UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Faculty of Electrical and Electronic Engineering Technology

DEVELOPMENT OF ABB IRB 120 ROBOT BARTENDER

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Bachelor of Electronics Engineering Technology (Industry Automation and Rbotics) with Honours

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A project report submitted
in partial fulfillment of the requirements for the degree of
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Sesi Pengajian : 2021

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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.

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DEDICATION

To my beloved parents, who have always been a source of motivation and encouragement when I was on the verge of giving up, who continue to provide moral, emotional, and financial support for completing this bachelor's degree project (BDP).

and

To my supervisor Ts. Mohamed Azmi Said for his guidance and advice through this study. Also, to all my fellow friends in BEEA and the people who provide the support that minimises the difficulty of this study.

ABSTRACT

In the era of globalisation, an industrial robot is more than just a mechanical arm but also a combination of controller and software commitment. The robot is widely used in automation, and the potential in developing another area is huge due to artificial intelligence being a trend. The feature of the industrial robot can create high quality, complicated geometric routes, as well as the various size of an object with the right end of the arm tool and programming. In this study, the development of IRB 120 is simulated from human action obtained from a motion capture technology. It will be programmed in RobotStudio to mimic human trajectory based on bartending, which is the process of shaking an object. In this study, the human motion trajectory is captured in skeletal view by Microsoft Kinect V2, a camera sensor connecting to pc and running in MATLAB software. In MATLAB, the Microsoft Kinect V2 can capture 25 joint points at one frame per second (fps) and export each joint point's Cartesian coordinates (x, y, z) for analysis. Each joint point represents the respective body part, and the joint point for the hand is intent in this study. With the position data obtained from Kinect, proceed to implement the data to IRB 120 in RobotStudio and program the motion to act like a human arm. Last, the configuration of the gripper as an end effector of the robot to hold the object with the sensor become a smart mechanism.

ABSTRAK

Dalam era globalisasi, robot perindustrian bukan sekadar lengan mekanikal tetapi juga gabungan pengawal dan komitmen perisian. Robot ini digunakan secara meluas dalam automasi, dan potensi dalam membangunkan kawasan lain adalah besar kerana kecerdasan buatan menjadi trend. Ciri robot industri boleh mencipta laluan geometri yang berkualiti tinggi dan rumit, serta pelbagai saiz objek dengan hujung kanan alat lengan dan pengaturcaraan. Dalam kajian ini, pembangunan LHDN 120 disimulasikan daripada tindakan manusia yang diperoleh daripada teknologi tangkapan gerakan. Ia akan diprogramkan dalam RobotStudio untuk meniru trajektori manusia berdasarkan bartending, iaitu proses menggoncang objek. Dalam kajian ini, trajektori gerakan manusia ditangkap dalam paparan rangka oleh Microsoft Kinect V2, penderia kamera yang menyambung ke pc dan berjalan dalam perisian MATLAB. Dalam MATLAB, Microsoft Kinect V2 boleh menangkap 25 titik sambungan pada satu bingkai sesaat (fps) dan mengeksport setiap koordinat Cartesan titik sambungan (x, y, z) untuk analisis. Setiap titik sendi mewakili bahagian badan masing-masing, dan titik sendi tangan adalah niat dalam kajian ini. Dengan data kedudukan yang diperoleh daripada Kinect, teruskan untuk melaksanakan data kepada LHDN 120 dalam RobotStudio dan memprogramkan gerakan untuk bertindak seperti lengan manusia. Terakhir, konfigurasi gripper sebagai pengesan akhir robot untuk memegang objek dengan sensor menjadi mekanisme pintar.

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LIST OF ABBREVIATIONS

ABB	-	Automation Company
IRB	-	Industrial Robot
DOF	-	Degree of freedom
TCP	-	Tool Centre Point
CAD file	-	Computer-aided design file
STL file	-	Stand Triangle Language
MovL	-	Move Link
MoveJ	-	Move Joint
GUI	-	Graphical User Interface
EAOT	-	End of arm tooling
mm	-	Millimetre

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Background

This chapter discusses the project's background, problem statement, objective, and scope of work. The motivation for the project and study intent will also be discussed in this chapter.

