FAULT DIAGNOSIS ANALYSIS IN MILLING MACHINE USING MAGNETO RHEOLOGICAL DAMPER

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ABSTRACT

Regenerative chatter is a resonant phenomenon that occurs during machining, which can generate waves that lead to poor surface finish on the work piece. This also results in a decrease in the life of tools, the reliability of the machining operations, and safety. To overcome this problem, research has been focused on active vibration control. Work has been investigated in active vibration control and chatter elimination techniques using magneto-rheological fluid where the stiffness of the machine tool has been increased. Experimental works has been carried out to see which machining conditions and input current values in MR damper produce the best results for suppressing chatter marks in work pieces. The purpose of this research is to develop a Arduino-based vibration tracking system and use it to measure the performance of a milling machine.

1. INTRODUCTION

The most important and common machining operation in the production industry is the end milling operations. It is used for various operations like face milling, plain milling, angular milling, form milling, profile milling, etc. According to a study the dynamic position of the cutting tool affects the parameters like surface roughness, chip removal rate etc. The roughness depends mainly on depth of cut and feed rate. As the radial and axial depth of cut increases, there is an increasing in the cutting force and the vibration of the tool. Due to the vibration of the tool, chatters occur in the surface of the work piece. The chatter may affect machining parameters, tool wear, waviness-poor surface quality, inaccuracy, reduction in metal removal rate. To overcome the issue of chatter during the milling operations, a study was conducted to understand the machine, cutting tool and work piece. The issue of vibration can be solved by making the cutting tool as rigid as possible. Therefore MR damper was used in order to analyze the effect on cutting tool in conventional milling operations. Experimental work has been done with different machining parameters are measured from the milling tool with and without the applications of the MR damper. The main objective of this work is to minimize the surface roughness with the inputs of depth of cut to the work piece and voltage to the MR damper connected to the cutting tool.

1.1 MILLING OPERATION

Milling is the process of machining using rotary cutters to remove material by moving the cutter towards the work piece. This can be done in a variety of directions on one or several axes, the head speed and pressure of the cutter. Milling can encompass a variety of operations and machines on a small scale all the way up to large, heavy-duty operations. Milling is a common process used to manufacture parts to precise tolerances. There are many types of milling machines available to homeowners and

professionals.

1.2 HSS END MILL CUTTER

High speed steel is a type of steel that is commonly used as a cutting tool material. It is often used in power saw blades. The new high-carbon steel tools are better than the older tools used extensively through the 1940s because they can withstand higher temperatures without losing their temper (hardness). This property allows HSS to cut faster than high carbon steel, hence its name, high speed steel. At room temperature, under their commonly recommended heat treatment, HSS grades typically exhibit high hardness (above Rockwell 60) and abrasion resistance (typically associated with tungsten and vanadium, often used in HSS) compared to conventional carbon and tool steels.

1.3 TIALN COATED CARBIDE END MILL CUTTER

Carbide inserts are the most common because they are good for high performance milling operations. High speed steel is commonly used for tooling that is not commonly used for high production processes. Ceramics inserts are often used in high-speed machining with high production. Diamond inserts are commonly used in products requiring tight tolerances, usually consisting of high surface quality. Although most TiAlN and ALTiN coatings are industrially synthesized using alloy targets with specific percentages of aluminum and titanium, it is possible to produce TiAlN coatings with pure Al and Ti targets using a cathodic deposition technique.

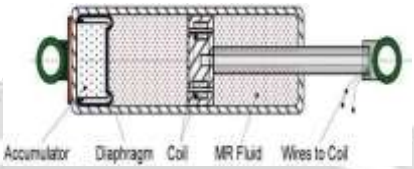
1.4 MILLING PROCESS

The experiment is to test the effectiveness of the magneto-rheological damper for end milling. The principle, usage range, and applications of each instrument used in the experiment are detailed below. A multi-meter is a console device used for service work with high precision. The two probes are insulated wires with pointed tips. The voltmeter is used to test the circuit and the results are displayed on a digital screen. A ball bearing is the component that uses a ball to help keep the surfaces moving in the bearing separated. The purpose of ball bearings is to reduce rotational friction and axial loads. The damper usually sits at the eye end of the pedal. During machining, use a 6 mm inner diameter ball bearing to hold the end mill shank at the eye end of the damper, and the inner groove rotates with the machine tool spindle. This experiment will study how magneto-rheological substances change when subjected to pressure.

