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Optimization for Machining Parameters in Turning of AISI 52100 Steel for Manufacturing Services-Genetic Algorithm Method

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Abstract: ***Because of its high wear and corrosion resistance, AISI 52100 steel is mostly used in automobile and aerospace applications. It is a high strength chromium steel with hardness usually greater than 45HRC.The prime objective of this study is to identify the influential machining parameters affecting metal removal rate (MRR) and cutting forces. During turning of AISI52100 steels, a central composite design (CCD) through response surface methodology (RSM) was employed to generate a model for predicting the MRR and cutting forces. The significant parameters and their contribution percentage were identified using analysis of variance (ANOVA). Furthermore, the affect of machining parameters in the MRR and cutting forces were examined and validated for identifying the accuracy of the predicted model. To conclude, the optimum values of MRR and cutting force along with the optimum parameters were ascertained using genetic algorithm (GA).***

Keywords: Cutting force, MRR, RSM, GA, AISI52100

I. INTRODUCTION

AISI 52100 steel is high chromium & carbon steel with low alloying composition. Because of its high mechanical properties like fatigue and strength, this steel is used in highly stressed components. The primary applications are heavy function shafts and aircraft bearings. Despite of its advantages, high hardness of the material makes it difficult to machine. [1] Hence it is dire necessary to find out suitable parameters during machining.Several parameters like tool nose radius, feed rate, depth of cut, cutting velocity etc., determine the performance of machining. In the recent years, lot of attention is paid towards the influence of the above parameters over Output responses like cutting force, Material Removal Rate (MRR), Surface finish, Tool wear etc [2,3]. Attensioa et al. performed machining on hardened AISI 52100 steel to study the influence of cutting speed and feed on material removal using PCBN inserts. Results revealed that MRR was primarily influenced by cutting speed [4]. In an experiment by Meddour et al. [5] significance of cutting parameters on cutting forces and surface roughness was studied during turning of AISI 52100 (59 HRC). Experimental design and statistical analysis was performed using Response Surface Methodology (RSM.). Also, the optimum parameters were found using response optimizer. Zhang et al.[6] studied the significance of input parameters during machining of 2.25 Cr 1Mo 0.25V high strength steel. RSM was used to analyze the relation between factors and responses. Genetic Algorithm (GA) was employed to identify the optimum parameters influencing MRR and cutting forces. During a study of optimizing cutting parameters affecting cutting force and surface roughness, Hamdi et al. [7] used RSM and proposed best machining conditions. On the other hand Anderson et al. adopted RSM to study the influential cutting conditions while turning AISI 52100 steel. Multi response optimization was performed for minimizing surface roughness and maximizing MRR. In a similar work by Gaurav et al. [8] performance analysis on surface finish and cutting forces were studied. A suitable parametric range was proposed for effective machining. Khaider et al. [9] performed cutting operation on AISI 52100 steel and studied the influence of parameters on MRR and cutting forces. GA was used to optimize the cutting parameters. Results revealed that depth of cut primarily influenced MRR. It is also seen that GA proved to be an effective optimization technique. In a similar study by Rahul et al. [10]GA was used to maximize MRR in turning Al Mg1 Si Cu. From results it was found that GA predicted the optimum values very accurately.

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II. MATERIALS AND METHOD

The surface finish of machined workpiece is often considered as the quality index of a material. Therefore, it is important to reduce the surface irregularities during machining. The machining parameters and their influence on MRR and cutting force were inspected.

a. Experimental set up

The turning operation was conducted using a semi automated lathe 7.5KW machine. The bed length of the machine is 1830mm with centre height 185mm. The spindle speed ranges from 45 rpm to 2000 rpm. The experimental conditions were taken from the previous work [11,12]

The Kistler make piezoelectric tool force dynamometer (9257B) is used to measure the cutting force. The data is computed and interpreted using XKM software.

b. Cutting Insert and Work material:

Multilayer coated carbide inserts with cutting edges were used in the experiment. The inserts were purchased from Sandvik Coromont India with ISO designation DNMG 11 04 08 PM 4325. The insert is mounted on right hand holder PDJNR 25 25 M11.

AISI 52100 steel (50HRC) of 40mm diameter was machined to an effective length of 250mm. Table I, shows the elemental composition of the work piece . The mechanical properties of AISI 52100 steel are presented in Table II.

