Optimization of Process Parameters For Surface Roughness And Material Removal Rate For Ss410 Material During Turning Operation

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Abstract---Machining of medium SS410 is very difficult. There are a number of parameters like cutting speed, feed and depth of cut etc. which must be given consideration during the machining of SS 410. The prediction of optimal machining conditions for good surface roughness and material removal rate plays a very important role in process planning. This study optimizes the process parameters for surface roughness and Material Removal Rate (MRR) in turning of SS 410 round bars on CNC machine. The experimentation was carried out with PVD-coated (WNMG) cutting tools; a first order mathematical model in terms of machining parameters was developed for surface roughness and material removal rate prediction using RSM. The multi response optimization problems i.e. Optimization of SR and MRR are solved by using Genetic Algorithm (GA). The optimization is done using twenty seven experimental runs based on L'27 orthogonal array. Analysis Of Variance (ANOVA) is also used to analyze the influence of cutting parameters during machining. Result outcomes from the ANOVA for surface roughness are that the Feed rate is found the most significant effect on surface roughness. Increase in feed rate, value of surface roughness is increase. for material removal rate is that the Feed and Depth of cut are found the most significant effect on material removal rate. Increase in feed and depth of cut, value of material removal rate is increase.

Keywords:- Orthogonal array, CNC Machine, Design of experiments, Full factorial, Genetic Algorithm, Minitab@16 software, MATLAB R2010a.

I. INTRODUCTION

A. Project Background:

The challenge of modern machining industries is mainly focused on the achievement of high quality, in term of work piece dimensional accuracy, surface finish. Surface texture is concerned with the geometric irregularities of the surface of a solid material which is defined in terms of surface roughness, waviness, lay and flaws. Surface roughness consists of the fine irregularities of the surface texture, including feed marks generated by the machining process. The quality of a surface is significantly important factor in evaluating the productivity of machine tool and machined parts. The surface roughness of machined parts is a significant design specification that is known to have considerable influence on properties such as wear resistance and fatigue strength. It is one of the most important measures in finishing cutting operations.

Fig. 1: CNC machine

B. Cnc Turning:

A CNC Lathe produces parts by "turning" rod material and feeding a single-point cutter into the turning material. Cutting operations are performed with a cutting tool fed either parallel or at right angles to the axis of the workpiece. The tool may also be fed at an angle relative to the axis of the workpiece for the machining tapers and angles. The workpiece may originally be of any cross-section, but the machined surface is normally straight or tapered. Have many possible shape can produce in CNC turning such as variety of plain, taper, contour, fillet and radius profiles plus threaded surfaces. CNC turning also can be used to create shafts, rods, hubs, bushes and pulleys.

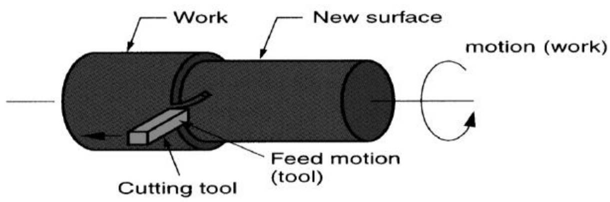

Fig. 2: Turning operation

C. Problem Statement:

Optimization of turning parameters is usually a difficult work where the following aspects are require such as like knowledge of machining and the specification of machine tool capabilities.

The level of parameters is the main point because it will affect the surface of the work piece, it also to avoid from scratch marks or inaccuracies in the cut. In a turning operation, it is important task to select a good combination of parameters level for achieving high cutting performance. Generally this combination is hard to find.

In turning operation, the performances of cutting tools are depending on a few cutting conditions and parameters. The proper selection of feed rate has direct effect to the product surface roughness. Turning process by maximizing cutting speed and depth of cut will optimize the cutting process and minimize the production cost. The tool life, machined surface integrity and cutting forces are directly dependent on cutting parameters and will determine the cutting tool performances. The study of surface roughness form will resolve the characteristic and phenomena happening during the machining process.

Input parameter: Cutting Speed, Depth of cut, Feed rate

Output parameter: Surface roughness, MRR

D. Project Scope:

The study has been conducted on the following scopes:

- CNC Turning machine employed for experimental work.
- Stainless Steel solid bar SS410 used as a workpiece material.
- Dimension of the workpiece is Ø28 mm X45 mm.

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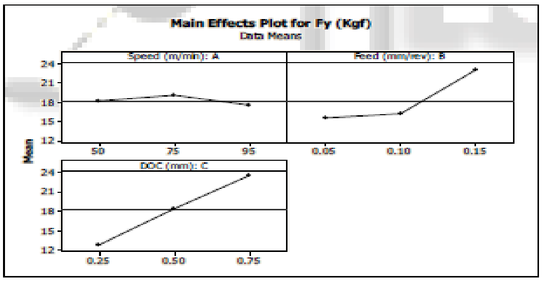
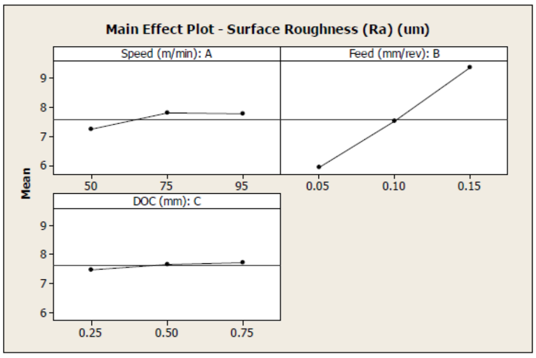
- Cutting speed, feed and depth of cut are the process parameters to be optimized.
- Performance will be primarily in terms of surface roughness and material removal rate will also be briefly discussed.
- Design of Experiment technique is used.
- Genetic Algorithm technique will be used for optimization.

II. Literature Review

Dr. C. J. Rao[1], were carried out "Influence of cutting parameters on cutting force and surface finish in turning operation". they describes the significance of influence of speed, feed and depth of cut on cutting force and surface roughness while working with tool made of ceramic with an Al2O3+TiC matrix (KY1615)and the work material of AISI 1050 steel (hardness of 484 HV). Experiments were conducted using Johnford TC35 Industrial type of CNC lathe. Taguchi method (L27 design with 3 levels and 3 factors) was used for the experiments. Analysis of variance with adjusted approach has been adopted. The results have indicated that it is feed rate which has significant influence both on cutting force as well as surface roughness. Depth of cut has a significant influence on cutting force, but has an insignificant influence on surface roughness. The interaction of feed and depth of cut and the interaction of all the three cutting parameters have significant influence on cutting force, whereas, none of the interaction effects are having significant influence on the surface roughness produced. If power consumption minimization is to be achieved for the best possible surface finish, the most recommended combination of feed rate and depth of cut is also determined.



