Optimization of Surface Roughness and M.R.R in End milling on 20MnCr5 Using RSM & MOGA Method

Under The Guidance Of

Internal Guide :-
Prof. Rishi kumar
(Mech Dept.)

External Guide :-
Mr. Chetan Jani
(Ammann Apollo Executive HR.)

Team No : 8519

By
Jay R. Soni(11me109)
Dhaval D. Prajapati (11me79)
Dhaval J. Sindhav (11me78)
Mukesh V. Chaudhary (11me69)

CONTENTS

INTRODUCTION

- Machining is the manufacturing process by which parts can be produced to the desired dimensions and surface finish from a blank by gradual removal of the excess material in the form of chips with the help of a sharp cutting tool.
- Almost all of the engineering components undergo some kind of machining during manufacture. Hence, it is very important to design those parts in such a way that would increase the efficiency of the machining process, increase the tool life and reduce the overall cost of machining. With the aim of achieving these objectives, a brief knowledge of various machining processes is required. A brief classification of various machining processes that are widely used in the manufacturing and fabrication industries of all kinds is shown in Fig.1.1

Milling Operation

- Milling is a versatile and useful machining operation.
- Milling is a process of producing flat and complex shapes with the use of multi-point (or multi-tooth) cutting tool.

Milling Machine

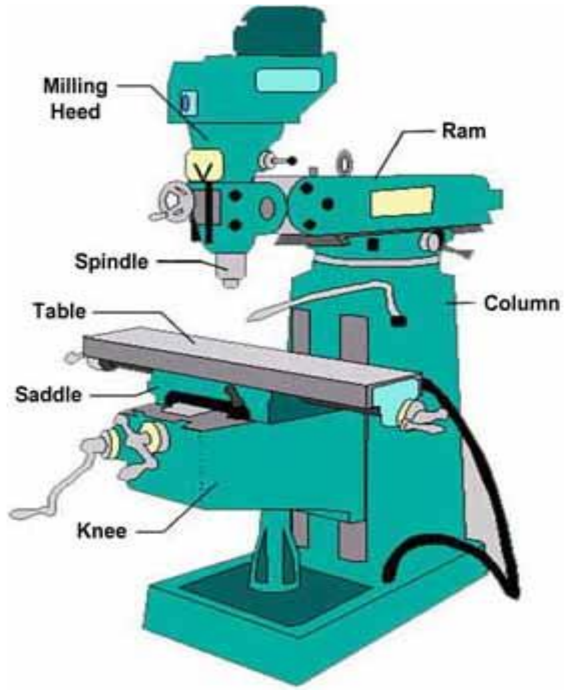


Fig.1.1

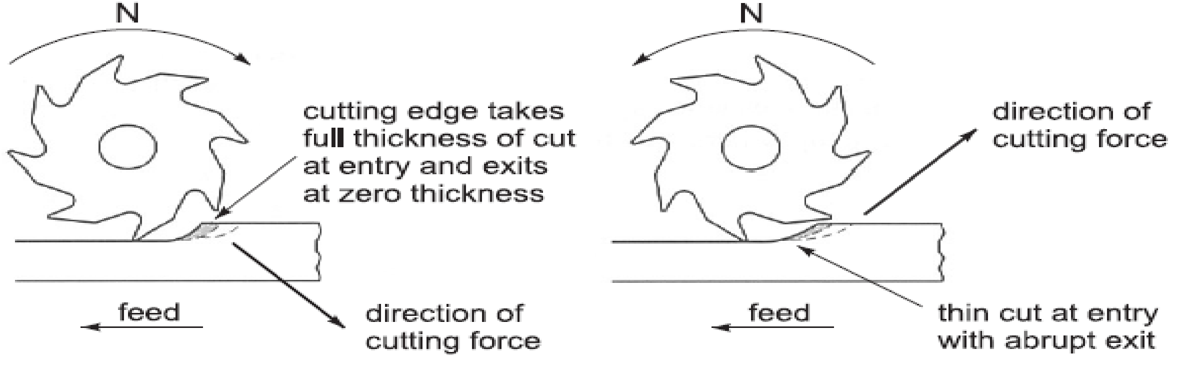
Two basic types of milling operations

Down Milling:

- When the cutter rotation is in the same direction as the motion of the workpiece being fed.

Up Milling:

- The workpiece is moving towards the cutter , opposing the cutter direction of rotation.

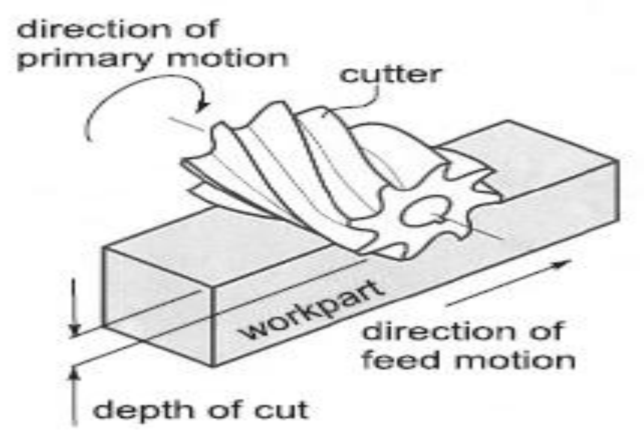


Schematic depiction of (a) Down milling and (b) Up milling operations

Depending on the orientation of the milling tool

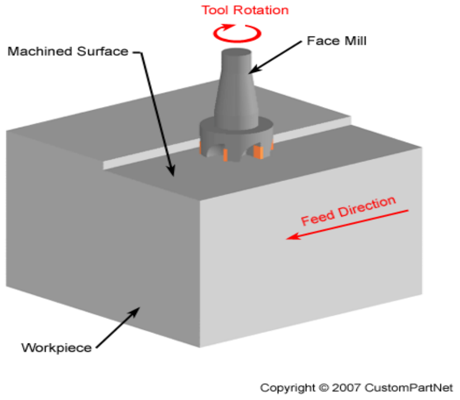
1. Peripheral Milling

- Operation performed by milling cutter to produce a machined surface parallel to axis of rotation of cutter.
- It can be either UP milling or DOWN milling.



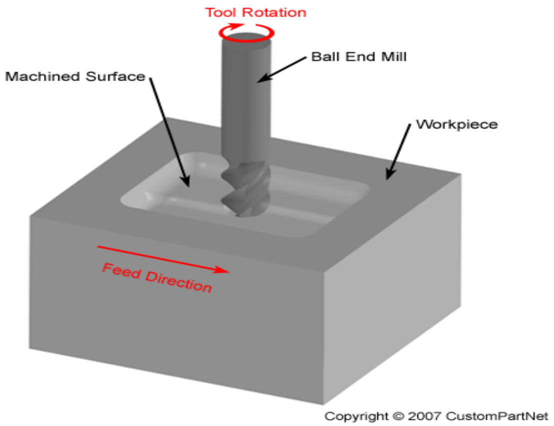
2.Face Milling

- The face milling cutter is rotated about an axis perpendicular to the work surface.



3. End Milling

- Combination of peripheral and face milling.
- Cutter has teeth both on end face and periphery.
- Vertical milling machine is most suitable for end milling operation.



