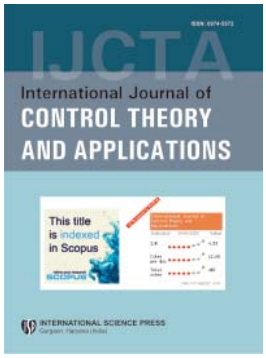

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Artificial Neural Network Applications in Machining Process: A Review

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Abstract: This paper represents the potential of use Artificial Neural Network employs the role in conventional and unconventional machining process like electro chemical machining, electro discharge machining, electro discharge micro machining, water jet machining, abrasive jet machining, tuning and milling. Initially the process parameter is identified, after which, the work explores the applications of Artificial Neural Network in the above machining process parameters are trained and tested. The processes parameter outcomes are quit complicate and justify the results in the manufacturing processes are essential to get the best values of required parameters. Therefore the factors such as process parameters modeling and testing, training of process parameter data's are reviewed using the existing literature. Using the prior information available, this paper advocates the use of ANN for the prediction of best results. However it must be noted that the recommendations are absolutely based on the data which is available and the authors interpretations of it although every effort have been made to be as logical as possible.

Keywords: *Artificial Neural Network, machining process, electrochemical machining, electro discharge machining, Water jet machining.*

1. INTRODUCTION

In current world modelling and optimization of operations and product are the vital industrial functions to improve the product performance as well as save manufacturing cost. An artificial neural network (ANN), usually called neural network is a mathematical model or computational model that is inspired by the structure and/or functional aspects of biological neural networks. Modern neural networks are non-linear statistical data modelling tools. They are usually used to model complex relationships between inputs and outputs. ANN can learn from examples, are fault tolerant in the sense that they are able to handle noisy and incomplete data, are able to deal with non-linear problems, and once trained can perform prediction and generalization at

high speed. Manufacturing and production field the role of unconventional machining process improved because of some key benefits. In the non-conventional machining process there is absence of physical contact and heat. There is less wear between the tool and work piece. So, there is no need to use expensive alloys to make the tool tougher than the work piece. The products produced from non-conventional machining process are used to make typical parts which can't be usually manufactured in conventional machining process. Whereas the conventional machining process like milling, tuning and gear hopping also plays a major role in manufacturing because of emerging trends in industrial applications. Compared to conventional machining process it is clear that unconventional machining process has no burrs, no stress, longer tool life with damage free machine surfaces. Selection of appropriate machining parameters is difficult and relies heavily on operator's experience. Hence an appropriate model is required to map the relationship between input variables and output response parameters. The significant of ANN in modeling of some machining process are surveyed and discussed in this paper.

2. ANN INFLUENCE ON UNCONVENTIONAL MACHINING

Prediction of some electrochemical machining process parameters using ANN was proposed by Hoda et al.[1]. They used multilayer feed forward Neural Network with levenbergmar quardt algorithm and gradient decent algorithm for prediction of process parameters and proved that ANN model were found to be in close agreement with the experimental data.

EyupBagci, and Birhan[2] were developed an artificial neural network and response surface model to predict surface roughness on the turned part surface.In the development of predictive models, cutting parameters of cutting speed, depth of cut and feed rate were considered as model variables. The required data for predictive models were obtained by conducting a series of turning test and measuring the surface roughness data. Good agreement was observed between the predictive models results and the experimental measurements

Tsai and Wang [3] established several surface models based on various neural networks taking the effects of electrode polarity in to account. They subsequently developed a semi empirical model, which is dependent on the thermal, physical and electrical properties of the work piece and electrode together with pertinent process parameters. It was noted that the model produces a more reliable surface finish prediction for a given work under different process conditions.

P. Asokan et al[4] suggested the Multiple regression model and ANN model have been developed to map the relationship between process parameters and objectives in terms of grade. While examining the average percentage deviations of three models, ANN was having less percentage deviation. So ANN is considered as the best prediction model. Based on the testing results of the artificial neural network, the operating parameters are optimized. Finally, ANOVA was used to identify the significance of multiple regression model and ANN mode.

Pradhan and Das[5] have used an Elman network for producing a mapping between machining parameter such as discharge current, pulse duration, duty cycle and voltage, and the response MRR in EDM process. Training and testing of ANN model were performed with extensive data sets from EDM experiments on AISI D2 tool steel from finishing, semi-finishing to roughening operations. The mean percentage error of the model was found to be 5.86 percent, which showed that the proposed model is in a satisfactory level to predict the MRR in EDM process.

Angelos P. Markopouloset. al [6] implemented an ANN model for the prediction of SR in EDM. The process parameter to the ANN model were work piece material, pulse current and pulse duration at 3,4 and 4 levels respectively. They used back propagation algorithm for training with model assessment criteria as MSE and R. Finally they conclude selected ANN was found efficient for prediction of SR of EDM process. A.Thillaivannan[7] et. al. have explored a practical method of optimizing machining parameters for EDM process under the minimum total machining time based on Taguchi method and Artificial neural network. Feed-forward back-propagation neural networks with two backpropagation training algorithms: gradient descent, and gradient descent with momentum were developed for establishing a relation between the target parameters current and feed with the process parameters required total machining time, oversize and taper of a hole .