(a)



(b)

Fig. 3: effect of cutting parameters on (a) cutting force and (b) surface roughness

M.kaladhar[2], were carried out "Determination of Optimum Process Parameters during turning of AISI 304 Austenitic Stainless Steels using Taguchi method and ANOVA". They investigated the effects of process parameters feed,speed,depth of cut and nose radius on surface finish and material removal rate (MRR) to obtain the optimal setting of these process parameters. And the Analysis Of Variance (ANOVA) is also used to analyze the influence of cutting parameters during machining. In this work, AISI 304 austenitic stainless steel work pieces are turned on computer numerical controlled (CNC) lathe by using Physical Vapour Deposition (PVD) coated cermets insert (TiCN- TiN) of 0.4 and 0.8 mm nose radii. The results revealed that the feed and nose radius is the most significant process parameters on work piece surface roughness. However, the depth of cut and feed are the significant factors on MRR. Optimal range and optimal level of parameters are also predicted for response. The aim of experimental investigation is to evaluate the effects of the process parameters on AISI 304 austenitic stainless steel work piece surface roughness and material removal rate by employing Taguchi's orthogonal array design and Analysis of Variance (ANOVA) using PVD coated Cermets tool on CNC lathe under dry environment.

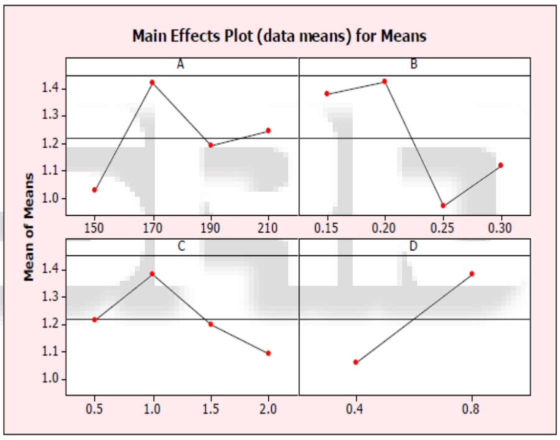


Fig. 4: (a) Main effect plot for SR

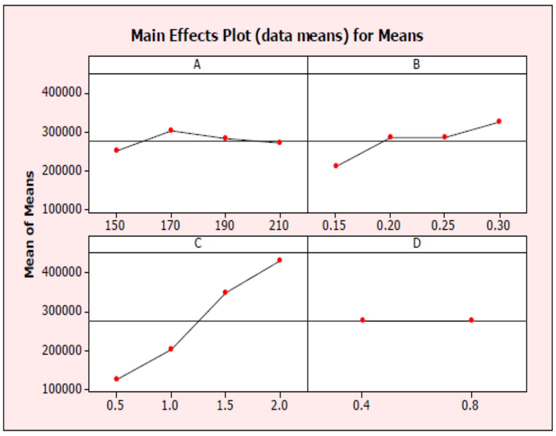


Fig. 4: (b) Main effect plot for MRR

Hamdi Aouici[3], were carried out "Analysis of surface roughness and cutting force components in hard turning with CBN tool: Prediction model and cutting conditions optimization".they describes the effects of cutting

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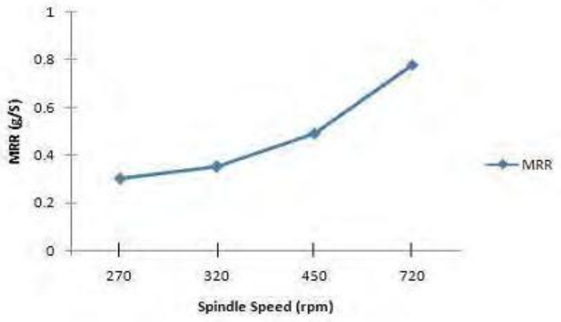
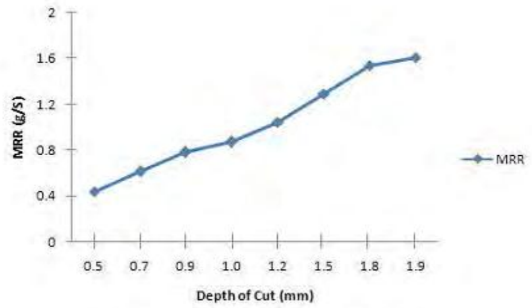
speed, feed rate, workpiece hardness and depth of cut on surface roughness and cutting force components in the hard turning were experimentally investigated. AISI H11 steel was hardened to (40; 45 and 50) HRC, machined using cubic boron nitride (CBN 7020 from Sandvik Company) which is essentially made of 57% CBN and 35% TiCN. Four-factor (cutting speed, feed rate, hardness and depth of cut) and three-level fractional experiment designs completed with a statistical analysis of variance (ANOVA) were performed. Mathematical models for surface roughness and cutting force components were developed using the response surface methodology (RSM). Results show that the cutting force components are influenced principally by the depth of cut and workpiece hardness; on the other hand, both feed rate and workpiece hardness have statistical significance on surface roughness. Finally, the ranges for best cutting conditions are proposed for serial industrial production.

Gaurav Bartarya[4], were carried out "Effect of cutting parameters on cutting force and surface roughness during finish hard turning AISI52100 grade steel". The present work is an attempt to develop a force prediction model during finish machining of EN31 steel (equivalent to AISI52100 steel) hardened to 60±2 HRC using hone edge uncoated CBN tool and to analyze the combination of the machining parameters for better performance within a selected range of machining parameters. A full factorial design of experiments procedure was used to develop the force and surface roughness regression models, within the range of parameters selected. The regression models developed show that the dependence of the cutting forces i.e. cutting, radial and axial forces and surface roughness on machining parameters are significant, hence they could be used for making predictions for the forces and surface roughness. The predictions from the developed models were compared with the measured force and surface roughness values. To test the quality of fit of data, the ANOVA analysis was undertaken. The favourable range of the machining parameter values is proposed for energy efficient machining.

Deepak Mittal[5], were carried out "An investigation of the effect of process parameters on MRR in turning of pure titanium (grade-2)". They investigate the effect of process parameters in turning of Titanium grade 2 on conventional lathe. A single point high speed steel (MIRANDA S-400) tool is used as the cutting tool. The round bar of Titanium grade 2, 40mm diameter and 50 mm length is used as the work piece. Three parameters namely spindle speed, depth of cut and feed rate are varied to study their effect on material removal rate and tool failure. The experiments are conducted using one factor at a time approach. A Total of 30 experiments were performed. The MRR was calculated by measuring the weight of the specimen before and after machining on the digital balance meter with a least count of 10 mg of Sansui (Vibra), model no. AJ3200E. Moreover, a few random experiments are also carried to study the phenomenon of tool failure. The study reveals that material removal rate is directly influenced by all the three process parameters. However the effect of spindle speed and feed rate is more as compared to depth of cut. An optimum range of input parameters has been bracketed as the final outcome for carrying out further research.



