



Faculty of Electrical and Electronic Engineering Technology



**Development Of PID Controller For Conveyor Belt System With
Different Tuning Method**

ABDUL WAFI BIN ABDUL RAHEM

**Bachelor of Electrical Engineering Technology (Industrial Automation & Robotics)
with Honours**

2021

Development Of PID Controller For Conveyor Belt System With Different Tuning Method

ABDUL WAFI BIN ABDUL RAHEM

**A project report submitted
in partial fulfillment of the requirements for the degree of
Bachelor of Electrical Engineering Technology (Industrial Automation & Robotics)
with Honours**



اونيورسيتي تیکنیکل ملیسيا ملاک
Faculty of Electrical and Electronic Engineering Technology
UNIVERSITI TEKNIKAL MALAYSIA MELAKA

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2021



اوتيمرسيتي تيكنيكل مليسيا ملاك
UNIVERSITI TEKNIKAL MALAYSIA MELAKA

UTeM

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

Title: Development Of PID Controller For Conveyor Belt System With Different Tuning Method

Sesi Pengajian: 2021

Saya **Abdul Wafi bin Abdul Rahem** mengaku membenarkan Laporan PSM ini disimpan di Perpustakaan Universiti Teknikal Malaysia Melaka (UTeM) dengan syarat-syarat kegunaan seperti berikut:

1. Laporan PSM adalah hak milik Universiti Teknikal Malaysia Melaka dan penulis.
2. Perpustakaan Universiti Teknikal Malaysia Melaka dibenarkan membuat salinan untuk tujuan pengajian sahaja dengan izin penulis.
3. Perpustakaan dibenarkan membuat salinan laporan PSM ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. **Sila tandakan (X)

Mengandungi maklumat yang berdarjah keselamatan atau

SULIT*

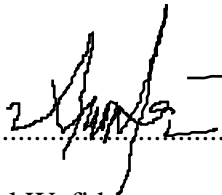
kepentingan Malaysia sebagaimana yang termaktub dalam AKTARAHSIA RASMI 1972.

TERHAD* Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan.

TIDAK TERHAD

Yang benar,

Disahkan oleh penyelia:



Abdul Wafi bin
Abdul Rahem

Ts. Dr. Sahazati binti Md
Rozali

Alamat Tetap:

Cop Rasmi Penyelia

NO 14 JALAN SERIKAYA 13,

SEGAMAT BARU, SEGAMAT

JOHOR

Tarikh: 8 / 1 / 2022

Tarikh:

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

*Jika Laporan PSM ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh laporan PSM ini

DECLARATION

I declare that this project report entitled “Development Of PID Controller For Conveyor Belt System With Different Tuning Method“ is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature

:



Student Name

:

Abdul Wafi bin Abdul Rahem

Date

:

8/1/2022



APPROVAL

I hereby declare that I have checked this project report and in my opinion, this project report is adequate in terms of scope and quality for the award of the degree of Bachelor of Electrical Engineering Technology (Industrial Automation & Robotics) with Honours.



DR SAHAZATI BINTI MD ROZALI

Pensyarah Kanan

Jabatan Teknologi Kejuruteraan Elektrik

Fakulti Teknologi Kejuruteraan Elektrik dan Elektronik

Universiti Teknikal Malaysia Melaka

Signature

:

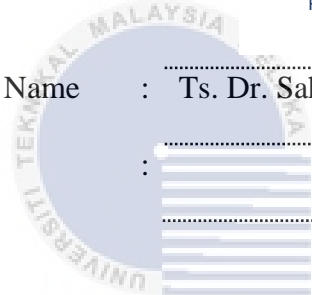
Supervisor Name

:

Ts. Dr. Sahazati binti Md. Rozali

Date

:



اونيورسيتي تيكنيكل مليسيا ملاك

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEDICATION

*To my beloved mother, ROZIAH BINTI ONAN, and father, ABDUL RAHEM BIN
PARIMUN,*



ABSTRACT

A conveyor system is a type of mechanical handling equipment used to transport products from one point to another. Conveying systems come in a variety of shapes and sizes, and it is used to meet the demands of numerous sectors. The goal of this project is to enhance a conveyor machine that is currently in use in a variety of industries or laboratories. Most of conveyor systems do not have a monitoring system to assess the conveyor belt's operation and efficiency. As a result, a conveyor's performance and durability decrease, and significantly interferes with effective production performance. Furthermore, the existing method for adjusting the speed is extremely inconvenient. Therefore, the goal of this research is to help prevent the problem from growing worse by developing PID control system for conveyor belt systems.