EXPERIMENTAL SETUP

2. MAGNETO – RHEOLOGICAL DAMPER

The MR damper is a semi-active device that contains magneto-rheological fluid. The fluid helps to control the movement of the damper, and it can be seen in the figure. MR Fluid consists of sunflower oil, and ferrous particles. When voltage is applied to the coil of the damper, tiny magnetic dipoles are scattered in the fluid in the form of ferrous particles. These dipoles align along the magnetic flux lines, creating a damper. The MR fluid state changes from a liquid to a semi-solid state which will absorb the vibration of a cutting tool. We can control the damping rate of the damper by changing the voltage applied to the coil. MR Fluid is composed of sunflower oil, and iron particles.



MR DAMPER

3. ARDUINO BOARD

The Arduino Uno is a microcontroller board designed to use the microchip ESP8266, which is based on the microchip ESP8266. Arduino.cc is the developer of this board. The board has a variety of inputs and outputs that can be connected to other components. Arduino is a popular open-source electronics platform that is easy to use. Arduino boards are able to receive input from sensors, and other devices. They can then turn on LEDs, publish data online, or anything else that can be done with input. The Arduino Uno is a microcontroller board based on the ESP8266 chip. It is a popular board for hobbyists and software developers who want to create simple circuits and projects. The board has 14 digital input/output pins, 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, and a reset button.

ARDUINO BOARD

4. MATLAB SIMULINK

Simulink is a graphical programming environment for modeling, simulating, and analyzing multi domain systems. The primary interface for this tool is a graphical block diagramming tool with a variety of block libraries that can be customized. Simulink is an add-on product for MATLAB that allows users to model, simulate, and analyze dynamic systems graphically. It makes it easy to create virtual prototypes that allow you to explore design concepts at any level of detail with minimal effort. The field of robotic engineering involves the use of mechanics, electronics, and computer science to create machines that look and act like humans. Robotic researchers and engineers use MATLAB to design and optimize algorithms, model real-world systems, and automatically generate code in one software environment.

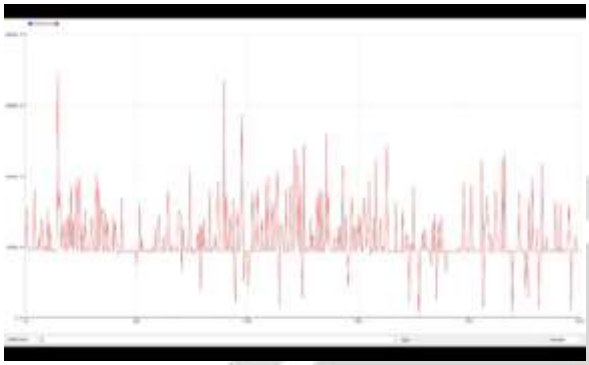
4.1 SIGNAL ANALYSIS

Signal analysis is a common way to characterize systems. The simplest way to identify a system is by using linear methods. Depending on the degree of nonlinearity in the system, linear methods may not always produce useful results. Digital signal processing is the use of computers to perform various digital processing operations. Digital Signal Processing (DSP) is not just limited to computers; it can also be done using processors specifically made for it, such as digital signal processors. The output of digital signal processing is

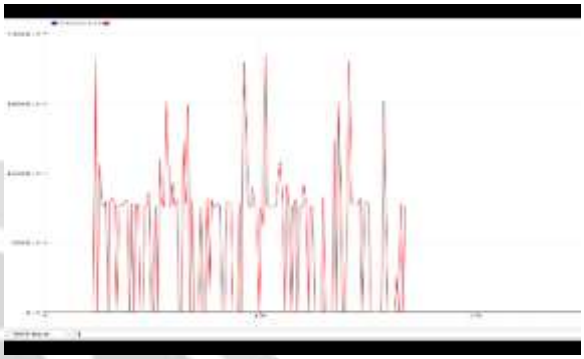
usually a sequence of numbers that represents the analog waveform samples of a variable in domains such as frequency, space, and time. A digital signal is represented by a periodic pulse pattern. Digital signal processing is a key part of signal processing, and it allows you to use the same hardware for a variety of applications, which saves money.

5. RESULTS AND DISCUSSION

HSS TOOL



0.25 DEPTH OF CUT AT MINIMUM VOLTAGE



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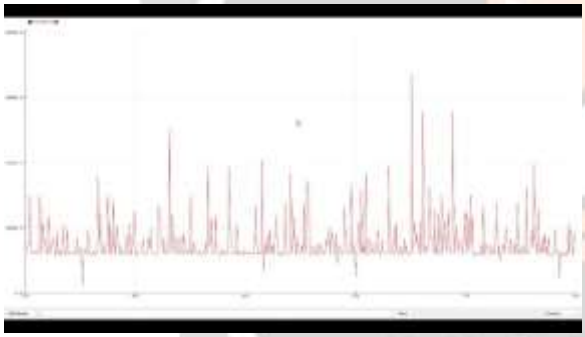