(a)



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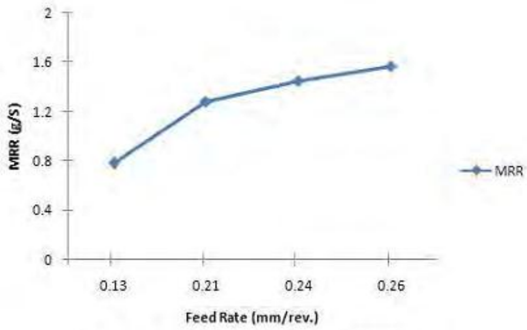

(c)

Fig. 5: effect of (a) speed, (b) DOC and (c) feed rate on MRR

Tian-Syung LAN[6], were carried out "Parametric Deduction Optimization for Surface Roughness". They investigated with four parameters (cutting depth, feed rate, speed, tool nose runoff) with three levels (low, medium, high) were considered to optimize the surface roughness for Computer Numerical Control (CNC) finish turning. The finishing diameter turning operation of S45C (ϕ45 mm×250 mm) work piece on an ECOCA-3807 CNC lathe is arranged for the experiment. The TOSHIBA WTJNR2020K16 tool holder with MITSUBISHI NX2525 insert is utilized as the cutting tool. In investigation, the variable quantification and deduction optimization for CNC turning operations were proposed using fuzzy set theory and Taguchi method respectively. Additionally, twenty-seven fuzzy control rules using trapezoid membership function with respective to seventeen linguistic grades for the surface roughness was constructed. Considering thirty input and eighty output intervals, the defuzzification using center of gravity was moreover completed. Through the Taguchi experiment, the optimum general deduction parameters can then be received.

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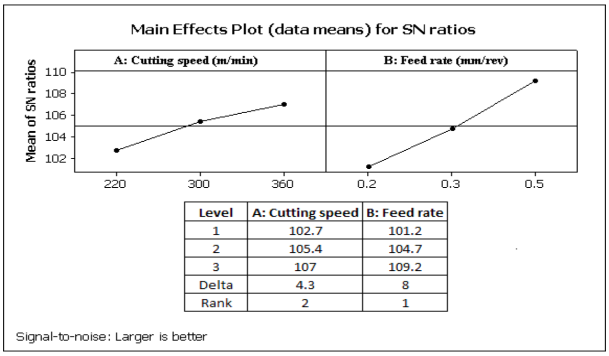
The confirmation experiment for optimum deduction parameters was furthermore performed on an ECOCA-3807 CNC lathe. It was shown that the surface roughness from the fuzzy deduction optimization parameters are significantly advanced comparing to those from benchmark. This study not only proposed a parametric deduction optimization scheme using orthogonal array, but also contributed the satisfactory fuzzy approach to the surface roughness for CNC turning with profound insight.

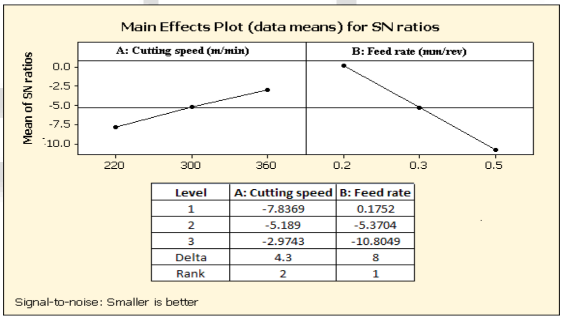
J.S.Senthilkumaar[7], were carried out "Selection of machining parameters based on the Analysis of surface roughness and flank wear in finish Turning and facing of inconel 718 using Taguchi Technique". Single pass finish turning and facing operations were conducted in dry cutting condition in order to investigate the performance and study the wear mechanism of uncoated carbide tools on Inconel 718 in the form of cylindrical bar stock of diameter 38 mm. The experiments were conducted on the L16 ACE designer CNC lathe with constant speed capability. Uncoated carbide inserts as per ISO specification SNMG 120408-QM H13A were clamped onto a tool holder with a designation of DSKNL 2020K 12 IMP for facing operation and DBSNR 2020K 12 for turning operation. Cutting experiments were conducted as per the full factorial design under dry cutting conditions. The effects of the machining parameters on the performance measures surface roughness and flank wear were investigated. The relationship between the machining parameters and the performance measures were established using the non-linear regression analysis. Taguchi's optimization analysis indicates that the factors level, its significance to influence the surface roughness and flank wear for the tuning and facing processes. Confirmation tests were conducted at an optimal condition to make a comparison between the experimental results foreseen from the mentioned correlations. Based on Taguchi design of experiments and analysis, the cutting speed is the main factor that has the highest influence on surface roughness as well as flank wear of turning and facing processes. Optimal machining parameters for minimum surface roughness were determined. The percentage error between experimental and predicted result is 8.69% and 8.49% in turning and facing process respectively. Optimal machining parameters for minimum flank wear, the percentage error between experimental and predicted result is 4.67% for turning process and 2.63% for facing process. Based on the Taguchi's optimization analysis for the turning process the cutting speed and depth of cut are the dominant factors whereas in facing process cutting speed and feed are dominant factors which affecting the performance measures.

H. Yanda[8], were carried out "Optimization of material removal rate, surface roughness and tool life on conventional dry turning of fcd700". They investigate the effect of the cutting speed, feed rate and depth of cut on material removal rate (MRR), surface roughness, and tool life in conventional turning of ductile cast iron FCD700 grade using TiN coated cutting tool in dry condition. The machining condition parameters were the cutting speed of 220, 300 and 360 m/min, feed rate of 0.2, 0.3 and 0.5 mm/rev, while the depth of cut (DOC) was kept constant at 2 mm. The effect of cutting condition (cutting speed and feed rate) on MRR, surface roughness, and tool life were studied and analyzed. Experiments were conducted based on the Taguchi design of experiments (DOE) with orthogonal L9 array, and then followed by optimization of the results using Analysis of Variance (ANOVA) to find the maximum MRR, minimum surface roughness, and maximum tool life. The optimum MRR was obtained when setting the cutting speed and feed rate at high values, but the optimum tool life was reached when the cutting speed and feed rate were set as low as possible. Low surface finish was obtained at high cutting speed and low feed rate. Therefore time and cost saving are significant especially is real industry application, and yet reliable prediction is obtained by conducting machining simulation using FEM software Deform 3D. The results obtained for MRR using the proposed simulation model were in a good agreement with the experiments.



