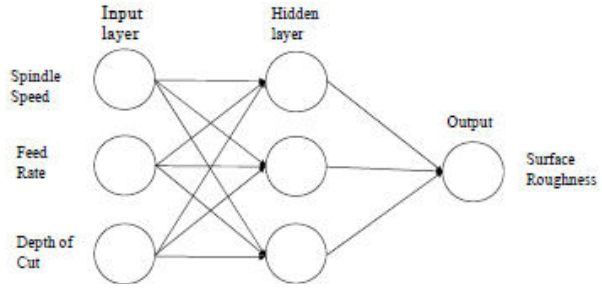

Fig 1 NN Computational Model

An artificial neural network (ANN) is capable of learning from an experimental data set to describe the nonlinear and interaction effects more effectively. The network consists of an input layer used to present data, output layer to produce ANN's response, and one or more hidden layers in between. The network is characterized by their topology, weight vectors, and activation function that are used in hidden and output layers of the network. Networks with biases, a sigmoid layer, and a linear output layer are capable of approximating any function with a finite number of discontinuities. The knowledge is presented by the interconnection weight, which is adjusted during the learning stage using the back propagation learning algorithm to minimize the mean square between the actual output of the network and the desired output pattern [23]. Firstly, the roughness parameters were used as an input to predict the output which is the machining process. Secondly, both of roughness parameters and the predicted machining process were used to predict cutting parameters which are: feed, speed and depth of cut. Neural network is a highly flexible modeling tool with the ability to learn the mapping between input and output parameters.

Material Selections

Work Piece of MS material with Length of 100 mm, Width 60 and thickness of 10 mm has been selected for the experimental work. The reason behind the selection is, MS material are increasingly being used for different engineering applications because of their superior qualitative advantages include high ratio of strength to weight , high fracture strength and toughness , excellent thermal and corrosion resistance. For machining of MS material and advanced materials requiring high precision of MRR and high surface finish, selection of tool to be widely processed and applicable in manufacturing industries.The experiment presented by the interconnection weight, which is adjusted during the learning stage using the back propagation learning algorithm to minimize the mean square between the actual output of the network and the desired output pattern.

Result and Discussion

The machining was carried out on Vertical milling machine is carried out by selecting proper spindle speed and feed rate during each experimentation. On completion of each pass the surface roughness is measured on the work piece at four locations. The experimental training data set and testing data set, which were also used. A Carbide coated tool four-flute end milling cutter with a diameter of 3/4" in the experiment to machine MS Material. Three factors, spindle speed (*Sp*), feed rate (*Fe*) and depth of cut (*Dep*), are used to analyze the influence on surface roughness (*Ra*) and Material Removal Rate (MRR). The schematic of developed experimental has done and their result is shown in table 5.3, It consists of tool Carbide coated high speed steel-E (CCHSS-E) and workpiece dimension (size 100 mm x 60 mm x 10 mm). Experiments were conducted to mill machine the surface o plate. The experiments were conducted using Taguchi orthogonal array.Several experimental design techniques have been used to aid in the selection of appropriate design points. Taguchi method is a powerful design of experiments tool

for engineering optimization of a process. It is an important tool to identify the critical parameters and predict optimal setting of each parameter. The output predicted data of milling process were obtain with error by applying ANN as shown in table 1.

Table 1 Simulation Result and Error

Simulated		Simulation Error	
MRR	**R_a**	**MRR**	**R_a**
0.2964	3.3134	0.06750	-0.4234
0.3096	3.3435	2.6703	1.0664
0.3227	3.3737	-0.0237	0.2062
0.2858	3.3991	-0.01081	0.06082
0.4696	3.0147	-0.2216	0.1447
0.4958	3.0750	-0.1848	1.0349

Regression Performance

Finally, a confirmation run is carried out to test the regression model is to predict new response.

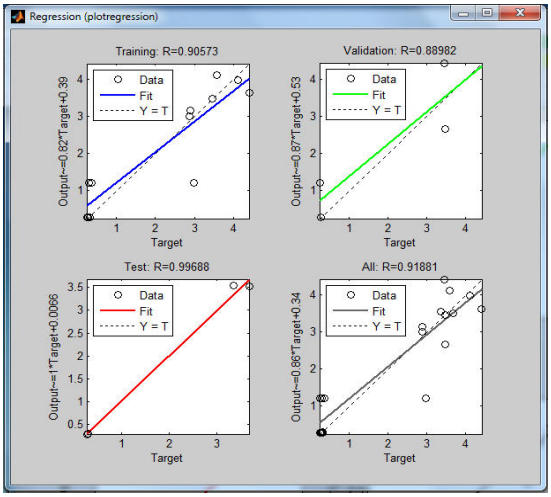

Fig 5.1 Regression Plots of Prediction

From the Regression plot of the generated model, shown in Fig 2, it can compare the effect of output factors of targets. The response of all target value is quit better as given below

- Training performance index are 90%
- Validation performance index are 88%
- Test performance index are 99%

Conclusions

The machining parameters were used as inputs to the ANN to predict MRR and surface roughness. The DOE model could make the design of experiment and is done by milling machine. The experiments so far are promising and encouraging for further exploration. The predicted values were found to be close to the measured values. In doing this, experimental measurements, artificial neural network are exploited in an integrated manner.

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