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# Review of Surface Roughness Prediction in Cylindrical Grinding process by using RSM and ANN

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**Abstract—** In recent years, one of the innovative technologies which enable automatic computerized devices for the purpose of evaluation, inspection, analyzing of various static and dynamic images is Machine Vision System. MVS provides various benefits in various fields like Surveillance cameras for Security, MAT LAB for analysis of Engineering designs, RSM and ANN for analysis of various parameters for optimizing variables, etc. MVS has some various innovative techniques like automatic capturing of images, evaluation and processing capabilities. This paper is about optimization of various parameters such as depth of cut, feed rate, cutting speed, dressing conditions, etc. For improving the accuracy obtained in Cylindrical (Surface) grinding process. The main objective of our idea is to identify the surface roughness of work piece obtained in Cylindrical grinding process in according to various input parameters like feed rate, depth of cut, dressing speed, etc. The method used here is RSM and ANN which are used to optimize the response of input parameters on output parameters and to provide algorithm for pre-trained model for visualization along with simulation of neural networks.

**Keywords—** Surface Roughness, Response Surface Methodology, Artificial Neural Network, Work piece Materials, Methodology.

## I. INTRODUCTION

The determination of surface roughness of cylindrical job has been made easy from the following researches. The researches we used for analysis are Marius Winter, Wen Li (2013),determining the optimal process parameters to increase eco-efficiency of grinding process using the input parameters like cutting depth, cutting speed, dressing speed, work piece speed. These features results in fine surface finish along with geometrical accuracy using the algorithm of empirical model and geometric programming. M.Janardhan (2015), an integrated evaluation approach for modeling and optimizing of surface grinding process parameters which as Wheel speed and Depth of cut using Response Surface Methodology.

N.Sudheer Kumar Varma,S.Rajesh(2016), Neural network and fuzzy logic based prediction of surface roughness and MRR in cylindrical grinding process using input parameters such as work speed, depth of cut, feed rate based on the principle Neural Network Modeling and ANFIS on AISI1040 STEEL. Jae-SeobKwak(2005) application of Taguchi and response surface methodology for geometric error in surface grinding process by input parameters as Wheel speed, Depth of cut, on the principle RSM and Taguchi. Jae-SeobKwak(2006), an analysis of grinding power and surface roughness of hardened steel using RSM by optimizing Depth of cut, Work piece speed.

Kuldip Singh Sangwan(2015), optimization of machining parameters such as Cutting speed, Feed ,depth of cut to minimize surface roughness using Integrated ANN-GA approach. Kiran A patel(2016) A study of RSM and ANN model for surface roughness using RSM and ANN by thee input parameters of Spindle Speed, Interference, Feed and Number of tool passes.

## II. LITERATURE SURVEY

| S.No | Author &Year | Title | Input Parameters | Work piece Material | Methodology/ Algorithm | Result / Output Parameter |
|---|---|---|---|---|---|---|
| 1. | Marius Winter(2013) | Determining optimal process parameters to increase the eco-efficiency of grinding process. | Cutting depth, Cutting speed, Dressing speed, Work piece speed. | Hardened Carbon Steel 1.3505 [DIN100G6] | Empirical Model and Geometric Programming. | Great Geometrical accuracy and Surface Roughness. |
| 2. | M. Janardhan (2015) | An integrated evaluation approach for modeling and optimization of Surface grinding process parameters. | Wheel speed, Depth of cut, Table speed, Dressing condition. | AISI4 340 STEEL | Response surface methodology and NSGA-II. | Good Surface roughness and desired surface finish. |
| 3. | Jae-Seob Kwak (2006) | An analysis of grinding power and surface roughness in external cylindrical grinding process. | Depth of cut, Work piece speed, Traverse speed, Chip thickness, Contact length. | Hardened SCM440 STEEL | Response Surface Methodology. | Surface roughness and grinding power. |