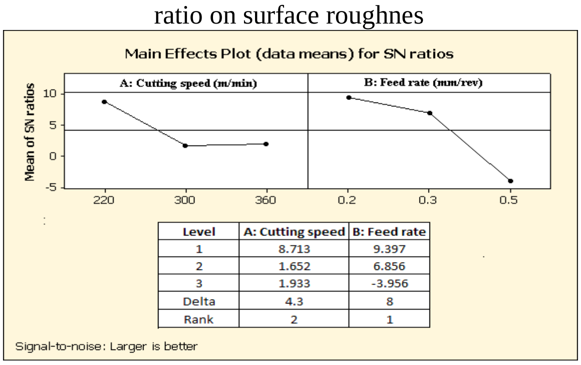
Level	A: Cutting speed	B: Feed rate
1	102.7	101.2
2	105.4	104.7
3	107	109.2
Delta	4.3	8
Rank	2	1

Fig. 6(a): effect of cutting speed and feed rate parameters in the S/N ratio on MRR



Level	A: Cutting speed	B: Feed rate
1	-7.8369	0.1752
2	-5.189	-5.3704
3	-2.9743	-10.8049
Delta	4.3	8
Rank	2	1

Fig. 6(b): effect of cutting speed and feed rate in the S/N ratio on surface roughnes



Level	A: Cutting speed	B: Feed rate
1	8.713	9.397
2	1.652	6.856
3	1.933	-3.956
Delta	4.3	8
Rank	2	1

Fig. 6(c): effect of cutting speed and feed rate parameters in the S/N ratio on tool life

Anderson P. Paiva[9], were carried out "A multivariate hybrid approach applied to AISI 52100 hardened steel turning optimization". This paper presents an alternative hybrid approach, combining response surface methodology (RSM) and principal component analysis (PCA) to optimize multiple correlated responses in a turning

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process. Since a great number of manufacturing processes present sets of correlated responses, this approach could be extended to many applications. As a case study, the turning process of the AISI 52100 hardened steel is examined considering three input factors: cutting speed (*V*c), feed rate (*f*) and depth of cut (*d*). The outputs considered were: the mixed ceramic tool life (*T*), processing cost per piece (*K*p), cutting time (*C*t), the total turning cycle time (*T*t), surface roughness (*R*a) and the material removing rate (MRR). The aggregation of these targets into a single objective function is conducted using the score of the first principal component (PC1) of the responses' correlation matrix and the experimental region (*Ω*) is used as the main constraint of the problem. Considering that the first principal component cannot be enough to represent the original data set, a complementary constraint defined in terms of the second principal component score (PC2) is added. The original responses have the same weights and the multivariate optimization lead to the maximization of MRR while minimize the other outputs. The kind of optimization assumed by the multivariate objective function can be established examining the eigenvectors of the correlation matrix formed with the original outputs. The results indicate that the multiresponse optimization is achieved at a cutting speed of 238 m/min, with a feed rate of 0.08 mm/rev and at a depth of cut of 0.32 mm. It was observed that to maximize the material removal rate while minimizing the cutting times, costs and surface quality simultaneously.

Muammer Nalbant[10], were carried out "Comparison of Regression and Artificial Neural Network Models for Surface Roughness Prediction with the Cutting Parameters in CNC Turning". The experimental results corresponding to the effects of different insert nose radii of cutting tools (0.4, 0.8, 1.2 mm), various depth of cuts (0.75, 1.25, 1.75, 2.25, 2.75 mm), and different feed rates (100, 130, 160, 190, 220 mm/min) on the surface quality of the AISI 1030 steel workpiece have been investigated using multiple regression analysis and artificial neural networks (ANN). Regression analysis and neural network-based models used for the prediction of surface roughness were compared for various cutting conditions in turning. The data set obtained from the measurements of surface roughness was employed to and tests the neural network model. The trained neural network models were used in predicting surface roughness for cutting conditions. A comparison of neural network models with regression model was carried out. Coefficient of determination was 0.98 in multiple regression model. The scaled conjugate gradient (SCG) model with 9 neurons in hidden layer has produced absolute fraction of variance (R2) values of 0.999 for the training data, and 0.998 for the test data. Predictive neural network model showed better predictions than various regression models for surface roughness. However, both methods can be used for the prediction of surface roughness in turning.

B Sidda Reddy[11]**,** were carried out "Surface roughness prediction technique for CNC technique". They developed a surface roughness prediction model for machining aluminum alloys using multiple regression and artificial neural networks. The experiments have been conducted using full factorial design in the design of experiments on CNC turning machine with carbide cutting tool. A second order multiple regression model in terms of machining parameters has been developed for the prediction of surface roughness. The adequacy of the developed model is verified by using co-efficient of determination, analysis of variance, residual analysis and also the neural network model has been developed using multilayer perception back propagation algorithm using train data and tested using test data. To judge the efficiency and ability of the model to predict surface roughness values percentage deviation and average percentage deviation has been used. The experimental result show, artificial neural network model predicts with high accuracy compared with multiple regression model.

Ihsan Korkut[12]**,** were carried out "Determination of optimum cutting parameters during machining of AISI 304 austenitic stainless steel"they describes that High strength, low thermal conductivity, high ductility and high work hardening tendency of austenitic stainless steels are the main factors that make their machinability difficult. In this study determination of the optimum cutting speed has been aimed when turning an AISI 304 austenitic stainless steel using cemented carbide cutting tools. The influence of cutting speed on tool wear and surface roughness was investigated.

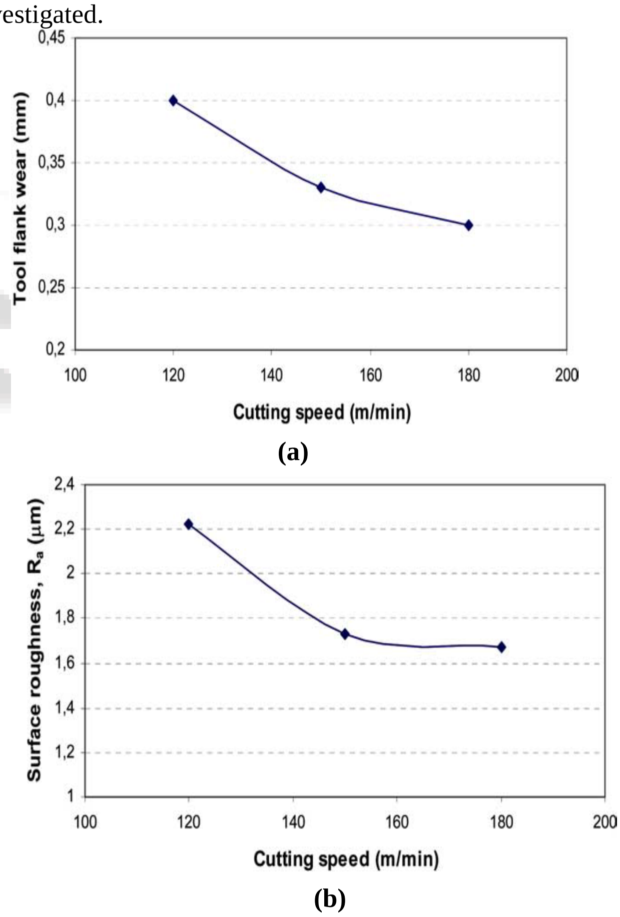

Fig. 7: effect of cutting speed on (a)Tool Flank wear and (b)Surface roughness

Dusan petkovic [13] **,** were carried out "using genetic algorithms for optimization of turning machining process". They describes that Optimization methods of machining processes are tools for improving product quality and reducing cost and production time. Modern optimization methods, among which genetic algorithms (GA) have been, used a lot during last two decades. This paper describes the optimization of machining processes by using genetic algorithms.Optimal parameters of machining (cutting speed and feed) were determined. Also, minimal cost for the turning process was achieved.

