International Journal of Engineering Applied Sciences and Technology, 2022
Vol. 6, Issue 10, ISSN No. 2455-2143, Pages 45-49
Published Online February 2022 in IJEAST (http://www.ijeast.com)

EFFECT OF MACHINING PARAMETERS ON SURFACE ROUGHNESS IN CNC TURNING

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Abstract: **Surface roughness is one of the important criteria for product quality in manufacturing processes. It depends on many factors according to different manufacturing processes. In relation to the operation of the lathes, which is the focus of our study, it was found that the controllable factors affecting surface smoothness are (cutting speed, feeding rate and depth of cut). Samples of mild steel are used for the experiment; with different settings. Readings of the surface roughness are measured using sensitive digital devices, and then analyzed using octave programs. The experimental results and graphs showed that the surface roughness is greatly affected by the cutting parameters, and using of cooling liquid. The results obtained from this work showed that the surface roughness decreases with increasing spindle speed, decreasing cutting depth and feed.**

Keywords: **Surface Roughness, cutting speed, feed, cutting coolant, CNC Machine.**

I. INTRODUCTION

The surface roughness is very important because it is related to many problems such as friction and wear, surface contact, lubrication, fatigue strength and tightness of joints, cleanliness, reflectivity of the surface and sealing action .Surface roughness also influences some functional characteristics of parts, such as, contact causing surface finish, wearing, light reflection, heat transmission .etc. [1]. It definitely affects the positional accuracy of mating parts for good fittings, load-carrying capacity, resistance to corrosion and adhesion of paint and coatings [2]. And then the accuracy and surface finish requirements for machine parts in the modern industry are becoming more and more focusing. Product functionality is affected when manufacturing defects exceed design specifications. So, it is very essential to check whether the design of the work piece complies with the functional requirements of the product [3]. Hence it is necessary to check the geometry and the surface characteristics of the work piece. Due to the increasing demand for quality products, manufacturing engineers encounter the difficult problem of increasing productivity without compromising quality [4][5][6]. In modern industry, the goal is to manufacture low cost, high quality products in short time. Automated and flexible manufacturing systems are employed for that purpose along with machine tools those are capable of achieving high accuracy and very low processing time [7].Survey of literature on surface roughness reveals that particular efforts were devoted to the determination of the most precise model for surface roughness prediction. Most of the researches have proposed the multiple regression and AI-based methods to predict surface roughness [6].Choosing suitable cutting conditions has contributed to the minimization of required time and cost. Moreover, it could be used to determine the appropriate cutting conditions and result in a desired surface roughness [7]. However, the machining process is very complex and does not permit pure analytical physical modeling [8]. Thus, experimental and analytical models, or those called explicit (empirical) models that are developed by using conventional approaches such as the statistical regression technique, have remained as an alternative for modeling the machining process [9]. Surface roughness is measured by the vertical deviations of a real surface from its horizontal ideal form. If these deviations are relatively large, the surface is rough; if they are relatively small, the Surface is smooth [10]. Several factors affect the final surface roughness in CNC turning machines such as controllable factors (spindle speed, feed rate, and depth of cut) and other factors are uncontrollable such as (tool geometry, material properties of both tool and work piece and environment). Turning is the most common method in machining processes [11].

Experiments

In this study, 27 steel specimens were used of 40 mm diameter and 60 mm length was machined on a CNC lathe (Fanuc 0i mate system CKE6150Z/2000) With coolant (Mak-cutol-10), and using carbide tools (turning holder 25*25 sandvik).

The Following assumptions are made:

1. The cutting tools used are identical in property.
2. The hardness of each work piece is same throughout the length of the work piece.
3. Surface roughness values measured within the measuring area are sufficient to represent the roughness of entire work piece.
4. Vibration is negligible.
5. Cutting edge of the tool is constant.

II. RESULTS AND DISCUSSION

Surface roughness was measured for the turned component at different cutting parameters by changing one parameter and fixing the others to determine the effect of each parameter on the surface roughness. It is clear that surface roughness decreased by increasing cutting speed in all, this attributed is due to the decrease in the built up edge size at higher speed according to [12], where the influence of the built up edge became negligible. In addition, the cutting process becomes more and more stable as the speed increases, and the vibration during cutting at the highest speed is lower which concede with [13].

However, it is obviously that increasing the feed significantly influences the surface roughness than increasing the depth of cut. Thus, it is recommended to increase the depth of cut more than feed to improve the machining productivity. Using cutting fluid so as to reduce the tool temperature which reduces the formation of built-up edge and the coefficient of friction. And fluid penetration into the cutting interface reduces adhesion between the tool face and the chip which reduces the size of the built up edge [14]. Using CNC turning machine because it is related to the stiffness and dynamic characteristics of the machine-tool structure.

