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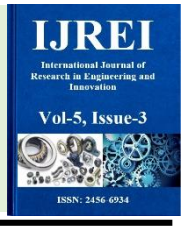

ORIGINAL ARTICLE

Role of surface roughness in optimization of cutting parameters during machining: A review

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Abstract

Different types of products are manufactured in various industries; the product's quality is very important with manufacturing for competition viewpoint. So, there are different machining like milling, drilling, grinding is performed on materials for enhancing the product quality. Various parameters belong to quality of product like as finishing of surfaces, material removal rate, surface hardness and surface strain etc but most of the cases surface roughness is most important for quality of products. Various techniques are used to determine best combination of machining parameters. This paper aims for presentation of many methods and techniques all are focused on surface roughness of the predicted model or product.

1. Introduction

International competition in market to fulfill the demand of customer, attracts various manufacture's interest to implement cost effective manufacturing process for improvement in quality of product and to boost productivity. Various researchers made a lot of efforts from past few eras for optimization of machining parameters. Machining parameters plays a considerable role in surface alternations during machining due to which the functional performance of the product varies. The reason behind this is to increase performance, life and reliability. As per Customer's point of view the product quality and cost of product are most important factors [1]. The quality of product depends on various parameters like finishing of surface, fatigue life of components; corrosion resistance [2]. Finishing of surface is a multiple-factor, multi- objective problem of optimization. To solve this multi-objective problem of optimization is imperative of optimal parametric combination identification. Surface roughness is most significant outcome parameter for any product, in today's era dynamic and economic market and continuously improvements in finishing of surfaces is top priority of industries. During machining of components to minimize surface roughness engineers have to face mainly two problems, the first one is to determination of optimal combination of process parameters, which are related to desire product quality and the second one is, to complete manufacturing process in available resources. The surface roughness is mostly used product quality index and a requirement for technical purpose. From last some years there are many attempts has done for determination of optimal machining parameters for reaching to better surface finish from online and offline mode. Machining parameters during optimization can be categorized as machine tool properties, tool properties, work piece properties, cutting parameters, thermal parameters, dynamic parameters as shown in fig. 1

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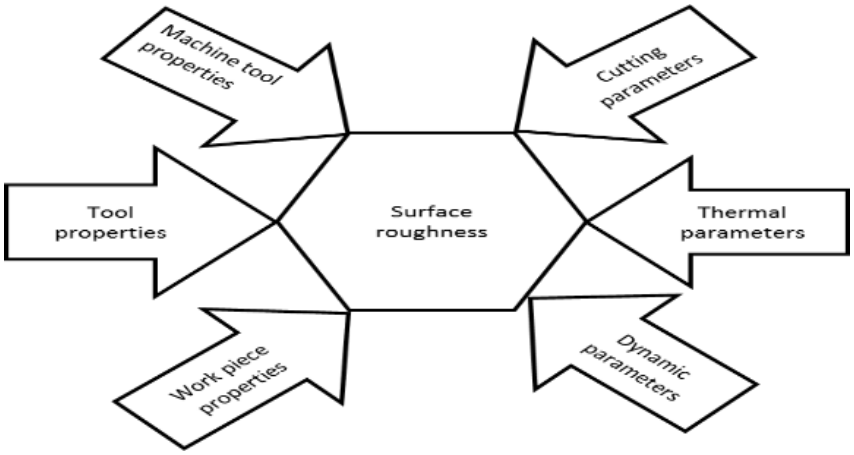

Figure 1: Six major categories that effect on surface roughness

1.1 Manufacturing Problems

After Studied many researchers article on surface roughness detect there are many problems related for finishing of surfaces for products or components and observe that when doing machining like shoulder milling on Aluminium the chip formation is high and chips are cling on the surfaces of material and because of that the finishing of surfaces are reduced and tool warm out, material removal rate is high, from all of them surface roughness is the biggest reasons for better quality of products. In today's era the quality of products is most important and to fulfill the requirement of customer of same product at low cost because of competition point of view. For all these and better surface roughness of product have to keep some points in minds. Customer need to be fulfilled, minimum time consumption for production, product available at lowest cost, product life should be good, quality of product and finishing of surfaces to be good. Parameters of manufacturing for overcome above customer's points and for better surface finish:

- The cost of production to be Minimum.
- Raw material should be easily available and to be good quality.
- The time of production to be minimum
- A perfect manufacturing process to be considered
- Proper selection of machining parameters
- Higher production rate
- High tool life
- Higher material removal rate
- Higher surface finish.

There are various kinds of methods used for optimization of surface roughness these are Taguchi method based grey relational analysis, nature algorithm, genetic algorithm, ant colony algorithm and Tabu search etc.

1.2 Literature Survey

Many researchers studied on various kinds of metals and consider different parameters for optimization like as depth of cut, feed rate, spindle speed and coolant as input parameters and roughness of surfaces, material removing rate, micro hardness and many more but in most cases roughness of surfaces is on top priority. Table 1 shows various researchers who considered surface roughness as outcome parameter during optimization by using different techniques.