Literature Survey

Narayana Reddy. A R et. al(Sept. 2014) The effect of process parameters cutting speed, Feed, Depth of cut and Tool Hardness on response Characteristics MRR and Surface roughness were studied on 20MnCr5 steel alloy in CNC Turning.. The experimental results showed that the Taguchi parameter design is an effective way of determining the optimal cutting parameters for achieving low surface roughness and maximum material removal rate. The relationship between cutting parameters (cutting speed, feed, depth of cut and hardness of cutting tool) and the performance measures (surface roughness and material removal rate) are expressed by multiple regression equation which can be used to estimate the expressed values of the performance level for any parameters levels.[1]

Sahoo, P. et. al (2011) The three level rotatable central composite designs are employed for developing mathematical models for predicting surface roughness parameters in CNC turning of AISI 1040 mild steel It is seen that the surface roughness parameters Ra and Rsm decrease with increase in depth of cut and spindle speed but increase with increase in feed. Genetic Algorithm is used to determine the optimum machining parameters in order to obtain the best possible surface quality. [9]

Literature Survey (continued)

K.Kadirgama et.al(2010) This research illustrates the machining of aluminium alloy (AA6061-T6) with end-milling methods and predicting their subsequent surface roughness. There is becoming a need for investigating the machining of various types of aluminium and their surface roughness, which in turn can be useful in developing more cost effective personalised products. The authors have shown the use of RACO to formulate an optimised minimum surface roughness prediction model for end machining of AA6061-T6.[2]

V. Tandon et. al(2006) This work has presented a new approach to optimizing the cutting conditions in end milling (feed and speed) subject to a near to comprehensive set of constraints. The original set of seventeen constraints was reduced to an equivalent set (of only three equations). Next, a production cost objective function was used to define the parameter to optimize (in this case, minimize).[4]

Tung- Hsu Hou et. al (2007) The fitness function of GA was obtained by RSM and was applied to find the optimal parameters for a nano-particle milling process. This integrated approach resulted in very good output responses in the nano-particle wet milling process. [6]

Literature Survey (continued)

P.V.S. Suresh et. al(2002) The two-stage effort of obtaining a surface roughness model by surface response methodology, and optimiz- ation of this model by Genetic Algorithms, has resulted in a fairly useful method of obtaining process parameters in order to attain the required surface quality. This has validated the trends available in the literature, and extended the data range to the present operating con- ditions, apart from improving the accuracy and model- ling by involving the most recent modelling method.[5]

Franci Cus et .al(2003) This paper presents a genetic algorithm optimization approach for solving the machining operations problem with milling. The results obtained from comparing the proposed genetic algorithm optimization approach with those taken from recent literature prove its effectiveness. The results of the proposed approach are compared with results of simulated annealing, fuzzy possibilistic-genetic algorithm, linear-programming approaches.[7]

Literature Survey (continued)

M.Subramanian1 et. al(2013) In this work, response surface methodology and genetic algorithm have been utilized for establishing optimum end mill process parameter guiding to minimum cutting force during shoulder mill Aluminium 7075-T6 with different cutting condition. Shoulder mill cutting parameters cutting speed, cutting feed, axial depth of cut used to conducting experiments. A response surface methodology was developed to regression model cutting force by manipulating experimental measurements found from these cutting forces. The established RSM model was further coupled with an established genetic algorithm to novelty the optimum end mill cutting parameter prominent to the minimum cutting force value.[8]

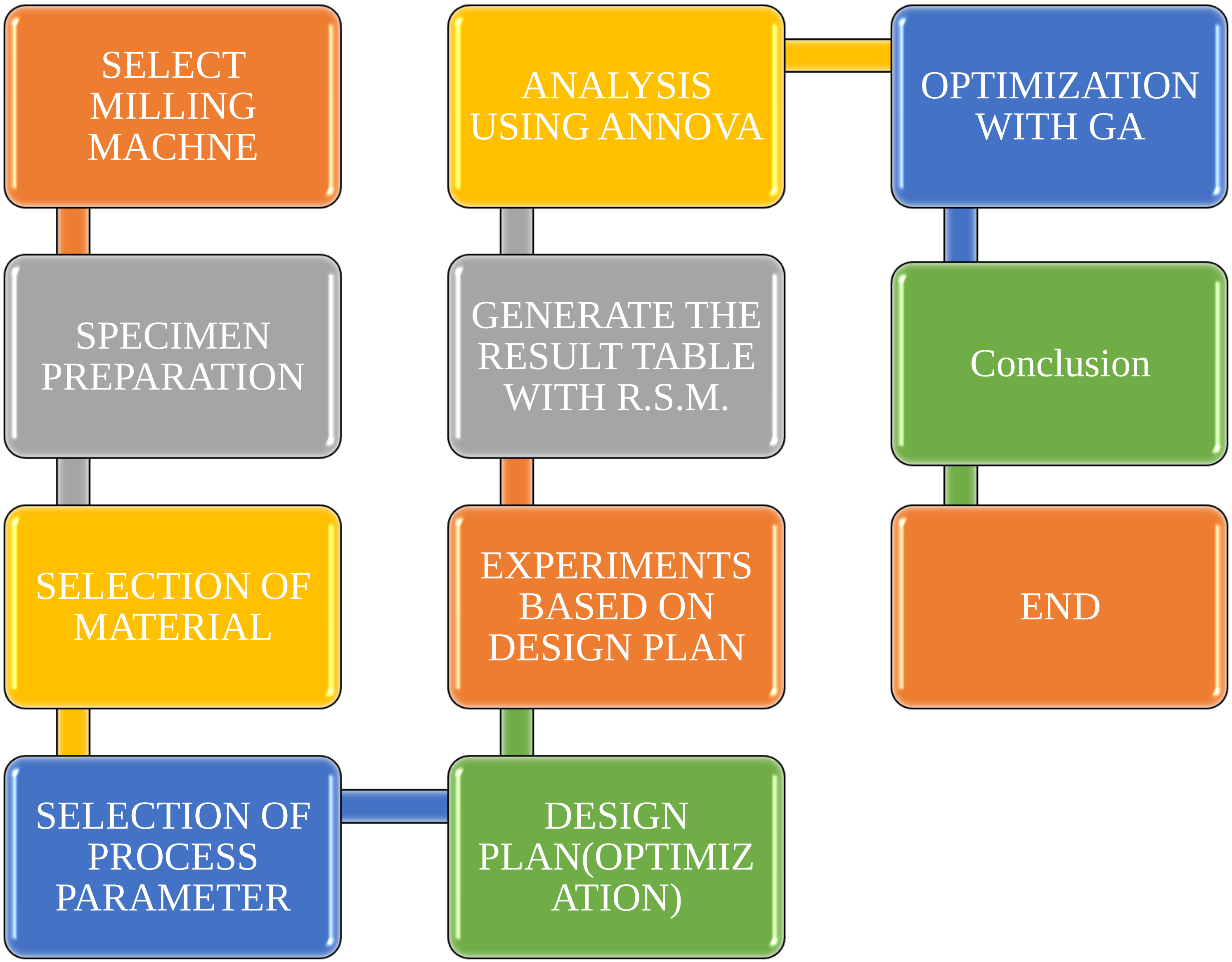
S. Gopalakannan et. al(2013) A novel ultrasonic cavitation method used for bulk fabrication of nano-composites.Enhanced properties were obtained with lower volume fraction of nanoparticles.Machining of nano-composites with better surface finish can be obtained with EDM.Effects of process parameters were investigated using response surface methodology.Research finding provides technical database for aerospace, military applications.[10]

Objectives

The objectives of present research are as follows:

1. To determine optimum surface roughness in milling process to maximize the production rate, quality of product and minimum production cost in industry.
2. To predict the surface roughness in milling process to make an optimization.
3. Analysis of experimental results using statistical methods and developing mathematical models either first or second order response surfaces with better fittings. ANOVA is performed to find the most influential parameters on both MRR and Ra.
4. Optimum parameter selection for overall improvement in milling performance using multi objective genetic algorithm.
5. Multi objective Genetic algorithm (MOGA) to obtain pareto-optimal setting.

