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Evaluation of cutting parameter using Taguchi method for reducing Surface roughness during Face milling operation

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ABSTRACT

This research is based on optimization of machining processes by the application of Taguchi method. In this research three parameters are selected: spindle speed (X), feed rate (Y), and depth of cut (Z), with three levels of variation: level 1, level 2, and level 3. Taguchi L9 Orthogonal array approach was chosen as the experimental design. Cast iron, AISI 304 stainless steel, and mild steel 1018 workpiece dimensions are 230x140x255 mm, 280x190x25 mm, and 750x370x20 mm, respectively. All nine trials were carried out using the design of experiment on all three workpiece, and the roughness was calculated using the surface roughness tester.The difference between the experimental and intended values is then calculated using a loss function. Taguchi suggests using the loss function to calculate the quality characteristic's divergence from the desired value. The overall loss function's value is then converted into a signal-to-noise (S/N) ratio. Based on the S/N analysis, the S/N ratio for each level of process parameters is calculated. A lower S/N ratio corresponds to a better quality characteristic regardless of the category of the quality characteristic. As a result, the process parameter level with the largest S/N ratio is the ideal level.

Key words: Milling, Surface roughness, Taguchi, machining,S/N ratio

Introduction

As quality and productivity play a vital part in today's industrial industry, manufacturing companies continue to demand better production rates and improved machine capability. The degree of satisfaction of consumers with the obtained item (or product) is influenced by its quality. As a result, product quality should be a top priority for any manufacturing or production unit. Aside from quality, there is a criterion known as productivity, which is linked to profit and the organization's goodwill. The metal-based sector is concentrating on improving production and part quality. All components of each process must be monitored in order to achieve this goal. In this project we present Taguchi's parameter design offers a systematic approach for optimization of the parameters in order to minimize the surface roughness in Face Milling operation.Surface roughness is an important indicator of a product's technological excellence and a component that has a significant impact on manufacturing costs. The quality of the surface has a substantial impact on the turning performance, since a high-quality turned surface improves fatigue strength, corrosion resistance, and creep life.There have been numerous research advancements in surface roughness modelling and machining parameter optimization in recent years.

Using the Taguchi approach, Kvak investigated the effect of cutting tools, cutting speed, and feed rate on surface roughness.Experiments were carried out using the Taguchi technique L9 orthogonal array, and the results were assessed using the lower is better idea. This study reveals the most critical and influential component influencing the milling operation's responses.

Literature Review

Many machining processes were optimized by the researchers for improving the surface roughness quality of the productP George et al [1] applied Taguchi optimizationto optimise CNC dry milling parameters for martensitic stainless steel (MSS) grades AISI 410 and AISI 420. The tests are designed using a L9 orthogonal array with three levels of spindle speeds and feeds with a constant depth of cut. Surface roughness was studied in relation to machining parameters. For both MSS grades 410 and 420The percentage contribution of spindle speed to surface roughness is higher than feed, according to ANOVA data. Cutting characteristics were found to be optimal at a spindle speed of 1500 rpm and a feed rate of 30 mm/min.

Y.D. Chethanet al [2] In this research paper Acoustic emission (AE) and machine vision signals were used to determine the ideal cutting settings, which might potentially characterise the status of tool wear, and the results are presented in this studyTaguchi's L27 array is used for parametric optimization. During the experiment, the spindle speed, feed, and cutting depth were changed, and the tabulated data in terms of AE and machine vision signals were evaluated

Mohamed ZakariaZahafet al [3] This reseach calculate Statistical analysis, mathematical modelling, and optimization of machined surface roughness (Ra) and workpiece displacements (D) observed during shoulder and contour milling of AISI 52100 bearing steel are part of this experimental investigation.This study shows that how the radial depth of cut affects shoulder, groove, and contour milling when the Axial depth of cut is strong while the Radial depth of cut is weak.

Patricio Quitiaquezet al[4] The goal of this research is to identifies a geometry that is suited for high-speed steel cutting tools used in turning and facing operations. Different angles were addressed in the Polyamide PA-6 material, such as the tip, free, attack, and nose radius angles, which allowed for clean machining with the least amount of roughness.The study allowed for the selection of the best variable for each parameter in order to propose the lowest possible roughness; the nose angle 45˚, 6˚ free, 8˚ attack, and nose radius 0.7 mm were determined for the turning tool.