Ishwer Shivakoti [14] **,** were carried out "Analysis of Material Removal Rate using Genetic Algorithm Approach". They describes that In the present scenario of manufacturing industries particularly in all of the machining processes, the application of various optimization techniques is playing vital role which seeks identification of the best process parametric condition for that pa rticular manufacturing or metal removal process. Manufacturing process involves a number of process parameters (controllable and uncontrollable). Since selection of wrong cutting parameter in any machining process may lead to several negative effects. For example, high maintenance cost of the lathe machine, poor surface finish of the work piece, short tool life, low production rate, material wastage and increased production cost. In this research paper, Genetic Algorithm (GA) has been applied for optimizing of machining parame ters during turning operation of mild steel using conventional lathe machines. The purpose of this pap er is to find the optimum parameters values for turning operations for maximizing the material removal rate. The machining parameters that been consider in this paper are cutting speed, feed rate and spindle speed. The Turbo C compiler is used to develop the GA simulation. GA can be used in optimization problems such as scheduling, materials engineering, optimal control, and so forth.

K.Saravanakumar [15] , were carried out "Optimization of CNC Turning Process Parameters on INCONEL 718 Using Genetic Algorithm". This paper is aimed at conducting experiments on Inconel 718 and investigation the influence of machining process parameters such as cutting speed (X1, m/min), feed rate(X2, mm/rev), and depth of cut (X3, mm) on the output parameters such as material removal rate and surface roughness. Cost effective machining with generation of good surface finish and maximum material removal rate on the Inconel 718 material by turning operation is a challenge to the manufacturing industry. Major advantages of high-speed machining are high material removal rates, more dissipation of heat, high chip removal rate and better surface finish. Therefore, by optimizing input parameters such as cutting speed, feed rate, and depth of cut, etc., the output parameters like surface finish and metal removal rate can also be optimized for economical production.

N.Zeelan Basha [16] , were carried out "Optimization of CNC Turning Process Parameters on ALUMINIUM 6061 Using Genetic Algorithm". The main objective of this paper is to predict the surface roughness. Aluminium 6061 is taken into a consideration, machining is done by using coated carbide tool. A second order mathematical model is developed using regression technique of Box-Behnken of Response Surface Methodology (RSM) in design expert software 8.0 and optimization carried out by using genetic algorithm in matlab8.0. This study attempts the application of genetic algorithm to find the optimal solution of the cutting conditions.

III. DESIGN OF EXPERIMENT FOR CNC TURNING MACHINE

A. *Factors And Their Levels In Cnc Turning:*

Table. 3.1: factors and their levels in turning

Process parameter	**Process designation**	**Level 1**	**Level 2**	**Level 3**
Cutting speed (m/min)	A	110	160	210
Feed (mm/rev)	B	0.14	0.22	0.3
Depth of cut (mm)	C	0.2	0.6	1

Table. 3.2 Experimental Design for turning

Sr No.	**Cutting speed (rpm)**	**Cutting speed (m/min)**	**Feed (mm/rev)**	**Depth of cut (mm)**	**Surface roughness (µm)**	**MRR (mm3/min)**
1	1251	110	0.14	0.2	0.83	3057.7
2	1251	110	0.14	0.6	0.84	9041
3	1251	110	0.14	1	0.89	14848
4	1251	110	0.22	0.2	1.51	4804.9
5	1251	110	0.22	0.6	1.66	14207
6	1251	110	0.22	1	1.79	23333
7	1251	110	0.3	0.2	1.67	6552.1
8	1251	110	0.3	0.6	1.79	19374
9	1251	110	0.3	1	1.8	31818
10	1819	160	0.14	0.2	0.75	4446.4
11	1819	160	0.14	0.6	0.84	13146
12	1819	160	0.14	1	0.85	21590
13	1819	160	0.22	0.2	1.18	6986.5
14	1819	160	0.22	0.6	1.27	20658
15	1819	160	0.22	1	1.19	33927
16	1819	160	0.3	0.2	1.1	9527
17	1819	160	0.3	0.6	1.36	28170
18	1819	160	0.3	1	1.48	46264
19	2388	210	0.14	0.2	0.59	5836.7
20	2388	210	0.14	0.6	0.68	17258
21	2388	210	0.14	1	0.75	28344
22	2388	210	0.22	0.2	1.42	9171.9
23	2388	210	0.22	0.6	1.33	27120
24	2388	210	0.22	1	1.32	44540
25	2388	210	0.3	0.2	1.47	12507
26	2388	210	0.3	0.6	1.61	36982
27	2388	210	0.3	1	1.58	60736

B. Experimental Work : In order to investigate the effects of different cutting parameters (cutting speed, feed, doc) in turning, work piece material this is to be holding on CNC turning centre. The machining is done by a PVD Coated Carbide tool under dry cutting condition. Material removal rate of work piece is measured with the help of equation and surface roughness of work piece was measured using the surface roughness tester TR 110. Experimental design using design of experiment technique is applied to evaluate the material removal rate and surface roughness with different levels of cutting parameters.

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C. Experimental Setup: In order to achieve the goal of this experimental work the cutting tests were carried out in BATLIBOI SPRINT-16TC CNC turning center at SMART INSTRUMENT LIMITED, CHHATRAL.The CNC turning centre has 5.5 kw / 7.5 kw spindle motor power and a maximal machining diameter of 225 mm, maximal spindle speed of 5000 rpm, spindle speed

range 40 to 5000 rpm and maximal turning length 300mm.

D. Workpiece Material:

– Steel AISI 410 or SS410.
– Dimension for material is Ø28 X 45 mm.

IV. Analysis Of Variance (Anova)

– For SR analysis shows the percentage contribution of individual parameters on surface roughness. The percentage contribution of cutting speed is 12.01 %, feed rate 78.45 % and depth of cut is 2.04 % and the error is 7.48 %. This error is due to human ineffectiveness and machine vibration.
– For MRR analysis shows the percentage contribution of individual parameters on material removal rate. The percentage contribution of cutting speed is 14.67 %, feed rate is 18.14% and depth of cut is 58.57 % and the error is 8.59 %.This error is due to human ineffectiveness and machine vibration.