Table 1: Literature review

Author/Year	Area	Methodology	Outcome parameters
OP Singh et al. (2019)	Optimization of machining parameters for different material by Taguchi based grey relational method	Taguchi method	A review for role of Taguchi based GRA
Ghan R Het al. (2017)	Review for different material optimization for machining parameters	Review paper for surface roughness	Surface roughness in turning
Jitendra thakkar et.al. (2014)	Review paper for optimization of machining parameters for SR and MRR for SS410 during turning	Design of experiment with full factorial design	Surface roughness and material removal rate in turning for SS 410
Om Prakash et al. (2019)	Shoulder milling for AA 6063 T6 aluminium alloy	Taguchi based GRA	Surface roughness and material removal rate for AA6063 T6 alloy
P.G. Benardos et al. (2002)	A review by various methodology	Review paper for predicting surface roughness	Surface roughness

A.Mahyarkhorasani et al. (2012)	Machining parameters analysis for surface roughness	AI, ANN	Surface roughness
B.Radha Krishnan et al.(2020)	Surface roughness review	By various types algorithms	Surface roughness
Adel T. Abbas & Faraz H. Hashmi (2019)	High speed machining of Ti-6Al-4V, surface roughness optimization	MOORA and PSO	Surface roughness and material removal rate
Júlia Hricová et al. (2013)	Tool material effect on AlMgSi surface roughness	ANOVA	Surface roughness
Muhammad abas & Lal saydet al. (2020)	Machining parameters optimization for aluminium alloy 6029 T9	MQL technique	Surface roughness, tool life, material removal rate
Milon D. Selvam et al. (2012)	Machining parameters optimization for face milling operation	Genetic algorithm	Surface roughness
Om Prakash et al. (2020)	Uses of application of Taguchi method in AA 6063 aluminium alloy optimization	Taguchi method	Material removal rate, depth of cut, surface roughness
Gaurav kumar et al. (2021)	SS 304 end milling optimization by using Taguchi method	Taguchi method	Surface integrity parameters
Mukesh kumar et al. (2021)	SS 321 deep drilling by using GRA based on Taguchi an optimization	Taguchi based GRA	Surface roughness of deep drilled holes

Jitendra thakkar et al. [3] conducted 27 experiments on SS410 by using DOE full factorial design by turning process, by using MRR equation by software MRR were find out and compare these all data are related to finish of surfaces. Om Prakash et al. [4] conducted 18 experiments on AA6063 T6 alloy of aluminium by using GRA based on Taguchi method. ANOVA and grey relational grade were used for improving the multi performance features of VMC shoulder milling operation to improve surfaces finish and high material removal rate. P.G. Benardos et al. [5] considered various methodologies for surface roughness prediction and showed manufacturing process become more productive and competitive. A.Mahyarkhorasani et al. [6] carried out various investigation for offline and online parameters estimation. Discussed technique was AI, ANN and knowledge based expert system. Parameters were divided into six numbers as properties of tool, work piece, tool of machine, thermal and dynamic parameter and cutting. B.Radha Krishnan et al. [7] studied conventional testing methods used for surface roughness in various industries like Stylus Profilometer. There were various parameters for surface roughness like Average value (R_a), Root mean square (R_z), Peak to valley (R_t). Adel T. Abbas & Faraz H. Hashmi [8] done the optimization by using MOORA integrated regression and PSO. These were considered for better finishing of surface and for maintaining good material removal rate. Júlia Hricová et al. [9] done the milling operation to remove redundant part of any material, studied in this article there are milling done on AlMgSi for determination of influence of different tool material on surface roughness. Muhammad abas & Lalsayd [10] performed Turning on Aluminium alloy 6026-T9 by using MQL and in dry conditions by using various cutting parameters for better surface finish. Milon D. Selvam et al. [11] used Taguchi method and genetic algorithm for improve finishing of surface with zinc coated carbide tool. Om Prakash et al. [12] focused on application of Taguchi method used for AA6063 shoulder milling optimization. Gaurav kumar et al. [13] increased surface finishing of material by using VMC milling machine and M series solid carbide tool SS 304 optimization done by Taguchi method. Mukesh kumar et al. [14] done the deep drilling optimization on SS 321 by using L_{18} orthogonal array of Taguchi based GRA for improvement of surface finish of material or product.

2. Parameters for surface roughness

Surface roughness categorized into three number of parameters are described below

R_a – Average roughness, R_q – Root mean square roughness and R_p, R_v, R_t

2.1 Average roughness R_a

The area between the profile of roughness and center line of work piece is called average roughness. Or absolute value of surface roughness integral.

$$R_a = \frac{1}{L}\int_0^l |r(x)|dx$$

2.2 R_q – Root mean square roughness

Is found by another integral for profile of roughness is called root mean square roughness.

$$R_q = \sqrt{\frac{1}{L}\int_0^l r^2(x)dx}$$

R_p, R_v and R_t: Roughness profile highest peak over the evolution length called peak roughness as well as roughness profile deepest valley is called deep roughness and at last the

total of both or distance from deepest valley to highest valley.

$$R_v = |min[r(x)]| \text{ , } 0<x<L$$
$$R_v = |min[r(x)]| \text{ , } 0<x<L$$
$$R_t = R_v + R_p$$

3. Conclusions

In this review paper we have studied about many methodologies and various parameters uses for identification of surface roughness. According to this literature survey surface roughness and other parameters were found by different method and techniques. And Taguchi and Grey Relational Analysis (GRA) is the most usable technique for optimization. R_a, R_q and R_t is used for most of the researches. So, this paper is useful for future improvement in surface roughness.

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