This project provides an overview of belt conveyor technology with an emphasis on the several types of control systems that may be implemented using a PID controller. The features, performance measures, requirements, and operating method of belt conveyor drives and control systems are also highlighted in this project.

ABSTRAK

Sistem tali sawat adalah sejenis peralatan pengendalian mekanikal yang digunakan untuk mengangkut produk dari satu titik ke titik yang lain. Sistem ini datang dalam berbagai bentuk dan ukuran, dan ianya juga digunakan bagi memenuhi permintaan berbagai sektor. Matlamat projek ini adalah untuk meningkatkan mesin tali sawat yang kini digunakan di pelbagai industri atau makmal. Kebanyakan sistem tali sawat tidak mempunyai sistem pemantauan untuk menilai operasi dan kecekapan dalam pengoperasiannya. Akibatnya, prestasi penghantar dan ketahanan berkurangan, justeru mengganggu prestasi pengeluaran yang berkesan. Selain itu, kaedah untuk melaraskan kelajuan yang sedia ada adalah amat terhad. Oleh itu, tujuan penyelidikan ini adalah untuk membantu mencegah masalah daripada bertambah buruk dengan mengembangkan kawalan PID dalam sistem tali sawat.

Projek ini memberikan gambaran keseluruhan teknologi sistem tali sawat baharu dengan penekanan pada beberapa jenis sistem kawalan yang mungkin dilaksanakan menggunakan pengawal PID. Ciri-ciri, ukuran prestasi, keperluan, dan kaedah operasi pemacu tali sawat dan sistem kawalan juga diserlahkan dalam projek ini.

ACKNOWLEDGEMENTS

First and foremost, I would like to express my gratitude to my supervisor, Ts. Dr. Sahazati binti Md. Rozali for her precious guidance, words of wisdom and patient throughout this project.

I am also indebted to Universiti Teknikal Malaysia Melaka (UTeM) and my beloved father, Abdul Rahem bin Parimun for the financial support through find the components which enables me to accomplish the project. Not forgetting my fellow colleague, Nur Aidil Fitri Iskandar bin Johor and Muhd Zahid bin Zaharudin for the willingness of sharing his thoughts and ideas regarding the project.

My highest appreciation goes to my parents, and family members for their love and prayer during the period of my study. An honourable mention also goes to my eternity lovely mom, Roziah binti Onan for all the motivation and understanding.

Finally, I would like to thank all the fellow colleagues and classmates, the Faculty members, as well as other individuals who are not listed here for being co-operative and helpful.

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

TABLE OF CONTENTS

	PAGE
DECLARATION	
APPROVAL	
DEDICATIONS	
ABSTRACT	i
ABSTRAK	ii
ACKNOWLEDGEMENTS	iii
TABLE OF CONTENTS	4
LIST OF TABLES	6
LIST OF FIGURES	7
CHAPTER 1 INTRODUCTION	10
1.1 Background	10
1.2 Problem Statement	11
1.3 Project Objective	12
1.4 Scope of Project	12
1.5 Gant chart of Project	14
CHAPTER 2 LITERATURE REVIEW	16
2.1 Introduction	16
2.2 Conveyor Belt Design	16
2.2.1 Types of Designs for Conveyor Belts .	17
2.2.2 Design frame structure for conveyor belt.	18
2.3 Type of PID System.	19
2.3.1 Fuzzy type PID controller	20
2.4 Conveyor belt with development of PID system.	21
2.4.1 The PID controller will be used along with the DC motor.	22
2.4.2 Optimum Speed in Conveyor motor	23
2.5 Sensor was used for classification material in the process	24
2.6 Related project	25
2.6.1 Development of Sensor in Conveyor Belt System to determine the type of material in waste management industries	25
2.6.2 Developments of rubber material wear in conveyor belt system	26
2.6.3 Experimental study and performance of flat belt conveyor system with different speed	27
2.6.4 Comparison of Fuzzy-PID and PID Controller for Speed Control of DC Motor using LabVIEW	28