This project is to develop a robot bartender by using an industrial robot as a manipulator. ABB IRB 120, as the smallest multipurpose robot, is designed for a wide range of industries, including food and beverage, electronic, machinery, or investigation sectors. Safety can be ensured using lightweight construction materials, rounded corners, intrinsic speed, force limitation, sensors and software that guarantee safe conduct. Industrial robots are programmable, autonomous, and operate on three or four axes.

The ABB IRB 120 robot can be programmed to learn a trajectory, optimise operating space, and work in restricted mode. In this project, IRB 120 is chosen for robot manipulators as the robot bartender to shake the shakers. The trajectory of human arm motion on shaking will be analysed using Microsoft Kinect Camera Sensor V2 through the software MATLAB and implement the data gain to the IRB 120 in RobotStudio.

1.2 Problem Statement

The trajectory of bartending will be examined by human hand movement and applied to the robot eventually. The most popular techniques for properly 3D capturing human movement require a laboratory setup and the placement of markers, sensors, and body parts. There is the excessive expense of these items; however, it is a limiting issue in our workplace. In order to obtain the data or information of the human movement, a costly MOCAP (motion capture) system were introduced with high-speed cameras and reflective markers. However, the complexity expensive were persuaded to discover an affordable and useful motion capture system while executing the robot. Therefore, Motion capture technologies such as Microsoft Kinect camera sensor V2 provide new ways to use motion capture technology. The MS Kinect may be programmable via C++, MATLAB or OpenCV to obtain the desired output for skeletal view. And based on the data obtained, when implemented to robot IRB 120, it will mimic human hand motion. This project is designed for a simple 6-axis robotic arm (IRB 120) to perform the task similarly to the human arm.

1.3 Project Objective

The objective of this project is as below:

a) To analyse the trajectory of human arm motion and obtain data based on the motion capture system MS Kinect v2 camera sensor.

b) To implement the respective skeletal data to IRB 120 in RobotStudio by mimicking the motion obtained from Microsoft Kinect V2 based on a human arm.

c) To develop and evaluate human movement to RAPID robot program code using RobotStudio simulation software.

1.4 Scope of Project

The scope of this project are as follows:

a) The project use RobotStudio simulation software to run the RAPID robot program code that the ABB company operates.

b) The human arm motion trajectory will be captured and monitored in MATLAB software.

c) The configuration of the gripper as end effector will be evaluated to act as a mechanism tool.

d) The RAPID movement program in simulation software is developed in C/C++ language that needs to be compiled for use.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

A literature review is an analysis of scholarly sources on a specific topic relevant to a particular issue or area of research. This chapter will review and summaries the existing research paper, journal, thesis, and published knowledge related to the project's scope. The purpose of this chapter is to explain and provide justification for this project. The sources have been selected based on the project scope similarity.

2.2 A History of Industrial Robot

The idea of automation in the industry to help distribute or work for humanity has been explored over the past half-century. This research paper describes the criteria are mainly the early automation in the industry. An industrial robot is developed and driven by a computer and integrated circuits. In the beginning, robots were used for simple tasks such as picking and placing due to the limitation of no external sensing. They replace humans in monotonous, heavy, and unsafe jobs. When the industrial robot eventually achieves precise motion and external sensor capacity resulting some complex applications were widespread such as welding and grinding. Although robots can solve most of the serious human problems in the area of automation, industrial but not commercially available. [1] In this project, ABB and their IRB as industrial robots will be implemented to fulfil our objective, and they can program by advancements in software such as RobotStudio.

2.2.1 ABB Industrial Robot

ABB robotics introduce the Industrial Robot 120 is, a new model with six axes for flexibility and efficient freedom. The IRB 120 is the newest member of ABB's current fourth generation in robotic technology. IRB 120 is designed for pick-and-place, especially material handling or assembly application. It is fast, small, light, with excellent control and pathway accuracy. Besides, because of its small size, the IRB 120 can be placed almost anywhere and at any angle, such as within a unit, on the highest point of a machine, or beside other robots. It weighs 25kg, with an end effector, can weigh up a maximum of 3kg payload, and has a plane reach of 580mm. The robot is trained completely on some complex tasks due to the higher acceleration and velocity with a repeatability position precision of 0.01mm. [2] The figure above shows the axes of the robot manipulator IRB 120 with six degrees of freedom.