Figure (1) shows the distribution of surface roughness when the speed of machine is 400 rpm. The x-axis represents the feeding rate in mm per min where the y-axis for depth of cutting in micrometer. The color bar represents the gradient of roughness from blue as minimum to red as maximum.

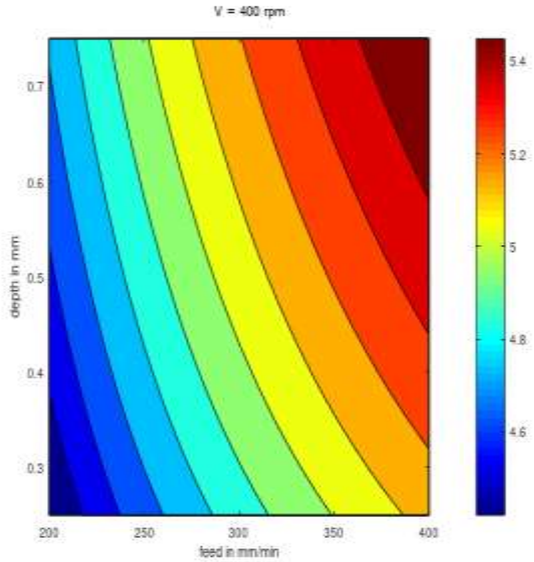

Figure 1: Roughness for different depth and feeding at speed 400 rpm

As shown from figure (1), it is clear that the roughness of the surface at any given depth, for example at depth 0.3 um, increases as the feeing rate increases. Likewise, for any given feeding rate, for example at 200 mm/min, the roughness also increases as increasing the depth of cutting. Figures (2) and (3) have the same trend of roughness distribution with a subtlety in the magnitude of the roughness, in which that the roughness decreases as increasing the rotational speed.

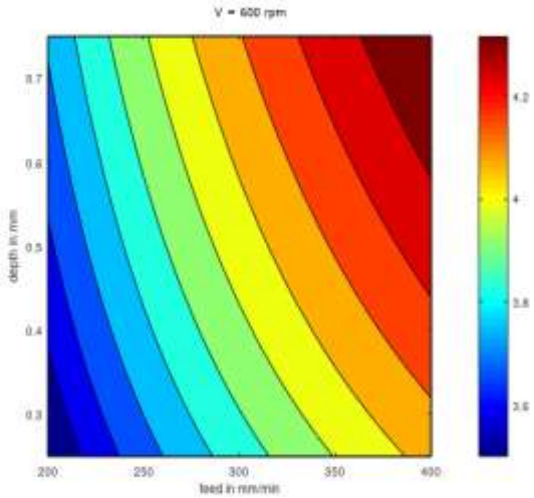

Figure 2: Roughness for different depth and feeding at speed 600 rpm

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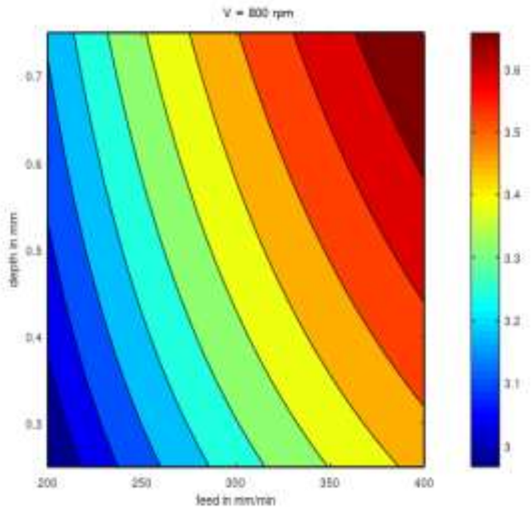

Figure 3 Roughness for different depth and feeding at speed 800 rpm

Figure (4) demonstrates the surface roughness at any depth and feed in three dimensional presentations for three different speeds presented in three distinct layers, where the upper layer for lower rotational speed of 400 rpm, middle layer for 600 rpm and lower layer for 800 rpm which corresponds to lower surface roughness. Each layer is inclined in both two horizontal axes representing the variation of depth and feeding rate with roughness of the surface.