Methodology



Research Methodology

Machine tool, Work piece and coolant

20MnCr5 is categorized as case hardened steel produced by casting, it is easily machinable and can have a wide variety of surface finishes. It also has high strength and stiffness. It is used in the field of high stressed components in automobile industry like small gear, shafts, crankshafts, connecting rods, cam shafts, piston bolts, spindles and other mechanical controlling parts. The experiment was performed on 20mncr5 of cross section 130mm×94mm×15mm. The chemical, physical and mechanical properties of 20mncr5 is shown in Table 3.1(a), 3.1(b) and 3.1(c) respectively.

C	Si	Mn	P	S	Cr	Ni
0.22%	0.40%	1.40%	0.035%	0.035%	1.30%	0.019%

Table 3.1(a) Chemical Composition of 20MnCr5 (Wt %)[22]

Table 3.1(b) Physical Properties[22]

Density	7.81 g/cm^3
Melting Point	1400°C
Thermal Expansion	$10^{-8}\ °C^{-1}$ /K
Modulus of Elasticity	210 Gpa
Thermal Conductivity	42 W/m.K
Electrical Resistivity	$0.16\,\Omega\ .mm^2/m$

Table 3.1(c) Mechanical Properties[22]

UTS	658.17 MPa
Tensile Strength	1200 MPa
Elongation A5	28%
Shear Strength	80 GPa
Yield Point	48KN
Break Point	56KN

Tool

- To conduct the experiment, the tool used is cobalt bonded cemented carbide End milling cutter tool (Fig 3.3) of 10 mm diameter having six numbers of flutes and teeth on both side and periphery of the cutter. The coolant used is S 500 CF which is water soluble and chlorine free.

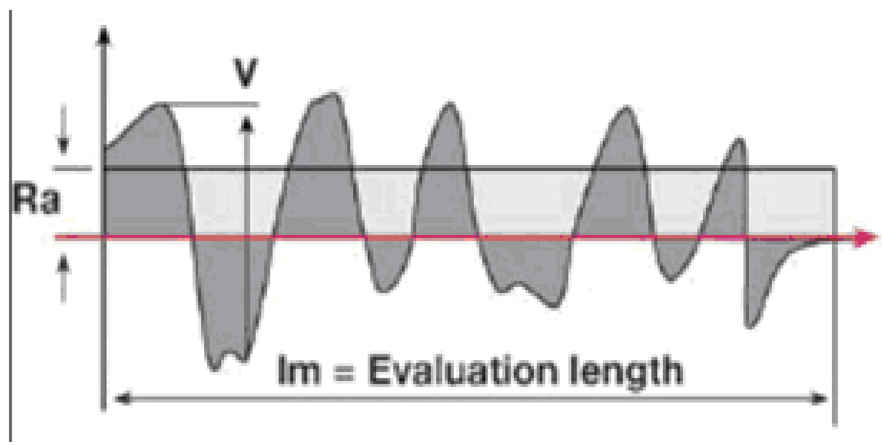
Figure 3.3 End Milling Tool[23]

Surface Roughness

- Roughness is defined as the arithmetic value of the profile from the centerline along the length and can be expressed as

$$Ra = \frac{1}{L}\int \left| y(x) \right| d(x)$$

where L is the sampling length, y is the profile curve and x is the profile direction. The average "Ra" is measured within L = 0.8 mm.



Surface roughness measurement was carried out using a portable stylus type profilometer, Talysurf (Taylor Hobson, Surtronic 3+) as shown in Figure.

Roughness measurements were carried out in the transverse direction. The measured profile was digitized and processed through the dedicated advanced surface finish analysis software

The roughness measuring conditions are shown in Table

Roughness measuring condition

Condition	Value
Probe tip radius	0.005 mm
Measuring range	0.800 mm
Traverse length	4.000 mm
Speed	1.000 mm/s
Filter	2 CR

The MRR for every parameter setting was measured by the weight loss method in volumetric scale using digital single pan balance with a precision of 0.001 g and a maximum capacity of 500 g. By weighing work piece before and after each experiment, average value of MRR was calculated using equation 1

$$MRR = \frac{\mathrm{w(i)} - w(f)}{\mathrm{p} * t}$$

Where, w(i) = initial weight before experiment

W(f) = final weight after experiment

p =density of 20MnCr5 alloy

t= machining time in minutes

Measurement Of MRR.

The weight of work piece and tool has taken by high precision balance Figure whose capacity is 1960 gram and accuracy is 0.001 gram. By weighing work piece before and after each experiment, average value of MRR was calculated using equation 3.7

$$MRR = \frac{\mathrm{w(i)} - w(f)}{\mathrm{p} * t} \qquad (3.7)$$

Where w (i) = initial weight before experiment,

W (f) = final weight after experiment,

Figure 3.7 Weight Measuring Instrument[24]

Design Of Experiment (DOE)

- The objective of any experimental activity is to obtain the maximum realistic information about a system with the minimum number of well designed set of experiments. An experimental program identifies the major "factors" that affect the outcome of the experiment. The factors may be identified by observing at all the quantities that may affect the outcome of the experiment. The most important among these may be identified using a few exploratory experiments or from past experience or based on some underlying theory or hypothesis. The next thing one has to do is to select the number of levels for each of the factors. The data is gathered for these values of the factors by conducting the experiments by maintaining the levels at these values. Hence in brief, we can say that the selection Process is known as Design of Experiments.[12]
- Design of experiments (DOE), or statistically designed experiments (SDE), is defined as a scientific approach that allows the experimenter to understand process and to determine how the input variable (factors) affects the output or quality characteristic. In other words it is a systematic approach to process optimization. [12]

Response surface modeling of process measures

- The response surface method developed by Box and Wilson in the early 1950 s is a collection of mathematical and stastical techniques that are used to model and analyze engineering applications in which a response of interest is usually influenced by several factors and the objective is to find the combination of factors that can optimize the response.
- In general, the procedure of RSM consists of the following steps:-

Step 1. Design and conduct a series of experiments to find adequate and reliable measurements of responses of interest.

Step 2. Develop mathematical models of the first and second order response surfaces with best fittings.

Step3. Find the optimal set of process parameters that produce optimized value of the response.

Step 4. Represent and analyze the direct and interactive effects of the process parameters

Machining parameters and design of experiment

- In order to determine the working characteristics of milling machine, a number of preliminary experiments were conducted. Four controllable milling parameters namely velocity, feed, depth of cut, coolant speed were chosen to evaluate the process efficiency in terms of MRR (mm^3/min). Table 3.1(d) summarizes the pertinent machining conditions in both coded and actual form. Table 3.1(e) lists all the parametric settings of experimental runs along with their obtained corresponding responses. Fig. 3.4 to Fig 3.6 shows Work piece after Experiment.