Table- I: AISI 52100 steel (50HRC) elemental composition

Element	C	Mn	Cr	P	S	Si	Ni	Mo	Cu	Fe
Weight percentage	1.04	0.34	1.49	0.007	0.017	0.24	0.07	0.02	0.16	Balance

Table- II: AISI 52100 steel (50HRC) properties

Properties	**Metric**
Density	7.81 g/cm^3
Bulk modulus	140 GPa
Shear modulus	80GPa
Elastic modulus	190-210 GPa
Poisson ratio	0.27-0.30
Hardness	64HRC
Thermal Conductivity	46.6 W/mK

c. Machining layout

The influential machining parameters on MRR and cutting force were identified under various machining conditions. L15 orthogonal array was selected and 15 experiments were performed. The machining parameters and their levels were presented in Table III and Table IV.

Table- III: Turning parameters experiment table

Coding	Cutting Parameter			Experiment Value	
	V	*fz*	*d*	F (N)	MRR(mm^3/min)
1	55	0.15	0.3	437.86	2003.3
2	75	0.15	0.3	366.32	3163.2
3	55	0.23	0.3	749.63	3291.7
4	75	0.23	0.3	499.67	5126.2
5	55	0.15	0.7	637.51	4137.3
6	75	0.15	0.7	621.26	6206.9
7	55	0.23	0.7	1216.84	6996.3
8	75	0.23	0.7	987.35	11016.8
9	45	0.19	0.5	836.22	4133.2
10	85	0.19	0.5	589.42	8112.4
11	65	0.11	0.5	423.39	2563.1
12	65	0.27	0.5	1026.54	7762.3
13	65	0.19	0.1	355.81	1685.3
14	65	0.19	0.9	1002.36	8535.2
15	65	0.19	0.5	673.57	5201.6

Table- IV: Machining factors and levels

Cutting parameter	Level				
v (m/min)	45	55	65	75	85
f_z(mm/r)	0.11	0.15	0.19	0.23	0.27
d(mm)	0.1	0.3	0.5	0.7	0.9

III. STATISTICAL MODELING

The Response surface methodology is an effective method for statistical analysis and optimization. Taguchi partial factorial design is used to obtain the design matrix for carrying out the experiments. The modeled data is verified using full quadratic regression equation. The relationship between input factors and output responses is established and their significance was analyzed using variance analysis (ANOVA). Response surface optimizer is employed to optimize the cutting parameters. The optimization goal is to minimize the cutting force and maximize material removal rate.

The following quadratic equation presents the correlation between input factors and output responses.

$$y = b_0 + \sum_{i=1}^{k} b_{\,i} x_i + \sum_{i=1}^{k} b_{ii}\; x_i^2 + \sum_{i<j} b_{ij} x_{ij} \qquad (1)$$

Where b_o is a constant, b_i is coefficient of linear term, b_{ii} is coefficient of quadratic term and b_{ij} is coefficient of interaction term. Regression analysis is used to obtain coefficients of the polynomials. Minitab version 17 was used to model the data and optimize the values.

a. Regression analysis

A regression model is established with the output responses (MRR and tool force) as objective function. The regression equation obtained for cutting force is

$F = 66 + 0.3.v + 4840 .f_z - 1005 .d + 0.1071 .v.v + 8590. f_z.. f_z + 57. d. d - 122.4 .v.f_z + 4.73 .v.d + 7817 .f_z$. (2)

Similarly, the obtained regression equation for MRR is

$MRR = 20944 – 468.v - 56354 . f_z - 16658 . d + 2.477. v.v + 4799. f_z . f_z – 136. d. d + 820. v. f_z + 193.5.v.d + 69024 .f_z.d$. (3)

IV. ANALYSIS OF VARIANCE (ANOVA)

Table III displays the experiment design and the corresponding results for MRR and tool force. The significance and the contribution percentage of the factors and the importance of model coefficients are obtained through variance analysis.

