UNIVERSITI TEKNIKAL MALAYSIA MELAKA

THE PREDICTION OF MULTIPLE POLISHING PARAMETERS OPTIMIZATION BY USING MANFIS-PID

This report is submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for Bachelor Degree of Manufacturing Engineering (Hons.)

by

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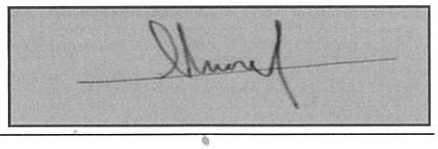

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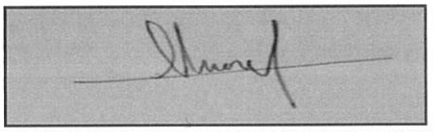

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APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of Universiti Teknikal Malaysia Melaka as a partial fulfilment of the requirement for Degree of Manufacturing Engineering (Hons). The member of the supervisory committee is as follow:

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ABSTRAK

Penggilapan adalah proses sekunder yang berfungsi untuk memberikan permukaan seragam produk. Walaupun tahap automasi semakin meningkat secara beransur-ansur selama bertahun-tahun, industri ini masih menyokong kaedah penggilap manual atau separuh automatik kerana kos yang mahal dan masa makan. Lebih-lebih lagi, dalam proses penggilapan melibatkan beberapa parameter seperti daya penggilap dan nilai-nilai kasar untuk melaksanakan permukaan yang berkualiti tinggi produk. Dilaporkan bahawa, dalam *artificial intellegent* (AI) mempunyai batasan sendiri dalam melakukan ramalan. Dalam projek ini akan membentangkan ramalan untuk pelbagai parameter penggilap yang melibatkan daya penggilapan (PF), tempoh penggilapan (PT) dan saiz grid (GS) sebagai output sistem dengan data input yang diberikan kekasaran permukaan (RA) nilai. Matlamat utama projek ini untuk mencapai ramalan ketepatan yang tinggi daripada MANFIS-PID berbanding dengan sistem MANFIS. Model MANFIS-PID dicadangkan kerana ia dapat menumpukan perhatian kepada pengenalan tunggal dengan output pelbagai keluaran (SIMO) untuk membuat ramalan pada parameter penggilap pelbagai dengan tambahan kawalan PID untuk mengurangkan ralat output subsistem MANFIS tanpa meningkatkan kerumitan sistem. Sistem ini melalui dua data analisis jenis iaitu data latihan, untuk menentukan kebolehpercayaan dan ujian untuk tujuan pengesahan dengan menggunakan perisian MATLAB/Simulink. Keputusan MANFIS-PID melaksanakan nilai RMSE yang lebih rendah berbanding dengan sistem MANFIS.

ABSTRACT

The polishing is a secondary process that function as to give a uniform surface roughness of the product. Although the automation level is increasing gradually over many years, the industry still supports manual or half-automatic polishing method due to expensive cost and time consume. Moreover, in polishing process involves several parameters such polishing force and abrasive values to perform a high quality surface roughness of the product. Reported that, in artificial intelligent (AI) have its own limitation in performing prediction. In this project attempt to present a prediction for multiple parameter polishing optimization which involves polishing force (PF), polishing time (PT) and grid size (GS) as the outputs of system with input data given of Surface roughness (Ra) values. The main goal of this project to achieve high accuracy prediction of the MANFIS-PID compared to MANFIS subsystem itself. The MANFIS-PID model is proposed as it able to concentrate on the Single Input Multiple Output (SIMO) identification to make the prediction on the multiple polishing parameters with additional of PID control for reduce the error output of MANFIS subsystem without increasing complexity of system. This is system undergo two type analysis data which are training data, for determine reliability and testing for validation purpose by using MATLAB/Simulink software. As the result MANFIS-PID perform lower RMSE value compare to MANFIS-subsystem itself.

DEDICATION

Only

my beloved father, Mazlan Mat Arshad

my beloved mother, Saripah binti Omar

my adored sister Syamimie Farhana & Syamimie Fazlyn

as well my fellow friends

for giving me moral support, motivation, cooperation and encouragement

Thank You So Much & Love You All Foreve.

