CONDITION MONITORING OF DEEP DRILLING

PROCESS FOR COOLING CHANNEL

MAKING IN HOT PRESS DIE

MUHAMAD ASLAM BIN ABDUL RAUB

Report submitted in partial fulfillment of the requirements

for the award of the degree of

Bachelor of Engineering in Mechatronics Engineering

Faculty of Manufacturing Engineering

UNIVERSITI MALAYSIA PAHANG

JUNE 2016

UNIVERSITI MALAYSIA PAHANG

FACULTY OF MANUFACTURING ENGINEERING

I certify that the project entitled *"Condition Monitoring Of Deep Drilling Process For Cooling Channel Making In Hot Press Die"* is written by *Muhamad Aslam Bin Abdul Raub*. I have examined the final copy of this project and in my opinion, it is fully adequate in terms of scope and quality for the award of the degree of Bachelor of Mechatronics Engineering. I herewith recommend that it be accepted in partial fulfillment of the requirements for the degree of Bachelor of Mechatronics Engineering.

Dr. Mohd Azmir Bin Mohd Azhari Signature

Examiner

SUPERVISOR'S DECLARATION

I hereby declare that I have checked this project report and in my opinion, this project is adequate in terms of scope and quality for the award of the Degree of Bachelor of Engineering in Mechatronics Engineering.

Signature	:	
Name of supervisor	:	Assoc. Prof. Dr. Ahmad Razlan Bin Yusof
Position	:	Deputy Dean (Acedemic & Student Affairs)
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Date	:	31 MAY 2016

STUDENT'S DECLARATION

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

Signature	:	
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Date	:	31 MAY 2016

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LIST OF SYMBOLS

M	Samples number which is positive and negative class
W	M – dimensional vector
b	Scalar used to define the separating hyperplane position
$f(\boldsymbol{x})$	Decision function to create separating hyperplane
α	Decay (growth) rate
b	Bias
μ_{mj}	Synaptic weight on output layer
w_{nm}	Synaptic weight on hidden layer
η_1, η_2	Learning rates
γ_1, γ_2	Momentum coefficients
J	Epochs number

LIST OF ABBREVIATIONS

SVM	Support Vector Machine
ANN	Artificial Neural Network
CNC	Computer Numerical Control
TCM	Tool Condition Monitoring
HSS	High Speed Steel
BTA	Boring and Trepanning Association
DTD	Deep Twist Drill

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ABSTRACT

Deep drilling operation is one of the major process that is widely used in the manufacturing industry. To make a cooling channel of hot press forming die, deep drilling is a crucial process which is the drilling depth is 10 times of the drill bit diameters itself. However, the major complications that occur is the drill bits will become wear and breaks as the drilling depth keep increasing. This will impact the efficiency of the drilling process. To overcome this drawback, Tool Condition Monitoring (TCM) was introduced to refining the quality of the drilling process by monitor the drilling operation, whether by direct or indirect monitoring, thus will improve tool life expectancy by notifying the operator to stop the machine. SKD 61 which is widely used as die material and High Speed Steel (HSS) drill bit was chosen. To improve accuracy, Tri-axial Accelerometer (PCB356B21) was used to detect the vibration of the drill bit when drilling process occurs. The data obtained from this experiment is in the form of acceleration and Fast Fourier Transform (FFT) signal which is acceleration x, acceleration y, acceleration z, FFT x, FFT y, and FFT z. Tool condition can be classify into five types by using this data which is good condition, small corner wear, medium corner wear, large corner wear and fracture. To classify this data, machine learning method such as Support Vector Machine (SVM) and Artificial Neural Network (ANN) was employed. SVM performs classification process based on the data input vector that comprise as fault in the machine. The fault is then being produced as the pattern and SVM will recognize thus classify this pattern corresponding to the fault. Nevertheless, the major downside of SVM is less accurate of classifying result due to the data over-fitting. To get an accurate result, the data is compared with Artificial Neural Network machine learning. ANN performs an excellent classifying by determining the correct set of input data, number of hidden layers, target data, and applying a suitable algorithm, which is proven better classifying result than SVM in the aspect of classifying accuracy and number of errors. Consequently, ANN is the most suitable method to classify tool condition, and are capable to be employed for online tool failure detection system which is beneficial for optimizing tool condition in industries.