The objective of the variance analysis is to find out significance of each parameter and the model coefficients individually. The ANOVA analysis for MRR and cutting forces are presented in tables V and VI respectively. The insignificant factors were automatically removed using back elimination process. It is one of the efficient methods of modeling the statistical data as the redundant values are eliminated.

a. ANOVA for MRR

From the variance analysis of MRR, it is revealed that the R^2 value (99.56%) is very near to 100%, which is highly desirable. Moreover the adjusted R^2 value (98.76%) is closed to the obtained R^2 value. This indicates high goodness–of-fit of the generated model. As the statistical analysis was performed for 95% confidence level, any factor having p-value less than 0.05 is considered as significant. Table V. shows depth of cut is the most significant factor with 48.91% contribution followed by speed (27.53%).Besides, the interaction of depth of cut with speed and feed also has influence.

Table- V: Analysis of variance analysis of cutting force model

Source	DF	Seq SS	Contribution	Adj SS	Adj MS	F-Value	P-Value
Model	9	103125670	99.56%	103125670	11458408	124.80	0.000
Linear	3	97227020	93.86%	97227020	32409007	352.98	0.000
v	1	18153650	27.53%	18153650	18153650	197.72	0.004
f_z	1	28405595	17.42%	28405595	28405595	309.38	0.600
d	1	50667775	48.91%	50667775	50667775	551.84	0.001
Square	3	1399750	1.35%	1399750	466583	5.08	0.056
v - v	1	1396984	1.35%	679619	679619	7.40	0.002
f_z - f_z	1	2440	0.00%	653	653	0.01	0.936
d - d	1	327	0.00%	327	327	0.00	0.955
2-Way Interaction	3	4498900	4.34%	4498900	1499633	16.33	0.005
v - f_z	1	861617	0.83%	861617	861617	9.38	0.028
v - d	1	1197951	1.16%	1197951	1197951	13.05	0.004
f_z - d	1	2439332	2.35%	2439332	2439332	26.57	0.004
Error	5	459078	0.44%	459078	91816		
Total	14	103584749	100.00%				

b. ANOVA for Cutting force

From the model summary obtained, the R^2 value is 99.63% indicating very high fitness of the model. The adjusted R^2 value (98.97%) is found to be very close to R^2 value. Table 6., presents that feed and depth of cut are significant factors with p-value less than 0.05.Of these, depth of cut has highest contribution of 45.35% followed by feed with 41.87%. Additionally, the interaction of speed and feed, and feed and depth of cut also have considerable significance.

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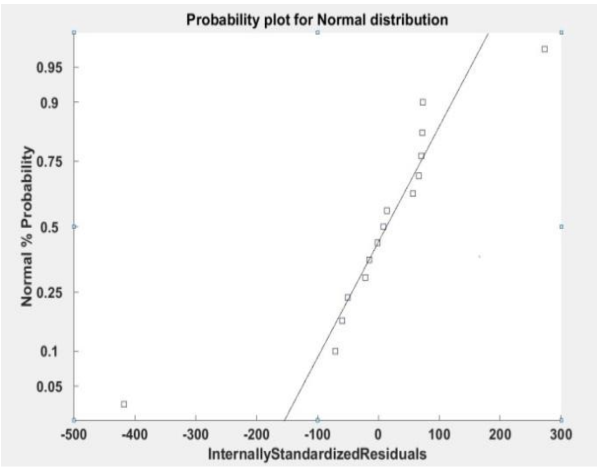
Table- VI: Analysis of variance analysis of MRR model

Source	DF	Seq SS	Contribution	Adj SS	Adj MS	F-Value	P-Value
Model	9	1002889	99.63%	1002889	111432	151.02	0.000
Linear	3	948306	94.21%	948306	316102	428.41	0.000
v	1	70336	6.99%	70336	70336	95.33	0.000
f_z	1	421474	41.87%	421474	421474	571.22	0.000
d	1	456496	45.35%	456496	456496	618.69	0.000
Square	3	3403	0.34%	3403	1134	1.54	0.314
v - v	1	439	0.04%	1270	1270	1.72	0.247
f_z - f_z	1	2907	0.29%	2092	2092	2.84	0.153
d - d	1	57	0.01%	57	57	0.08	0.792
2-Way Interaction	3	51180	5.08%	51180	17060	23.12	0.002
v - f_z	1	19175	1.90%	19175	19175	25.99	0.004
v - d	1	717	0.07%	717	717	0.97	0.369
f_z - d	1	31288	3.11%	31288	31288	42.40	0.001
Error	5	3689	0.37%	3689	738		
Total	14	1006578	100.00%				

