

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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I hereby, declared this report entitled "The Prediction of Multiple Polishing Parameter Optimization by Using MANFIS-PID" is the result of my own research except as cited in references.

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APPROVAL

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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.

i

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 MANFISsubsystem 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

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iii

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TABLE OF CONTENTS

Abstra	ık		1
Abstra	act		ii
Dedic	ation		iii
Ackno	wledge	ment	iv
Table	of Cont	ents	V
List of	f Tables		vii
List of	f Figure	s	viii
List of	f Abbrev	viations	Х
List of	f Symbo	ols	xi
CHA	PTER 1	: INTRODUCTION	
1.1	Backg	round	1-2
1.2	Proble	m Statement	3
1.3	Object	tives	4
1.4	Scope		4
1.5	Thesis	Origination	5
1.6	Summ	ary	6
CHA	PTER 2	: LITERATURE REVIEW	
2.1	Polish	ing	7
	2.1.1	Relationship Between the Polishing Parameter and Surface	8-11
		Roughness (RA)	
	2.1.2	Advantages of Robotic Polishing Machine with Aid of Artificial	
		Intelligent (AI) system	11-12
2.2	Appli	cation of Artificial Intelligent (AI) System	12-13
2.3	Artific	cial Neuro-Network (ANN) Model	13-14
	2.3.1	Membership Function in Artificial Neuro-Network (ANN)	14

		2.3.1.1 Subtractive-Clustering Function	15
2.4	Fuzzy	zy Logic System	
2.5	Adaptive Neuro-Fuzzy Inference System (ANFIS) model		15-19
	2.5.1	Co-active Adaptive Neuro-Fuzzy Inference System (CANFIS)	19-20
	2.5.2	Multiple Adaptive Neuro-Fuzzy Inference System (MANFIS)	
		Model	20-21
2.6	Propor	tional, Integral and Derivatives Control System	21
	2.6.1	Proportional Response	22
	2.6.2	Integral Response	22
	2.6.3	Derivative Response	23
2.7	MANI	FIS-PID system	23
2.8	Summ	ary	24
CHAP	TER 3	: METHODOLOGY	
3.1	An Ov	verview of Methodology	25-26
	3.1.1	Identify Project Title	27
	3.1.2	Literature review	27
	3.1.3	Define Problems, Objectives and Scope	27
	3.1.4	Design System Structure Methodology	28
3.2	Data C	Collection	28
3.3	Propos	sed Software for Develop MANFIS-PID Model	29-30
	3.3.1	Procedure to Train ANFIS	32-34
	3.3.2	Toolbox for Developing Architecture of MANFIS-PID Model	34-35
	3.3.3	Conceptual Development of MANFIS	35-36
	3.3.4	Conceptual Model of MANFIS-PID	34-35
		3.3.4.1 Construct Closed Loop Circuit with PDI Controller	37

vi

		3.3.4.2 Procedure to Build Transfer Function for MANFIS-PIF System	38
		3.3.4.3 Tuning PID controller	38-39
3.4	Data A	Analysis of MANFIS –PID and MANFIS	39-4 1
3.5	Summ	ary	41
CHAF	PTER 4	: RESULT AND DISCUSSION	
4.1	Data A	Arrangement	42-43
	4.1.1	ANFIS Training Data	43-45
4.2	MAN	FIS Structure Model	46-47
	4.2.1	Analysis of Training Data using MANFIS	47-48
		4.2.1.1 Correlation Analysis of Training Data using MANFIS	48-50
	4.2.2	Testing Data using MANFIS	51
4.3	MAN	FIS-PID Sturcture Model	51-2
	4.3.1	Tuning PID Controller	53-55
	4.3.2	Analysis of Trainig Data using MANFIS-PID	56
		4.3.2.1 Correleation Analysis of Training Data using MANFIS	
		PID	56-58
	4.3.3	Analysis of Testing Data using MANFIS-PID	59
4.4	Discus	ssion	59-60
45	Summ	ary	61