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Assalamu'ulaikum & Greetings

In the name of ALLAH, the most gracious, the most merciful, with the highest praise to ALLAH that I manage to complete this final year project (FYP) successfully although facing may difficulty especially during pandemic Covid-19 occurred in our country.

My respect toward Dr Ruzaidi Bin Zamri as my supervisor for the great mentoring that was given to me throughout the project, kind supervision advice and guidance as well as exposing me with meaningful experiences during this final year project 1 & 2

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CHAPTER 1

INTRODUCTION

The chapter 1 explain about the project's background study based on information that related to surface roughness parameter used for polishing process and Artificial Intelligent program to predict the polishing parameter optimization. The overview of problem statement and objectives of the study also briefly explain in this chapter. Then the limitation of the project study is described in the scope.

1.1 Background of study

Nowadays, with implementing industry revolution 4.0 in Malaysia industries, the robotic automation plays a vital role in performing tasks and working in any kind of environment. The modern robotic automation with the aid of artificial intelligent (AI) that apply the logic concept can generate decisions about the output of the process, evaluate the quality, and serve a feedback to another components of a production system via information technology. The term of artificial intelligent refers to the simulation of human intelligence in machines that are programmed to think like humans and mimic their actions. (ARORA & BAENZIGER, 2013).

In addition according to Reinsel, Gantz, & Rydning, (2018) claimed that artificial intelligent could present new degrees of efficiency and became into mainstream because it allowed us to make a prediction based on the analysis from the huge giant amount of information in real-time where international information could be develop more 61% from 175 zettabytes. This shows

the increasing number of users apply the artificial intelligent system integrate it with the machine or computer aid-program.

The field of artificial intelligence is essentially when machines can do tasks that typically require human intelligence. It encompasses machine learning, where machines can learn by experiences and acquire skills without human involvement. Deep learning is a subset of machine learning where artificial neural networks, algorithms inspired by the human brain, learn from enormous amounts of data. For my project I focusing to develop a system deep learning that have the capability of learning unsupervised from data unstructured or unlabeled. For instance, deep learning consists of various type of learning program, Fuzzy Logic Algorithms, Artificial Neuro Network ANN, Adaptive Neuro-Fuzzy Inference System (ANFIS) etc.

In another hand, this project Multiple Adaptive Neuro-Fuzzy Inference System (MANFIS)-PID controller models would be implemented to predict multiple polishing parameters between grid size (GS), polishing force (PF) and polishing time (PT) with surface roughness(Ra) as a single input. The general goal of this project is to construct a MANFIS-PID model structure and to predict the optimization polishing parameter. At the end of the study, the result of MANFIS PID model would be compared between MANFIS. As expectation from this project, the MANFIS-PID model be able to achieve better accuracy of prediction compared to the MANFIS model.

1.2 Problem statement

The polishing is a secondary process that function as to give a uniform surface roughness of the product. Although the automation level is increasing gradually over many years, the industry still supports manual or half-automatic polishing method due to expensive cost and time consume. The choice of the polishing process parameter such polishing force, polishing time and amount of pressure applied is based on the experience of the polishing worker and involves a long iteration of "test and error". Thus, those method will may be major effect to the poor surface roughness of the product. (Zhang et al., 2010). Despite of that, by several method of deep learning is suggested in this project to predict polishing parameter that will provide better surface roughness quality compare to traditional method. This because AI system ability of the system itself very efficient to solve complex problem and provide high accuracy to generate decision-based on output of the process. (Besari, Prabuwono, Zamri, & Palil, 2010).

Consequently, in polishing process involves with multiple parameter to perform great surface roughness, in this project the deep learning system is necessary to predict three parameter output which is grid size, polishing force and polishing force with one input parameter surface roughness. However, in deep learning system also has it limitation for serving a decision for user. For instance an ANFIS and ANN model only can manage to assign single output parameter with multiple or single input parameter (Micheal, 2005). This factor can be overcome by utilizing MANFIS-PID model system where it can predict multiple output with benefit PID controller to control and reduce error output of parameter achieved.

