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Analyzing the Vibration Effect of Cutting Tool on Surface Roughness of Turning Work Piece in Lathe Machine

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Abstract: Tool condition observation systems area unit essential in small milling applications. A tool's slenderness needs high-precision observation systems for on-line measurements. In most cases, tool health is indirectly calculable by process and analyzing the cutting method parameters cutlery wear may be a essential development that influences the standard of the machined half. Vibration signals from metal cutting processes are investigated for varied functions, together with in-process tool wear monitoring. Reducing the machining energy consumption (MEC) of machine tools for turning operations is important to market manufacturing producing. during this study, the link between vibration and gear wear is investigated throughout high-speed dry turning by victimization applied math parameters. it's aimed to show however tool wear and therefore the work piece surface roughness changes with tool vibration signals. For this purpose, a series of experiments were conducted in a lathe machine. Modal analysis of each traditional and wear cutlery are going to be perform for locating Natural frequency of cutting tools in ANSYS 19 code. Experimental testing of cutlery are going to be perform using FFT instrument. afterward the comparative analysis are going to be dispensed between the experimental and analysis results and afterward the result & conclusion are going to be drawn.
Keyword: Cutting tool. Modal analysis, FFT.

I. INTRODUCTION

In turning operations, vibration is a frequent problem, which affects the result of machining, in particular, the tool wear. Vibration can be defined as an object being repeatedly displaced at a very high frequency. In turning process, three types of mechanical vibrations are present. They are free, forced and self-excited vibrations. They occur due to lack of dynamic stiffness/rigidity of the machine tool system comprising tool, tool holder, work piece and machine tool. Machining vibrations, also called as chatter, correspond to the relative movement between the work piece and the cutting tool. These vibrations affect typical machining processes, such as turning, milling and drilling. Relative vibration amplitude between the work piece and cutting tool influences the tool life. Cutting tool and tool holder shank are subjected to dynamic excitation due to the deformation of the work material during the cutting operation. The dynamic relative motion between the cutting tool and work piece will affect the quality of the machining, in particular, the surface finish. Furthermore, the tool life is correlated with the amount of vibration. In turning, the presence of tool vibration is a major factor which leads to poor surface finish, cutting tool damage, increase in tool wear and unacceptable noise. With the production and productivity increasing in modern society, the manufacturing energy consumption is increased with intensifying the energy crisis and global warming [1]. According to International Energy Agency [2], manufacturing is responsible for nearly 1/3 of the global energy consumption and 36% of carbon dioxide emissions [3]. Increasing energy price and requirements to improve energy efficiency are the severe challenges faced by modern manufacturing enterprises. Increase in manufacturing production is characterized by technological development, which is driven by increased competitiveness. Machining processes must therefore also undergo changes in order to meet market requirements in order to guarantee the expected quality, reduce production costs, and increase productivity.

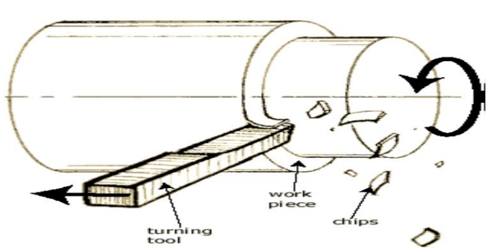

Fig. 1: Turning Process

Machining is any of various processes in which a piece of raw material is cut into a desired final shape and size by a controlled material-removal process. The processes that have this common theme, controlled material removal, are today collectively known as subtractive manufacturing, in distinction from processes of controlled material addition, which are known as additive manufacturing. Machining is a part of the manufacture of many metal products, but it can also be used on materials such as wood, plastic, ceramic, and composites. A room, building, or company where machining is done is called a machine shop. Much of modern-day machining is carried out by computer numerical control (CNC), in which computers are used to control the movement and operation of the mills, lathes, and other cutting machines.

