



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**DEVELOPMENT OF CAD G-CODE TO ABB
ROBOTSTUDIO RAPID PROGRAMMING
CONVERSION APPLICATIONS.**

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electrical Engineering Technology (Industrial Automation & Robotics) with Honours.

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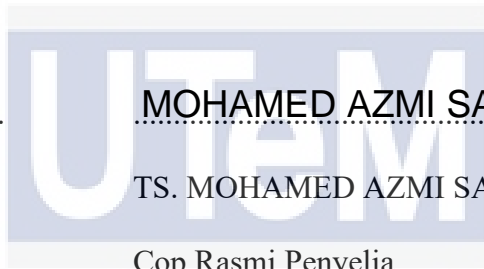
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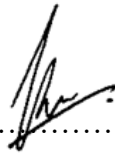
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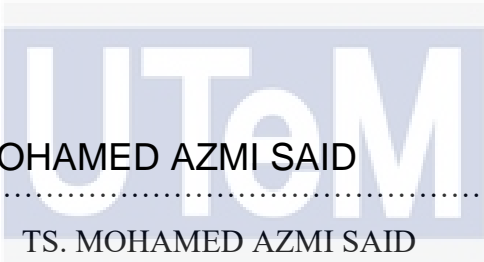



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APPROVAL

This report is submitted to the Faculty of Mechanical and Manufacturing Engineering Technology of Universiti Teknikal Malaysia Melaka (UTeM) as a partial fulfilment of the requirements for the degree of Bachelor of Mechanical Engineering Technology (Industrial Automation & Robotics) with Honours. The member of the supervisory is as follow:



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ABSTRAK

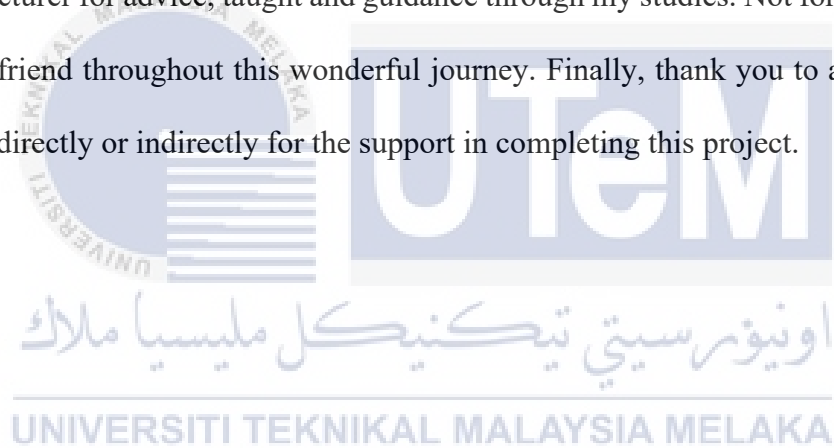
Pada masa kini, robot perindustrian bukan hanya lengan mekanikal, tetapi ia merupakan gabungan daripada pengawal dan perisian. Pelarik adalah salah satu aplikasi robot yang popular. Robot pelarik melangkah ke industri pelarik untuk menggantikan mesin CNC. Robot mempunyai tahap fleksibiliti yang tinggi untuk menggunakan alat yang berbeza, Robot mempunyai kemampuan untuk menghasilkan pergerakan geometri kompleks, berkualiti tinggi, ukuran atau bentuk objek yang berbeza dengan memilih alat dan pengaturcaraan hujung lengan yang sesuai. Setiap pengeluar robot mempunyai bahasanya sendiri, tidak ada standard bahasa robot seperti G-Code untuk robot. Robot industri terdahulu mempunyai banyak masalah seperti program pelarik yang kompleks, beban yang beribu-ribu baris kod. Sebagai penyelesaiannya, setiap pengeluar robot utama menawarkan aplikasi khas untuk menukar bahasa robot menjadi G-Code. Tetapi biasanya aplikasi khas ini adalah aplikasi tambahan dengan bayaran tambahan. Selain itu, kebanyakan industri atau institut tidak mempunyai pengetahuan tentang operasi dan pengaturcaraan robot pelarik. Tetapi mereka mempunyai pengetahuan dalam G-code yang biasanya digunakan dalam Mesin CNC. Oleh itu, aplikasi percuma penukaran G-Code to Rapid Code perlu menggunakan G-Code dan memudahkan operasi dan pengaturcaraan robot pelarik.