Therefore, this study focuses to design and simulate a deep learning system that able to help user obtain high surface roughness in polishing process.

1.3 Objectives

The broad goal is to develop and analyses the accuracy of MANFIS-PID model which help to estimate the values of polishing parameters used be in the polishing robotic arm machine. The objectives of this study are.

i. To develop a MANFIS-PID model structure to predict multiple polishing parameters by using MATLAB/Simulink.

ii. To analyze the accuracy of MANFIS-PID model by comparing with MANFIS subsystem itself.

1.4 Scopes

The main goals in this project is to develop and analyses the accuracy of the MANFIS-PID model to predict the polishing parameter optimization by using the MATLAB/Simulink software. MATLAB/Simulink consist various type of engineering tool, application, and program that easy to simulate them. Besides, the process involves of this research is polishing process by using G3141 cold rolled steel as main material of the experiment. Meanwhile only three type of polishing parameter grid size (GS), polishing force (PF) and polishing time (PT) serve as out came of the prediction the MANFIS-PID model system. Instead of the that the membership function of neural network that used during simulation is sub-clustering only. Further detail used of MATLAB/Simulink, parameters, and membership function will be explained Chapter 2 and Chapter 3. After the simulation, the MANFIS-PID model's accuracy will be analyses by using linear regression method.

1.5 Organization of Thesis

In chapter 1 explain the background study of the prediction of multiple polishing parameter optimizations by using MANFIS-PID system. The problem statement has been described to prove the current situation occur and the aims are purpose to overcome the problem. Then the scope of study and the importance of study also narrated in chapter 1

Chapter 2 gives a piece of general fundamental knowledge about the polishing, artificial intelligent (AI), Artificial neuron network (ANN), Fuzzy Logic System, Adaptive Neuro-Fuzzy Inference System (ANFIS), Co-active ANFIS, Multiple-ANFIS, and PID controller. Past studies referring to illustrate how the subject has been studied previously.

Chapter 3 describe the method implemented to achieve the objective, especially for data analysis and simulation. The method used to develop the MANFIS- PID model briefly explained in this chapter. Flow chart of overall simulation conducted also will be explained in this chapter.

Chapter 4 the result discusses the details about obtained result and discussion data collection to the achievement of the accuracy of the MANFIS-PID model. The result will be analyses using a linear regression method.

Chapter 5 will be including the overall findings and discussion of the project and recommendation for future work is outlined in this study are presented.

1.6 Summary

In the nutshell this topic had briefly explained an introduction and overview about this study which will be conducted for entire period project. The main problem that need to overcome is the implementation of deep learning system into polishing process and limited output parameters predicted. Hence the MANFIS-PID is implemented to optimize the prediction of multiple the polishing parameter, to respond the objective above. After all the problem statement objective and scope are establish, the study will be continuing on the next Chapter 2 (literature review) to allocate the suitable method and information.

CHAPTER 2

LITERATURE REVIEWS

Basically in chapter 2 illustrated a brief overview of polishing, effect of the polishing parameter toward Surface roughness (Ra) artificial neural network (ANN), fuzzy logic, system, adaptive neuro fuzzy inference system(ANFIS), multiple adaptive neuro fuzzy inference system (MAFIS), PID controller and co-active adaptive neuro fuzzy inference system(CANFIS) All the information related to this project is used to continue in chapter 3 (Methodology).

2.1 Polishing

Formerly polishing defined as mechanical finishing to sustain the smooth surface of the product by removed the amount of metal or nonmetallic surface, then followed by buffing process to remove the definite coarse pattern which persists after the polishing process. (Lea, 1999).Polishing process is crucially important in the manufacturing industry as to perform a high-quality product to their customer. Since that, to obtain a precise surface roughness of the product, each polishing parameter used required an explicit control from the machine or the worker itself.

