PREDICITION OF MATERIAL REMOVAL RATE USING GENETIC ALGORITHM

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Abstract- Due to the advancement of technology, the demand of the hour is increasing. Metal machining is one of the important aspects. During machining, several process parameters such as cutting speed, feed rate and depth of cut affecting the material removal rate, machining performance and its productivity. The majority of work performed by the engineers is to find out the optimal level of parameter to obtain the desired quality and maximize the performance of machining.

There are several techniques available to determine the optimum values of these parameters. We are using Genetic algorithm for the prediction of material removal rate (MRR). From this genetic algorithm, we are selecting optimum result relating to process parameters.

***Keywords-* Genetic Algorithm, Material Removal Rate**

I. INTRODUCTION

A.Material Removal Rate

Metal cutting is one of the important and commonly used manufacturing processes in any metal processing or business industries. By machining processes or manufacturing operations, attempts are made to make a product in several steps as of required dimensions and shapes to ensure the quality of machining products for the intended applications made for. The step-by-step machining is done on the material to reduce the machining costs thereby increasing the machining effectiveness. Every manufacturing

Industry aims at producing many products within relatively lesser time. It has long been recognized that conditions during cutting, such as feed rate, cutting speed and depth of cut, should be selected to optimize the economics of machining operations, as assessed by productivity, total manufacturing cost per component or some other suitable criterion.

The optimization of cutting parameters during machining is a difficult task as it involves several aspects such as knowledge of machining, empirical equations of tool life, cutting forces, power consumed, machining surface finish etc. All these aspects should be considered during machining optimization to develop an effective optimization criterion. Manufacturing industries have long depended on the skill and experience of shop-floor machine-tool operators for optimal selection of cutting conditions and cutting tools.

B.Genetic Algorithm (GA)

In computer science and operations research, a genetic algorithm (GA) is a process of natural selection that belongs to the larger class of evolutionary algorithms (EA). Genetic algorithms are commonly used to generate high-quality solutions to optimization and search problems by relying on bio-inspired operators such as mutation, crossover and selection.

In a genetic algorithm, a population of candidate solutions (called individuals, creatures, or phenotypes) to an optimization problem is evolved toward better solutions. Each candidate solution has a set of properties (its chromosomes or genotype) which can be mutated and altered; traditionally, solutions are represented in binary as strings of 0s and 1s, but other encodings are also possible.

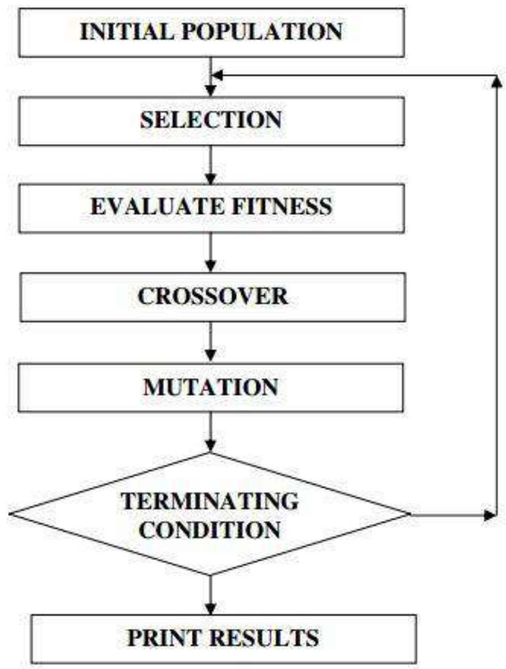

Fig. 1 Genetic Algorithm

The evolution usually starts from a population of randomly generated individuals, and is an iterative process, with the population in each iteration called a generation. In each generation, the fitness of every individual in the population is evaluated; the fitness is usually the value of the objective function in the optimization problem being solved. The more fit individuals are stochastically selected from the current population, and each individual's genome is modified (recombined and possibly randomly mutated) to form a new generation. The new generation of candidate solutions is then used in the next iteration of the algorithm. Commonly, the algorithm terminates when either a maximum number of generations has been produced, or a satisfactory fitness level has been reached for the population.

II. DESCRIPTION OF THE PROBLEM

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 particular 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.

Genetic Algorithm (GA) has been applied for optimizing of machining parameters during turning operation of mild steel using conventional lathe machines. 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 MAT LAB is used to develop the GA simulation. GA can be used in optimization problems such as scheduling, materials engineering, optimal control, and so forth.