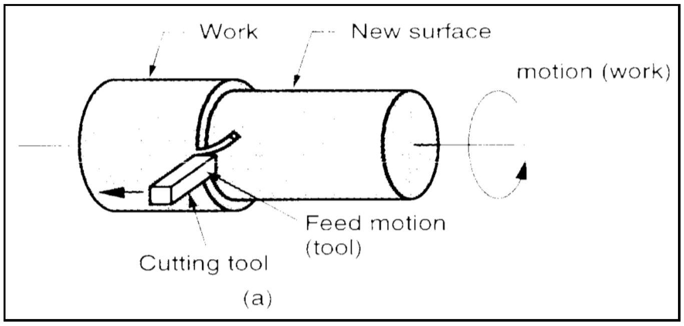

Fig. Cutting tool use for turning operation

II. LITERATURE REVIEW

Saurabh Gupta etal. [1] This research paper presents a detailed study of the past researches made on machining parameters that affects the turning operation. Machining is an important production technique to produce highly accurate and quality products. For many industrial components manufactured by casting, welding and powder metallurgy processes machining is required. It is the final stage of product development. It can be performed by using conventional as well as non-conventional machining methods. Quality and requirements of the client are the two main objectives that any manufacturing industry in the world tries to achieve. Machining is one of the main operations of metal processing in any manufacturing industry. The quality of the metal cut obtained depends on many parameters of the process. These process parameters affect the output response or performance characteristics the important machining parameters such as type of material, spindle speed, feed and depth of cut that affecting the responses as surface roughness, cutting time and MRR are reviewed in this research work.

Mehmet Alper Ince etal. [2] This paper presents the influence on vibration of Co28Cr6Mo medical alloy machined on a CNC lathe based on cutting parameters (rotational speed, feed rate, depth of cut and tool tip radius). The influences of cutting parameters have been presented in graphical form for understanding. According to this paper the relationship between cutting speed and vibration is inversely proportional. Generally, increasing the cutting speed decreases the vibration. The relationship between feed rate and vibration is proportional. Generally, increasing the feed rate increases the vibration. The relationship between depth of cut and vibration is proportional. Generally, increasing the depth of cut increases the vibration. The relationship between tool tip radius and vibration is inversely proportional. Generally, increasing the tool tip radius decreases the vibration.

S. C. Eze etal.[3] This study investigates experimentally the relationship between induced vibration and surface roughness in turning of 41Cr4 Alloy steel using Response Surface Methodology RSM. The data are generated by lathe turning of 41Cr4 Alloy steel samples at different levels of low, medium and high. From the study it shows that Induced vibration has a significant effect on surface roughness of work piece. The surface roughness of work piece is proportional to cutting tool acceleration. This effect interacts with other independent variables such as depth of cut, cutting speed and cutting tool overhang etc. Experimental results have shown that induced vibration has significant impact on surface roughness which can be used to control the finished surface of a work pieces during mass production.

S. Syath Abuthakeer etal. [4] The main objective of this study is experimental vibration analysis of the spindle bearing assembly with self-exited vibration. Experimental Modal analysis was carried out to obtain the natural frequency and vibration responses are investigated at various parametric levels and combinations using LabVIEW software. The parameters in the investigation include feed, depth of cut, and cutting speed. Output parametric is surface finish and vibration level. Experimental data collected are tested with analysis of variance Taguchi design of experiments was used to optimize the process parameter for the responses, surface roughness and vibration level. Regression model developed serves in prediction for the responses on the completion of the experimental test ANOVA is used to validate the results.

A. H. El-Sinawi [5] This work represents a comprehensive approach to the control of tool's position, in the presence of machine tool structure vibration, nonlinear cutting force, and random tool vibration due to random distribution of microhardness of workpiece material. The controller is combination of Proportional and linear quadratic gaussian type constructed from an augmented model of both tool-actuator dynamics and a nonlinear dynamic model relating tool displacement to cutting forces. The latter model is obtained using black-box system identification of experimental orthogonal cutting data in which tool displacement is the input and cutting force is the output. The controller is evaluated and its performance is demonstrated.