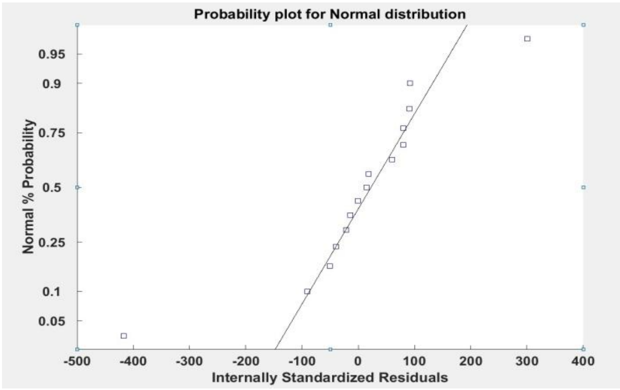
c. Model validation

Model validation is a confirmation test after establishing a regression model. Hence, the generated models for MRR and cutting force were verified using probability graphs. Figure-1(a) & 1(b) displays the probability graphs of MRR and force respectively. From the plot it is desired to have all the residuals falling close to mean line. The curves limiting the mean line above and below are upper and lower deviations. A model is estimated to be accurate if all the residuals fall within the deviation curves. From figure 1, it is very clear that all the residuals for MRR and force lie very close to mean line indicating very high accuracy of the model.

The interaction effects of various parameters on MRR and cutting force were verified using 3-D surface plots. Figure 3(a) shows the surface plotted for the interaction of speed and feed on cutting force, where as 3(b) shows the interaction of feed and depth of cut. Similarly, Figure 4(a) shows the surface plotted for the interaction of speed and feed on MRR, whereas 4(b) shows the interaction of speed and depth of cut and Figure 4(c) shows the interaction of feed and depth of cut.



(a) Normal plot for residuals of cutting force



(b) Normal plot for residuals of MRR

Fig. 1. Residuals vs. Normal probability

V. VALIDATION OF RESPONSE OPTIMIZATION USING GENETIC ALGORITHM

a. Optimization through GA:

GA is a global optimization technique which is primarily inspired by Darwin's natural phenomenon on genetic evolution. This employs survival-of –the-fittest principle by selecting the best chromosomes in genetic evolution process. Subsequently, the selected chromosomes are subjected to stochastic swap over techniques. GA is based on artificial intelligence by associating biological principles which is highly effective in obtaining the global optimum solution. This in turn surpasses the conventional optimization techniques. Initially, the potential chromosomes are identified by performing random quest with in the search space. These identified chromosomes are converted into bit strings for performing stochastic swap over operations like cross-over and mutations. The fitness value of the new output strings are inspected for optimum solution and similar operations are performed until the optimum solution is obtained. Moreover,

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GA simultaneously execute global and parallel search in order to eliminate deficient chromosomes. Figure 2. Shows the flow chart of the algorithm.

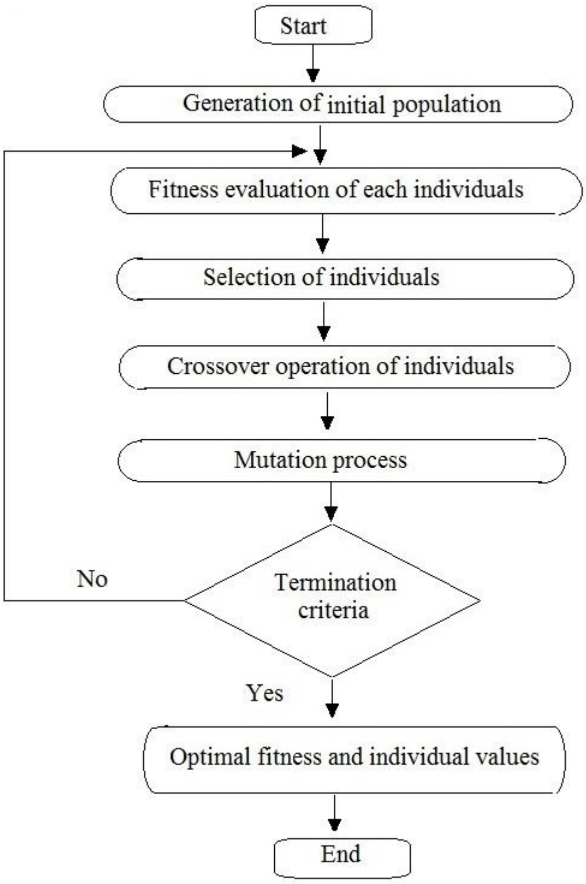


Fig.2. Flow chart of genetic algorithm optimization process

This work is aimed at obtaining the optimum MRR and cutting force. This work is aimed at obtaining the optimum machining parameters which pertain to maximum MRR and minimum cutting force. The objective function for the optimization is given as:

$W1=\min [F(v,f_z,a_p)]$

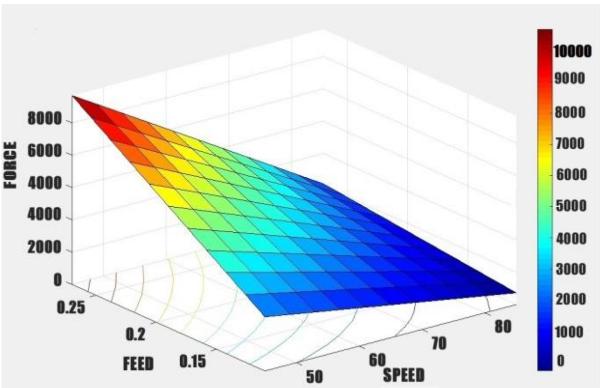
$W2=\min [-\beta (v,f_z,a_p)]$

Constraint equation:

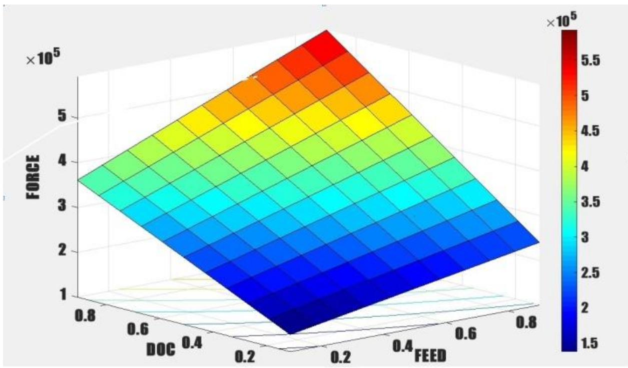
$45 \leq v \leq 85$

$0.11 \leq f_z \leq 0.27$

$0.1 \leq a_p \leq 0.9$ (4)