RESULTS & CONCLUSION

A.Calculated the Material Removal Rate using Taguchi Technique

Table 1. MRR Obtain by Taguchi Technique

Feed rate	Spindle speed	Cutting speed	Material Removal Rate
0.62	40	3.14	2331.245558
0.62	40	25.13	1024.172273
0.62	40	47.112	282.4254973
0.62	320	3.14	19954.45787
0.62	320	25.13	18647.47078
0.62	320	47.112	17340.95918
0.62	600	3.14	37577.67018
0.62	600	25.13	36270.76929
0.62	600	47.112	34964.34386
0.8	40	3.14	3009.213758
0.8	40	25.13	1258.822073
0.8	40	47.112	490.9328173
0.8	320	3.14	25823.62607
0.8	320	25.13	24073.32058
0.8	320	47.112	22323.65186
0.8	600	3.14	48638.03838
0.8	600	25.13	46887.81909
0.8	600	47.112	45138.23654
0.98	40	3.14	3687.181958
0.98	40	25.13	1493.471873
0.98	40	47.112	699.4401373
0.98	320	3.14	31692.79427
0.98	320	25.13	29499.17038
0.98	320	47.112	27306.34454
0.98	600	3.14	59698.40658
0.98	600	25.13	57504.86889
0.98	600	47.112	55312.12922

Table 2. Ranges for MRR

S.No.	Ranges	Cutting Speed (m/min)	Spindle Speed (rpm)	Feed Rate (mm/rev.)
1.	Maximum	95.5	1000	0.98
2.	Minimum	3.5	40	0.62

Table 3. Machining Parametric Combinations and Results of Responses

Expt. No.	Feed Rate (mm/rev)	Depth of Cut (mm)	Cutting Speed (m/min)	MRR (mm^3/sec)	Machining Time (min)	Spindle Speed (rpm)
1	0.73	1	3.82	2396.66	4.75	40
2	0.86	1	5.73	4765.92	2.70	60
3	0.98	1	8.59	8146.39	1.58	90
4	0.89	1	12.89	11097.3	1.16	135
5	0.76	1	19.10	14039.1	0.91	200
6	0.62	1	28.65	17179.4	0.75	300
7	0.84	1	38.20	31033.3	0.42	400
8	0.82	1	64.46	51122.8	0.25	675
9	0.77	1	95.50	71119.3	0.18	1000

The method adopted in this project succeeded in evaluating the relative importance of the parameters that has a direct impact on the surface quality. The research succeeded in developing different algorithms for the generation of five different tool path movements to completely cover the simulated sample: scan line tool path, zigzag tool path, contour offset tool path, Constant overlap spiral path pattern and Parallel spiral tool path. Following conclusions were made from the research based on extensive analysis and observations from simulations:

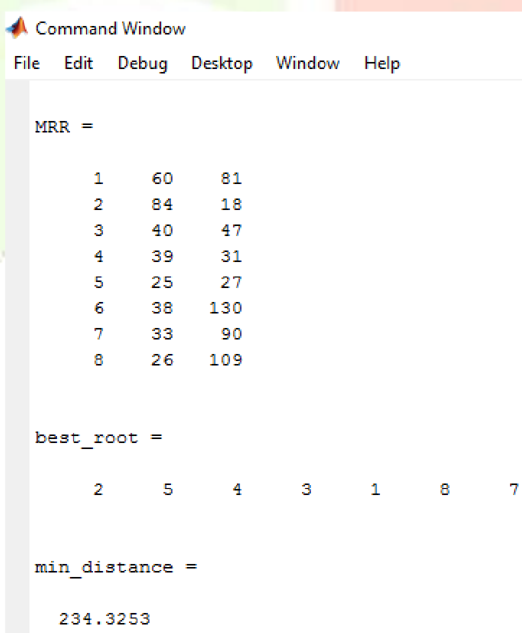

Fig.2 Material Removal Rate

1. Tool path is the most significant parameter to be considered while performing the evaluations for surface quality and control in finishing processes.

2. Surface errors increases with increase in the values of step over. Optimum step over range was found to be 10-20%.

3. Zig zag tool path pattern was obtained as the most efficient tool path which gave low surface errors and uniform material removal from the surface in comparison with other tool paths.

4. Rotary or Pad tool was observed to have lowest error to removal ratio and surface imperfections together with regular material removal.

5. Relatively large rotary and brush tools are efficient in providing the surface with low errors. Radial tool with small diameters are effective in obtaining relatively smooth surface.

6. Rotation of the tool influence function at the corners can be used as an effective strategy to significantly reduce the impact of corner effects which has an adverse effect on the surface quality. Rotation of tool influence function reduced error/removal for contour tool paths. Hence this strategy can also be adopted as a tool path optimization approach for contour paths.

7. Method of appending one tool path over the other was observed as being efficient in cancelling out the peaks and hence offer relatively low surface error values. This strategy is clearly effective in optimization of contour tool paths.

8. Varying the pressure uniformly along the side step or orthogonal direction was derived as an effective strategy towards obtaining surfaces with low errors. Strategy helped in minimizing the effect of localized pressure points on the path line and also offered uniform distribution of pressure across the entire surface.

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