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Effect of Tool Diameter on Surface Roughness during CNC Milling of Brass Using ANN

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Abstarct : *Optimisation of machining parameters needs to determine the most significant factor for required output. The controllable parameters for the CNC milling machine are cutting tool variables, workpiece material variables, and cutting conditions whereas the main desired output are surface roughness. Present work discusses the findings of an experimental investigation into the effects of cutting speed, feed rate and tool diameter during CNC milling of Brass keeping the depth of cut constant. An artificial neural network (ANN) model used through feed forward back-propagation network to predict the surface roughness. ANN showed that the tool diameter was the most influencing parameter for the minimization of surface roughness followed by feed.*

Keywords: *Surface Roughness; CNC Milling; Experimental Analysis; Brass; ANN*

I. INTRODUCTION

Surface roughness is the most significant parameter nowadays for the manufacturing industries and from the research point of view. It is an important critical quality indicator for the machined surface. Basically, surface roughness affects the different properties such as wear resistance, fatigue strength, the coefficient of friction, lubrication and corrosion resistance of the machined surface. To minimise the cost and time in the assessment of surface quality, different numerical techniques are used. Here, brass is itemised because of its unique properties. It is stronger and harder than copper, easy to form into different shapes. It is a good conductor of heat and resistance to the corrosion from saltwater. Therefore, brass is equipped in electrical and precision engineering industries. It is used to make pipes and tubes, weather stripping, and other architectural trim pieces, screws, radiators, musical instruments, and cartridge casting for firearms.

Recently industries are inclined towards the artificial neural network (ANN) technique to determine the relationship between the process parameters and the surface roughness parameters. ANN is based on the statistical approaches and most powerful modelling technique. In addition to it did not require any kind of mathematical mode l. ANN model was developed [1] during the turning of free machining steel to identify the effect of the feed rate, cutting speed, and depth of cut on the surface roughness. To predict [2] the surface roughness performance, which is measured during machining performance, an ANN technique was equipped as the essential method for measuring surface roughness. [3]ANN and support vector regression (SVR) methods are occupied to calculate the surface roughness , tool wear and the required power depending upon cutting speed, feed rate and cutting time, and the results showed that ANN and SVR models provided better accuracy than the response surface methodology.

The aim of this present work is to get an accurate numerical technique in the prediction of surface quality that minimises cost and time in machining surface operation. At the desired cutting conditions the surface roughness is obtained, are used as the input data to ANN model. Matlab R2015a is used to lead to this to the results.

II. EXPERIMENTAL SETUP

Experiments were conducted on CNC Milling Machine. Brass is taken as workpiece material; HSS end milling cutter is used. Machining has been done as per the Design Matrix. The influencing parameters considered are speed, feed, and tool diameter whereas the depth of cut is taken constant. Table 1 shows the process parameters and their values.

The process was studied with a standard RSM design called a (CCD) Central composite design. The factorial portion is full factorial design with all the factors at three levels; the star points are at the face of cube portion of the design which corresponds to the value of -1. This is commonly referred to as a centred face CCD. The centre points, as implied by the name, are the points with all the levels set to coded level 0, the midpoint of the each factor range, and this is repeated six times.

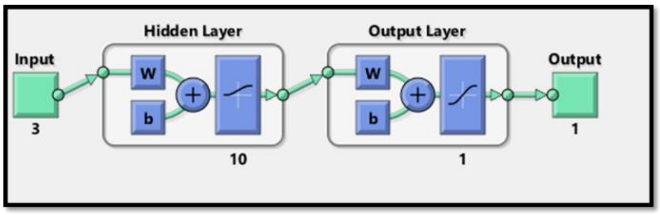


Figure 1 : Neural Network of ANN technique

Table 1: The process parameters and their values

Levels	Speed (A) (m/min)	Feed (B) (mm/revolution)	Tool Diameter (C) (mm)	Depth of cut (mm)
1	1400	40	8	0.7
2	1550	55	10	0.7
3	1700	70	12	0.7

Twenty experiments were conducted. For every experimental trial, a new cutting edge was used. Minitab-17 was used to develop the experimental plan for response surface methodology. The same software was also used to anatomize the data collected.

III. RESULTS AND ANALYSIS

Fig. 1 shows a diagram depicting the selected network, where Hidden layers and output layers are shown. Table 1 shows the process parameters and Table 2 containing all the required data and cutting parameters and the experimental surface roughness (Ra1). Figure 2 represents the performance plot which is given by the Matlab software. Table 3 consisting the surface roughness analysed by the ANN technique in the Matlab software with the errors.

Table 2: Design Table

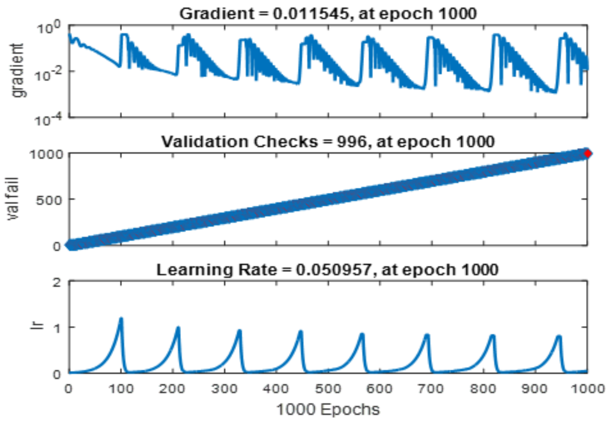
S.No	SPEED	FEED	TOOL DIA.	Ra (measured)
1	1400	40	8	0.73
2	1400	40	12	1.465
3	1400	55	8	0.84
4	1400	55	10	0.575
5	1400	55	12	2.99
6	1400	70	8	0.84
7	1400	70	10	0.7
8	1400	70	12	3.4
9	1550	40	10	0.46
10	1550	40	12	2.073
11	1550	55	8	0.71
12	1550	55	10	0.58
13	1550	55	12	2.3
14	1550	70	8	0.95
15	1550	70	12	2.92
16	1700	40	8	1.34
17	1700	40	10	0.7
18	1700	40	12	2.36
19	1700	55	8	1.14
20	1700	55	10	0.67

Figure 5 represents the different fits against the target data and clearly shown the regression is as nearly as to one, which is considered to be the good result. Table 4 shows the predicted surface roughness of the considered cutting parameters by the neural network analysis in Matlab R2015a software.