Parameter	Unit	Level		
		-1	0	+1
Speed (A)	m/min	74.35	160.74	247.14
Feed (B)	mm/min	50	75	100
Depth of Cut (C)	mm	0.4	0.8	1.2
Coolant Speed (D)	Litters Per Min.	0	2	4

Table 3.1(d) Milling Parameters & Their Levels

Design layout and experimental results

Run Order	Speed (RPM)	Feed (mm/min)	Depth of Cut (mm)	Coolant speed (Lt./hr)	Machine time (Min.)	MRR (mm3/min)	Ra(µm)
1	160.74	100	0.8	2	1.17	642.73	0.365
2	160.74	75	0.8	2	1.09	689.91	0.280
3	160.74	75	0.8	2	1.15	653.91	0.261
4	247.14	50	1.2	0	1.05	1074.28	0.200
5	74.35	75	0.8	2	1.06	709.43	0.322
6	160.74	75	1.2	2	1.38	817.39	0.241
7	160.74	75	0.8	4	1.13	665.49	0.255
8	74.35	50	0.4	0	0.63	595.25	0.265
9	74.35	50	1.2	4	1.13	998.23	0.247
10	247.14	75	0.8	2	1.23	611.38	0.162
11	247.14	50	1.2	4	1.30	867.69	0.175
12	74.35	100	0.4	4	0.68	544.92	0.435
13	160.74	75	0.8	2	1.38	637.28	0.251
14	160.74	75	0.8	0	1.10	683.64	0.350
15	247.14	100	1.2	4	1.44	783.33	0.235
16	247.14	50	0.4	4	0.84	446.73	0.111
17	247.14	100	1.2	0	1.	980.86	0.321
18	160.74	75	0.4	2	0.80	469.02	0.260

Design layout and experimental results

19	160.74	75	0.8	2	1.09	689.91	0.250
20	74.35	100	0.4	0	0.64	584.45	0.470
21	160.74	75	0.8	2	1.11	677.47	0.260
22	247.14	100	0.4	4	0.84	445.85	0.250
23	160.74	75	0.8	2	1.09	675	0.286
24	74.35	50	0.4	4	0.67	557.03	0.225
25	160.74	75	0.8	2	1.12	671.43	0.270
26	247.14	50	0.4	0	0.85	438.06	0.215
27	160.74	50	0.8	2	1.12	671.42	0.218
28	247.14	100	0.4	0	0.88	425.66	0.335
29	74.35	100	1.2	4	1.13	998.23	0.452
30	74.35	50	1.2	0	1.11	1016.22	0.317
31	74.35	100	1.2	0	1.11	1016.22	0.480

Analysis of Variance

The most powerful analytical tool for identifying the main and interaction effects is analysis of variance (ANOVA).This is a tool used for sub-dividing the total variation in the data into useful and meaningful component of variation. In the context of orthogonal array experiments, ANOVA is a useful tool to sub-divide the total variation into variation due to main effect, variation due to interaction effects and variation due to error. Therefore, mathematically, we can write as,[13]

Total variation=Vm +Vi +Ve;

A low P- value (≤ 0.05) indicates statistical significance for the source on the corresponding response ($\alpha = 0.05$) or 95% confidence level

- The model with the rest of the terms after backward elimination process in order to discard the insignificant terms (p-value greater than 0.05) so as to adjust the fitted quadratic model is illustrated in tables for MRR. It can be observed that the p-values of all these terms are less than α-value which means that they are significant hence these are included in the model.

Table 5.2 Test results for the independent MRR

Term	Coeff	SE Coeft	T- Value	P- Value
Constant	514.096	12.61	52.046	0.000
Speed	-1.250	10.02	-5.246	0.000
Feed	-3.3261	10.02	-1.346	0.197
DOC	592.9506	10.02	22.432	0.000
CS	-11.34	10.02	-2.812	0.013
CS*DOC	-30.563	10.63	-2.301	0.035

S = 42.51, R-Sq = 97.3%, R-Sq(adj) = 94.9%

Table 5.3 Test results for the independent Ra

Term	Coefficient	SE Coefficient	T- Value	P- Value
Constant	0.1025	0.00553	47.733	0
Speed	-0.0012	0.00443	-15.032	0
Feed	0.0042	0.00443	17.301	0
DOC	0.004	0.00443	1.153	0.261
CS	-0.0508	0.00443	-7.246	0
SPEED*SPEED	-0.008	0.01114	-2.34	0.029
FEED*FEED	-0.001	0.1142	2.102	0.047
CS*CS	0.0344	0.01114	3.089	0.005
SPEED*FEED	-0.022	0.0047	-4.694	0

S = 0.01880, R-Sq = 96.6% , R-Sq(adj) =95.4%

Mathematical modeling for MRR and effect of factors

Mathematical modeling for MRR and effect of factors are as following. The mathematical relation obtained on the basis of RSM analysis for analyzing the influences of the various dominant machining parameters on MRR is given by[13],

MRR= 514.096+ (-1.250)*SPEED+ (-3.3261)* FEED+ (592.9506)*DOC+ (-11.34)*CS + (-30.563)*DOC*CS.

Fig. 5.1 shows the main effect plot for MRR which can be used to graphically assess and compare the magnitude of the main effects of the factors when it is dealt with multiple factors. The points are the means of the response variables at different levels of each factor with a reference line drawn at the grand mean of the response data. It can be seen that depth of cut are the most influencing parameters as there is sharp increase in MRR. [16]

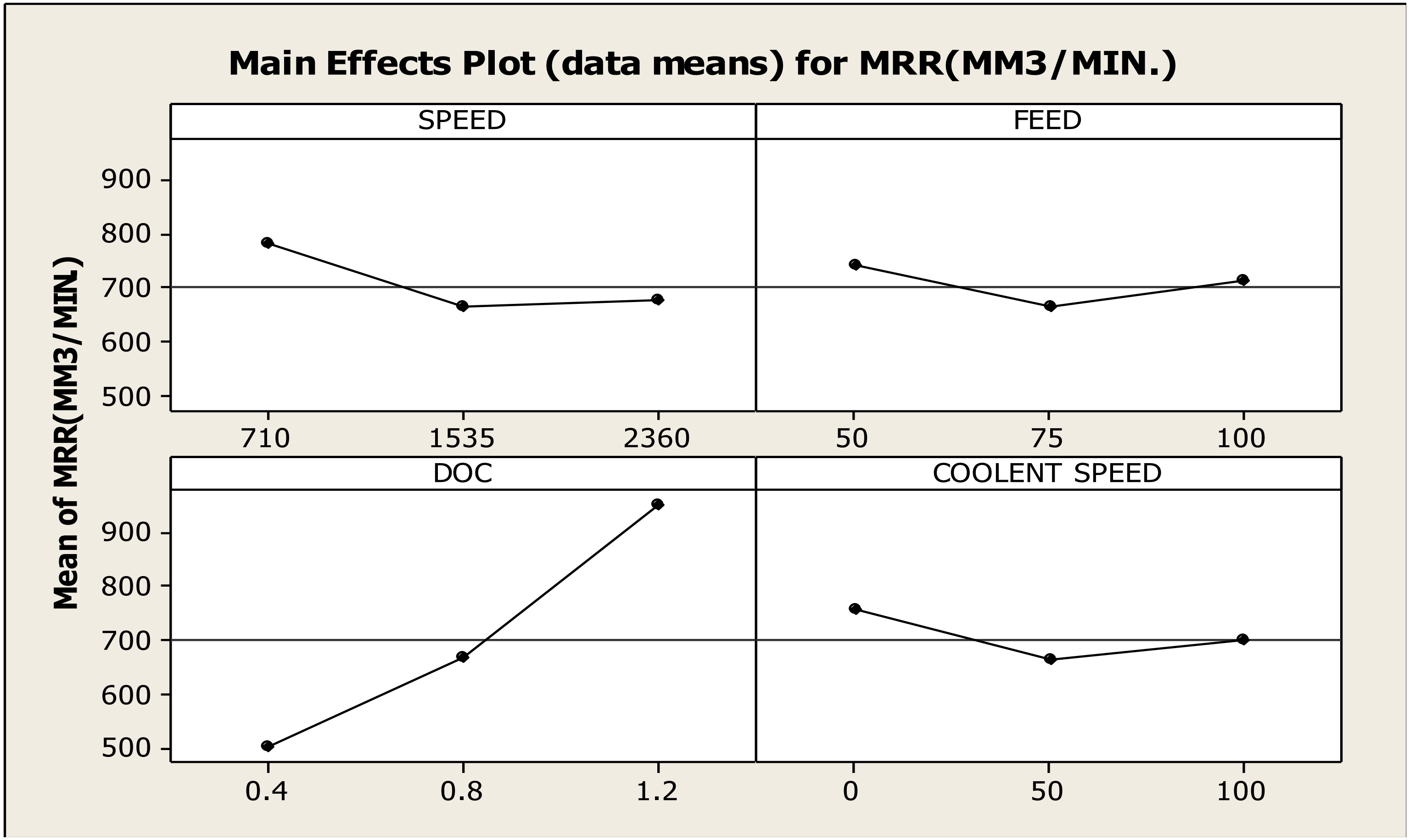


Figure 5.1 Main Effects Plot for MRR

Mathematical modeling for Ra and effect of factors

•On the basis of RSM analysis, the mathematical relationship for correlating the surface roughness Ra for analyzing the influences of various parameters on Ra is given by

$$Ra = 0.1025 + 0.0000*Speed - 0.00424*Feed - 0.004*DOC - 0.0508*(CS) + 0.0080*(CS)*(CS) - 0.0001*Speed*(Feed)$$