ABSTRACT

Nowadays, an industrial robot is not only a mechanical arm, but it is a combination of controller and software. Milling is one of the popular applications for robot. Milling robot is stepping into the milling industry to replace the CNC machines. Robot has high level of flexibility to use different tools, Robot have abilities to produce high quality, complex geometry paths, different size or shape of object by choosing the suitable end of arm tools and programming. Every robot manufacturer has its own languages, there is no robot language standard as G-Code for robot. The preceding of industrial robot has a lot of problem such as load complex milling programs that are thousand lines of code. As the solution every major robot manufacturer offers special application to convert robot language to G-Code. But normally this special application is add-on application with additional paid. Besides, most of the industry or institute are don't have the knowledge of operating and programming a milling robot. But they might have the knowledge in G-code which is typically used in CNC Machines. Therefore, the G-Code to Rapid Code free conversion application is needs to make use of G-Code and simplify robot milling operation and programming.

DEDICATION

I would like to express my special dedication to people who support me with this thesis. I am grateful and acknowledge for both of my parent also sibling for gives me encouragement and endless support to me for complete this bachelor's degree Project (BDP). Without them, I probably not reach this stage. Besides, special thanks for all my fellow lecturer for advice, taught and guidance through my studies. Not forgetting, all my beloved friend throughout this wonderful journey. Finally, thank you to all people who help me directly or indirectly for the support in completing this project.



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LIST OF ABBREVIATIONS

CNC	Computer Numerical Control
CAD	Computer Aided Design
DLL	Dynamic Link Library
KRL	KUKA Robot Language
CAM	Computer Aided Manufacturing



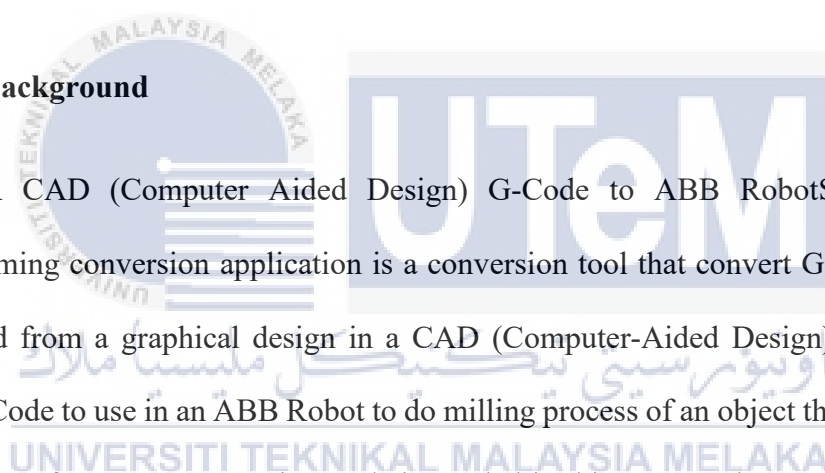
CHAPTER 1

INTRODUCTION

1.1 Introduction

This chapter introduces this project also includes this project's background, problems statements, objective, and scope of work. The introduction also will elaborate the purpose of this project and indicate the importance of this project.

1.2 Background



A CAD (Computer Aided Design) G-Code to ABB RobotStudio RAPID Programming conversion application is a conversion tool that convert G-Code, that are generated from a graphical design in a CAD (Computer-Aided Design) software into RAPID Code to use in an ABB Robot to do milling process of an object that are designed in a CAD software. A conversion tools is needed in this process due to every industrial robot from different manufacturer has their own language and they cannot be command by using the typical G-Code that are using in the machining industry. This conversion application function as a third-party tool that users can simply design a product in their favourite or commonly used CAD software then generate a G-Code and import the G-code into this application and set the offset parameter then this application will convert the G-code into RAPID Code.

In future of machining manufacture, a milling robot replace a CNC (Computer Numerical Control) machine will be realization soon. The differences between robots and CNC machines are getting smaller and smaller over the last decade. Currently robots able to do some machining task such as milling with comparable performance. The specialty of CNC machines is the accuracy and high performance for specific machining application. Whiles, the specialty of robots is the flexibility and variety of operations can be done. Figure below shown a machining robot.