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| 4 | N Saran Kumar, N Kaleeswaran, B Radha Krishnan | Review on optimization parametrs in Abrasive Jet Machining process | Nozzle Diameter, Standoff Distance, Particle Size | steel | ANN, RSM | Surface roughness |
| 5. | Kiran A Patel(2016) | A Study of RSM and NN model for surface roughness. | Spindle speed, Interference, Feed and number of tool passes. | Aluminium Alloy 6061 | RSM and ANN. | Surface roughness. |
| 6. | Kuldip Singh Sangwan (2015) | Optimization of machining parameters to minimize surface roughness. | Cutting speed, Feed, Depth of cut. | Ti-6AL-4v Titanium alloy | Integrated ANN -GA. | Surface roughness. |
| 7. | Jae-Seob Kwak(2005) | Application of RSM and Taguchi for geometric error in Surface grinding. | Wheel speed, Depth of cut, Table speed, Dressing condition. | High speed tool STEEL (SKH51) | Taguchi and RSM. | Surface roughness and geometric error. |
| 8. | N. Sudheer Kumar Varma(2016) | NN and ANFIS based prediction of Surface roughness and MRR in cylindrical grinding process. | Work speed, Depth of cut, Feed rate. | AISI1040 STEEL | Neural Network Modeling and ANFIS. | Surface roughness and MRR. |
| 9. | Rogelio L. Hecker(2003) | Predicative modeling of surface roughness. | Chip thickness, Depth of cut, Speed ratio. | Hardened Steel 52100 with 62HRC | Analysis of grooves left by grains. | Surface roughness. |
| 10. | Grynal D Mello (2017) | Surface roughness modeling in high speed | Cutting speed, Feed rate, Depth of cut, tool | Ti-6Al-4V Titanium alloy | ANN | Surface roughness ($R_a$, $R_t$) |

 

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|---|---|---|---|---|---|---|
| | | turning | flank wear. | | | |
| 11 | B.Radha Krishnan, M. Ajith, .Ajith kumar, P. Bala, G.Gwalbert Maurice | Determination of Surface Roughness in AA6063 Using Response Surface Methodology | Cutting speed, Feed rate, Depth of cut | AA6063 | Response Surface Methodology | Surface roughness ($R_a$) |
| 12. | Yanni Chen (2016) | A nested ANN Prediction model for Surface roughness. | Cutting forces and Tool vibration. | Ti-6Al-4V Titanium alloy | Nested –ANN and RSM | Surface Roughness ($R_a$) |
| 13. | M.N.Dhavlikar (2002) | Combined taguchi and dual response method for optimization of grinding operation | Feed speed, Depth of cut, Angle of regulating wheel | Steel | Taguchi and dual response method | Roundness error |
| 14. | Mei-Ling Huang (2016) | Validation of a method using Taguchi, RSM, Neural network and genetic algorithm | Cutting depth, Type of cutting fluid, Spindle speed. | Carbon Steel | Taguchi, RSM, Back-propagation, Genetic algorithm. | Process yield. |
| 15. | Sathish T, Tamizharasan N (2017) | Optimisation of Surface Roughness in CNC Milling Process Using RSM | Cutting speed, Feed rate, Depth of cut. | Aluminium 6063 | Response Surface Methodology | Surface roughness, $R_z$ |
| 16. | Ravinder Kumar (2015) | Study of Surface roughness using RSM and ANN. | Cutting speed, Feed rate. | Al 7075 hard ceramic and hybrid composites. | RSM and ANN | Surface roughness. |
| 17. | B.Radhakrishnan, S.TharunKumar (2017) | Optimization of CNC machining parameters for surface roughness in | Cutting speed, Feed rate, Depth of cut. | Aluminium 6063 T6 | Response Surface Methodology | Surface roughness, $R_z$ |

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|---|---|---|---|---|---|---|
| | | turning of aluminium 6063 T6 with response surface methodology | | | | |
| 18. | Kuldip Singh Sangwan (2017) | Optimization of machining parameters for improving energy efficiency | Cutting speed, Feed rate, Depth of cut. | AISI 1045 Steel | RSM and Genetic algorithm. | Power Consumption |
| 19. | B Radha Krishnan, R Aravindh (2018) | Prediction of Surface Roughness (AISI 4140 Steel) in Cylindrical Grinding Operation by RSM | Cutting speed, Feed rate, Depth of cut. | AISI 4140 Steel | Response Surface Methodology | Surface roughness. |

## III. EXPERIMENTAL SETUP

### A. *Work piece Material*

We have selected EN 19(V 320) STEEL for our experiment. It has the following Chemical composition and heat treatment specification respectively.