2.6.5	Design and Implementation of Conveyor Belt Speed Control using PID for Industrial Applications	29
2.6.6	Experimental Study and Design of Flat Belt Conveyor with different R.P.M.	30
2.6.7	Design and control of the belt-polishing tool system for the blisk finishing process	32
2.6.8	Feedforward and Feedback DC Motor Control Methods of Control Systems	33
2.7	Comparison between related projects	35
2.8	Summary	37
CHAPTER 3 METHODOLOGY		38
3.1	Introduction	38
3.2	Flowchart of Project Development	38
3.2.1	Main flowchart	40
3.3	Methodology of Work Flow	41
3.3.1	First Milestone	41
3.3.1.1	Project description	41
3.3.1.2	Literature Review	42
3.3.2	Second Milestone	42
3.3.3	Third Milestone	44
3.3.3.1	Hardware Development	45
3.3.3.2	Development of GUI monitor in PID control system	48
3.3.3.3	Mechanical Design	49
3.4	Summary	50
CHAPTER 4 RESULTS AND DISCUSSIONS		51
4.1	Introduction	51
4.2	Results for Electrical, Program and Mechanical	51
4.2.1	Electrical design and result	52
4.2.2	Program design and result	56
4.2.3	Mechanical design and result	58
4.2.4	Assembly process and result	61
4.3	Result Analysis and Discussion.	62
4.3.1	Analysis by using Ziegler-Nichols tuning method.	63
4.3.2	Analysis by reverse technique by developing Root Locus and Bode Plot tuning method	67
4.4	Summary	72
CHAPTER 5 CONCLUSION AND RECOMMENDATIONS		73
5.1	Conclusion	73
5.2	Recommendations	74
5.3	Project potential	74
REFERENCES		75

LIST OF TABLES

TABLE PAGE	TITLE	
	Table 2.1: Speed 50 R.P.M. of DC motor	23
	Table 2.2: Gear Head DC motor with different speed	32
	Table 2.3: Comparison between related project to analyze the suitable method that can be used on the project	35
	Table 4.1: Data analysis by different value of k	66
	Table 4.2: Graph plot affected by different tuning method	71



LIST OF FIGURES

FIGURE PAGE	TITLE	
Figure 2.1 :	Conveyor belt system in distribution system	17
Figure 2.2 :	Basic type of conveyor that is used in industries	17
Figure 2.3	Conveyor belt drawing	18
Figure 2.4:	Close loop of speed control by PID	19
Figure 2.5:	Comparison data between Fuzzy PID controller with simple PID controller	20
Figure 2.6:	Conveyer Belt in warehouses	21
Figure 2.7:	PID in controlling the DC motor speed	22
Figure 2.8:	Block diagram of the recyclable waste separation system	24
Figure 2.9:	Prototype of the waste management system	26
Figure 2.10:	Schematic of belt structure and pulley with rubber lining	26
Figure 2.11:	Experimental setup of data between two axis of rotor in the conveyor	28
Figure 2.12:	Responses of PID and Fuzzy-based PID Controller	29
Figure 2.13:	Dc motor conveyor system by Matlab.	29
Figure 2.14:	Experimental Setup for Flat Conveyor with different R.P.M	31
Figure 2.15:	Feedforward Load Disturbance Rejection	33
Figure 3.1:	Main Project Flowchart	40
Figure 3.2:	Methodology workflow	41
Figure 3.3:	Flow chart from start to software design	42
Figure 3.4:	Flow chart from software design to mechanical design	43
Figure 3.5:	Flow chart from mechanical design till finish	44
Figure 3.6:	Arduino Uno	45

Figure 3.7: DC motor	46
Figure 3.8: H-bridge L298N	46
Figure 3.9: Arduino IDE software	48
Figure 3.10: Visual Studio IDE software	49
Figure 3.11: Basic design of the project	49
Figure 4.1: Circuit Diagram	52
Figure 4.2 Short circuit of wiring design	53
Figure 4.3 modified connection in I2C and Arduino with component.	54
Figure 4.4 Result of LCD which show the running process.	54
Figure 4.5: Virtual screen by MS Visual Studio	55
Figure 4.6: Program design by MS Visual Studio	56
Figure 4.7: Program design by Arduino	57
Figure 4.8: Result for program design	58
Figure 4.9: Design 3D of conveyor belt	58
Figure 4.10: Design 3D coupling and motor base	59
Figure 4.11: 3D print of DC Motor's coupling and base	60
Figure 4.12: Design 3D of conveyor belt	60
Figure 4.13: Overall project for Conveyer Belt System with PID Control System	61
Figure 4.14: Step-respond founded by Matlab	64
Figure 4.15 : Comparison between the Matlab and Visual Studio graph chart	65
Figure 4.16: After a lengthy period of time	65
Figure 4.17: Root Locus initial state diagram	68
Figure 4.18: Bode Diagram initial state diagram	68
Figure 4.19: Root Locus diagram effect by poles	69
Figure 4.20: GUI plot graph by the same value of PID by Root Locus	70