Figure 1.2.1 Machining Robot

A milling robot has the same function as a CNC machine, by using milling robot the milling process can achieve higher accuracy and more flexibility. But a milling robot does not understand the G-Code that are normally used in an automated control machining industry, every robot manufacturer has its own languages. There is no robot language standard as CNC machines G-Code for robot. Therefore, to ease the users to use milling robot, a G-code to Robot language conversion tool is needed.

A CNC machines is an automated control machining tools which used to drills, lathes and 3D printers. A CNC machines able to process a piece of metal, plastic, wood,

ceramic or composite to a desired shape and size that are command by programmed code instruction without human operator. The code that used in CNC machine are knows as G-Code. This program code able to write by a person or generated from a graphical in a CAD (Computer-aided design) software.

The future of manufacturing highly depends on the industrial robot. There is a wide range of robot applications such as material transportation, precision assembly, welding, and machining. Based on the statistical data from the International Federation of Robotics shows that the annual robotic sales globally in 2018, an increase of 6% compared to 2017 shipments. The International Federation of Robotics also expect that average increase of 12% per year from 2020 to 2022. [1]. Figure below shown the statistics of annual robot installations.

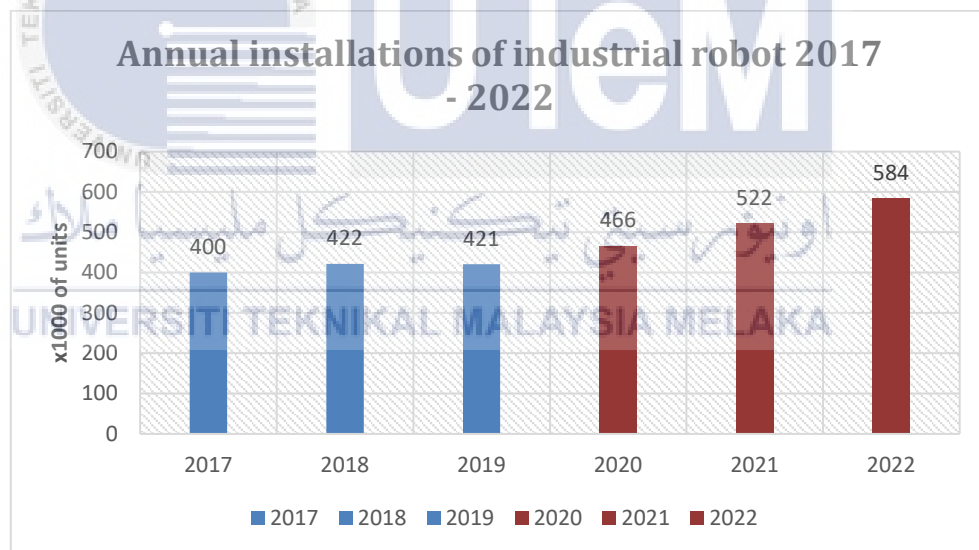


Figure 1.2.2 Annual Installation of Industrial Robot.

1.3 Problem Statement

A typical machining industry, CNC machine is commonly used for machining or milling process. Every CNC machine has their limitation in dimension, orientation, and precision. A specific CNC machine for a specific size of work piece dimension and orientation, ones need a different size or type of CNC machine to do different type of work piece. A high-end CNC machine with multiple axis of orientation is needed to perform a complex and the cost of a CNC machine is high. Besides, a new machine is complicated to setup.

In today's modern technology, an industrial robot can replace a CNC machine. An industrial robot can do multiple task such as pick and place object, welding, painting, assembly, machining, and other industry need. A machining robot has the same function as high-end CNC machine that can perform any dimension or complex machining and has multiple axis of orientation. Besides, a single robot also able to perform multiple tasks at the same time such as, loading and unloading the workpiece after the machining process or change a different workpiece by itself.

1.4 Objective

The objectives of this project as follow:

1. To change the CNC machine process by using machining robot to perform complex shape and orietation of process.
2. To tranform milling machine process that use G-Code into using a robot to perform the process.
3. To make it possible to create robot paths based on G-Code from a graphical design in a CAD software.

1.5 Work Scope

The scopes of this project are as follows:

1. The project is developed in C# programming language by using Microsoft Visual Studio 2019.
2. The project use ABB RobotStudio 6.05 to simulate the Rapid Code that are converted by the software.
3. The project use Dassault Systèmes SolidWorks 2019 to design robot tools and work object. And generate G-Code from the graphical work object.