Mr. Amol N. Varade etal [6] The main aim of this Project work is to study experimentally the influence of depth of cut, cutting speed, and feed rate on the tool tip temperature, Material Removal Rate, Surface Roughness during turning process. The experiments will be obtained by varying one parameter while, the remaining two parameters were kept constant. So, the influence of tool tip on different machining parameters is done in this research work. To increase the tool life, Taguchi Optimization method is used to optimization of machining parameters. Through this study, not only the optimal cutting parameters for turning operations are obtained, but also the main cutting parameters that affect the cutting performance in turning operations will be evaluated. Experimental results will be provided to confirm the effectiveness of this approach. It will give the best result for turning operation of EN19 Material.

Sukhdev S. Bhogal etal [7] In this paper, the effect of cutting parameters on tool vibration, and surface roughness has been investigated during end milling of EN-31 tool steel. Tool vibration and surface roughness are two important parameters which affect the quality of the component and tool life which indirectly affect the component cost. Response surface methodology (RSM) has been used to develop mathematical model for predicting surface finish, tool vibration and tool wear with different combinations of cutting parameters. The experimental results show that feed rate is the most dominating parameter affecting surface finish, whereas cutting speed is the major factor effecting tool vibration. The results of mathematical model are in agreement with experimental investigations done to validate the mathematical model.

Dhiraj K Patel etal [8] The main purpose of this review paper is to check whether quality lies within desired tolerance level which can be accepted by the customers. So, experimental investigation surface roughness, material removal rate and power consumption using various CNC machining parameters including spindle speed (N), feed rate (f), and depth of cut (d) and nose radius. As such, a solemn attempt is made in this paper to investigate the response parameters, viz., Surface Roughness (Ra) and power consumption by experimentation on EN 19 turning process. The Design of experiments is carried-out considering various methods like full factorial, analysis of variations and Taguchi Technique with four input parameters, namely, spindle speed, feed rate, and depth of cut and nose radius. The experiments are conducted considering the above materials for L8 and then the impact of each parameter is estimated by ANOAVA. Then the regression analysis is carried-out to find the trend of the response of each material. This experimental study aims at taguchi method has been applied for finding the effect on surface roughness and power consumption by various process parameters. And after that we can easily find out that which parameter will be more affect.

Tapas Banerjee etal [9] The present work includes a methodical study of the effects of input parameters viz. spindle speed, longitudinal feed and depth of cut on surface roughness (Ra) of machined components and vibration generated during machining. Vibration is an output response produced in metal cutting operation. This vibration acts directly as a response which takes part in roughness formation on work materials. There is an impact on both surface finish and productivity. The design of experiment plan is based on L16 orthogonal array with three factors and four levels for each variable as per Taguchi method. The experiments are conducted on Low Carbon steel, Grey Cast Iron and Bakelite on Centre Lathe using HSS single point turning tool under dry cutting condition. Response variables viz. surface roughness (Ra) and cutting vibration (dB) in the three directions are recorded by using accelerometer placing on the periphery of work holding chuck end bearing housing. An attempt is made to optimize the cutting parameters in respect of multi-response variables viz. surface roughness (Ra) and cutting vibration (dB) in three directions to achieve a breakeven level of both the quality and yield by using low-cost tool material. CQL perception in WPCA based Taguchi technique is used to evaluate optimal input parameters.

Yang Tian etal [10] According to this research paper vibration characteristics of heavy CNC machine tools are directly affected by their foundations. To analyze vibrations of heavy CNC machine tools caused by internal and external loads, a system dynamics model of a rigid-flexible coupled heavy-duty CNC machine tool-foundation system was established based on the multibody transfer matrix method. Since joint surfaces can seriously affect the accuracy of system mechanics models, the substructure synthesis method was first used to establish a dynamic model of the joint surface. frequency response function was then used to identify model parameters. Moreover, to improve the accuracy of parameter identification of the joint surface, a residual frequency compensation function was used to reconstruct the frequency response function. Finally, the multibody system model was implemented by combining surface elements.

To verify the system dynamics model, an experimental model of the heavy-duty machine-foundation system was built, taking into consideration joint surface factors, and the theoretical model was validated by comparing theoretical, simulation, and experimental results. Using the theoretical model, the influence of different forms of concrete foundations, materials, and soil properties on the vibration characteristics of heavy-duty CNC machine tools was analyzed, thus providing a theoretical basis for optimizing and improving CNC machine tools.

