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A Review on Optimization of Machining Parameters for End Milling Operation

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Abstract:-
During machining operation it is essential to have proper selection of machining parameters. Now-a-days machining parameters are mainly selected on the basis of previous work experience of the process planner or thumb rule or machining data hand book. All these techniques are time consuming and very tedious.There is a need to develop a model that could able to find the optimal machining parameters for the required surface finish in machining.In this work, the effect of machining parameters is studied to obtain the optimum machining parameters for end milling operations.Many researchers have used the various techniques such as Taguchi method, Genetic Algorithm, Neural Network, ANOVA, Ant Colony Optimization (ACO) and so on have become very popular due to its versatile usage in various engineering applications especially in machining problems. In this PSO has been used to optimize the machining parameters.
Keywords:Machining; Optimization; Process Parameters; PSO

I. INTRODUCTION

Milling is a fundamental machining operation which is used for producing flat, contoured or helical surface, for cutting threads and toothed gears and for preparing helical grooves. It is a process of producing flat and complex shapes with the use of multi-tooth cutting tool, which is called as cutter and the cutting edges are called teeth. The axis of revolution of the cutting tool is perpendicular to the direction of feed, either parallel or perpendicular to the machined surface. The machine tool that conventionally performs this operation is a milling machine. The cutter is a cutting tool with sharp teeth in the milling machine and rotates at high speeds. By feeding the work piece into the rotating cutter, material is thrown away from this work piece in the form of small chips to create the desired shape.

End milling is the important milling operation and it is usually used in most of the manufacturing industries due to its ability to produce the complex geometric surfaces with reasonable accuracy and surface finish. However, with the inventions of Computer Numerically Controlled milling machine, the flexibility has been adopted along with versatility in end milling process. It is observe that many research works have been done so far on optimization of machining parameters of end milling process. In end milling operation surface finish and material removal rate are two major aspects, which require attention both from industry personnel and in Research & Development, because these two factors greatly influence machining performances. In modern industry, one of the conditions is to manufacture the component with low cost, high quality products in minimum time. Automated and flexible manufacturing systems are used for that purpose. CNC machines are considered most suitable in flexible and automated manufacturing system. Computer Numerically Controlled milling machine is very useful for both its flexibility and versatility. Processing time is also very low as compared to some of the conventional machining process.

However, material removal rate (MRR), which indicates processing time of the work piece, is another important factor that greatly influences production rate and production cost. Hence, there is a need for a tool that should allow the evaluation of the surface roughness and material removal rate value before the machining of the part and which can easily be used in the production-floor environment contributing to the minimization of required time and production cost and the production of desired surface quality.

Some research has been done on optimization of machining parameters in milling operations. In recent years, there has been increasing interest to optimize the machining parameters and machining economic

problems. The selection of optimum cutting parameters is an important element of process planning for every machining operation.

Though new machining procedures have more complex, essentials out of these did not change, whereas equations can be easily upgraded in order to get them up-to-date. Following work presents proposal concept for usage of the intelligent methods in order to successfully model and optimize CNC based production processes. It can be easily adoptable, with less modification, for basically all standard cutting procedures. So we can adopt these procedures to maximize the efficiency in the manufacturing process.This can be stated in form of following segments:

- increased accuracy,
- increased productivity,
- improved quality,
- machining of complex parts,
- costs optimization and reduction,
- repeatability
- cheaper end products
- more profit

In this paper we present a particle swarm optimization algorithm implementation in order to achieve optimal machining parameters for purposes of end milling operation.

II. LITRETURE REVIEW

Many investigators have suggested various methods to explain the effect of machining parameter on various outpour parameters such as surface roughness, MRR, tool life, production cost, production time, productivity, in CNC end milling process.

Mohammed T. Hayajneh, Montasser S. Tahat, Joachim Bluhm [1] (2007) : In this article presented the effects of spindle speed, cutting feed rate and depth of cut on the surface roughness and to build a multiple regression model. The model generated, which includes the effect of spindle speed, feed rate, depth of cut, and the any two-variable interactions, predicts surface roughness reasonably well. The deviation between predicted and measured surface roughness values was within an error band of about 12%.

LadislavMisik, KatarínaMonková and SergejHloch [2] (2009), presented factors analysis affecting the roughness at side milling. In this artical deals with evaluation of side milling factors, which influence the surface roughness parameter.

K. Kadirgama, M. M. Noor, K. A. Abou- El-Hossein, H. H. Habeeb, M. M. Rahman, B. Mohamad, R. A. Bakar [3] (2010)This work discussed the effect of the dry cutting on cutting force and tool life when machining aerospace materials(Haynes 242) with using two different coated carbide cutting tools (TiAlN and TiN/MT-TiCN/TiN). Response surface method (RSM) was used to minimize the number of experiments. ParTiAlN Swarm Optimisation (PSO) models were developed to optimize the machining parameters (cutting speed, federate and axial depth) and obtain the optimum cutting force and tool life. It observed that carbide cutting tool coated with TiAlN performed better in dry cutting compared with TiN/MT-TiCN/TiN.