A. Main Effect Plots Analysis: The analysis is made with the help of a software package MINITAB 16. The main effect plots are shown in Fig.5.1 and Fig.5.2. These show the variation of individual response with the three parameters i.e. cutting speed, feed, and depth of cut separately. In the plots, the x-axis indicates the value of each process parameter at three level and y-axis the response value. Horizontal line indicates the mean value of the response. The main effects plots are used to determine the optimal design conditions to obtain the optimum surface finish.

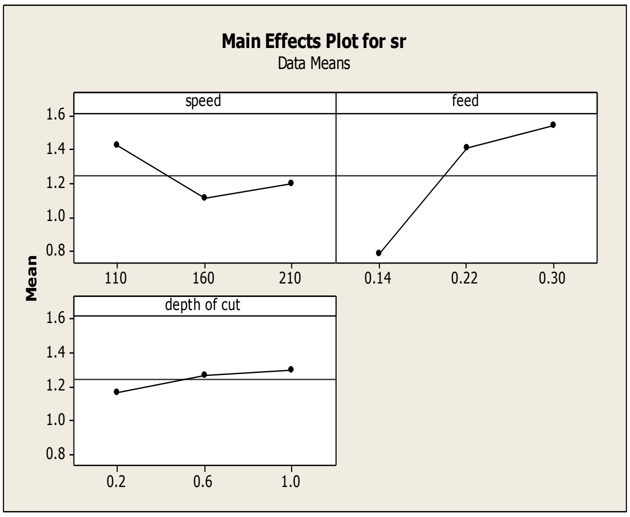

Fig. 4.1: Main effect plot for Surface Roughness

According to this main effect plot fig.4.1, the optimal conditions for minimum surface roughness are:

– Cutting speed at level 2 (160 m/ min),
– Feed rate at level 1 (0.14 mm/ rev),
– Depth of cut at level 1 (0.2 mm).

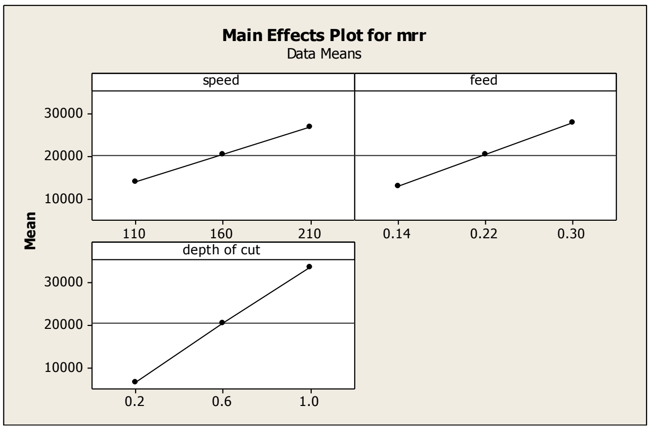

Fig. 4.2: Main effect plot for Material removal rate

Fig. 4.2 shows the main effect plot for material removal rate. According to this main effect plot, the optimal conditions for maximum material removal rate are:

– Cutting speed at level 3 (210 m/ min),
– Feed rate at level 3 (0.30 mm/ rev),
– Depth of cut at level 3 (1.0 mm).

V. Optimization

A. Genetic Algorithm: In 1975, Holland developed this idea in his book Adaptation in natural and artificial systems. He described how to apply the principles of natural evolution to optimization problems and built the first Genetic Algorithms. Holland's theory has been further developed and now Genetic Algorithms (GAs) stand up as a powerful tool for solving search and optimization problems. Genetic algorithms are based on the principle of genetics and evolution [20]. Goldberg, 1989 gives an excellent introductory discussion on GA, as well as some more advanced topics. Genetic algorithms are a probabilistic search approach which is founded on the ideas of evolutionary processes. The GA procedure is based on the Darwinian principle of survival of the fittest. An initial population is created containing a predefined number of individuals (or solutions), each represented by a genetic string (incorporating the variable information). Each individual has an associated fitness measure, typically representing an objective value. The concept that fittest (or best) individuals in a population will pro-duce fitter offspring is then implemented in order to reproduce the next population. Selected individuals are chosen for reproduction (or crossover) at each generation, with an appropriate mutation factor to randomly modify the genes of an individual, in order to develop the new population. The result is another set of individuals based on the original subjects leading to subsequent populations with better (min. or max.) Individual fitness. Therefore, the algorithm identifies the individuals with the optimizing fitness values, and those with lower fitness will naturally get discarded from the population. Ultimately this search procedure finds a set of variables that optimizes the fitness of an individual and/or of the whole population. As a result, the GA technique has advantages over traditional nonlinear solution techniques that cannot always achieve an optimal solution. For the genetic algorithm, the population encompasses a range of possible outcomes. Solutions are identified purely on a fitness level, and therefore local optima are not distinguished from other equally fit

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individuals. Those solutions closer to the global optimum will thus have higher fitness values. Successive generations improve the fitness of individuals in the population until the optimization convergence criterion is met. Due to this probabilistic nature GA tends to the global optimum, however for the same reasons GA models cannot guarantee finding the optimal solution. The GA consists of four main stages: evaluation, selection, crossover and mutation.

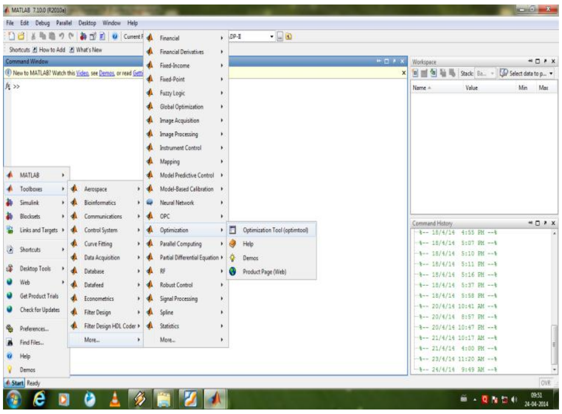

Fig. 5.1: MATLAB Tool Selection Window

B. Regression Equations: Regression equations were formed using Minitab software for material removal rate and surface roughness Ra

The regression equation for surface roughness (SR) is

SR = 0.403 - 0.00123 * Cutting Speed + 4.48 * Feed Rate + 0.185 * Depth of Cut - 0.0012 * Cutting Speed * Feed Rate - 0.00125 * Cutting Speed * Depth of Cut + 0.78 *Feed Rate * Depth of Cut (5.1)

The regression equation for material removal rate(MRR) is

MRR = 20208 - 126 * Cutting Speed - 91854 * Feed Rate - 33680 * Depth of Cut + 583 * Cutting Speed * Feed Rate + 210 * Cutting Speed * Depth of Cut + 153102 * Feed Rate * Depth of Cut (5.2)

In genetic algorithm (GA) these equations are written in

the form of

The regression equation for surface roughness (SR) is

Function y = surface roughness(x)

SR = (0.403 - 0.00123 * (x(1)) + 4.48 * (x(2)) + 0.185 * (x(3)) - 0.0012 * (x(1) * x(2)) - 0.00125 * (x(1) * x(3)) + 0.78 * (x(2) * x(3))); (5.3)

The regression equation for material removal rate (MRR) is

Function y = removal rate(x)

MRR = - (20208 - 126 * (x(1)) - 91854 * (x(2)) - 33680 * (x(3)) + 583 * (x(1) * x(2)) + 210 * (x(1) * x(3)) + 153102 * (x(2) * x(3))); (5.4)

C. Genetic Algorithm Result For Sr And Mrr:

1) *Minimization Of Surface Roughness:* Best fitness for minimization of surface roughness is shown in below using genetic algorithm tool. Population size 100, current iteration 51.