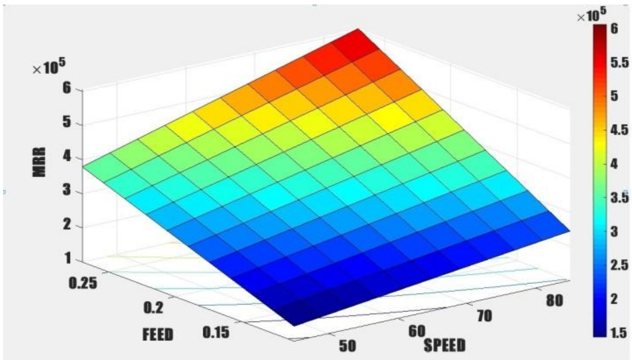


3 (a) Cutting force as a function of v, fz

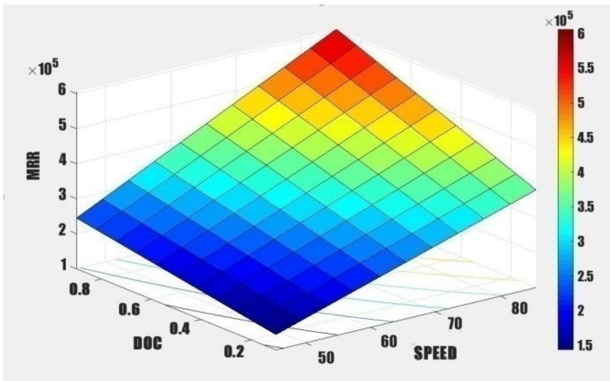


3 (b). Cutting force as a function of fz,,d

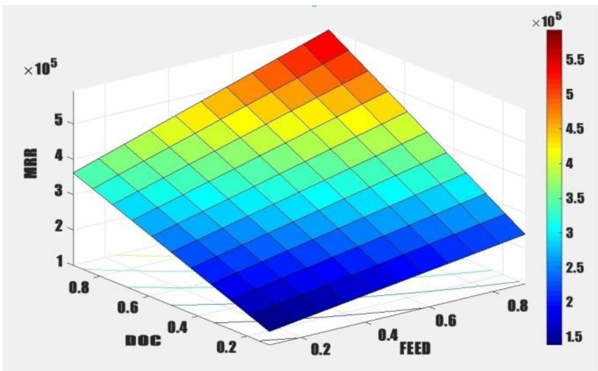
Fig. 3.Surface plots of cutting force



4(a). MRR as a function of v, fz



4 (b). Cutting force as a function of v, d



4 (c). Cutting force as a function of fz,,d

Fig. 4.Surface plots of MRR

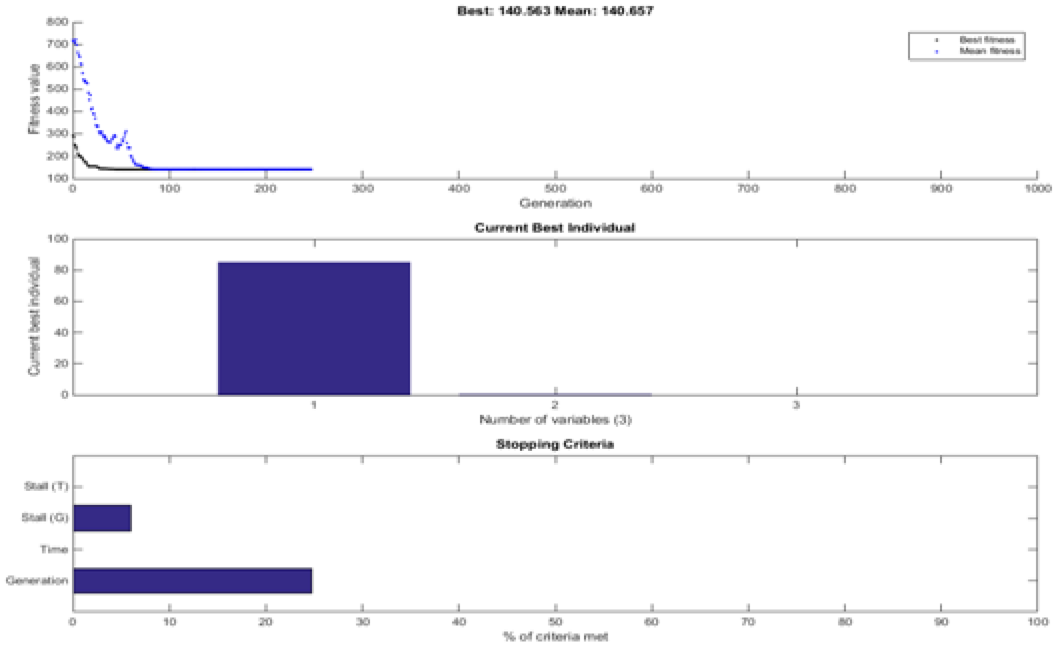


Fig. 5. Optimized results of Cutting force

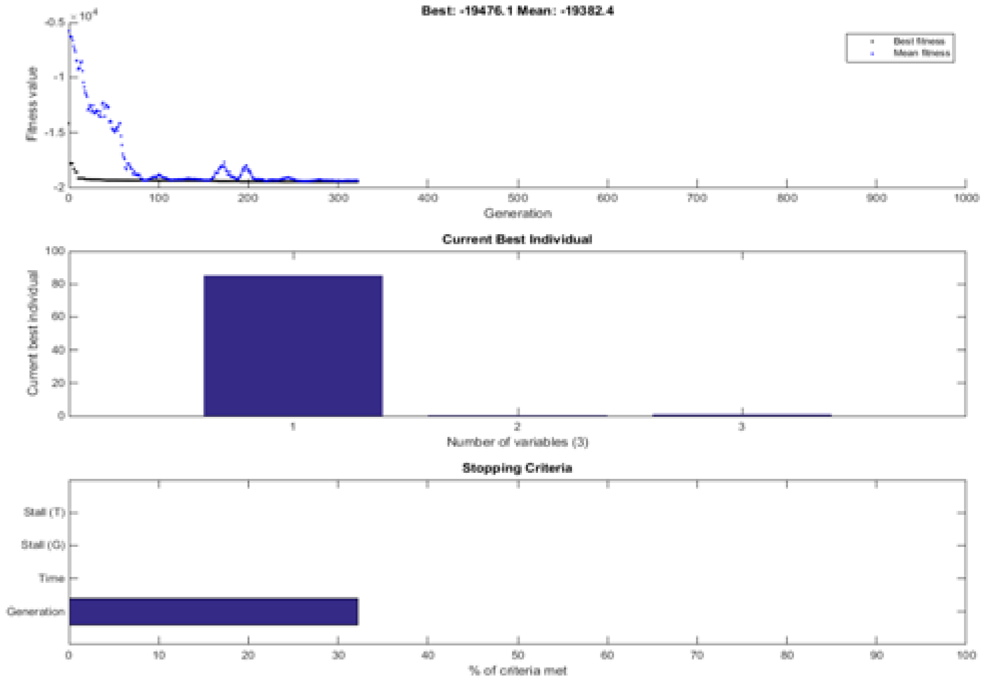


Fig. 6. Optimized results of MRR

The optimization was performed with the mutation and crossover rate of 0.001 and 0.9 respectively, considering the population size as 200.The maximum value of evolutionary algebra is 500. The graphs for minimum cutting force and maximum metal removal using genetic algorithm were presented in figure (5) and figure (6).The optimum values of metal removal rate and cutting forces were identified at 243rd and 326th generations respectively. The optimum value for MRR is 19476.8mm^3/min, where as the optimum machining parameters were cutting speed of 84.985 m/min, feed 0.157 mm/rev and depth of cut 0.897mm.

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The optimum parameters for least cutting force were speed 84.996 m/min, feed 0.27mm/rev and depth of cut 0.1mm. The optimum value is 140.56N.

b. Validation of model

In the context of validating the accuracy of the generated model, the MRR and cutting forces were evaluated with the obtained optimum machining parameters. Furthermore, the errors and residuals were compared by evaluating the actual and predicted values. The actual and predicted values for MRR are presented in table 7.The actual and predicted values are 19476.8mm3/min and 19694.2mm^3/min respectively. The residual value is 217.4 with an error percentage of 1.11. The optimum parameters are v=85m/min,f_z=0.15 mm/rev and ap=0.9mm. Table VII. displays the actual and predicted values of cutting force s. The optimum parameters of v=85m/min,f_z=0.27mm/rev and a_p=0.1mm resulted in actual value of 140.56N and predicted value of 137.13N. The residual value is 3.43 with error percentage of 2.45.