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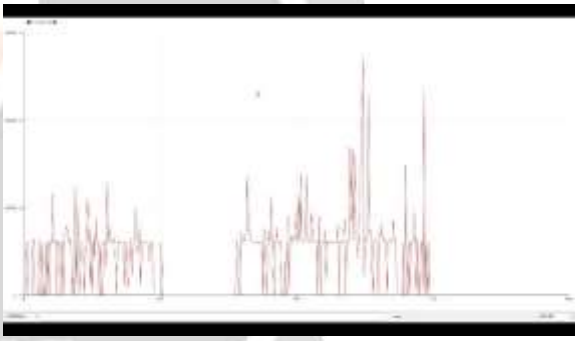
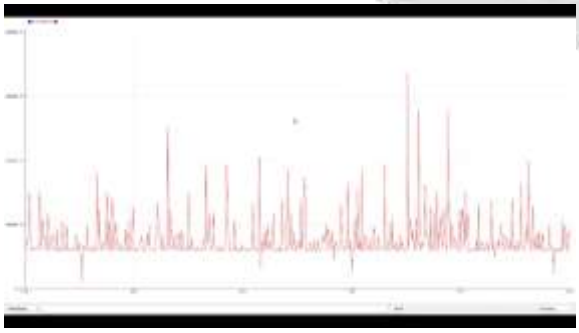


0.5 DEPTH OF CUT AT MAXIMUM VOLTAGE

CARBIDE TOOL



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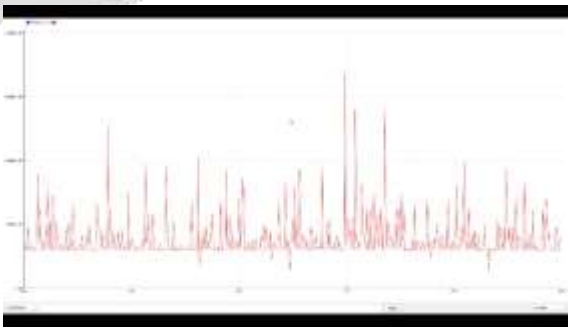

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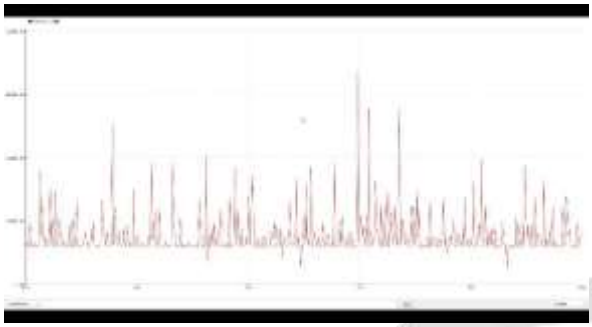
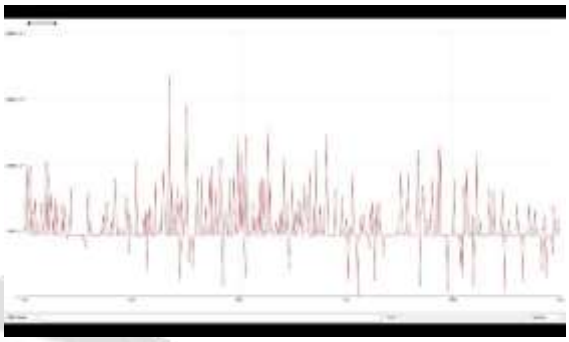


0.25 DEPTH OF CUT AT MAXIMUM VOLTAGE



0.5 DEPTH OF CUT AT MAXIMUM VOLTAGE

From this graph, while applying minimum voltage maximum vibration occurs and at maximum voltage minimum vibration occurs. In this project milling operation without using damper, the vibration is maximum.

6. CONCLUSIONS

Various vibration analysis techniques have been used to diagnose faults in rotating machines. Recently, some different vibration techniques have been studied from a new perspective. Even in perfect operating conditions, machines will have some vibration because of small defects. Each machine has a specific vibration level that is considered normal. Sometimes the vibration level on the machine becomes too high. The cause of the excessive vibration is usually an unbalance, misalignment, or worn gears or bearings. If the gears or bearings are loose, the vibration will be even worse. The vibration level of the machine is monitored with sensors. The MR damper has been attached to the milling machine to reduce the vibration of the milling cutter. With the help of the ESP8266 UNO board and the Arduino IDE software, various vibration signals have been captured. MATLAB used to model the sensors on the ESP8266. It has been observed that vibration is maximum without the use of MR damper 0V. When the voltage is maximum 12V, vibration is arrested to the maximum level.

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