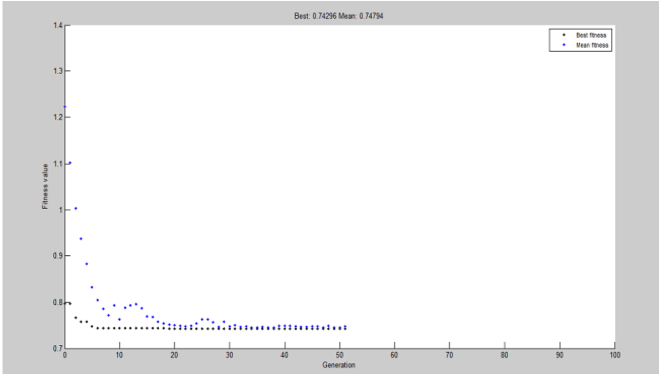

Fig. 5.2: Graph for Surface Roughness

- Cutting speed = 209.99 m/min, feed rate = 0.14 and depth of cut = 0.200 mm
- Best fitness for minimization of surface roughness is 0.7429609811393024 µm.

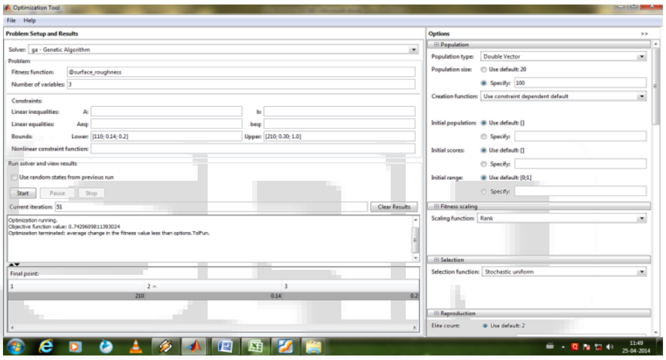

Fig. 5.3: GA Toolbox in MATLAB Environment for SR

2) *Maximization Of Material Removal Rate*: Best fitness for maximization of material removal rate is shown in below using genetic algorithm tool. Population size 100, current iteration 51

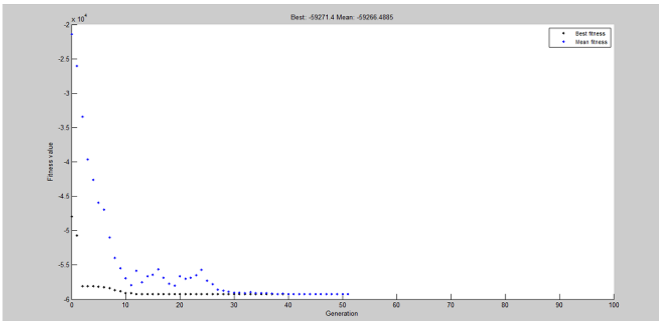

Fig. 5.4: Graph for Material Removal Rate

- Cutting speed = 209.99 m/min, feed rate = 0.30 mm/rev and depth of cut = 1.0 mm
- Best fitness for minimization of surface roughness is 59271.39999580036 mm^3/min.

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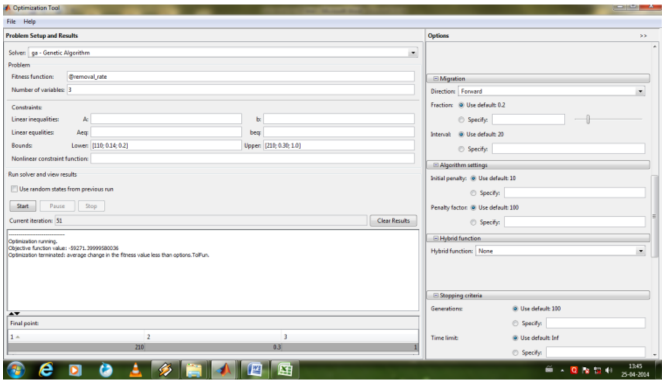

Fig. 5.5: GA Toolbox in MATLAB Environment for MRR

VI. CONCLUSION

In this dissertation work, various cutting parameters like cutting speed, feed and depth of cut have been evaluated to investigate their influence on surface roughness and material removal rate for turning operation. Based on the result obtained, it can be concluded as follows:

VII. SURFACE ROUGHNESS

- Cutting speed, feed rate and depth of cut significantly effects on surface roughness.
- Feed rate is found the most significant effect on surface roughness. Increase in feed rate, value of surface roughness is increase.
- Cutting speed is found to have effect on surface roughness. Increase in cutting speed, value of surface roughness is decrease.
- Depth of cut is found to have effect on surface roughness. Increase in depth of cut value of surface roughness is increase.
- The percentage contribution of cutting speed is 12.01 %, feed of 78.45 % and depth of cut of 2.04 % on surface roughness for straight turning operation.
- From the ANOVA it is conclude that the feed rate is most significant parameter which contributes more to surface roughness.
- In multi response optimization the optimum cutting parameter combination is meeting with parameter combination value is 0.200 mm depth of cut, 209.99 m/min cutting speed and 0.14 mm/rev feed rate surface roughness is 0.7429609811393024 µm.

VIII. MATERIAL REMOVAL RATE

- The volume of material removed can be achieved better when machining was done at high depth of cut and high feed rate.
- Feed and Depth of cut are found the most significant effect on material removal rate. Increase in feed and depth of cut, value of material removal rate is increase.
- The percentage contribution of cutting speed is 14.67 %, feed of 18.14 % and depth of cut of 58.57 % on material removal rate for turning operation.
- From the ANOVA it is conclude that the depth of cut is most significant parameter which contributes more to material removal rate.
- In multi response optimization the optimum cutting parameter combination is meeting with parameter combination value is 1.0 mm depth of cut, 209.99 m/min cutting speed and 0.30 mm/rev feed rate surface roughness is 59271.39999580036 mm^3/min.