III. CONCLUSION

The optimization result for MS is: Speed = 424 RPM, Feed = 0.10 Depth of Cut = 2.0
From FEA modal analysis it conclude that natural frequency of lathe cutting tool at mode shape is Maximum.

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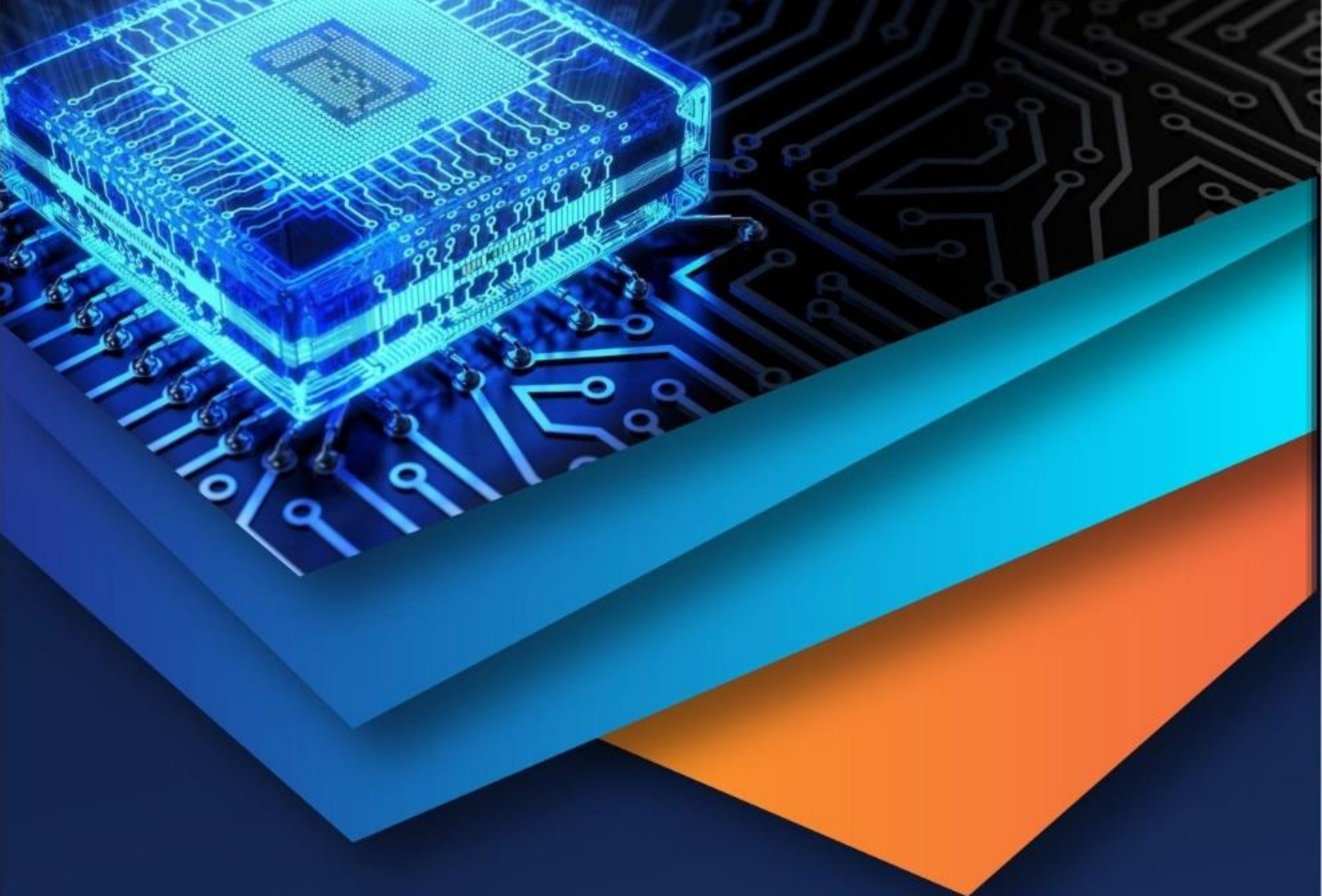

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