•The main effect plot for Ra is shown in figure 5.2 It can be seen that speed and coolant speed have significant effect on Ra which is supported by ANOVA results. However coolant speed is the most influencing parameter showing a sharp decrease in Ra from 0.35 µm to 0.25 µm when coolant speed increase from 0 to 2 liters per min.

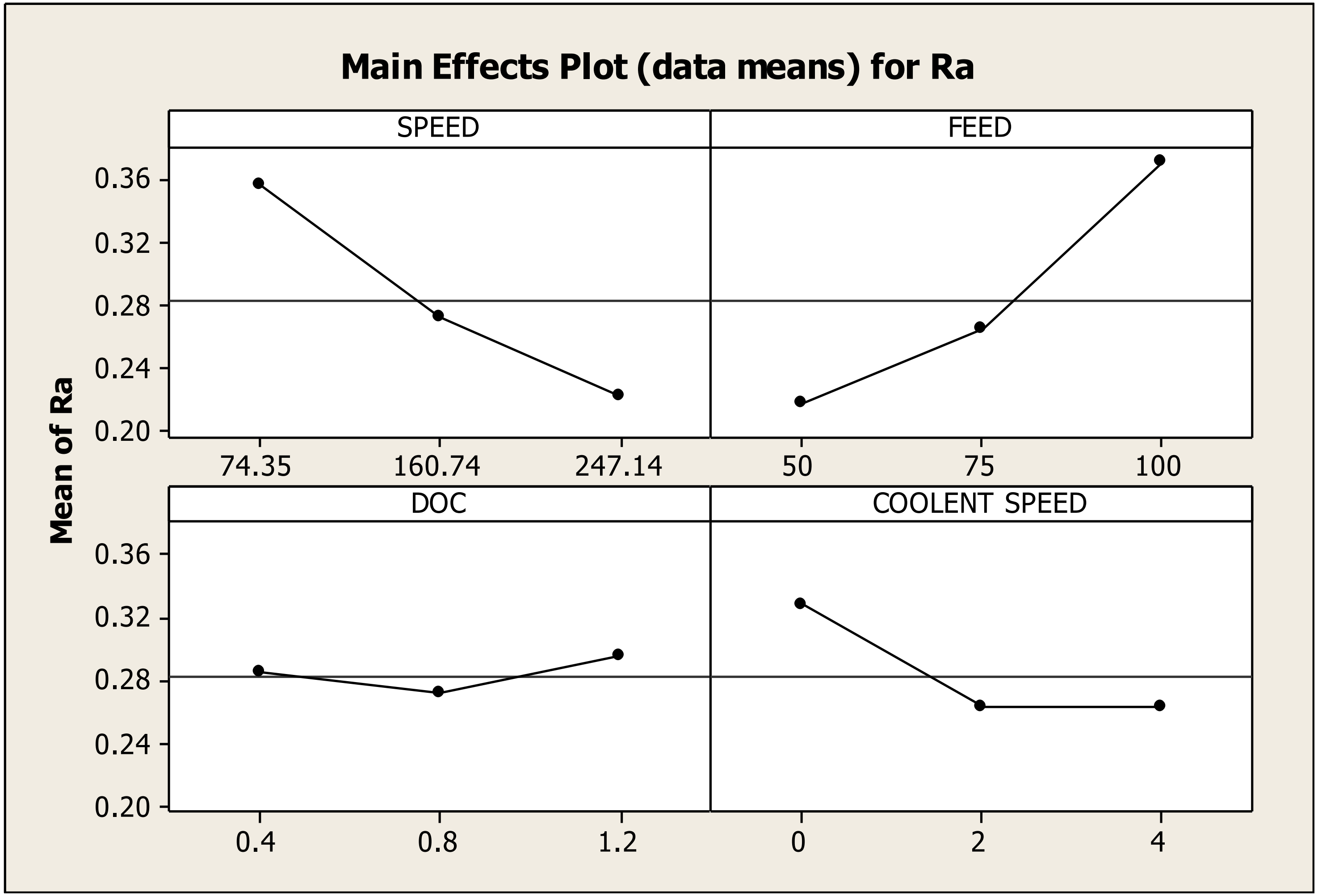


Figure 5.2 Main Effects Plot for RA

Normal Probability Plot of the Residuals for MRR

Fig. 5.3 shows the variation between residuals and their expected value. It indicates that the residuals are following a normal distribution.

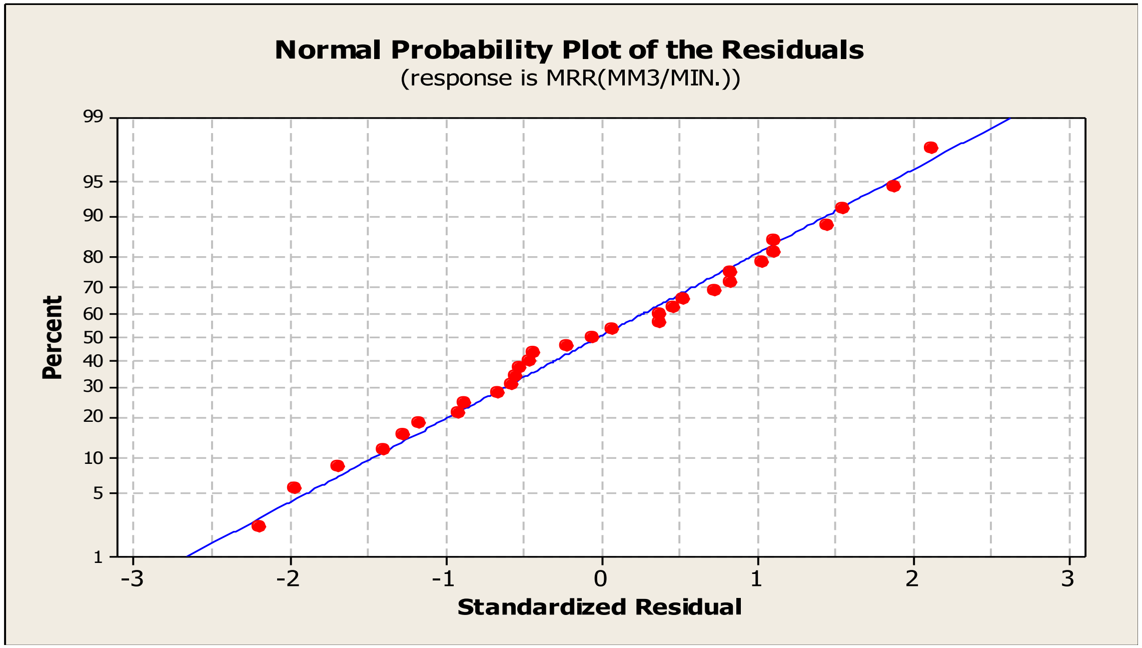


Figure 5.3 Normal Probability Plot of the Residuals for MRR

Normal Probability Plot of the Residuals for Ra

Fig. 5.6 shows the variation between residuals and their expected value. It indicates that the residuals are following a normal distribution.