Figure 2 : Performance curves

Table 3:Design table with ANN

S.No	SPEED (RPM)	FEED mm/rev	Tool Dia (MM)	Ra_1	Ra_2	Error
1	1400	40	8	0.73	0.72984	0.0002
2	1400	40	12	1.465	1.46576	-7E-04
3	1400	55	8	0.84	0.73382	0.1062
4	1400	55	10	0.575	5.74E-01	0.0007
5	1400	55	12	2.99	2.77037	0.2196
6	1400	70	8	0.84	1.0152	-0.175
7	1400	70	10	0.7	0.73299	-0.033
8	1400	70	12	3.4	3.23587	0.1641
9	1550	40	10	0.46	0.45969	0.0003
10	1550	40	12	2.073	1.84557	0.2274
11	1550	55	8	0.71	0.70953	0.0005
12	1550	55	10	0.58	0.67458	-0.095
13	1550	55	12	2.3	2.30491	-0.005
14	1550	70	8	0.95	0.94823	0.0018
15	1550	70	12	2.92	3.21712	-0.297
16	1700	40	8	1.34	0.52865	0.8114
17	1700	40	10	0.7	7.00E-01	0.0004
18	1700	40	12	2.36	1.81728	0.5427
19	1700	55	8	1.14	0.67246	0.4675
20	1700	55	10	0.67	0.6715	-0.002



Figures 3 : Transient state

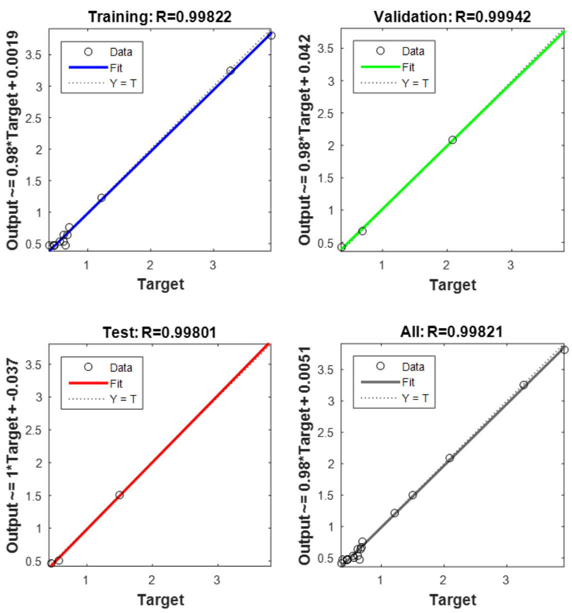


Figure 4 : Regression fits

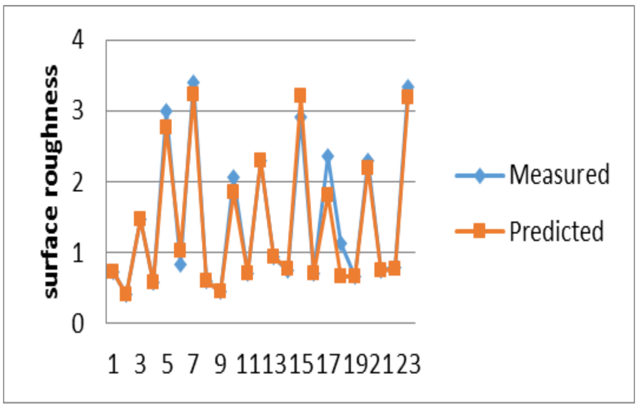


Figure 5 : Ra_1 Ra_2 Comparision

Figure 5 represents the graph plotted surface roughness (Ra1, Ra2) and states that the experimental value and the predicted values of surface roughness are very close enough. Predicted results by ANN are shown in table 4.

Table 4: Predicted surface roughness by ANN

Speed (rpm)	Feed (mm/rev)	Tool Diameter (mm)	Measured Ra	Predicted Ra
1400	40	**10**	0.41	0.43768
1550	40	**8**	0.6	0.58616
1550	70	**10**	0.76	0.72243
1700	70	**8**	0.75	1.346

IV. CONCLUSION

The paper presents an integrated artificial neural network genetic algorithm approach for predicting the effect of machining parameters on the surface roughness during the machining of Brass. It has been observed that the tool diameter is the most influencing parameter for the minimization of surface roughness followed by feed. The figures and plots constructed during the study can be used for choosing the optimal machining parameters to obtain particular values of surface roughness or vice-versa these can be used by the machine tool manufacturers to provide the range of cutting speeds, tool diameter and feed for the particular application. The statistic and results show that the artificial neural network (ANN) predicts the results close enough. The optimum value of surface roughness in the given range of parameters as depicted by graphs is 55 mm/rev (feed), 10 mm (tool diameter) and 1550 rpm (speed). Therefore, ANN technique results close enough to predict the cutting parameters, which were considered in this work.

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