2.1.1 Relationship Between Polishing Parameter and Surface Roughness (Ra)

The polishing process involves a few different parameters, such as: force(F), abrasive values (μ), speed of rotation (ω), and polishing time. The relationship between turning speed and time of polishing is defined in the following equation.

$$\omega = \frac{2\pi}{T} = 2\pi f \qquad \text{Equation 2.1}$$

The rotational speed is equivalent to angular speed (ω), while the polishing time is equal valent to period (T) with length of one cycle and the period is the corresponding with the frequency (f). Those parameters are related to each other for determining the speed of motor required for polishing process. At the same time, the relation between polishing force (F) with abrasive values (μ) crucially important during the polishing process this is because higher polishing force can produce high friction which may cause poor quality surface roughness of the product. Meanwhile, the significant of surface changes will also be depending to values of abrasive This is illustrated by the equation below.

$$F_f = \mu_k . N \qquad \text{Equation 2.2}$$

Force is equivalent to frictional force when each object is driven in the other direction in relation to the other surface. The mean abrasive value (μ) is equal to μk (kinetic friction coefficient) for surfaces in relative motion μ= μk. The abrasive value is provided in a fixed value. As a result, the frictional force is the potential abrasive value parameter.

In meantime, uniformity of the pressure distribution was discussed as a factor that affects the flatness of the polished plate. It was pointed out one of the effected the uniformity of pressure distribution was influenced by the different type of polishing pad and thickness of polishing pad (H). The thicker of polishing pad, the higher uneven distribution will be. (Cai, Lu, Cai, & Zheng, 1998)

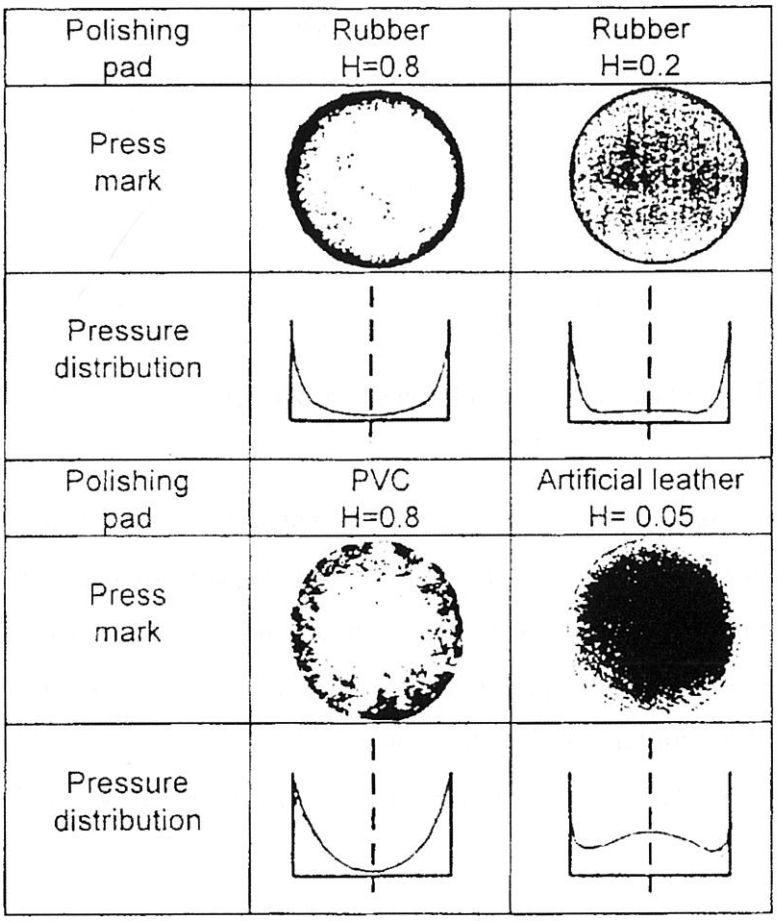

Figure 2.1: Press mark test results for different type and thickness of polishing pad (Cai et al., 1998)

Similar to that, an experiment carried out by Lacharnay et al.,(2015) found that, the polishing force influenced the polishing time to gain the desired surface roughness. Two different polishing force had been tested and the result showed the with the highest polishing force applied the time take to reach the desired surface roughness was quicker compared to lowest polishing force