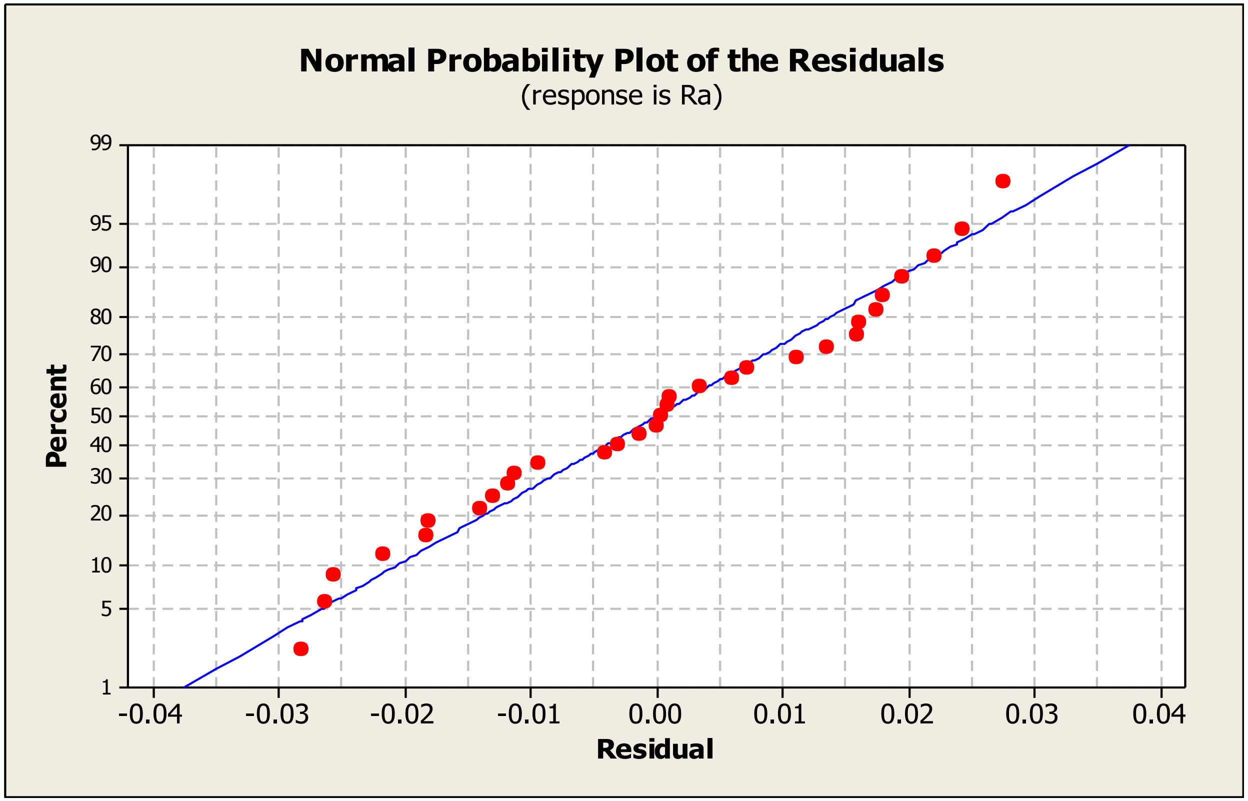


Figure 5.6 Normal Probability Plot of the Residuals for Ra

Optimization of milling process using GA

•The genetic algorithm (GA), introduced by John Holland (1971) is a stochastic search technique based on the mechanism of natural selection and natural genetics for solving difficult optimization problems with high complexity and an undesirable structure.

• This approach represents a powerful, general purpose optimization paradigm in which the computational process mimics the theory of biological evolution.

•**Implementation of GA**

GA approach in solving an optimization problem can be summarized as follows

Coding

In order to use GAs to solve the problem, variables x_i's are first coded in same strings which has only ones and zeros.

Fitness Function

A fitness function F(x) is derived from the response function and is used in successive operations.

•**Reproduction**

This is the first operator applied on a population.

In this process, copies of individual strings are copied into a separate string called the ‘mating pool’, in proportion to their fitness values.

•The strings which have higher fitness values will have higher probability of contributing more strings as the search progress

• **Crossover**

•This is the second operator among genetic operator applied after reproduction; the population is enriched with good strings from the previous generation.

• It swaps the parent strings partially causing offspring’s to be generated in order to create better strings.

•The total number of participative strings in crossover is controlled by crossover probability which is the ratio of total strings selected for mating and the population size.

To use the GA Tool, we must first enter the following information

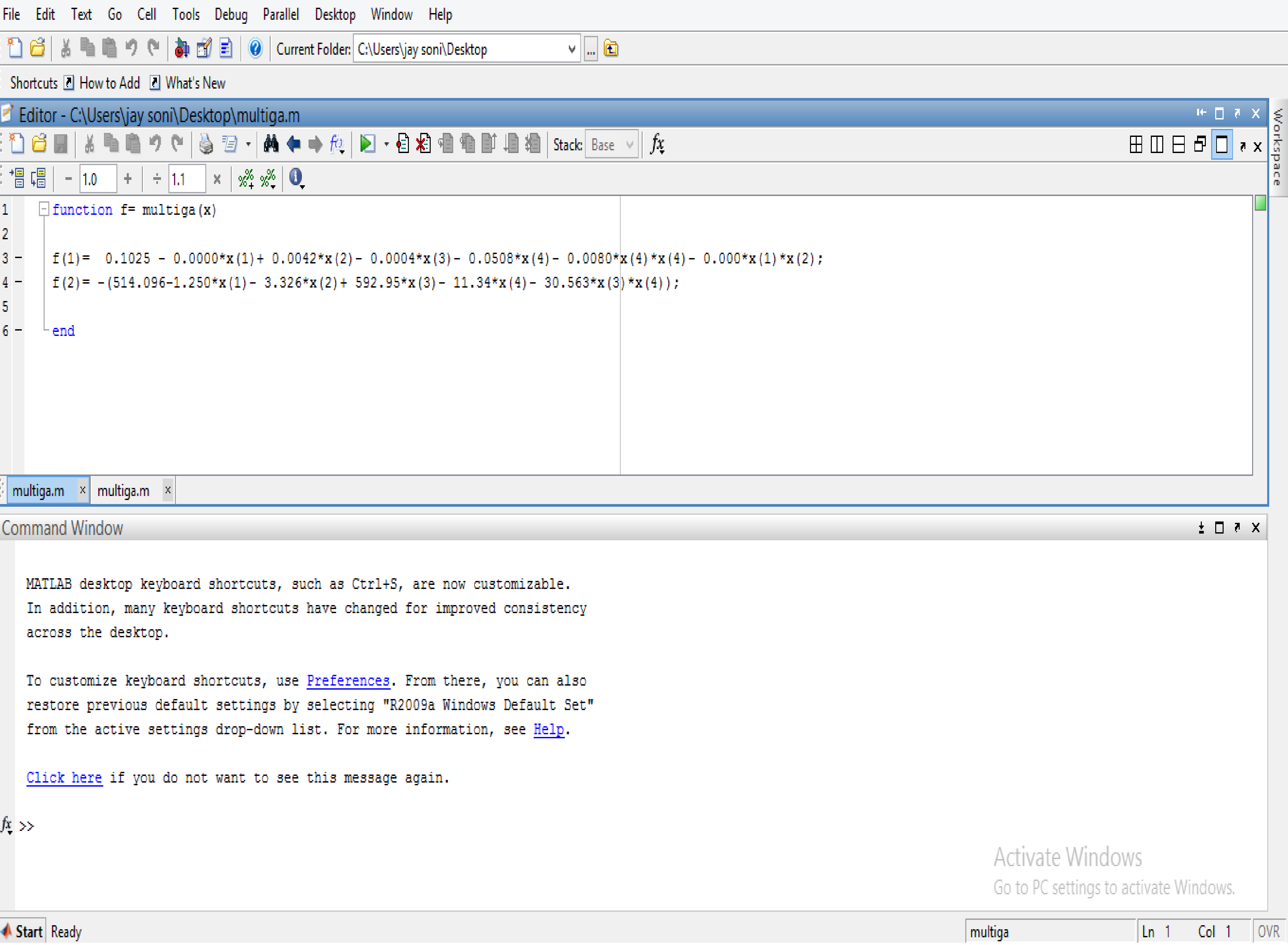
- Fitness function — The objective function you want to minimize. Enter the fitness function in the form @multiga, where multiga.m is an M-file that computes the fitness function.

