Review on optimization of CNC Turning Process Parameters for Surface Roughness and Material Removal Rate Using Taguchi, GRA, and RSM Approaches

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Abstract

Nowadays, the realization of a fine surface finish is the main objective of the metal cutting industry during the turning processes.This work consists of an analysis of the work carried out by the researchers in the field of filming process parameters, to Examine the impact of speed, cutting speed (feed), and depth of cut in a computer numeric control machine. This study will provide insight into current trends research in the area of Taguchi, Grey Relational Analysis, Response Surface Method, ANOVA & CNC Turning.

Keywords: CNC Machine, Taguchi, ANOVA, GRA

1. Introduction

CNC turning is the first broad machine used for the manufacture of diametrically shaped parts in less time, featuring a better surface finish and high material removal rate exact dimensions as well. It is very much desired that the result of having a good surface finish and high material removal rate be made in a short time. The quality of the surface finish of a product is generally determined as a function of the surface roughness measured. Surface roughness typically hangs on such cutting parameters as speed, feed, and depth of cut.

Choosing the right management factors for the experience is very important to provide the parts with better surface end and high material removal rate in a brief time. Over the past couple of decades, a lot of work has been done to raise the standard of the commodity and power in machining. The still diverse aspects of this paper constitute a unit to be explored.

2. Literature Review

Year & Author	Aim of Research Work	Material	Input Parameters	Output Parameter	Technique Used	Result Observed
R. Viswanathan et al. (2020)	Optimization of turning parameters for magnesium alloy	Mg alloy AZ91D	Cutting speed, Feed, & Depth of cut	Flank wear, Surface roughness, Cutting force & Material removal rate	Taguchi, GRA, PCA	The most dominating parameter on the multiple performances was found to be the depth of cut.
S. Dhanalakshmi& T. Rameshbabu (2020)	Optimization of Process Parameters in CNC Turning of LM 25 Alloy Using the Taguchi-Grey Approach	LM 25 Aluminum Alloy	Cutting speed, Feed, Depth of cut & Cutting fluid flow rate	Surface roughness, Material removal rate & Total machining cost	Taguchi, GRA, ANOVA	Depth of cut is predominating variable for MRR, and feed & cutting speed predominating variable for SR and TMC
S.P. Palaniappan et al. (2020)	process parameters optimization on Aluminum 6082 alloy	Aluminum 6082	Spindle speed, Feed & DOC	Surface roughness & Material removal rate	Taguchi, ANOVA	significant parameter for MRR was speed & feed was the most significant parameter for SR.
Ning Li et al. (2019)	Multi Response optimization	Ti-6Al-4V	Insert Type, Feed & DOC	Radial thrust force, Cutting power & Coefficient of friction	GRA, KPCA	Feed rate has the most dominant effect on thrust force & e depth of cut is the most the significant factor for cutting power and coefficient of friction
A.Saravanakumar et al. (2018)	Optimization of CNC Turning Parameters	Aluminum 6063	Speed, feed & DOC	Surface roughness	Taguchi	The feed is the major influencing parameters among the three controllable factors
Suneel Kumar Rathore et al. (2018)	Determination of optimum parameters in CNC turning	Aluminum 6463	Spindle speed, feed, DOC & Coolant	Surface roughness	GRA, PCA	Quantitative involvements of the different factors are 15.33 % of SS, 3.06% of FR, 0.40% of Doc, and 30.87% of coolant respectively.
Vijay Kumar et al. (2018)	Optimization of Machining Parameters in CNC Turning	SS (EN19)	Lubrication, feed, DOC & spindle speed	SR & MRR	Taguchi	MRR increase with the increase in feed & SR decrease with increase in DOC & speed
Bikram Jit Singh et al. (2017)	Parametric optimization of CNC turning	Al 7020	Cutting speed, feed & DOC	SR & MRR	RSM	Best turning parameters found for maximum MRR and minimum SR are:- cutting speed = 167 m/min, feed = 0.1 mm/rev and depth of cut = 2.0 mm
M. Nataraj& K. Balasubramanian (2017)	Parametric optimization of CNC turning process	LM6 aluminum alloy	Cutting speed, feed & DOC	Work-tool interface temperature, SR & Vibration	ANOVA	Feed was the major contributor for vibration & Doc and cutting speed were the major contributors to surface roughness.

Franko Puh et al. (2016)	OPTIMIZATION OF MACHINING PARAMETERS FOR TURNING OPERATION	Carbon steel Ck45	Cutting speed, feed & DOC	SR & MRR	GRA	Surface roughness and material removal at cutting speed of V = 400 m/min, feed rate of f = 0,1 mm/rev and depth of cut d = 1,2 mm are significant
R Rudrapati et al. (2016)	Optimization of process parameters in CNC turning	Aluminum Alloy	Spindle speed, feed rate & DOC	SR	RSM & TLBO	Optimal parametric condition spindle speed = 700 rpm, feed rate = 25 mm/min and depth of cut = 0.2 mm and corresponding surface roughness is 0.42081 µm.
Singh MK et al. (2015)	Optimization of Process Parameters on CNC lathe	Al-6082 T-6	Feed, speed & DOC	SR	Taguchi	Depth of Cut had minimum impact on Surface Roughness contributing 16.27%
Murat Sarıkaya et al. (2015)	Multi-response optimization of MQL parameters	Haynes 25	Cutting fluid, flow rate & cutting speed	TWR, SR	GRA	MQL parameters like cutting speed, cutting fluid, and flow are the significant factors affecting tool wear and surface roughness
Murat Sarıkaya et al. (2014)	Analysis of machining parameters in CNC turning	AISI 1050	Cutting speed, feed & DOC	SR	Taguchi & RSM	Feed rate and the cooling condition have the highest influence on machined surface roughness.
K. Chandrasekaran et al. (2013)	Prediction Model for CNC Turning	AISI316	Cutting speed, feed & DOC	SR & TWR	RSM	The response surface model for SR and TW are developed from the observed data the predicted and measured values are fairly close,
IlhanAsiltürk&SüleymanNeseli (2012)	Multi response optimization of CNC turning parameters	AISI 304	Cutting speed, feed & DOC	SR	Taguchi & RSM	Both Taguchi and response surface statistical analyses indicated that the main effect of the feed rate is the most significant factor on the workpiece surface roughness
S. Ranganathan& T. Senthilvelan (2011)	Multi-response optimization of machining parameters in hot turning	stainless steel (type 316)	Cutting speed, feed, DOC &workpiece temperature	SR, MRR & Tool life	GRA	cutting speed at 113.1 m/min, feed rate at 0.381 mm/rev, and workpiece temperature at 400°C will give the optimum results for hot turning
Aman Aggarwal et al. (2008)	Optimizing power consumption for CNC turned parts	AISI P-20	Cutting speed, feed, DOC, Environment & Nose Radius	Power Consumption	Taguchi & RSM	Taguchi's technique revealed that cryogenic environment is the most significant factor & RSM also revealed that cryogenic environment has very significant effect in reducing power consumption.

3. Conclusion

In this work, the researchers performed studies on process parameters such as spindle speed, feed, depth of cut, environment, nose radius, and the impact on surface roughness, material removal rate, power consumption, tool wear rate, and thrust force.

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