Faculty of Electrical and Electronic Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Development of an IoT-based Sorting System for Colour-based Products

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

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Development of an IoT-based Sorting System for Colour-based Products

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

Faculty of Electrical and Electronic Engineering Technology

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2021

DECLARATION

I declare that this project report entitled " Development of an IoT-based Sorting System for Colour-based Products" 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.

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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.

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ABSTRACT

Following the currents of modernity must be consistent with the development of technologies that can support the development of technological systems. In order to do justice to the revolution of industrial expansion IR 4.0, colour-based product isolation systems have to be developed from time to time. The entire industry needs work-controlled image processing. Immediately afterwards, the Internet of Things (IoT) can help people monitor the image processing process with the help of the Raspberry Pi usage system. This project aims to automate the product classification system by colour through image processing; Next, the project consists of developing a goods separation system using intelligent devices with monitors. Additionally, by analyzing the performance of the image processing and system monitoring; The method to make this project a success was to process product images for analysis by the Raspberry Pi with a camera. The way this image is processed is by capturing the number of pixels and separating red, blue and green. To successful the project, several data need to be taken. The data been taken is ideal data for image processing image for three types of colours, ideal angular of the sorting product, the servostep for decreasing time taken for one cycle product and the IoT data analysis for tracking the counter for each type of colour product. This prototype project is suitable for iii manufacturing process that have sorting system process to improve quality of logistic and less burden of worker.

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ABSTRAK

Mengikuti arus zaman permodenan perlulah sejajar dengan perkembangan teknologi yang dapat membantu perkembangan sistem teknologi. Bagi memenuhi Revolusi perkembangan industri IR 4.0. sistem pengasingan barang berdasarkan warna harus diperkembangkan dari semasa ke semasa. Seterusnya, hampir seluruh industri memerlukan pemprosesan imej tetapi dikawal oleh tenaga manusia. Sejurus dengan hal tersebut, Internet Pelbgai Benda (IPB) dapat membantu manusia memantau proses imej pemprosesan dengan bantuan sistem pengaturan kawalan Raspberry Pi. Projek ini bertujuan untuk, mencipta sistem automasi pengasingan barang menikut warna dengan mengunakan pemprosean imej. Seterusnya, projek ini adalah untuk mengembangkan sistem pengasingan barang dengan menggunakan peranti pintar dengan memantau ataupun memberi arahan. Tambahan pula, dengan menganalisis prestasi pemprosesan imej dan pemantauan sistem. Kaedah yang digunakan untuk menjayakan projek ini adalha dengan menggunakan kamera untuk memproses imej produk untuk di analisis oleh Raspberry Pi. Produk yang telah di analisis akan diasingkan dalam tiga bekas. Seterusnya dengan menganalisis prestasi pemprosesan imej dan pemantauan sistem. Kaedah yang digunakan untuk menjayakan projek ini adalha dengan menggunakan kamera untuk memproses imej produk untuk di analisis oleh Raspberry Pi. Data yang telah di analisis dalam projek ini adalah, pemprosesan imej, bilangan langkah untuk servomotor2 dan kecekapan aplikasi Blynks pada projek ini. Akhir sekali adalah rekomendasi dan kesimpulan adalah projek ini berjaya dilaksanakan dengan lancar.

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TABLE OF CONTENT

Table of Contents

ABSTRACT i

ABSTRAK ii

ACKNOWLEDGEMENTS iii

TABLE OF CONTENT iv

LIST OF TABLES vii

LIST OF FIGURES viii

LIST OF APPENDICES x

CHAPTER 1 INTRODUCTION 1

1.1 BACKGROUND 1

1.2 PROBLEM STATEMENT 2

1.3 PROJECT OBJECTIVE 3

1.4 SCOPE OF PROJECT 3

CHAPTER 2 LITERATURE REVIEW 4

2.1 INTRODUCTION 4

2.2 REVIEW OF THE CURRENT SITUATION 5

2.2.1 Review of Sorting System 6

2.3 THEORY 6

2.3.1 Microcontroller Devices 6

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2.3.2 Comparison Microcontroller and Microprocessor 8
2.3.3 Raspberry Pi 9
2.3.4 Arduino Uno 10
2.3.5 Comparison between Arduino and Raspberry 11
2.4 WIRELESS MODULE 11
2.4.1 Bluetooth 11
2.4.2 Wi-fi 12
2.4.3 Zigbee 12
2.5 Comparison Between Wireless Modules 13
2.6 HARDWARE COMPONENT 13
2.6.1 Servo Motor 13
2.6.2 Stepper Motor 15
2.7 JOURNAL RELATED 17
2.7.1 Raspberry Pi as Internet of Things hardware: Performances and Constraints 17
2.7.2 Object Sorting Automated System using Raspberry Pi 18
2.7.3 Color-Based Sorting System for Agriculture Applications 20
2.7.4 Real-Time Image Processing Method Using Raspberry Pi for a Car Model 21
2.7.5 Color's Influence on the Workplace 22
2.8 SUMMARY 23
CHAPTER 3 METHODOLOGY 24
3.1 INTRODUCTION 24
3.2 FLOWCHART 24