SanjitMoshat, SauravDatta, AsishBandyopadhyay and Pradip Kumar Pal [4] (2010). The surface finish of the machined surface has been identified as quality attribute whereas MRR has been treated as performance index directly related to productivity. Attempt has been made to optimize quality and productivity in a manner that these multi-criterions could be fulfilled simultaneously up to the expected level.

SanjitMoshat, SauravDatta, AsishBandyopadhyay and Pradip Kumar Pal [5] (2010) To meet the basic assumption of Taguchi method; in the present work, individual response correlations have been eliminate first by means of Principal Component Analysis (PCA). Correlated responses have been transformed into uncorrelated or independent quality indices called principal components.

B. Sidda Reddy, J. Suresh Kumar and K. Vijaya Kumar Reddy [6] (2011),In this article, minimization of surface roughness has been investigated by integrating design of experiment method, Response surface methodology (RSM) and genetic algorithm. To achieve the minimum surface roughness optimal conditions are determined. The experiments were conducted using Taguchi's L50 orthogonal array in the design of experiments (DOE).

Vikas Pare, GeetaAgnihotri& C.M. Krishna [7] (2011) In this work, four input variables are selected and surface roughness is taken as output variable. Particle swarm optimization technique is used for finding the optimum set of values of input variables and the results are compared with those obtained by GA optimization in the literature.

R. A. Mahdavinejad and S Saeedy [8] (December 2011)This works on optimize turning parameters of AISI 304 stainless steel. Turning tests have been performed in three different feed rates (0.2, 0.3, 0.4 mm/rev) at the cutting speeds of 100, 125, 150, 175 and 200 m/min with and without cutting fluid.

NitinAgrawal [9] (Jan 2012) A multiple regression model is developed with spindle speed, feed rate and depth of cut as the independent variables and surface roughness parameter "Ra" as the dependent variables. The prediction ability of the model has been tested and analyzed using 't-test' and it has been observed that there is no significant different between the mean of Ra values of theoretical and experimental data at 5% level significance.

V V K Lakshmi, Dr. K VenkataSubbaiah [10] (Mar.-Apr. 2012)In this study, the average surface roughness values obtained when milling EN24 grade steel with a hardness of 260 BHN using solid coated carbide tools were modelled and optimized using response surface methodology. Input variables consist of cutting speed (V), feed rate (f) and depth of cut (d).The output variables are surface roughness and Material removal rates. Variance analysis is conducted using Design Expert 8.0. The response surface methodology (RSM) has been utilized for the postulation of a second order quadratic model.

Poornima, Sukumar [11] (Mar.-Apr. 2012) This study involved in identifying the optimized parameters in CNC turning of martensitic stainless steel. The optimization technique used Response surface methodology, and Genetic algorithm. These optimization techniques are very helpful in identifying the optimized control factors with high level of accuracy.

Ishan B Shah, Kishore, R. Gawande [12] (April 2012)This paper discussed of the literature review of Optimization of tool life in milling using Design of experiment implemented to model the end milling process that are using solid carbide flat end mill as the cutting tool and stainless steels s.s-304 as material due to predict the resulting of Tool life. Data is collected from CNC milling machines were run by 8 samples of experiments using DOE approach that generate table design in MINITAB packages.

H. M. Somashekara et al.[13] (May 2012)
In this work, an attempt has been made to generate a model to predict Surface Roughness using Regression Technique. Also an attempt has been made to optimize the process parameters using Taguchi Technique. S/N ratio and ANOVA analysis were also performed to obtain significant factors influencing Surface Roughness.

Milon D. Selvam, Dr. A. K. ShaikDawood, Dr. G. Karuppusami [14] (August, 2012) The experimental study was carried out in a FANUC series CNC vertical machining center (VMC). The experiments have been planned using Taguchi's experimental design technique. The machining parameters used are Number of passes (P), Depth of cut (dc), Spindle speed (N), and Feed rate (f). The effect of machining parameters on surface roughness is evaluated and the optimum cutting condition for minimizing the surface roughness is determined.

P. Chockalingam, Lee Hong Wee [15](August, 2012)In this study, the comparison between different coolants' effect to the milling of AISI 304 stainless steel is done and the results from the study can provide very useful information in manufacturing field. The experiment results showed that water-based emulsion gave better surface finish and lower cutting force followed by synthetic oil and compressed cold air. Anil Antony Sequeira,

RavikanthaPrabhu, N. S. Sriram, ThirumaleshwaraBhat [16] (Sep-Oct. 2012) Effect of Cutting Parameters on Cutting Force and Surface Roughness of Aluminium Components using Face Milling Process - a Taguchi Approach This study investigates the optimum parameters that could produce significant good surface finish and optimum cutting force thereby reducing tooling cost. It employs the Taguchi design method to optimize the surface roughness quality and cutting force in a Computer Numerical Control (CNC).