Methodology:

In this investigation an effort was made to find out the best process parameters of MILLING on cast iron, AISI 304 stainless steel and mild steel 1018.The Taguchi Method of L9 orthogonal array is employed to carry out the experiment. Three variables (depth of cut, spindle speed, and feed rate) with three levels are present in the L9 orthogonal array (Level 1, level 2 and level 3). To limit the number of experiments, the Taguchi Method is applied. For the analysis of parameter optimization, this method is effective and simple.

1 Parameter values, Surface Roughness & S/N ratio for CI

Experiment Number	Parameter values			Surface Roughness (µm)	S/N Ratio (dB)
	Spindle Speed (X)	Feed (Y)	Depth of Cut (Z)		
1	1200	250	0.10	2.3	-7.2345
2	1200	300	0.13	1.8	-5.1004
3	1200	350	0.16	2.0	-6.0206
4	1500	250	0.10	1.2	-1.5810
5	1500	300	0.13	2.3	-7.9588
6	1500	350	0.16	3.0	-9.5420
7	1800	250	0.10	0.8	-1.9382
8	1800	300	0.13	1.5	-3.5202
9	1800	350	0.16	2.1	-6.4404
Mean of S/N Ratio					**-5.4811**

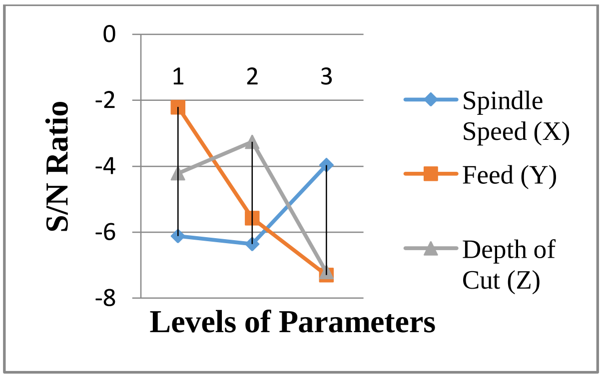
2 Parameter values, Surface Roughness & S/N ratio for AISI 304 SS

Experiment Number	Parameter values			Surface Roughness (µm)	S/N Ratio (dB)
	Spindle Speed (X)	Feed (Y)	Depth of Cut (Z)		
1	250	100	0.4	3.0	-9.5424
2	250	140	0.5	3.7	-11.36
3	250	180	0.6	4.0	-12.0412
4	300	100	0.4	1.9	-5.5702
5	300	140	0.5	1.3	-1.5836
6	300	180	0.6	2.4	-2.2704
7	350	100	0.4	1.5	-3.5218
8	350	140	0.5	1.3	-2.2788
9	350	180	0.6	1.8	-5.1088
Mean of S/N Ratio					**-5.9196**

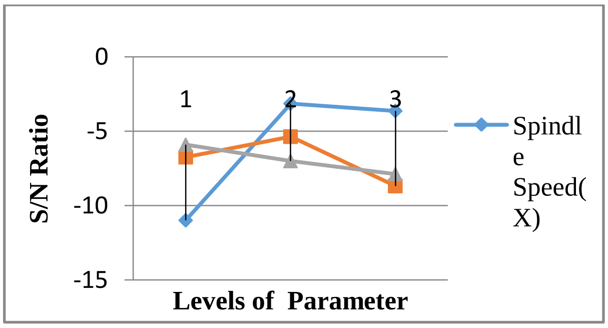
3 Parameter values, Surface Roughness & S/N ratio for MS 1018

Experiment Number	Parameter values			Surface Roughness (µm)	S/N Ratio (dB)
	Spindle Speed (X)	Feed (Y)	Depth of Cut (Z)		
1	170	160	0.6	2.3	-7.2388
2	170	200	0.5	3.1	-0.9827
3	170	240	0.4	3.8	-11.5956
4	210	160	0.6	1.7	-4.6089
5	210	200	0.5	1.3	-2.2788
6	210	240	0.4	3.6	-11.1260
7	250	160	0.6	1.9	-5.5750
8	250	200	0.5	1.5	-3.5218
9	250	240	0.4	2.4	-7.6042
Mean of S/N Ratio					**-6.0590**

