RESEARCH ARTICLE OPEN ACCESS

Optimization of Force and Surface Roughness for Carbonized Steel in Turning Process through Neural Network

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ABSTRACT
These days one of the most important machining processes in industries is turning. Turning is affected by many factors such as the cutting velocity, feed rate, depth of cut and geometry of cutting tool etc., which are input parameters in this paper work. The desired product of dimensional accuracy and less surface roughness is influenced by cutting force and tool vibration which are the responses and the functions of these input parameters. In this paper work we determine the optimal setting of cutting parameters cutting speed, depth of cut, feed and of the tool by using artificial neural network to get a maximum cutting force an minimum surface roughness. This study highlights the use of modern optimization technique to optimize the multi response in turning operation.
Keywords: Neural Network, Neuron, surface roughness, turning.

I. INTRODUCTION

In the modern industry technology is advancing. For that engineers should be ready to achieve product of good surface finish, economic production, less wear of cutting tool with optimizing the use of resources. One of the most important manufacturing processes in mechanical engineering is metal cutting which is defined as metal removal of chips from job to achieve the desired product of appropriate shape, size and surface roughness. In metal cutting most regularly used method is turning in which a single point cutting tool does metal removal by giving feed in a parallel direction to the axis of rotation. Turning can be done in an automated lathe machine which does not require more labor or frequent supervision by operator.

Referring to earlier practices it is an evident that conditions like speed of cut, Feed rate and Depth of Cut is chosen to optimize the economics of machining operations. In Large manufacturing sites use of hand book based conservative methods are practiced at the process planning level. Other techniques which have been used to optimize the machining parameters include goal programming and geometrical programming. In present scenario high concentration is given to Exactness also called as accurateness and Surface Roughness of the work piece taken into consideration.

Machinability of the material is best decided by Surface roughness. Surface Roughness and dimensional Exactness are chief factors to predict the machining performances of any machining operation. Generally Surface Roughness prediction models are experimental and they are generally based conducted in the laboratory. Optimization of these parameters increases the utilization for economics of machining and also increases the quality of product to higher level.

1.1 Turning Process Parameters

The main affecting process parameters for turned parts are

1. Cutting Tool parameters-Tool Geometry and Tool material
2. Work piece related parameters –Hardness, Metallographic
3. Cutting parameters-Cutting Speed, Feed, Depth of Cut.
4. Environmental parameters-Dry cutting, Wet cutting.

The following process parameters were selected for the present work:
1. Cutting speed,
2. Feed,
3. Depth of Cut

Cutting speed: It is the speed of the surface of work piece. By definition it is the rate of rotation of surface of work piece moves against the tool and is calculated as the ratio of rotary speed of spindle (rpm) and circumference of the work piece (mm/rev).[5]

Feed rate: It is the speed at which the cutting tool moves is moved into the part and part is moved into tool. It is given in mm /minute or mm /revolution of the work piece. The latter will be used in this study.[5]

Depth of cut: It is the amount of the thickness of metal removed from the workpiece by tool face. This measurement is made along a line perpendicular to the longitudinal axis of the work piece.[5]

1.2 Earlier works on this process

Earlier many procedures are interrelated in the turning of a cylindrical component .generally machining operations is also involved along with turning resulting in a very complicated problem and no attempt for solving such a problem were shown in the literature search .Determinations of optimum cutting conditions in an external turning operation have been developed by many researchers. There published techniques involve optimization of cutting conditions for minimum cost, maximum production rate or maximum profit. Each researcher takes into account slightly different cutting constraints and utilizes unlike method for estimating the cutting forces.

Most assume a linear relationshipof the form $F = l*(\alpha + \beta*he)$ where l is the active contact length between the tool and workpiece, he is the equivalent chip thickness, and α andβ are empirically determined constants dependent on the tool-workpiece material combination.

These forces are unanimously recognized to be dependent on the combination of tool-workpiece, Material as the knowledgeof physical parameters to estimate cutting force, which must be obtained by experiment, the published solutions of researcher are automatically constraint to only some combinations of material.

II. NEURAL NETWORK

A neural network consists of unit particles working simultaneously. The particles are influenced by nervous systems present in living bodies. Generally, the relationship between particles finds the function of network. A neural network can be trained to carry out any operation by changing the respective parameters of the connections (weights) between particles.[4]

Mostly,for obtaining a particular target output from given inputs, the values of neural networks is altered. [4]

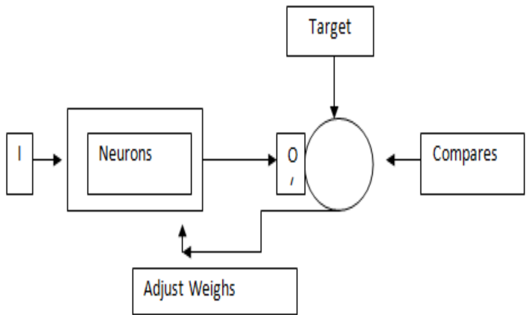

Fig 1.structure of Neural Network [4]

The fig.1shows a situation, where the network is adjusted, based on a comparison of the output and the target, until the network output matches the target. Generally, large no of such input/target pairs are needed to train a network.[4]
Neural networks nowadays are trained to function for solving complex functions in various fields, including pattern recognition, identification, classification, speech, vision, and control systems.[4]

Neural networks can also be trained to solve problems that are difficult for conventional computers or human beings