WDS. Milton. Ponnala, K. L. N. Murthy [17] (Nov. 2012)The optimization process involved the optimal selection of machining parameters such as cutting speed, feed and depth of cut, subjected to practical constraints of surface finish, tool wear, dimensional accuracy and machine tool capabilities. Several researches have used different techniques in literature to optimize machining process by considering a machining problem as single objective optimization problem.

C. Ramudu, Dr. M. Naga PhaniSastry [18] (November- December 2012)This work suggested on turning process is a Response Surface Methodology applied on the most effective process parameters i.e. feed, cutting speed and depth of cut while machining Aluminium alloy and resin as the two types of work pieces with HSS cutting tool. M. S .Kasim, C. H. CheHaron, J. A. Ghani, M. A Sulaiman [20] (2013) The investigated milling parameters were cutting speed (100, 135 and 170 m/min), feed rate (0.15, 0.2 and 0.25 mm/rev) and depth of cut (0.6, 0.8 and 1.0 mm). The results showed that the interaction between the feed rate, fz and the radial depth of cut was the primary factor controlling surface roughness. The responses of various factors were plotted using a three-dimensional surface graph. The quadratic empirical models were developed with a 95% confidence level. Amit Joshi &PradeepKothiyal [21] (2013) The effects of various parameters of end milling process like spindle speed, depth of cut, feed rate have been investigated to reveal their Impact on o Material Removal Rate using Taguchi Methodology. Experimental plan is performed by a Standard Orthogonal array.

MandeepChahal [22] (2013)The study was conducted in machining operation for hardened die steel H-13. The processing of the job was done by solid carbide four flute end-mill tools

M. Y. Ali, A. R. Mohamed, A. A. Khan, B. Asfana, M. Lutfiand M. I. Fahmi [23] (2013) The vibration was measured using accelerometer (DYTRAN Instruments Inc., USA). The optimum solution for minimum average vibrations 64.3 Hz with spindle speed 2500 rpm, feed rate 2 mm/min and depth of cut 1.5 mm. These micro end milling parameters are suitable to machine PMMA to get high precision.

R Ashok Raj, T Parun, K Sivaraj and T T M Kannan [24] (January 2013) Optimum machining parameters of milling operations are great concern with manufacturing environment. In this experimental investigation was observed the machining performance with various cutting speed, feed and depth of cut using side and face milling cutter. Mainly surface roughness where investigated employing Taguchi design of experiments and analysis of variance (ANOVA).

Adnan Jameel, MohamadMinhat, Md. Nizam [25] (May 2013) This study optimized with GA algorithm in different machining aspects in turning operation like surface roughness, production rate, tool life, production cost, machining time and cutting temperature under finishing conditions.

B. Vijaya KrishnaTeja, N. Naresh, K. Rajasekhar [27] (August 2013)This paper presented multi-objective optimization of milling process parameters using Grey-Taguchi method in machining of AISI 304 stainless steel. The experiments are conducted based on Taguchi's L27 orthogonal array by taking cutting speed, feed rate and depth of cut at three levels. MananKulshreshtha [28] (August 2013) Surface finish is important in terms of tolerances; it reduces assembly time and avoids the need for secondary operation, thus reduces operation time and leads to overall cost reduction. Besides, good-quality turned surface is significant in improving fatigue strength, corrosion resistance, and creep life. In this research, the main objective is to study the effect of cutting speed and depth of cut on surface roughness of EN 36 in turning operation.

G. Harii Krishna Rao, M. N. M. Ansari, Shahida Begum [29] (November 2013)This research becomes part of major contribution for the manufacturing industry especially machining of MWCNT/epoxy composite materials using CNC milling process. Interestingly, this project can be regarded as an exclusive work because the information's and solutions achieved at the end of this research was significant and can be implemented in future demanding CNC industries especially in carbon nanotube/epoxy composites applications.

Jatin, Pankaj Sharma [30] (November 2013)The study was conducted in machining operation for hardened die steel H-13. The processing of the job was done by solid carbide four flute end-mill tools under finishing conditions. L-9 standard orthogonal array is used for calculation of no. of variables and no. of levels. Signal to Noise Ratio and ANOVA are calculated to draw the graphs and come to the results.

IV.CONCLUSION

From various literatures survey efforts found out that many researchers have investigated the process parameters like cutting speed, feed and depth of cut of CNC millingusing various traditional and non-traditional methods such as Genetic Algorithm , Neural Network, Design Of Experiment Analysis of Variance, Taguchi ,Response Surface Methodology ,ParticleSwarm Optimizationetc. optimization methods.It was find out that From various non-traditional or soft computing techniques, PSO gives more better result andthere is very few investigator worked on optimization of material removal rate of CNC end milling. Most of the research is done on surface finish parameter of CNC milling. So that, in this research work we want to investigateinfluences of input machining parameters like cutting speed, feed rate, depth of cut and nose radius on response parameters MRR, surfaceroughness, tool life, productivity, machining tine, machining cost using PSO technique.

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