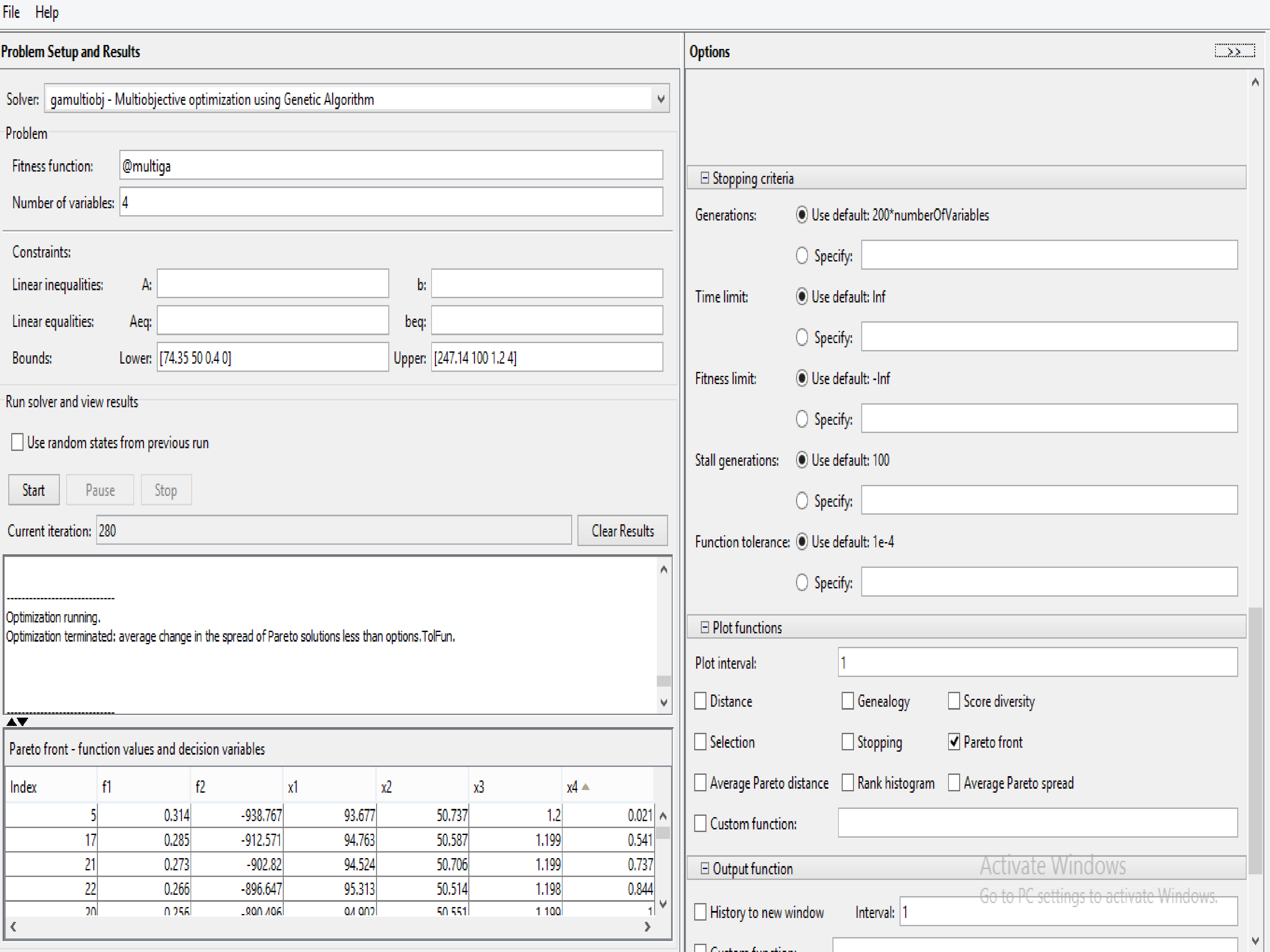
- Number of variables — The length of the input vector to the fitness function

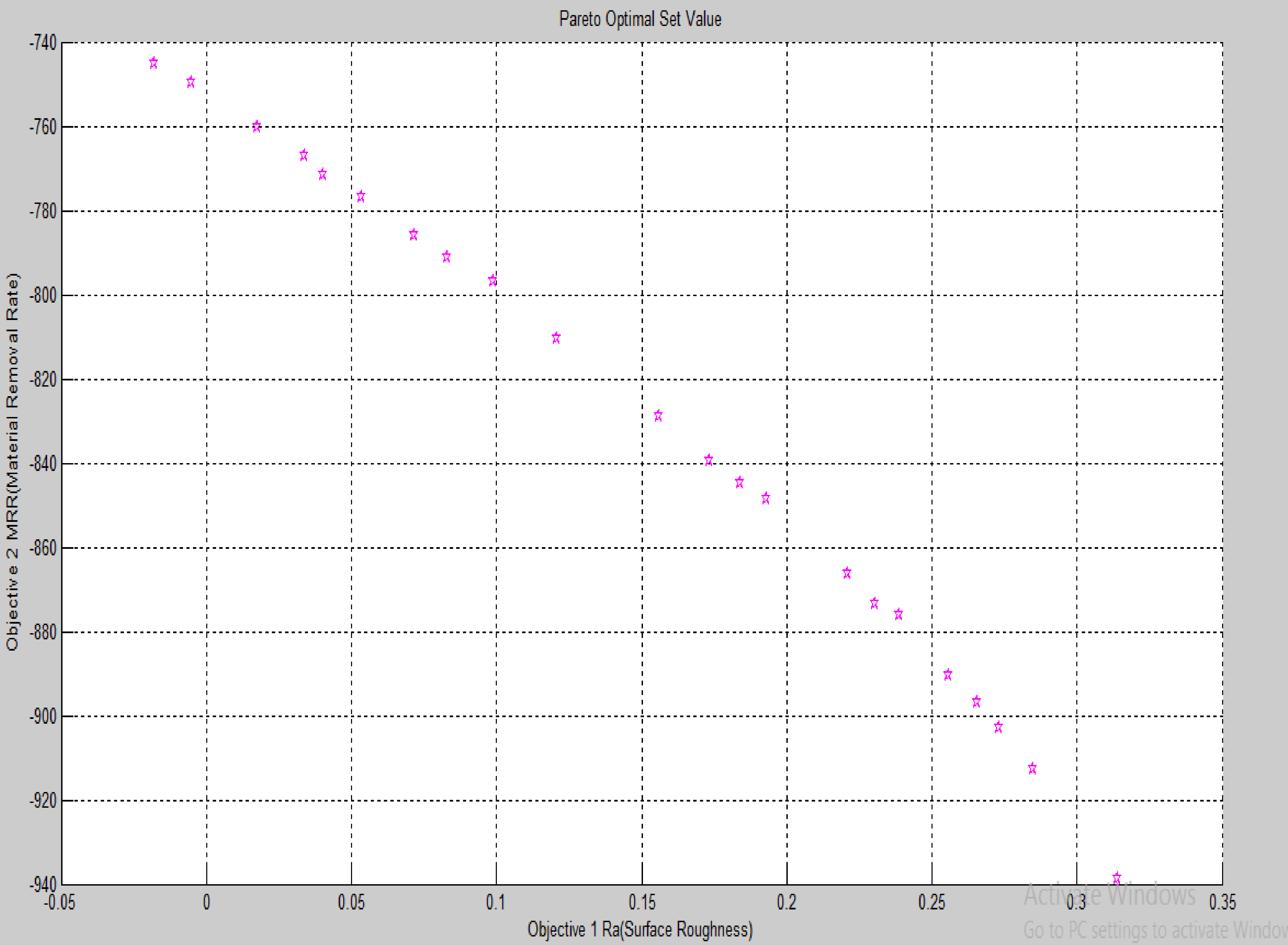
- To run the genetic algorithm, click the Start button. The tool displays the results of the optimization in the Status and Results pane.
- In order to convert the responses into single characteristic, it is suitably modified. The objective functions after modification are given below.

