OPTIMIZATION OF CUTTING PARAMETERS ON MILD STEEL WITH HSS & CEMENTED CARBIDE TIPPED TOOLS USING ANN

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Abstract

Optimum Selection of cutting conditions importantly contribute to the increase of productivity and the reduction of cost, therefore utmost attention is paid to this problem in this contribution. In this paper, a neural network based approach to complex optimization of cutting parameters is proposed. To reach higher precision of the predicted results a neural optimization algorithm is developed and presented to ensure simple, fast and efficient optimization of all important turning parameters. The approach is suitable for fast determination of optimum cutting parameters during machining, where there is not enough time for deep analysis.

Surface roughness, an indicator of surface quality is one of the most specified customer requirements in a machining process. To predict the surface roughness, an Artificial Neural Network (ANN) model was designed through back propagation network using MATLAB 7.1 software for the data obtained.

Keywords: *Surface Roughness, ANN, MATLAB.*

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INTRODUCTION

The important goal in the modern industries is to manufacture the products with lower cost and with high quality in short span of time. There are two main practical problems that engineers face in a manufacturing process. The first is to determine the values of process parameters that will yield the desired product quality (meet technical specifications) and the second is to maximize manufacturing system performance using the available resources.

Today, Metal cutting process places major portion of all the manufacturing processes. Within these metal cutting processes the turning operation is the most fundamental metal removal operation in the manufacturing industry. Surface roughness, which is used to determine and evaluate the quality of a product, and is one of the major quality attributes of a product obtained from turning operation. Surface roughness is a widely used as an index of product quality and in most cases a technical requirement for mechanical products [1, 2]. Achieving the desired surface quality is of great importance for the functional behavior of a part. Surface roughness is a measure of the quality of a product and a factor that greatly influences manufacturing cost [3]. It can be generally stated that the lower the desired surface roughness the more the manufacturing cost and vice versa. In order to obtain better surface roughness, the proper setting of cutting parameters is crucial before the process takes place [4].

Factors such as spindle speed, feed rate, and depth of cut that control the cutting operation can be setup in advance. However, factors such as geometry of cutting tool, tool wear, and joint material properties of both tool and work piece are uncontrollable [5]. One should develop techniques to evaluate the surface roughness of a product before machining in order to determine the required machining parameters such as feed rate, spindle speed and depth of cut for obtaining a desired surface roughness and product quality [6, 7].

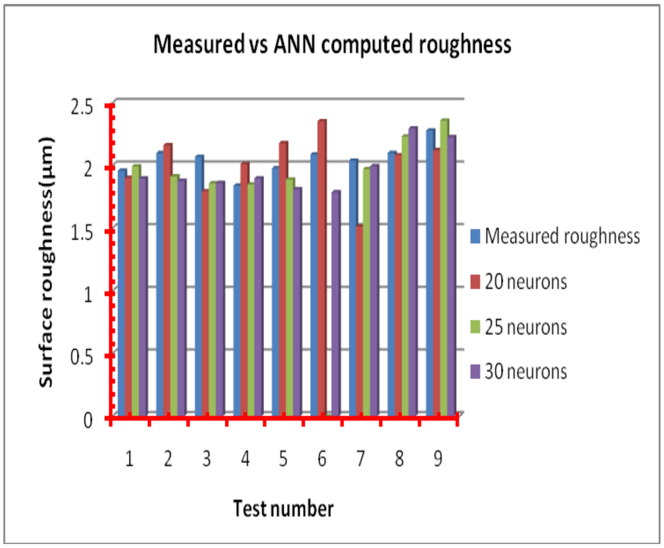
EXPERIMENTAL PROCEDURE

Experimental details and specifications

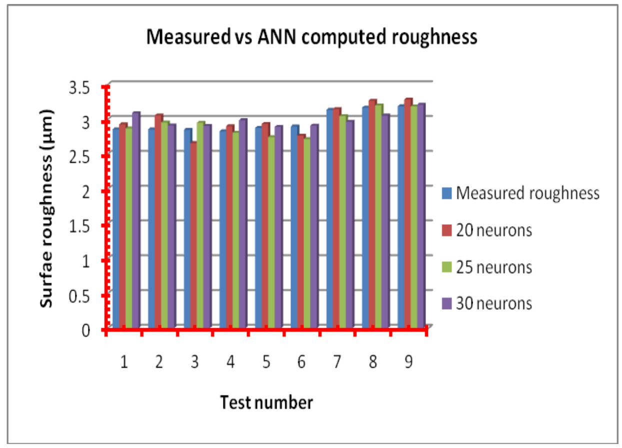
Machine tool : Engine Lathe
Work material : Mild steel
Cutting tool : High speed steel, Cemented carbide tipped tool Cutting conditions
: Dry environment
Surface roughness measuring instrument
Mitutoyo SJ-201P
Traverse Speed :1mm/sec
Measurement : Metric/Inch