CHAPTER 1

INTRODUCTION

1.1 Background

A conveyor system is a common mechanical handling equipment that moves materials from one location to another. Conveyor systems allow quick and efficient transportation for a wide variety of materials, which make them very popular in the material handling and packaging industries. Various types of conveying systems are available that are used according to the various needs of different industries. There are chain conveyors (floor and overhead) as well. Chain conveyors consist of enclosed tracks, towline, power & free, and hand pushed trolleys. Conveyor systems are used widespread across a range of industries due to the numerous benefits they provide.

Conveyor systems are frequently used in many industries, including the automotive, agricultural, computer, electronic, food processing, aerospace, pharmaceutical, chemical, bottling and canning, print finishing and packaging. Although a wide variety of materials can be conveyed, some of the most regular items include food items such as beans and nuts, bottles and cans, automotive components, scrap metal, pills and powders, wood and furniture and grain and animal feed. Many factors affect the accurate selection of a conveyor system. It is important to know how the conveyor system will be used beforehand.

This project is to propose the development of PID controller in conveyer belt system. The main objective for this project is to apply a productive solution in Conveyer Belt System with PID control system. The main study of this project is to improve the performance of conventional conveyer belt systems in terms of speed and productivity, which can perform more productivity by maintaining the constant speed when it is worked on load. However, with the development of PID control, it can increase the length of its durability and effectiveness. The development of this project with a PID controller is targeted to overcome this lack of performance.

The PID controller continuously calculates an error value (motor speed) as the difference between a desired set point (SP) and a measured process variable (PV) and applies a correction based on the parameter of proportional, integral, and derivative terms (denoted P, I, and D respectively). This process will occur if a conveyor is used and there is a change of speed if a load is given to the conveyor.

1.2 Problem Statement

The fact that the majority of conveyer machines used in the industry are still applying the old method, which is incompatible with the current state of fast modernization. The majority of conveyer systems do not have a monitoring system to assess the conveyer belt's operation and efficiency. As a result, a conveyer's performance and durability decrease, and significantly interferes with effective production performance. Additionally, the existing method for adjusting the speed is extremely inconvenient. This is due to the fact because it is only limited to several speeds due to the application of potentiometer. As a result, the motor's time to achieve the designated speed is quite delay. Lastly the type of belting used

must be appropriate to the type of material that was used. If it is operated to arrange the goods in the right place, the flat belt conveyor type is definitely the most suitable, because it is very easy to use and to maintain. For heavy transfers, the chain conveyor is very relevant to work with because it is created for hard and challenging work such as cargo transfer and so on.

1.3 Project Objective

The aim is to develop more sophisticated methods to propose a systematic and effective methodology to estimate the conveyor system. After defining the problems, we will explain the goals of the previous project and research. The objective of the project is:

- a) To develop of PID controller to control speed of conveyer belt system by set the value speed.
- b) To analyze the effectiveness of PID controller on the system with different tuning method by monitoring the speed of the conveyor system.
- c) To build a GUI to monitor the speed and value of PID control.

1.4 Scope of Project

Based on the requirement of the project, the scopes will cover:

- a) The conveyor belt was able to be used in different value of speed.
- b) The motor used for the conveyer was a DC type and can be tuned with different speed according to the input speed given and have a low limit value of voltage for torque.
- c) There be a GUI for set the value of K_p , K_i , K_d and speed of DC motor.

- d) The GUI show the current speed value of DC motor throughout process.
- e) Push button are used to start and stop the process immediately if any emergency.
- f) Lastly, this design also gives access to tune the speed when the conveyor was running.