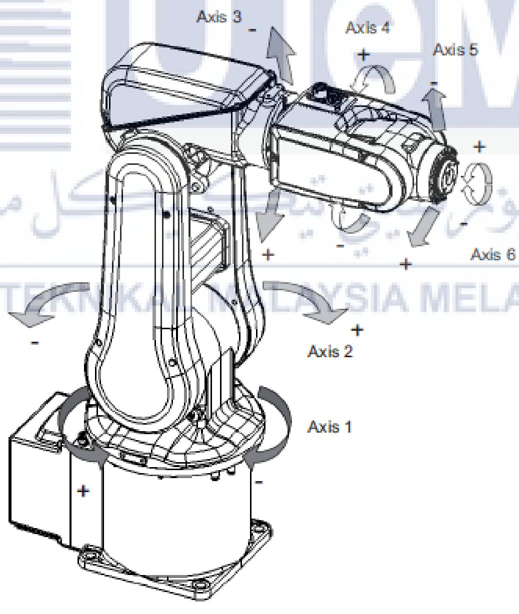

Figure 2.1Manipulator axes of ABB IRB 120

Phonsavanh Segaphone (2018), a master student at Tianjin University of Technology and Education (TUTE) using robotic (IRB 120), writes a human language based RAPID program in RobotStudio. The research paper focuses on the program of the ABB robot to compose Chinese characters (Robot) as well as attaching a specific end effector at the endpoint of the robot. The author retains a basic concept which the action of robot manipulator IRB 120 is regulated by a controller that is controlled by a device is running on software. As a result, the robot manipulator behaviour can be adjusted whenever the program has been modified. [3]

2.2.2 IRC5 Controller with Flex Pendant

The IRC5 is an industrial-robot controller that includes all the functions needed to optimise the robot's output for precise movements. The control module and the drive module are the two types of modules that compensate for the IRC5 controller. All control electronics, such as main machine input and output, I/O boards, and flash memory, are housed in the control module. The IRC5 enables our robots to carry out their duties quickly and effectively. The IRC5 optimises the robot's output by reducing cycle times and ensuring accurate path precision using sophisticated dynamic modelling.

Furthermore, when running the robot system, the control module can test the software that has been programmed. The drive module has made up of all the control electronics that power the robot motors when it comes to the drive module. In the same way, the IRB120 drive module has nine drive units and can handle six internal axes. The IRC5 compact controller also provides a one-phase power input, additional connectors for all signals, and a built-in, expandable 16 input and 16 output I/O system for fast commissioning. [4] The IRC5 is a motion control technology, and it plays an important role in robot performance in terms of accuracy, speed, and cycle period.

2.2.3 End Effector

End effectors, also known as the end of arm tooling (EAOT) in robotics, are devices or tools attached to the end of a robot arm. It is a crucial component of an automated robot that interacts with its surroundings. An end effector consists of a gripper or rather a tool that is attached to the robot endpoint.

According to H. Park and D. Kim research paper, the end effector is a joint structure inspired by the human hand. The distal interphalangeal (DIP), proximal interphalangeal (PIP), and metacarpophalangeal (MCP) joints make up the finger end effector for all four fingers except the thumb. The interphalangeal (IP), metacarpophalangeal (MCP), and carpometacarpal (CMC) joints are also seen on the thumbs. The hand end effector measures 84mm by 61mm by 235.5mm, and each finger measures 13.16mm by 13.2mm by 82mm. This hand end effector weighs 570 grammes in total. This hand end effector's shape and finger scale are close to those of a normal adult male hand. [5] The figure below represents the structure of the end effector of concept-based human writing.