From the results, it is quite apparent that for both MRR and cutting forces the experimental and computational values are very close to each other. However, the error percentage for MRR and cutting forces are 1.11 and 2.45.This indicates that the established model is very accurate with prediction capability more than 97%.

Table- VII: Actual and predicted values of cutting force and MRR

Machining parameter			MRR (mm^3/min)			
V(m/min)	f_z (mm/r)	a_p (mm)	Actual	Predicted	Residual	Error(%)
85	0.15	0.9	`19476.8	19694.2	217.4	1.11
Machining parameter			F(N)			
V(m/min)	f_z (mm/r)	a_p (mm)	Actual	Predicted	Residual	Error(%)
85	0.27	0.1	140.56	137.13	3.43	2.45

VI. CONCLUSIONS

The high carbon chromium containing AISI 52100 steel was machined using multi layer coated carbide inserts. The performance investigation was performed using RSM, ANOVA and GA. The prediction models were established to identify the influential machining parameters on MRR and cutting forces. The following conclusions were drawn:

- The Quadratic regression equations for MRR and cutting forces generated through RSM were highly accurate. The R^2 and adj R^2 value for MRR are 99.56% and 98.76%, whereas for cutting forces are 99.63% and 98.97%.
- The 3D surface plots generated for MRR and cutting forces effectively exhibit the interaction of machining parameters over the responses. At higher cutting feed rate there is a significant reduction along with rise in cutting speed. whereas at lower feed rate, there is a minute increment in cutting force as the cutting speed progresses. At constant cutting speed, the force followed an increasing trend with increased depth of cut and feed.
- The interaction of speed, depth of cut and feed has significant affect on MRR. All the parameters have direct influence on MRR, i.e. as the parametric combination increases, the MRR increased, and vice-versa.
- Additionally,the optimum machining parameters were obtained employing genetic algorithm ,the parametric combination of v=85m/min,f_z=0.15mm/rev,a_p=0.9mm resulted in maximum MRR of 19476.8mm^3/min,the combination of v=85m/min,f_z=0.27mm/rev and a_p=0.1mm resulted in least cutting force of 140.56N.