IX. REFERENCES

[1] Dr. C. J. Raga, Dr. D. Nageswara Raob, P. Srihari, “Influence Of Cutting Parameters On Cutting Force And Surface Finish In Turning Operation”, International Conference On Design And Manufacturing, Procedia Engineering 64 (2013) 1405 – 1415.
[2] M.Kaladhar, K.Venkata Subbaiah, Ch.Srinivasa Rao, “Determination Of Optimum Process Parameters During Turning Of AISI 304 Austenitic Stainless Steel Using Taguchi Method And ANOVA”, International Journal Of Lean Thinking Volume-3,Issue 1(June 2012).
[3] Hamdi Aouici, Mohamed Athmane Yallese, Kamel Chaoui, Tarek Mabrouki, Jean-François Rigal, “Analysis Of Surface Roughness And Cutting Force Components In Hard Turning With CBN Tool: Prediction Model And Cutting Conditions Optimization”, Measurement 45 (2012) 344–353.
[4] Gaurav Bartaryaa, S.K.Choudhury, “Effect Of Cutting Parameters On Cutting Force And Surface Roughness During Finish Hard Turning AISI52100 Grade Steel”, 5th CIRP Conference On High Performance Cutting 2012, Procedia CIRP 1 (2012) 651 – 656.
[5] Deepak Mittal, M. P. Garg, Rajesh Khanna, “An Investigation Of The Effect Of Process Parameters On Mrr In Turning Of Pure Titanium (Grade-2)”, International Journal Of Engineering Science And Technology (IJEST), Vol. 3 No. 8 August 2011.
[6] Tian-Syung Lan, “Parametric Deduction Optimization For Surface Roughness”. American Journal Of Applied Sciences 7 (9): 1248-1253, 2010 ISSN 1546-9239.
[7] J.S.Senthilkumaar, P. Selvarani, RM.Arunachalam,“Selection Of Machining Parameters Based On The Analysis Of Surface Roughness And Flank Wear In Finish Turning And Facing Of Inconel 718 Using Taguchi Technique”. Emirates Journal for engineering,15 (2), 7-14 (2010).
[8] H. Yanda, J.A. Ghani, M.N.A.M. Rodzi, K. Othman And C.H.C. Haron., “Optimization Of Material Removal Rate, Surface Roughness And Tool Life On Conventional Dry Turning Of FCD 700”, International Journal Of Mechanical And Materials Engineering (IJMME), Vol.5 (2010), No.2, 182-190.
[9] Anderson P. Paiva, Joao Roberto Ferreira, Pedro P. Balestrassi, “A Multivariate Hybrid Approach Applied To AISI 52100 Hardened Steel Turning Optimization”. Journal Of Materials Processing Technology 189 (2007) 26–35.
[10] Muammer Nalbant, Hasan Gokkaya, And ˙Ihsan Toktas, “Comparison Of Regression And Artificial Neural Network Models For Surface Roughness Prediction With The Cutting Parameters In CNC Turning”, Hindawi Publishing Corporation Modelling And Simulation In Engineering Volume 2007, Article ID 92717, 14 Pages.

[11] B Sidda Reddy, G.Padmanabhan And K.Vijay Kumar Reddy, "Surface Roughness Prediction Technique For CNC Technique". Asian Journal Of Scientific Research 1 (3): 256-264, 2008 ISSN 1992-1454.
[12] Ihsan Korkut, Mustafa Kasap, Ibrahim Ciftci, Ulvi Seker, "Determination Of Optimum Cutting Parameters During Machining Of AISI 304 Austenitic Stainless Steel". Materials And Design 25 (2004) 303–305.
[13] Dusan Petkovic, Miroslav Radovanovic, "Using Genetic Algorithms For Optimization Of Turning Machining Process",Journal Of Engineering Studies And Research-Volume 19(2013) No.1.
[14] Ishwer Shivakoti, Sunny Diyaley, Golam Kibria, B.B. Pradhan, "Analysis Of Material Removal Rate Using Genetic Algorithm Approach" , International Journal Of Scientific & Engineering Research Volume 3, Issue 5, May-2012
[15] K.Saravanakumar, M.R.Pratheesh Kumar, Dr.A.K.Shaik Dawood, "Optimization Of CNC Turning Process Parameters On INCONEL 718 Using Genetic Algorithm", Engineering Science And Technology: An International Journal (ESTIJ), ISSN: 2250-3498, Vol.2, No. 4, August 2012.
[16] N.Zeelan Basha, G.Mahesh, N.Muthuprakash, "Optimization Of CNC Turning Process Parameters On ALUMINIUM 6061 Using Genetic Algorithm", International Journal Of Science And Modern Engineering (IJISME) ISSN: 2319-6386, Volume-1, Issue 9, August 2013.
[17] Umesh Khandey , "Optimization Of Surface Roughness, Material Removal Rate And Cutting Tool Flank Wear In Turning Using Extended Taguchi Approach" ,Ethesis@Nitr-2009.
[18] International Journal Of Mechanical Engineering And Robotics Research ISSN 2278-0149 Vol.1, No.3, October 2012.
[19] Jiju Antony, "Design Of Experiments For Engineesrs & Scientists", Elsevier Science & Technology Books, October 2003.
[20] S.N.Sivanandam, S.N.Deepa, Introduction To Genetic Algorithm, ISBN 978-3-540-73189-4 Springer Berlin Heidelberg New York.
[21] Thakur.D, Ramamoorthy.B, And Vijayaraghavan.L, "Study On The Machinability Characteristics Of Super Alloy Inconel 718 During High Speed Turning", Materials And Design, Vol.30, 2009, Pp.1718-1725.
[22] Haddad.M.J And Tehrani.A.F, "Material Removal Rate (MRR) Study In The Cylindrical Wire Electrical Discharge Turning (CWEDT) Process", Journal Of Materials Processing Technology, Vol.199, 2008, Pp.369–378.
[23] Kose.E, Kurt.A And Seker.U, "The Effects Of The Feed Rate On The Cutting Tool Stresses In Machining Of Inconel 718", Materials Processing Technology, Vol.96, 2008, Pp.165–173.
[24] Sardinas.R.Q, Santana.M.R And Brindis.E.A, "Genetic Algorithm-Based Multi-Objective Optimization Of Cutting Parameters In Turning Processes", Engineering Applications Of Artificial Intelligence, Vol.19, 2006, Pp.127–133.
[25] Suresh.P.V.S, Rao.P.V And Deshmukh.S.G, "A Genetic Algorithmic Approach For Optimization Of Surface Roughness Prediction Model", International Journal Of Machine Tools & Manufacture, Vol.42, 2002, Pp. 675–680.
[26] Article Of ANOVA Calculation.
[27] Nutek, Inc, "Complimentary Copy: DOE-1 Basic Design Of Experiments"

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