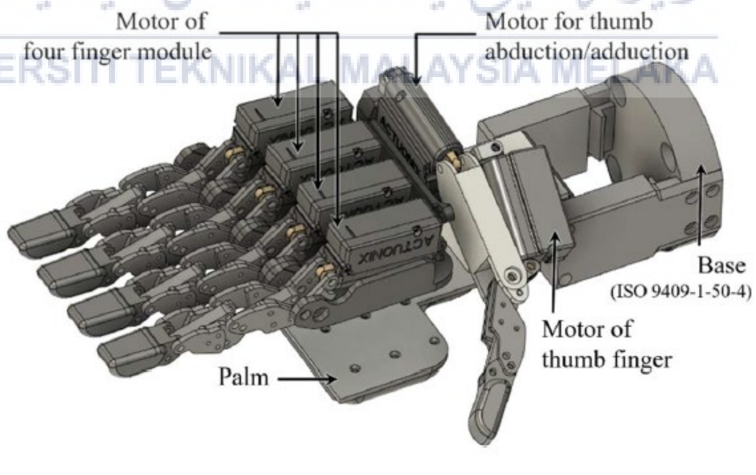

Figure 2.2The structure of the end effector

An Alternative research paper from Anurag Sharma reviews the study of the end effector. The study carried out an analysis of choices on end effectors that depended on the type of task performance. The particular gripper is selected for the task pick-and-place to a specific location, and various tools are fixed on numerous types of workshop operations. Several end effectors have been analysed when applied to multiple functions and workshops. The type of end effector introduced in this paper are mechanical grippers, also known as finger grippers, vacuum cups or called suction cups, magnetic grippers, elastic grippers, handles, and scoops. In this study, a co-relation and coordination of various forms of end effectors are discovered in this analysis to achieve the target purpose entirely. [6]

2.3 Software

This project will be developed using a variety of software to emulate the ABB IRB120 robot. A machine simulation is a programming paradigm that helps you to demonstrate operations to get the desired result. Instead of doing project production in real life, it will imagine the outcome and change the project if it does not fulfil our expectations. On the other hand, software deployment is a risk-free environment in which to test and investigate the project's progress.

2.3.1 RobotStudio

ABB's robot can be modelled, monitored, and simulated using RobotStudio, a virtual user interface (GUI) application. The ability to interact with a robotic IRC5 controller is one of the features of this RobotStudio. This software's capabilities allow us to work with a real physical IRC5 controller, also known as the real controller. In addition, RobotStudio can import CAD or STL files into the workstation as models, with the models being imported as geometries or libraries. The model's operating parameter can be set to travel along a certain path and act as a tool mechanism. The RobotStudio is a simulated environment that allows the user to see the robot operate on a RAPID program in a virtual environment and assess the robot ability to obey the path and targets in programming inside the robot manipulator's workspace. [7]

The research paper by V. Cohal of the Technical University of Iasi study a welding technology using RobotStudio. The findings of using offline programming in RobotStudio to build a welding workstation are presented in this paper. On top of that, it also shows how an assembly welding technology utilising a welding robot can be implemented. The model used in this case is the IRB 140 robot which was designed using the RobotStudio program. As a result, to demonstrate the flexibility of the robot software, the Virtual Studio Arc is used as a configuration and simulate welding to produce a welded assembly. [8] RobotStudio is important to decide the best angle for the welding process in this study and a cost-effective robot usage.

2.3.2 Robot Programming Language

The RAPID programming language is well known as the fundamentals of higher-level programming languages. The RAPID language was developed to solve the needs of increased power demand by industry and flexibility. It was introduced into the market in the first nineties and was a huge breakthrough for ABB. The RAPID language consists of a set of instructions describing the tasks to be performed by the robot. The job description and not of movement implies the existence of an extensive list of education, to which the function will be added to complete the loop. Generally, the instruction is associated with a number if arguments that the action to perform and can be defined in several ways, which are as a numeric value, a reference to datum, an expression, a function, or a string. The flow control program execution within procedures, functions and routines is by FOR loops and WHILE or IF branch instruction. [9]