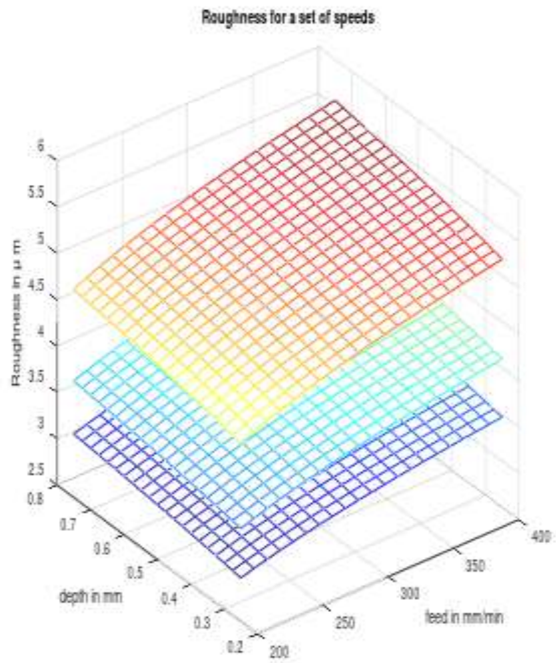

Figure 4: Roughness for a set of speeds

Figures (5), (6) and (7) illustrate the variation of roughness at different rotational speeds of 400, 600 and 800 rpm, respectively.

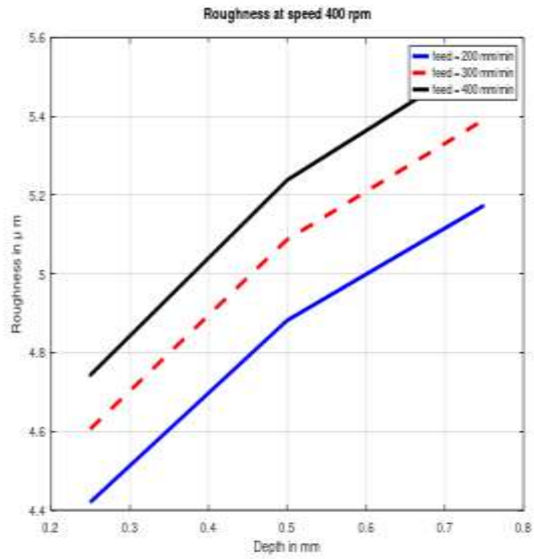

Figure 5: Roughness for different feeding at speed 400 rpm

The continuous blue line for feeding rate 200 mm/min, where dashed red line for 300 mm/min and black line for 400 mm/min. As depicted from these figures, it is concluded that the roughness increases as the feeding rate increase for a given depth. In general, increasing the depth will also increase the roughness of the surface.

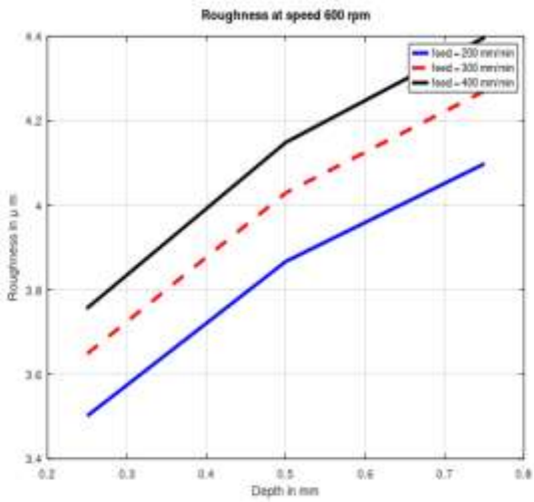

Figure 6: Roughness for different feeding at speed 600 rpm

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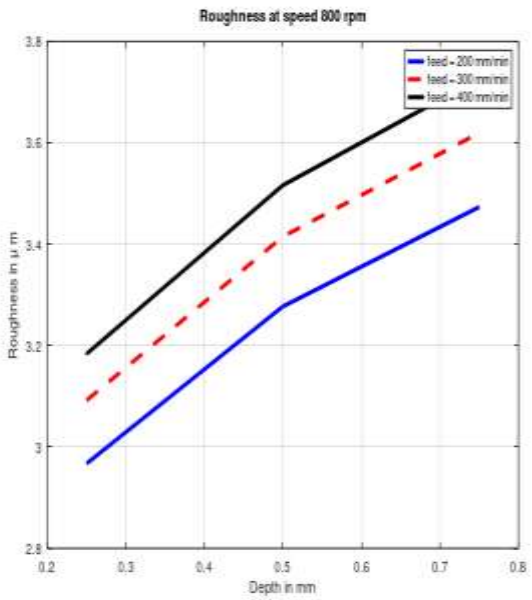

Figure 7: Roughness for different feeding at speed 800 rpm

III. CONCLUSIONS:

In this work, steel specimens were machined out on CNC turning machines at different cutting parameters. Surface roughness was measured for all of the machined specimens. The conclusions drawn from the present research are summarized as follows:

1- By increasing spindle speed, surface roughness decreased.
2- As the depth of cut increased, the Surface roughness increased.
3- Surface roughness increased by increasing the feed.
4- The feed had highest effect on surface roughness than depth of cut.