REFERENCES

1. AV Pradeep, SV Satya Prasad, LV Suryam, Y Kesava Rao, D Kesava "Effect of Cryogenic Treatment on Tool Life of HSS Tool (S400) and Surface Finish of the Material in Turning of SS304", Volume 149, conference 1,IOP Conference Series: Materials Science and Engineering, 2016.
2. Suryam, L. V., and B. Balakrishna. "Effect of machining parameters over surface roughness in contour milling of aluminium 2024-T351 using 5-axis parallel kinematic machine.", vol.12, no. 1 *International Journal of Agile Systems and Management* , 2019: 44-57.
3. AV Pradeep`, D Linga Raju, S Ramakrishna" Effect of MQL on Roughness, White Layer and Microhardness in Hard Turning of AISI 52100" ,Emerging Materials Research,Volume8,Issue1, 2019,Pages1-15.
4. A. Attanasioa, D. Umbrellob, C. Cappellinia, G. Rotellac, R. M'Saoubid, "Tool wear effects on white and dark layer formation in hard turning of AISI 52100 steel",Wear,Volumes 286–287,2012, Pages 98-107.
5. I. Meddour , M. A. Yallese , R. Khattabi , M. Elbah ,L. Boulanouar, Investigation and modeling of cutting forces and surface roughness when hard turning of AISI 52100 steel with mixed ceramic tool: cutting conditions optimizationThe International Journal of Advanced Manufacturing Technology , Volume 77, Issue 5–8, 2015,pp 1387–1399.
6. Wei Zhang, Lei Zh,Shuqi Wang. Baichen Ren,Shuai Meng, "Optimization of machining parameters of 2.25Cr1Mo0.25V steel based on response surfacemethod and genetic algorithm", International journal on interactive design and manufacturing,,Volume13, 2019,Page 1-11.
7. Hamdi Aouici,Mohamed AthmaneYallese, TarekMabrouki, Jean-FrançoisRigal, "Analysis of surface roughness and cutting force components in hard turning with CBN tool Prediction model and cutting conditions optimization", Measurement, Volume 45, Issue 3,(2012), Pages 344-353.
8. Gaurav Bartarya, Sounak K Choudhury, ,"Influence of machining parameters on forces and surface roughness during finish hard turning of EN 31 steel" ,Proc IMechE Part B:J Engineering Manufacture ,Volume: 228 issue: 9, 2013, page(s): 1068-1080,

9. Khaider Bouacha,Mohamed Athmane Yallese, SamirKhamel, SalimBelhadi, “Analysis and optimization of hard turning operation using cubic boron nitride tool”, International Journal of Refractory Metals and Hard Materials ,Volume 45, July 2014, Pages 160-178.
10. Rahul Dhabale, Vijaykumar S. Jatti,” Optimization of Material Removal Rate of AlMg1SiCu in Turning Operation using Genetic Algorithm”, Wseas Transactions on applied and theoretical mechanics, Volume 10, 2015, page(s): 95-101.
11. AV Pradeep, D Lingaraju, S Ramakrishna, “Application of response surface methodology in evaluating the performance of conventional, wiper, cryogenically treated and coated (TiN, TiAlN and TiCN) carbide inserts in turning of AISI 52100 steel”, International Journal of Agile Systems and Management,Volume11,Issue4, 2018, Pages340-363.
12. Venkat Pradeep Allu, D Linga Raju, S Ramakrishna, “Performance analysis of cryogenically treated plus tempered carbide inserts in turning of Inconel 718 using cryogenic minimum quantity lubrication cooling technique”, Proceedings of the Institution of Mechanical Engineers, PartJ: Journal of Engineering Tribology,Volume233,issue4,2019 https://doi.org/10.1177/1350650119845744.

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