MONITORING OF THE SURFACE ROUGHNESS BY USING ACOUSTIC EMISSION ANALYSIS DURING END MILLING PROCESS

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B.ENG (HONS.) MECHATRONICS ENGINEERING

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Report submitted in partial fulfillment of the requirements

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SUPERVISOR'S DECLARATION

We hereby declare that we have checked this thesis and in our opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Bachelor of Engineering in Mechatronics Engineering.

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STUDENT'S DECLARATION

I hereby declare that the work in this thesis is my own except for quotation and summaries which have been duly acknowledged. The thesis has not been accepted for any degree and is not concurrently submitted for award of other degree.

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LIST OF SYMBOLS

mm/min	millimeter per minutes
Ra	Average surface roughness
μm	micro meter
dB	Decibels
HP	horsepower
rpm	revolutions per minutes
Al	Aluminium
Cr	Chromium
Cu	Copper
Fe	Iron
Mg	Magnesium
Mn	Manganese
Si	Silicon
Ti	Titanium
Zn	Zinc

LIST OF ABBREVIATIONS

AE	Acoustic Emissions
AET	Acoustic Emissions Technique
CNC	Computer Numerical Control
NDT	Non-Destructive Testing
RMS	Root Mean Square
FFT	Fast-Fourier Transform
DFT	Discrete Fourier Transform
AEwin	Advanced Embedded and Network Solution

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ABSTRACT

Surface roughness of Aluminium Alloy 6061 has been investigated under different cutting condition by using Aoustic Emission (AE) sensor in milling operation. The experiment has shown that AE components are effectively respond to the change of occurrences in milling process.Three controllable factors are used as machining parameter. They are cutting speed, feed rate and depth of cut. The workpiece is clamped tightly on the workbench of milling machine and the AE sensor (PK15i) is mounted on top at the end of workpiece. The tool material used is 20mm 4 flute high speed steel cutting tool. All data collected from the AE sensor are displayed in AEWin and analysed in MATLAB software. Fast Fourier Transform (FFT) method is used to convert time domain into frequency domain signal and hence the rms, amplitude and frequency could be calculated. The surface roughness of the workpiece is measured by using Surfcom 130A. The results indicated that the most of the cutting parameter that influenced the surface roughness is feed rate, followed by cutting speed, and finally depth of cut.

ABSTRAK

kekasaran permukaan Aluminium 6061 telah dikaji berdasarkan kaedah pemotongan yang berbeza dengan menggunakan Aoustic Pelepasan sensor (AE) dalam operasi pemotongan. Eksperimen telah menunjukkan bahawa komponen AE yang digunakan berkesan dan bertindak balas kepada perubahan kejadian dalam proses pemotongan.Tiga faktor yang boleh dikawal digunakan sebagai 'parameter'. Antaranya adalah kelajuan sewaktu pemotongan, kadar makan dan kedalaman pemotongan. Bahan kerja diapit pada bangku kerja mesin pemotongan dan sensor AE (PK15i) dipasang di atas pada akhir bahan kerja. Bahan alat yang digunakan ialah 20mm 4 seruling kelajuan tinggi alat pemotong besi. Semua data yang dikumpul daripada sensor AE yang dipaparkan dalam AEWin dianalisis dalam perisian MATLAB. 'Fast Fourier Transform' (FFT) merupakan kaedah yang digunakan untuk menukar domain masa kepada isyarat domain frekuensi dan dengan itu rms, amplitud dan frekuensi boleh dikira. Kekasaran permukaan bahan kerja diukur dengan menggunakan Surfcom 130A. Keputusan menunjukkan bahawa sebahagian besar parameter pemotongan yang mempengaruhi kekasaran permukaan ialah kadar makan, diikuti dengan kelajuan pemotongan , dan akhirnya kedalaman pemotongan

CHAPTER 1

INTRODUCTION

This chapter describes the main idea of the project including the project background, problem statements, objectives, and project scopes. This chapter also provide some explanation and brief information about the project.

1.0 Project Introduction

In machining, there are two types of phenomena, which is avoidable and unavoidable events .Chip formation, tool failure, and flank wear can be categorized as the examples of unavoidable occcurrences. Tool breakage and process interruption, though very common occurrences in machining, are classified as avoidable by proper monitoring.Tool breakage is also known as the tool failure that is usually happens in some cases when the cutting force applied on tool insert exceeds its strength limit. It also occurs in case when there are no corrective actions taken in the early stages of crater or notch wear development (Bhuiyan et al., 2014).

The different occurrences in machining is usually make a change that is accomplished in the dynamic process. Surface roughness is one of the changes that is essential in machining that represents the quality of products obtained. The different cutting condition has a considerable effects on the workpiece surface roughness.The use of sensor in tool condition monitoring has made the process become more efficient by watching the cutting tool and process without penetrating or interrupting the operation. With the advent of sensor application, the real-time information on cutting tool and process can be obtained, which helps to avoid catastrophic tool failure during machining.

In sensor based tool condition monitoring, the process of selecting the right sensor(s) among a number of available sensing techniques for the appropriate applicationis crucially important (Bhuiyan et al., 2014).

1.1 Problem Statements

Surface roughness of a material plays an important role in machining process. It is generally accepted that the surface finish will influence the function of the machine parts. Besides, it is also affect the tool life, and resistance to wear. In manufacturing industry, an exact value of roughness is considerable essential because it will influence the capability of the parts and cost of producing a quality products. Therefore, the most important parameter to describe the surface integrity is by measuring the surface roughness. This method is a vital to control the quality of the machined workpiece. Hence, Acousic Emission Technique (AET) will be used to investigate its correlation with the surface roughness by using different cutting condition.

1.2 Project Objectives

The objectives of this projects is as follows

- To investigate the relationship of different cutting parameter and surface roughness with the AE signal produced during end milling process.
- To apply Fourier Transform method in analyzing AE signal data
- T o find frequency, rms and amplitude of AE signal generated.

1.3 Projects Scopes

The project research will be focused on :

1) Understanding the concept of acoustic emissions
2) Measuring the surface roughness of the workpiece
3) Study the correlation of acoustic emission with degree of surface roughness
4) Using cutting speed, feed rate and depth of cut parameter.

CHAPTER 2

LITERATURE REVIEW

2.0 INTRODUCTION

This chapter deals with the review from the previous research which is focus on acoustic emission (AE) method to monitor the cutting process under different cutting conditions. Some researchers found that AE has shown a very significant response to the surface roughness, chip formation and also the tool failure by applying various signal processing method. There are some features or parameters has been taken such as depth of cut, spindle speed, and also the state of cutting tool to make the dignostic system more universal. The literature review is an effective ways to increase the understanding on the project scopes.

2.1 MACHINING PROCESS

In industrial production, machining has been chosen as one of the processes which is responsible to transform raw material into a designed product to meet the demands of end users. Machining process is known as a method of removal or cutting a piece of raw material under several cutting conditions into a desired shape. Some manufacturer used metal as a machining part, but it also can be apply on materials such as composites, plastics, woods and ceramics. Cutting tool is used to remove excess material from the workpiece. It is made from material that is harder than the workpiece . Machining process principle is divided into three types which is turning,drilling, and milling. AE generated during machining process is illustrated as shown in Figure 2.1.

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