Mohan Senet. Al[8] presented a hybrid Neural Network and genetic algorithm approach for the multi-response optimization of the electro jet drilling process, where Artificial Neural Network model was used to predict the response parameters of the process and then, a genetic algorithm was applied to the trained Neural Network model to obtain the optimal process parameters Whereas, Soleimaniehr et. Al[9] developed an ANN for prediction of aluminium work piece, surface roughness is calculated in ultrasonic vibration assisted turning. To decrease the difficulty of prediction process, intelligent techniques using artificial Neural Networks were developed.

Hari Krishna etal [10] propsed, the effect of speed, feed and depth of cut on surface roughness is studied on aluminum alloy AA 6351 in four levels. Different levels of input conditions are derived from factorial Design of Experiments. Based on the the experimental results, two models the Artificial Neural networks Model and Adaptive Neuro Fuzzy-Inference System model are constructed. The best results based on ANN Model. ANN model has given the training error as 4.72 % . ANN model has given the Cross Validation error as 3.021% . ANN model has given the testing error as 3.868 % . Typically using more data for training network process have been taken large time but not ANN gives better prediction capabilities. For their work a back propagation neural network model is developed for the prediction of surface roughness in turning operation using feed and the cutting forces as inputs to the neural network model.

3. INFLUENCE OF ANN IN CONVENTIONAL MACHINING

Amir Mahyar Khorasani [11] concluded , (ANN) for modeling and predicting tool life life in milling process. In generating the (ANN) model statistical (RMS) was utilized. The accuracy error was found to be insignificant (3.034%). It was found that (ANN) prediction correlates very well with the experimental results. Finally the correlation for training and test was obtained 0.96966 and 0.94966 respectively and mean square error was calculated 3.1908% for test data.

Karniket at [12] described the comparison of the burr size predictive models based on artificial neural networks and response surface methodology on AISI 316L stainless steel work material. The ANN predictive models of burr height and burr thickness were developed using a multilayer feed forward neural network, trained using an error back propagation learning algorithm. The performance of the developed ANN models were compared with the second-order RSM mathematical models of burr height and thickness. The ANN models provide more accurate prediction compared to the RSM models.

ThitipongNavalertporn et al [13] proposed Neural Network and bidirectional PSO for optimizing process parameters in tile manufacturing. The ANN was used to model the relationships between input process parameters and output quality characteristics, while the bi directed PSO served to obtain the optimal process parameter combinations. The approach allows a multilayer feed forward Neural Network is an interconnection of perceptions in which data and calculations flow in a single direction, from the input data to the output data. Multilayer feed forwarded Neural Network is used for modelling and the best solutions are obtained for various output parameters.

4. DISCUSSION

The role of ANN in the modeling of process parameters in various unconventional machines are reviewed in this paper. From the review it is found that ANN can be used to model one or more than one output variables and it can be used for all kind of machines. In most cases ANN is trained using back propagation (BP) algorithm .In the back propagation algorithm mean square error is minimized to during training process. Type of machine number of input and output parameters used for modeling and the ANN training algorithm used are shown in table 1.

Table 1

Reference	*Machinining type*	*No of Input variables*	*No of output variables*	*ANN algorithm*
[1]	ECM	4	2	Levenberg marquardt
[2]	ECM	3	1	BP
[3]	EDM	3	1	BP,Gradient Decent
[4]	ECM	4	2	BP
[5]	EDM	4	1	BP
[6]	EDM	3	1	BP
[7]	EDM	2	3	BP(gradient descent, gradient descent with momentum)
[8]	AJM	3	1	BP
[9]	Milling	2	1	–
[10]	Turning	3	1	Levenberg
[11]	Milling	3	1	–
[12]	Drilling	3	2	Gradient Decent BP
[13]	Forging	3	1	

The commonly used neural network for modeling in machining process is multilayer feed forward neural network. From the survey it is observed that maximum of 4 input and 3 output variables are considered for ANN modeling. The cost of unconventional machining is high compared to conventional machining thus more researchers' focuses on the modeling of unconventional machining process parameters.

5. CONCLUSION

This paper represented the importance of Artificial Neural Network employs the role in machining process like electro chemical machining, electro discharge machining, water jet machining, abrasive jet machining, tuning and milling. The process parameter such as feed, speed, depth of cut are identified, after which the material removal rate and surface finish of the work explores the applications of Artificial Neural Network in the machining process parameters are trained and tested. To overcome the difficulties for optimizing the results in the manufacturing processes are essential to get the best values of required parameters. Therefore the factors such as process parameters modeling, testing, training of process parameter data's are reviewed and analyzed. Using the prior information available, this paper concluded the use of ANN for the prediction of best results. However it must be noted that the recommendations are absolutely based on the data which is available.

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