Level	Speed (v) (rpm)	Feed rate(f) (mm/rev)	Depth of cut(d) (mm)
1	228	0.05	0.4
2	450	0.08	0.6
3	740	0.1	1

S.No	Speed (rpm)	Feed (mm /rev)	Depth of cut(mm)	Measured Surface roughness Ra (µm)	ANN Computed roughness Ra (µm) w.r.t hidden neurons					
					@20 neurons	Deviation (%)	@25 neurons	Deviation (%)	@30 neurons	Deviation (%)
1	250	0.06	0.5	1.96	1.902	-5.78	1.993	3.310	1.899	-6.011
2	250	0.06	0.7	2.10	2.162	6.221	1.914	-18.51	1.879	20.21
3	250	0.06	0..9	2.07	1.795	-27.41	1.859	-21.05	1.863	-20.64
4	360	0.07	0.5	1.84	2.013	17.32	1.851	1.122	1.899	5.941
5	360	0.07	0.7	1.98	2.179	19.93	1.889	-9.090	1.813	-8.442
6	360	0.07	0.9	2.09	2.354	26.48	2..178	8.832	1.787	30.29
7	540	0.09	0.5	2.04	1.513	-46.25	1.973	-6.621	1.996	-4.347
8	540	0.09	0.7	2.10	2.083	-1.970	2.233	13.31	2.297	19.73
9	540	0.09	0.9	2.28	2.124	-15.93	2.359	7.941	2.227	-5.729
Average						18.589		9.782		13.48



S.No	Speed (rpm)	Feed (mm /rev)	Depth of cut (mm)	Measured Surface Roughness Ra (µm)	ANN Computed roughness Ra (µm) w.r.t hidden neurons					
					@20 neurons	Deviation (%)	@25 neurons	Deviation (%)	@30 neurons	Deviation (%)
1	250	0.06	0.5	2.86	2.931	6.313	2.873	0.475	3.091	22.92
2	250	0.06	0.7	2.86	3.058	18.31	2.958	9.078	2.915	4.796
3	250	0.06	0..9	2.85	2.661	19.36	2.953	9.935	2.909	5.514
4	360	0.07	0.5	2.83	2.903	6.708	2.811	-2.529	2.990	15.36
5	360	0.07	0.7	2.88	2.936	5.518	2.746	13.47	2.893	1.212
6	360	0.07	0.9	2.90	2.768	-13.33	2.720	-18.06	2.912	1.123
7	540	0.09	0.5	3.14	3.151	0.740	3.048	-9.389	2.968	17.97
8	540	0.09	0.7	3.17	3.270	10.14	3.202	2.430	3.057	-12.07
9	540	0.09	0.9	3.19	3.287	8.774	3.189	-1.014	3.212	1.357
Average						9.900		7.376		9.147



HSS tool on mild steel

Training performance				Test performance		
Hidden neurons	20	25	30	20	25	30
Regression	0.998	0.999	0.998	0.873	0.91	0.86

Cemented carbide tipped tool on mild steel

Training performance				Test performance		
Hidden neurons	20	25	30	20	25	30
Regression	0.995	0.997	0.995	0.855	0.93	0.850

Optimum cutting Conditions:

Type of tool Used on MS	Test optimum cutting conditions in ANN				
	Speed (rpm)	Feed (mm/rev)	Depth of Cut (mm)	ANN Ra (µm)	% approach by ANN Technique
HSS	729	0.056	0.44	1.73	92
Cemented Carbide	702	0.051	0.416	2.74	93

- The correlation coefficient (R) of test performance of HSS and cemented carbide tool on mild steel, is 0.91and 0.93 and their R^2 values are 0.821 and 0.864 respectively,
- Which means that 82% and 86% of the total variation in network prediction can be explained by the linear relationship between experimental values and network predicted values
- The other 18% and 14% of the total variation in network prediction remains unexplained.
- The value of R^2 increases up to hidden neuron 25. Then it starts to decrease mainly in terms of testing cases. So,

the network consisting of 25 hidden neurons was selected as the optimum one in this present work.

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