Table 1. Work piece chemical Composition

| Chemical | Composition (%) |
|---|---|
| Carbon | 0.35 TO 0.45 |
| Silicon | 0.10 TO 0.30 |
| Manganese | 0.5 TO 0.80 |
| Chromium | 0.90 TO 1.40 |
| Molybdenum | 0.20 TO 0.40 |
| Hardening Temperature | 900-950 $^0$C |
| Quenching Medium | OIL |
| Tempering Temperature | 200-225 $^0$C |
| Brinell Rockwell Hardness | 45-55 RC |

*B. Equipment*

Cylindrical Grinding Machine has been used to carry out our experiment It has the following specifications: (All dimensions are in mm)

Table 2. Grinding Machine Specification

| | |
|---|---|
| Size | 355 |
| Maximum length of work-piece | 355 |
| Maximum diameter of work-piece | 76 |
| Height of centre | 130 |
| Number of speed | 3 |
| Spindle speed range | 4/58-130rpm |
| Maximum table swivel | 7 degrees |
| Power required | 2 HP |
| Approx. weight | 1400 kgs |

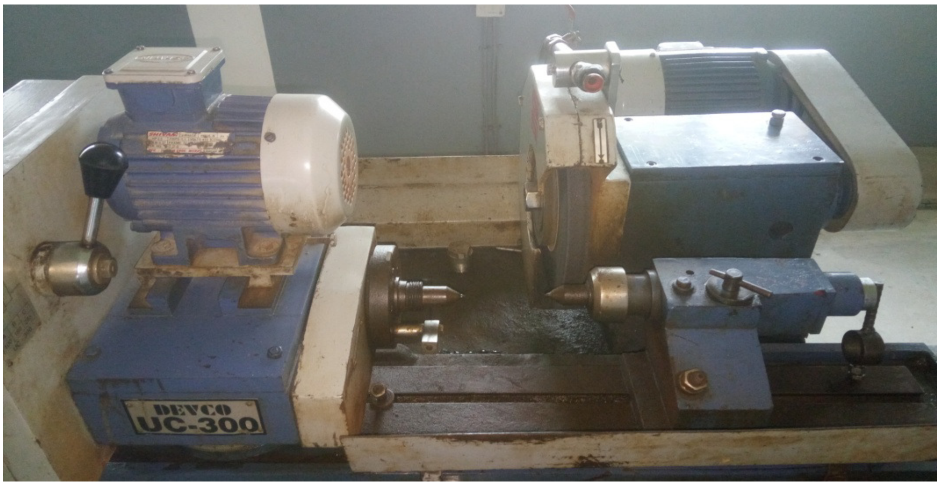


Fig .1.Cylindrical Grinding Machine

*C. Camera*

For image capturing and processing, we have selected a Canon EOS 600D With the following specification:

- 18-megapixel CMOS sensor
- Scene Intelligent Auto mode
- Full-HD EOS Movie
- On-screen Feature Guide
- Up to 3.7fps continuous shooting

 

- Wide-area 9-point AF
- 1,040k-dot vari-angle 7.7cm (3.0") screen
- Basic+ and Creative Filters
- Built-in wireless flash control

# IV. CONCLUSION

From the review papers, it is clear that the prediction of surface roughness of AISI 4040 STEEL in cylindrical grinding process is efficient by the principle of ANN. The optimum machining parameters observed for best surface roughness are 400 rpm work speed with 50 microns depth of cut and a feed rate of 1600 mm/min result efficiency of 91%. The material for our experiment is AISI 4140 STEEL [C%:0.35 TO 0.45, Si%:0.10 TO 0.30, Mn%:0.5 TO 0.80, Cr%:0.90 TO 1.40, Mo%:0.20 TO 0.40] using Response Surface Methodology and Artificial Neural Network with machining parameters such as Cutting speed, Depth of cut, Feed rate. The material AISI 4140 is used in components of mediums & large cross section, requiring high tensile strength & toughness such as in automobile engineering, gear & engine construction. Our conclusion is that the obtained efficiency in our experiment is about 95% using RSM and ANN.

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