1.6 Report Statement & Outline

The structure and layout of the thesis are as follow:

Chapter 1 – Introduction: In this chapter will evalobrate and explain about the introduction for this project and including the problem statement, objectives and work scopes of the project.

Chapter 2 – Literature Review: This chapter will discuss about existing G-code to RAPID Code conversion software, G-Code Programming, RAPID Code Programming, C# Programming language, and software that are used in this project.

Chapter 3 – Methodology: This chapter will explain about the processes and method that are conducted in this project as well as how the result is acquisitioned to achieve the project's objectives.

Chapter 4 – Result & Discussion: This chapter will justify about the result of the output data from the simulation software and analyse the data.

Chapter 5 – Conclusion & Recommendation: This chapter will conclude about the whole project and recommend for future work.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter will explain on analysis of previous or existing solution for G-code converter. Also, the detail information of software and programming languages that will be using in development this project, such as the RobotStudio, SolidWorks, Visual Studio, G-Code, RAPID Code, and C# programming language. The purpose of this chapter is to explain and provide justification for this project. Besides, the purpose is also to making sure that this project will achieve the objective and solve the problem that industrial is facing. The main material for writing this chapter will based on researching of, article, operation manual, website, thesis, journal, and other type of published knowledge within the topic of this project. Also, multiple studies and analysis have been done in studying the detail for G-code to RAPID Code conversion.

2.2 Existing solutions of G-code converter

There are multiple choices of a graphical design G-code to robot paths conversion software available today. The main component of this software is to convert G-code that are generate from any CAD software into a robot language for different robot brand in the industry. Some of the software may have special features which allow user to simulate robot motion and some may be capable of translation G-code to multiple robot language. Many of the software available are paid software or limited access for free trial users.

HAL Robotics Framework 1.0 an add-on software for Grasshopper develops by Thibault Schwartz in 2011, specialists on novel applications of robotic in creative and construction industries [2]. This software is used to create or generate robot paths with visualization in the CAD software. It also can support ABB IRC5 controllers which allow user to simulate the robot motions. The main function of this software is to allow users convert G-code into robot paths by importing the G-code that are generate from a CAD software. The special features for premium version are user able to create robot code straightforward in the HAL robotics framework software. HAL software capable to translate G-code to multiple robot language, such as ABB Rapid, KUKA KRL, or Universal Robot URScript.

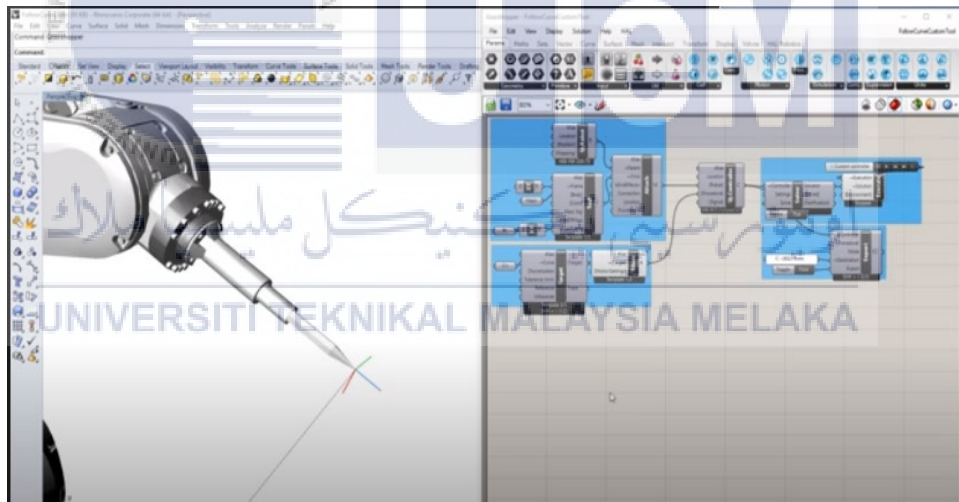


Figure 2.2.1 HAL Robotic Framework 1.0 User Interface.

RobotStudio Machining PowerPac is an add-in RobotStudio application that developed by ABB. The first release in on April 2015, this add-in is designed for CAD/CAM based applications which is ideal for machining, deburring, polishing, grinding and deflashing. It also allows user to easily generates machining paths and allow to created curve on free surfaces. The integrated post processor is creating accurate paths