1.5 Gant chart of Project

GANTT CHART PSM 1

ABDUL WAFI BIN ABDUL RAHEM

B081810065

DEVELOPMENT OF PID CONTROLLER FOR CONVEYOR BELT SYSTEM WITH DIFFERENT TUNING METHOD

Task Complete %	Task	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13	Week 14
100	MILESTONE 1 (LITERATURE REVIEW)	■													
100	Selection of title		■												
100	Set objectives, Project Scope, Problem Statement		■	■											
100	Chapter 1 - Introduction			■	■										
100	Chapter 2 – Literature Review				■	■	■	■	■	■	■	■	■	■	■
100	MILESTONE 2 (DESIGN)														
100	Hardware and software						■	■	■	■	■	■	■	■	■
100	Design the schematic diagram, develop part by part of the component's connection and the coding's for the project and troubleshooting								■	■	■	■	■	■	■
100	MILESTONE 3 (SIMULATION)														
100	Simulation, Initial result using software										■	■	■	■	■
100	TESTING AND DATA COLLECT														
100	Testing, record the initial result and tabulated											■	■	■	■
100	Report Writing														

Remarks:

Approved By

GANTT CHART PSM 2

ABDUL WAFI BIN ABDUL RAHEM

B081810065

DEVELOPMENT OF PID CONTROLLER FOR CONVEYOR BELT SYSTEM WITH DIFFERENT TUNING METHOD

Task Complete %	Task	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13	Week 14
0	MILESTONE 1 (LITERATURE REVIEW)														
0	Improvement previous PSM 1 report														
0	MILESTONE 2 (DESIGN)														
0	Develop the schematic diagram & troubleshooting for remaining sensors														
0	Develop the rest of the component's connection and the coding's for the projects & troubleshooting														
0	MILESTONE 3 (SIMULATION)														
0	Simulation, Initial result using software														
0	TESTING AND DATA COLLECT														
0	Testing, record and tabulate the final result														
0	Testing 1 – DC motor to the mechanism														
0	Testing 2 – Arduino programmed and GUI screen for PID														
0	Overall Report Writing														
Remarks:							Approved By								

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this chapter, research and case study is done by reviewing the previous research paper, journal, and anything related to the project titles. The information from the previous research gives an overview on the implementation of the project about how to prepare for the project and it can be used to improve the efficiency and functionality of the system.

2.2 Conveyor Belt Design

A conveyor system is a common piece of mechanical handling equipment that moves materials from one location to another. Conveyors are especially useful in applications involving the transportation of heavy or bulky materials. Conveyor systems allow quick and efficient transport for a wide variety of materials, which make them very popular in the material handling and packaging industries. They also have popular consumer applications, as they are often found in supermarkets and airports, constituting the bag delivery to customers. Many kinds of conveying systems are available and are used according to the various needs of different industries,(Galkin, 2019).



Figure 2.1 : Conveyor belt system in distribution system

Based on Figure 2.1 shows that the design of the conveyor at the distribution center used to transport and sort the goods to their respective places. The condition of the conveyor must be sturdier, durable and easy to manage the distribution of load. Conveyor design should also be simple for workers to perform tasks easily to help them place and pick up goods from the conveyor.

2.2.1 Types of Designs for Conveyor Belts

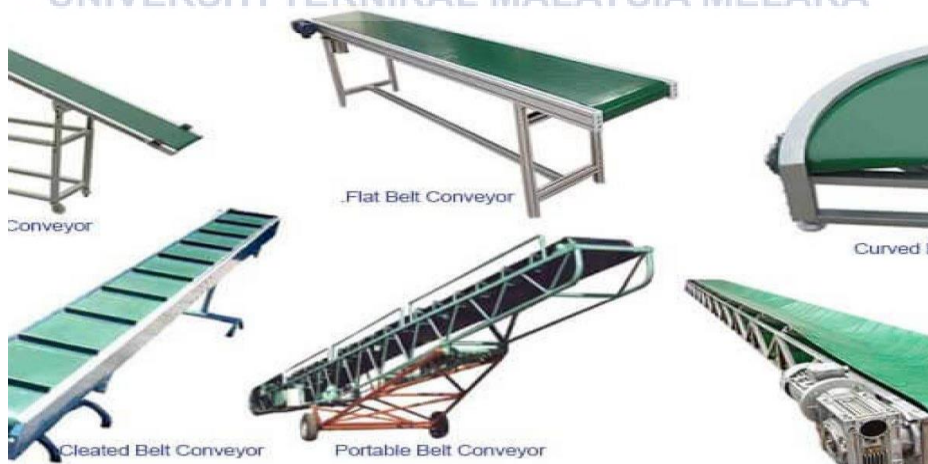


Figure 2.2 : Basic type of conveyor that is used in industries