ABSTRAK

Operasi penggerudian dalam ialah salah satu daripada proses utama yang digunakan secara meluas dalam industri pembuatan. Bagi menghasilkan saluran penyejukan untuk acuan bertekanan panas, penggerudian dalam merupakan satu proses penting dimana kedalaman penggerudian ialah sebanyak 10 kali daripada diameter mata alat. Walau bagaimanapun, masalah utama yang berlaku ialah mata alat gerudi akan haus dan patah selagi kedalaman penggerudian kian meningkat. Hal ini akan memberi kesan terhadap kecekapan proses penggerudian. Untuk mengatasi masalah ini, Pemantauan Kondisi Alat (PKA) telah diperkenalkan untuk meningkatkan kualiti proses penggerudian dengan memantau operasi penggerudian, samada dengan pemantauan langsung atau tidak langsung, dengan itu akan meningkatkan jangka hayat mata alat dengan memberitahu operator untuk memberhentikan mesin. SKD 61 yang mana digunakan secara meluas sebagai bahan acuan dan mata alat *High Speed Steel (HSS)* telah dipilih. Bagi meningkatkan ketepatan, aselerometer tiga paksi (PCB356B21) telah digunakan mengesan getaran mata alat ketika proses penggerudian berlaku. Data yang diperoleh daripada experiment ini ialah dalam bentuk pecutan dan isyarat *Fast Fourier Transform (FFT)* iaitu pecutan x, pecutan y, pecutan z, FFT x, FFT y, dan FFT z. Kondisi alat boleh dibahagikan kepada 5 jenis dengan menggunakan data ini iaitu keadaan baik, haus sudut kecil, haus sudut sederhana, haus sudut besar, and patah. Bagi mengelaskan data ini, kaedah pembelajaran mesin seperti *Support Vector Machine (SVM)* dan *Artificial Neural Network (ANN)* telah digunakan. SVM menjalankan proses pengelasan data berdasarkan vektor data masukan yang terdiri daripada *fault* dalam mesin. *Fault* tersebut kemudiannya dihasilkan sebagai corak dan SVM akan mengenali lalu mengelaskan corak ini berkait dengan *fault*. Namun begitu, kelemahan utama SVM ialah keputusan pengelasan yang kurang tepat disebabkan oleh data *over-fitting*. Untuk mendapatkan keputusan yang lebih tepat, data dibandingkan menggunakan kaedah pembelajaran mesin *Artificial Neural Network (ANN).* ANN mejalankan pengelasan terbaik dengan menentukan data kemasukan yang betul, bilangan lapisan tersembunyi, data sasaran, dan menggunakan algoritma sesuai yang terbukti menghasilkan keputusan pengelasan terbaik berbanding SVM dari aspek ketepatan pengelasan dan bilangan ralat. Kesimpulannya, ANN ialah kaedah yang paling sesuai bagi pengelasan kondisi mata alat, dan mampu digunakan untuk system mengesan kegagalan mata alat secara atas talian yang mana bermanfaat untuk mengoptimumkan kondisi mata alat dalam pelbagai industri.

CHAPTER 1

INTRODUCTION

1.1 PROJECT BACKGROUND

Recent demand for the automotive industry has influenced the improvement in manufacturing of automotive parts. It has become the pushing factor to produce an automotive parts which meets the criteria such as high strength, low cost, light weight and others. Hot press forming die is an advance forming process that was developed to increase the material strength and good formability which makes it possible to produce complex shapes with tensile strength up to around 1,500 Mpa in manufacturing of automotive parts (Karbasian et al, 2010).

Since hot press process using cooling channel, the material strength can be increased by allowing the material undergoes fast cooling after heating the material at desired temperature range. The heated material is in austenitic phase and the phase will transform into harder phase after quenching process, for example martensite.

Nowadays, a new technique based on considerably long twist drills, called Deep Twist Drilling (DTD) is presented. The hole of the cooling channel in hot press forming die is made by using a deep twist drilling process. DTD is a process of drilling hole ten times of the diameter of the hole. The previous method of producing cooling channel is by using Gun Drilling and Boring Trepanning Association (BTA) Drilling. It is estimated approximately 250 million twist drills are used annually, from the surveyed that has been carried out in the United States. (Pletting, 1999). It is proved that twist drills are most preferable tool operations used.

Nevertheless, the drilling machine itself can't detect the complications occur during the drilling process where the drill bits will become wears and break as the drilling depth increased. Therefore, tool condition monitoring (TCM) was designed and introduced to overcome this complication. TCM is used to monitor whether by online or offline from the beginning of the drilling process until the tool bits has reached the maximum limits before its wears and break by using the accelerometer sensor that was attached at the spindle of drilling machine and send the result to the software. As the result was obtained, the classifier such as an Artificial Neural Network (ANN) and Support Vector Machine (SVM) need to be decided to analyse the result.

1.2 PROBLEM STATEMENT

Deep twist drill is one of the machining processes which widely used in manufacturing industry especially in hot stamping process. However, the major issue is tool wear and breakage. Therefore, by monitoring the tool condition through classify it via several classifier such as SVM and ANN, it can detect the status of the tool, and through that, it is available to reduce the changes of tool to failures.

1.3 PROJECT OBJECTIVE

The main objectives for this study are:

I. To analyse deep drilling classifier on data collection.

II. To classify the tool drill failure mechanism of deep twist drilling based on several classifiers such as SVM and ANN based on actual deep drilling experiments data.

III. To classify the data obtained by using SVM and ANN via Weka and MATLAB software.

1.4 PROJECT SCOPE

This project is focusing on condition monitoring of deep drilling process which conducted based on this scope:

i. The parameter involved; feed rate, depth of cut and and cutting speed.
ii. The diameter and length of tool drills; 8mm and 210mm.
iii. Raw material used is SKD 61 and tool drills material is High Speed Steel (HSS).
iv. The accelerometer sensor is used to measure vibration during the drilling process is conducted.

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