IV. REFERENCES

[1]. Mikes.S.L.,Joseph C.,Cheu,Li M.(1998).Machine, materials and processes Quality Control Manufacturing .J,Ind.Technol., 15(1) (1999)

[2]. C. Natarajan, S. Muthu and P. Karuppuswamy, Investigation of cutting parameters of surfaceSystems with Applications, Volume 38, Issue 5, May 2011, PP. 5826–5832.

[3]. Ilhan Asiltürk, Mehmet Çunkas, Modeling and prediction of surface roughness in turning operations using artificial neural network and multiple regression method, ELSEVIER, Expert Systems with Applications, Volume 38, Issue 5, May 2011, PP. 5826–5832.

[4]. Karayel, D. (2009) 'Prediction and control of surface roughness in CNC lathe using artificial neural network', J Mater Process Tech, Vol. 209, pp.3125–3137.

[5]. Abouelatta, O.B. and Madl, J. (2001) 'Surface roughness prediction based on cutting parameters and tool vibrations in turning operations', J. Mater. Process. Technol., Vol. 118, Nos. 1–3, pp.269–277.

[6]. Arbizu, I.P. and Pérez, C.J.L. (2003) 'Surface roughness prediction by factorial design of experiments in turning processes', J. Mater. Process Tech., pp.143–144, 390–396.

[7]. Choudhury, I.A. and El-Baradie, M.A. (1997) 'Surface roughness in the turning of high-strength steel by factorial design of experiments', J. Mater. Process Tech., Vol. 67, pp.55–61.

[8]. Alauddin, M., El Baradie, M.A. and Hashmi, M.S.J. (1995) 'Computer aided analysis of a surface roughness model for end milling', J. Mater. Process Techn., Vol. 55, pp.123–127.

[9]. Kim, B.H. and Chu, C.N. (1999) 'Texture prediction of milled surfaces using texture superposition method', Comput Aided Des, Vol. 31, No. 8, pp.485–494.

[10]. Abburi, N.R. and Dixit, U.S. (2006) 'A knowledge-based system for the prediction of surface roughness in turning process', Robot. Comput. Integr. Manuf., Vol. 22, No. 3, pp.363–372.

[11]. Kanase Tanaji. S, Jadhav D. B., Enhancement of Surface Finish for CNC turning CuttingParameters by Using Taguchi Method, Indian Journal of Researches, Volume: 3, Issue, 5, June 2013.(1996) ,PP. 143-148.

[12]. D. Philip Selvaraj, Palanisamy Chandramohan, Influence of Cutting Speed, Feed Rate and BulkTexture on the Surface Finish of Nitrogen Alloyed Duplex Stainless Steels during Dry Turning, Engineering, doi:10.4236/eng 2010, 2,pp. 453-460, Published Online June 2010(http://www.SciRP.org/journal/eng).

[13]. A.K Ghani; I.A Choudhury; Husni, Study of tool life, surface roughness and vibration in machining nodular cast iron with ceramic tool, Journal of Materials Processing Technology Volume 127 issue 1, 2002, published by ELSEVIER.

[14]. Vishal S. Sharma, Suresh Dhiman, Rakesh Sehgal, S. K. Sharma,Estimation of cutting forces and surface roughness for hard turning, using neural networks, J Intell Manuf (2008), 19,pp.473–483, DOI 10.1007/s10845-008-0097-1, Springer Science+ Business Media, LLC 2008.

[15]. Davim, J.P. (2001) 'A note on the determination of optimal cutting conditions for surface finish obtained in turning using design of experiments', J. Mater. Process Tech., Vol. 116, Nos.2/3,pp.305–308.

[16]. Davim, P., Gaitondeb, V.N. and Karnikc, S.R. (2008) 'Investigations into the effect of cutting conditions on surface roughness in turning of free machining steel by ANN models', Journal of Materials Processing Technology, Vol. 205, pp.16–23.
[17]. Dimla, E. and Dimla, S. (1999) 'Application of perceptron neural network to tool-state classification in a metal-turning operation', Engineering Application of Artificial Intelligence,Vol. 12, No. 4, pp.471–477
[18]. Choudhury, I.A. and El-Baradie, M.A. (1997) 'Surface roughness in the turning of high-strength steel by factorial design of experiments', J. Mater. Process Tech., Vol. 67,pp.55–61
[19]. Benardos, P.G. and Vosniakos, G.C. (2002) 'Prediction of surface roughness in CNC face milling using neural networks and Taguchi's design of experiments', Robotics and Computer Integrated Manufacturing, Vol. 18, Nos. 5–6, pp.343–354
[20]. Karayel, D. (2009) 'Prediction and control of surface roughness in CNC lathe using artificial neural network', J Mater Process Tech, Vol. 209, pp.3125–3137