CHAPTER 5: Conclusion and Recommendation

62

vii

5.1	Conclusion		62-	-63
5.2	Recommendation		63-	-64
REFE	RENCES		65.	-68
APPE	NDICES			
А	Gantt Chart of FYP 1 & FYP 2		69-	-71
В	Procedure of ANFIS Train		72-	-75
С	Procedure Built Transform Fun	ction	76-	-80

D List of Research Gap 81-87

viii

LIST OF TABLES

4.1	Data Arrangement According to Polishing Parameter Group	43
4.2(a)	Grid Size Parameter Set	44
4.2(b)	Polishing Time Parameter Set	44
4.2(c)	Polishing Force Parameter Set	45
4.3	ANFIS Trained Data	45
4.4	Legend for MANFIS structure	47
4.5	Training Data of MANFIS	48
4.6	Pearson Correlation Coefficient of MANFIS	50
4.7	Testing Data using MANFIS	51
4.8	Controller Parameters	53
4.9	Characteristics of Curve Response, PID Controller, Subsystem 1	54
4.10	Characteristics of Curve Response PID Controller, Subsystem 2	54
4.11	Characteristics of Curve Response PID Controller, Subsystem 3	55
4.12	Training Data using MANFIS-PID	56
4.13	Pearson Correlation Coefficient MANFIS-PID	58
4.14	Testing Data using MANFIS-PID	59
4.15	Root Mean Square Error with Output Parameters	60

ix

LIST OF FIGURES

2.1	Press mark test results for different type and thickness of	9
	polishing pad (Cai, Lu, Cai, & Zheng, 1998)	
2.2	Effect polishing force on the polishing time (Lacharnay et al., 2015)	10
2.3	Polishing operation result (Márquez et al., 2005)	11
2.4	Robotic polishing machine with aid of the AI system	12
2.5	Analogy of ANN with human brain. (Zong-chang, 2013)	14
2.6	ANFIS structure model with six layers. (Jang, 1993)	17
2.7	Model CANFIS structure with multiple input multiple output (MIMO).	20
	(Mohanapriya & Jayanthi, 2019)	
2.8	Conceptual idea of MANFIS model	21
2.9	Example of PID Diagram	22
3.1	Flowchart of Project	26
3.2	Implementation of polishing robot system	28
3.3	ANFIS Editor	29
3.4	FIS Editor	29
3.5	Simulink Library Tools	30
3.6	Simulink Model Workspace	30
3.7	Flow chart for ANFIS training data	31
3.8	Icon used for developing the architecture of MANFIS-PID model	34
3.9	Idea of the architecture of MANFIS model	35
3.10	Flow chart to develop PID controller	36
3.11	Conceptual idea of closed loop circuit with PID controller	37
3.12	PID Tuning Tool [®]	39
3.12	Example of correlation data using Microsoft Excel	40
3.13	Example of linear regression using Microsoft Excel	41
4.1	MANFIS Structure	46
4.2	Correlation Plot between Expected and Predict, GS of MANFIS	49

4.3	Correlation Plot between Expected and Predict, PF of MANFIS	49
4.4	Correlation Plot between Expected and Predict, PT of MANFIS	50
4.5	MANFIS-PID model structure	52
4.6	Subsystem of PID controller circuit	52
4.7	Step Response PID controller, subsystem 1	53
4.8	Step Response PID controller, subsystem 2	54
4.9	Step Response PID controller, subsystem 3	55
4.10	Correlation Plot between Expected and Predict, GS of MANFIS-PID	57
4.11	Correlation Plot between Expected and Predict, PF of MANFIS-PID	57
4.12	Correlation Plot between Expected and Predict, PT of MANFIS-PID	58
4.13	Testing Data between MANFIS and MANFIS-PID	60

xi

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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.

5

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.

$$\omega = \frac{2\pi}{T} = 2\pi f$$
 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.

$$F_f = \mu_k . N$$
 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 $\mu = \mu k$. 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)

Polishing pad	Rubber H=0.8	Rubber H=0.2
Press mark		
Pressure distribution		
Polishing pad	PVC H=0.8	Artificial leather H= 0.05
Press mark		
Pressure distribution		

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