  Objective 1 = Ra =f(1)

  Objective 2 = - (MRR) =f(2)


File Edit Text Go Cell Tools Debug Parallel Desktop Window Help
Current Folder: C:\Users\jay soni\Desktop
Shortcuts How to Add What's New
Editor - C:\Users\jay soni\Desktop\multiga.m
Stack: Base
function f= multiga(x)
f(1)= 0.1025 - 0.0000*x(1)+ 0.0042*x(2)- 0.0004*x(3)- 0.0508*x(4)- 0.0080*x(4)*x(4)- 0.000*x(1)*x(2);
f(2)= -(514.096-1.250*x(1)- 3.326*x(2)+ 592.95*x(3)- 11.34*x(4)- 30.563*x(3)*x(4));
end
multiga.m
multiga.m
Command Window
MATLAB desktop keyboard shortcuts, such as Ctrl+S, are now customizable.
In addition, many keyboard shortcuts have changed for improved consistency
across the desktop.
To customize keyboard shortcuts, use Preferences. From there, you can also
restore previous default settings by selecting "R2009a Windows Default Set"
from the active settings drop-down list. For more information, see Help.
Click here if you do not want to see this message again.
>>
Activate Windows
Go to PC settings to activate Windows.
Start Ready
multiga
Ln 1 Col 1 OVR


File Help
Problem Setup and Results
Options
Solver: gamultiobj - Multiobjective optimization using Genetic Algorithm
Problem
Fitness function: @multiga
Number of variables: 4
Constraints:
Linear inequalities: A: b:
Linear equalities: Aeq: beq:
Bounds: Lower: [74.35 50 0.4 0] Upper: [247.14 100 1.2 4]
Run solver and view results
Use random states from previous run
Start Pause Stop
Current iteration: 280 Clear Results
Optimization running.
Optimization terminated: average change in the spread of Pareto solutions less than options.TolFun.
Pareto front - function values and decision variables
Index f1 f2 x1 x2 x3 x4
5 0.314 -938.767 93.677 50.737 1.2 0.021
17 0.285 -912.571 94.763 50.587 1.199 0.541
21 0.273 -902.82 94.524 50.706 1.199 0.737
22 0.266 -896.647 95.313 50.514 1.198 0.844
Stopping criteria
Generations: Use default: 200*numberOfVariables
Specify:
Time limit: Use default: Inf
Specify:
Fitness limit: Use default: -Inf
Specify:
Stall generations: Use default: 100
Specify:
Function tolerance: Use default: 1e-4
Specify:
Plot functions
Plot interval: 1
Distance Genealogy Score diversity
Selection Stopping Pareto front
Average Pareto distance Rank histogram Average Pareto spread
Custom function:
Output function
History to new window Interval: 1
Activate Windows
Go to PC settings to activate Windows.


Pareto Optimal Set Value
Objective 2 MRR(Material Removal Rate)
Objective 1 Ra(Surface Roughness)
-740
-760
-780
-800
-820
-840
-860
-880
-900
-920
-940
-0.05
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35

Optimal Combination of Parameters[17]

Sr No:	Ra(µm)	MRR	Speed	Feed	Doc	Coolant Speed
1	0.312988	959.274638	79.37866	50.2402	1.2	1.2354787
2	-0.01914	756.994435	84.47974	50.00796	1.190114	3.999996804
3	0.152179	841.794234	81.54617	50.18571	1.192675	2.316687449
4	0.275792	926.961749	80.26464	50.0899	1.19935	0.653368469
5	0.065254	802.264799	80.66883	50.07707	1.19777	3.225543753
6	-0.01914	756.99461	84.47924	50.00796	1.190113	3.999996788
7	-0.00774	769.719842	80.94813	50.0612	1.198154	3.90192227
8	0.214164	883.69727	80.11501	50.14385	1.199496	1.556614943
9	**0.029866**	**779.838508**	**84.04803**	**50.00902**	**1.19279**	**3.559606943**
10	0.202207	872.804544	83.00599	50.0988	1.199336	1.709578734
11	0.160649	852.982785	79.49163	50.14463	1.199927	2.217391661
12	0.207468	877.389409	81.12425	50.11684	1.197655	1.642793978
13	0.123603	830.235053	80.72163	50.12215	1.197043	2.629918243
14	0.181815	860.119458	81.40143	50.10269	1.194717	1.964104098
15	0.091261	815.245807	79.75996	50.19717	1.197894	2.971474439
16	0.191574	868.570702	80.57072	50.11577	1.197963	1.844688358
17	0.292503	941.337745	79.5423	50.16243	1.199993	0.375421377
18	0.242161	899.916665	81.23552	50.11715	1.19761	1.169487341
19	0.107149	825.068869	79.38616	50.06624	1.199457	2.801982808
20	0.22759	891.387893	79.96538	50.17655	1.197727	1.377715499
21	0.100385	815.337282	80.44886	50.0979	1.189846	2.873710297

Optimal Value of MRR & Ra

• The optimal machining parameters are shown in table below.

Optimal Experimental Combination				Experimental Value	
Speed	Feed	DOC	C.S	M.R.R (mm^3/ min)	Ra(μ m)
84.048	50.00	1.192	3.55960	779.83	0.0298

• The experimental results confirm the validity of the utilized Response surface Methodology (RSM) integrated with GA for improving the machining performance and optimizing the machining parameters.

Conclusion

The effect of process parameters cutting speed, Feed and Depth of cut on response Characteristics MRR were studied on 20MnCr5 steel alloy in End Milling.

- Thirty experiments have been conducted based on RSM with three levels for each four parameters, namely speed, feed, depth of cut and coolant speed. The MRR have been measured for each combination of parameters. Modeling is performed to establish relationship between input machining parameters and the responses of interest (MRR) in order to predict and analyze the responses.
- The analysis of variance revealed that feed and depth of cut are the most influential parameters.
- The result shows that MRR is almost same when coolant is ON and coolant is OFF. Therefore it can be concluded that MRR does not depend much on coolant.
- Interaction effects between cutting speed and depth of cut also possesses a major effect over the surface roughness value
- coolant speed is the most influencing parameter showing a sharp decrease in Ra from 0.35 µm to 0.25 µm when coolant speed increase from 0 to 2 liters per min.

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THANK YOU