III. PARAMETERS

In order to carry out the process of training neural network we need process parameters which are given in Table 1.
Work piece material is carbonized steel, with standard markings C45E(EN 10083/1996).Material was hot rolled into 6mlong cylinder with diameter of 100mm,after essential forming into cylinders it was tempered .Material is later cut into cylinders with dimensions of 100*380 [2]

Table 1 input and output values of turning parameters [2]

S. No.	Input			Output	
	V_c [m/min]	f [mm/rev]	a_p [mm]	F_c [N]	R_a[□m]
1	300	0.3	1.5	879.224	4.3
2	400	0.3	1.5	894.327	3.88
3	300	0.5	1.5	1436.299	11.11
4	400	0.5	1.5	1408.114	11.48
5	300	0.3	3	1754.215	4.21
6	400	0.3	3	1726.937	4.5
7	300	0.5	3	2896.122	14.29
8	400	0.5	3	2860.663	13.71
9	400	0.1	0.4	128.893	0.77
10	500	0.1	0.4	130.755	0.8
11	400	0.2	0.4	201.899	1.7
12	500	0.2	0.4	202.2	1.67
13	400	0.1	1.2	337.859	1.11
14	500	0.1	1.2	330.745	1.19
15	400	0.2	1.2	492.945	2.14
16	500	0.2	1.2	550.848	1.77

IV. PERFORMANCE

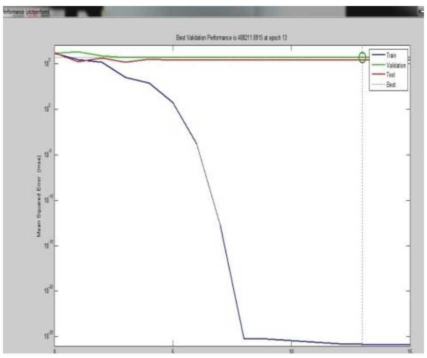

Fig.2 Performance curve

Fig. 2 explains that we are getting bestresults at epoch 13

V. RESULTS

Table2. Results for force and surface roughness

Force(N)	Ra □m
894.327	3.88
1436.2	11.11
1408.5	11.48
1726.9	4.5
2896.1	14.24
2860.7	13.77
130.755	0.06
2201.9	1.7
492.945	2.14
550.848	1.77

Table3. Corresponding to it network error is as follows

F	R_a
0	8.80E-16
0	1.70E-15
2.27E-15	0
0	8.80E-16
0	5.30E-15
0	1.70E-15
1.42E-13	2.20E-16
-8.53E-14	-6.60E-16
5.68E-14	4.40E-16
1.14E-13	-6.60E-16

VI. REGRESSION PLOT

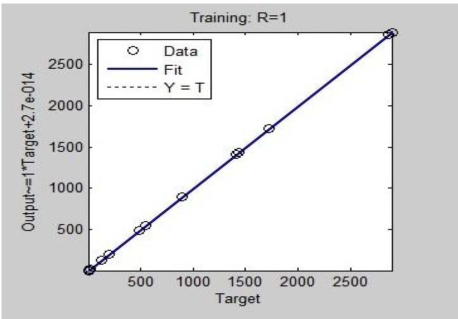

Fig3. Graph for training

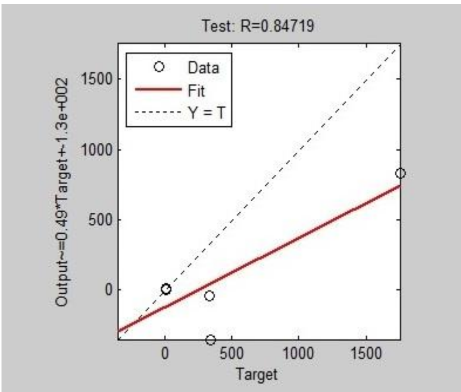

Fig.4 Graph for fitting

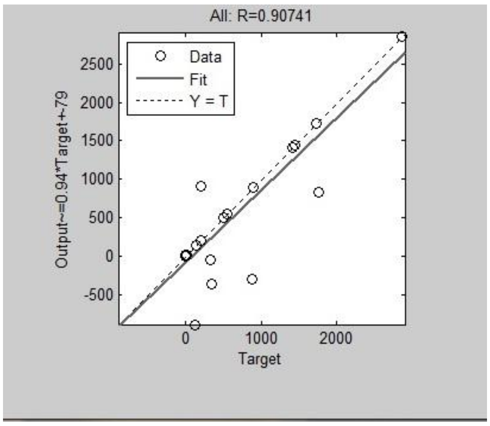

Fig.5 Regression plot

VII. CONCLUSIONS

In this paper, we introduce a procedure to formulate and solve optimization problems for multiple and conflicting objectives that may exist in finish turning processes using neural network modeling. The representative multiple objectives for hard turning are defined to obtain a group of optimal process parameters for three different case studies, which minimizes surface roughness values and maximizes the productivity at the same time, or maximizes tool life. The neural network models integrated with the particle swarm optimizer called swarm-intelligent neural networks system (SINNS) is can be used further in order to obtain a family of solutions that provides useful information to the user during the selection of machining parameters.[1]

SUMMARY

In this paper, optimization of cutting parameters is done by Neural network has been discussed comprehensively. According to the results, conclusions were drawn as follow:

(1) ANN in cutting parameters optimization can converge quickly to a consistent combination of spindle speed and feed rate.
(2) Machining process can be improved via cutting parameters optimization.
(3) And machining efficiency can also be improved.[6]

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