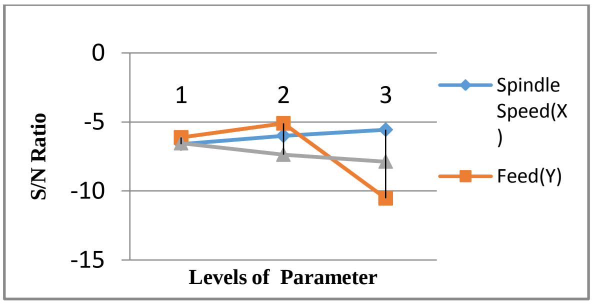
Result and Discussion



Variation of S/N Ratio with process parameter for cast iron



Variation of S/N Ratio with process parameter for AISI 304 SS



Variation of S/N Ratio with process parameter for MS 1018

Conclusion:

By analysing the Signal-to-Noise (S/N) ratio, Minitab 19 software was utilised to discover the best combination of milling parameters.
Following the S/N ratio study, the best parameters for the experiment are $X_3Y_1Z_2$, (for cast iron), $X_2Y_2Z_1$ (for stainless steel), and $X_2Y_2Z_1$ for (Mild Steel). A confirmation test demonstrates that the optimal parameters produce the desired output while reducing surface roughness.

REFERENCES:

[1] Pramod George, D. Philip Selvaraj "Cutting parameter optimization of CNC dry milling process of AISI 410 and 420 grade MSS", Materials Today: Proceedings 42 (2021) 897–901

[2] Y.D. Chethan, H.V. Ravindra , Y.T. Krishnegowda " Optiization of machining parameters in turning Nimonic-75 using machine vision and acoustic emission signals by Taguchi technique" Measurement 144 (2019) 144–154

[3] Mohamed ZakariaZahaf, MohieddineBenghersallah "Surface roughness and vibration analysis in end milling of annealed and hardened bearing steel" Measurement: Sensors 13 (2021) 100035

[4] PatricioQuitiaquez, Juan Cocha, William Quitiaquez, Xavier Vaca "Investigation of geometric parameters with HSS tools in machining polyamide 6 using Taguchi method" Materials Today: Proceedings xxx (xxxx) xx

[5] N.S. Patel, Priyansh L. Parihar, Jay S. Makwana "Parametric optimization to improve the machining process by using Taguchi method: A review" Materials Today: Proceedings xxx (xxxx) xx

[6] P. Rasagopal,P.Senthilkumar , G. Nallakumarasamy , S. Magibalan "A study surface integrity of aluminum hybrid composites during milling operation" jmaterreste chnol . 2 0 2 0;9(3):4884–4893

[7] P.M. Gopal, K. Soorya Prakash "Minimization of Cutting Force, Temperature and Surface Roughness through GRA, TOPSIS and Taguchi techniques in End Milling of Mg Hybrid MMC" Measurement S0263-2241(17)30713-3

[8] J. Santhakumar, U.Mohammed Iqbal , M. Prakash " Taguchi-Grey Relational Based Multi-Response Optimization on the Performance of Tool Coating Thickness in Pocket Milling" Materials Today: Proceedings 5 (2018) 13422–13428

[9] Jay Airao,,Bhavesh Chaudhary ,VivekBajpai , Navneet Khanna " An Experimental Study of Surface Roughness Variation in End Milling of Super Duplex 2507 Stainless Steel " Materials Today: Proceedings 5 (2018) 3682–3689

[10] M. Balaji, B.S.N.Murthy , N. Mohan Rao " Optimization of Cutting Parameters in Drilling Of AISI 304 Stainless Steel Using Taguchi and ANOVA " Procedia Technology 25 (2016) 1106 – 1113

[11] ȘenerKarabulut "Optimization of surface roughness and cutting force during AA7039/Al2O3 metal matrix composites milling using neural networks and Taguchi method " Measurement S0263-2241(15)00053-6

[12] Jihong Yan, Lin Li "Multi-objective optimization of milling parameters e the trade-offs between energy, production rate and cutting quality " Journal of Cleaner Production xxx (2013) 1- 10

[13] Fabrício José Pontes , Anderson Paulo de Paiva , Pedro Paulo Balestrassi , João Roberto Ferreira " Optimization of Radial Basis Function neural network employed for prediction of surface roughness in hard turning process using Taguchi's orthogonal arrays " Expert Systems with Applications 39 (2012) 7776–7787

[14] G.Ugrasena , H.V.Ravindra , G.V.Naveen Prakash , Y.N.Theertha Prasad " Optimization of process parameters in wire EDM of HCHCr material using Taguchi's technique " Materials Today: Proceedings 2 (2015) 2443 – 2452

[15] Girish Kant, Kuldip Singh Sangwan "Prediction and optimization of machining parameters for minimizing power consumption and surface roughness in machining" Journal of Cleaner Production S0959-6526(14)00801-4