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

3.2.1 Flowchart of the whole system 26

3.2.2 Problem statement 27

3.2.3 literature Study 28

3.3 REVIEW ON SELECTED COMPONENT 29

3.3.1 Raspberry Pi 29

3.3.2 Camera 30

3.3.3 Servo motor 31

3.3.4 Feeder (Shaft connector and bed frame) 32

3.3.5 Supporting frame 33

3.4 SOFTWARE DEVELOPMENT 33

3.4.1 AutoCAD 33

3.4.2 Python coding 36

3.4.3 Proteus 8 Professional 36

3.4.4 Blynk apps 37

3.5 FRAMEWORK PROJECT 38

CHAPTER 4 RESULTS AND DISCUSSION 40

4.1 Introduction 40

4.1.1 hardware implementation 41

4.2 Data analysis for image of three types of colours 42

4.3 Data analysis for colour product 42

4.4 TAKE THE DATA FOR SERVOMOTOR 48

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

4.4.2 Change the step of Servomotor1 50

4.4.2 Angular data analysis for Servomotor2 52

4.5 BLYNKS APPLICATION 54

4.5.1 Count the output product with categories 55

4.5.2 Control switching ON and OFF system 56

4.6 Summary 58

CHAPTER 5 CONCLUSION AND RECOMMENDATION 59

5.1 Conclusion 59

5.2 recommendation and feature 60

APPENDICES 63

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

LIST OF TABLES

Table 2.1: Comparison Microcontroller and Microprocessor ________________________ 8

Table 2.2: Comparison Between Arduino and Raspberry Pi ________________________ 11

Table 2.3: Comparison between wireless modules _______________________________ 13

Table 2.4: Stepper motor vs Servo motor____ 16

Table 4.1: Result for red product ____ 44

Table 4.2: Result data for Green Product____ 45

Table 4.3: Data analyse for blue product ____ 46

Table 4.4: Ideal Data for Three Colour ____ 47

Table 4.5: Time taken to complete one cycle process _____________________________ 51

Table 4.6: Data angle selected ____ 53

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

LIST OF FIGURES

Figure 2.1: The Worker Sorting the Product 5

Figure 2.2: Parts of Microcontroller 7

Figure 2.3: label diagram of Raspberry Pi 10

Figure 2.5: Servo motor 14

Figure 2.6: Stepper motor 15

Figure 2.7: Iot of Raspberry Pi 17

Figure 2.8: Flowchart of Image Processing by Shape 19

Figure 2.9 :Gardener sorting Plant 20

Figure 2.10 :The original image of Traffic Light Detection 22

Figure 3.1: Image processing flowchart 25

Figure 3.2: Flowchart whole process 26

Figure 3.3: Triangle Process of Literature Review 28

Figure 3.4: Input/Output Raspberry Pi 4 model B 30

Figure 3.5: Camera Raspberry Pi 31

Figure 3.6: Servo motor with Shaft 32

Figure 3.7: Bed Frame 32

Figure 3.8: Acrylic material of Prospect 33

Figure 3.9: view of plan and dimension 34

Figure 3.10: Multiples viewport 35

Figure3.11: The whole design of the product 35

Figure 3.12: Python 36

Figure 3.13: Proteus 8 Professional 37

Figure 3.14: blynks application 37

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Figure 3.15: Framework project 38
Figure 4.1: full hardware implementation 41
Figure 4.2: Coding for pop out the trackbar 42
Figure 4.3: Trackbar for calibrate the image 43
Figure 4.4: input data for three colours 47
Figure 4.5: output for green display 48
Figure 4.6: connection of Servomotor1 49
Figure 4.7: Connection of Servomotor2 49
Figure 4.8: Angle Movement Servomotor1 50
Figure 4.9: Method change speed Servomotor1 50
Figure 4.10: Time taken one cycle process by change value Servostep input 52
Figure 4.11: 5G connection support 55
Figure 4.12: Counter product program 55
Figure 4.13: Thonny platform and Blynk Application 55
Figure 4.14: initial condition 56
Figure 4.15: Switch OFF status Thonny Platform 56
Figure 4.16: ON status at Blynks application 57
Figure 4.17: System on at Thonny Platform 57
Figure 5.1: various types of colours 60

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

LIST OF APPENDICES

APPENDIX	TITLE	PAGE
Appendix 1	GANTT CHART	63
Appendix 2	CODING RASPBERRY	65

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

CHAPTER 1

INTRODUCTION

1.1 Background

This project aims to develop an IoT color-based product sorting system using the Raspberry Pi, which will calculate the program in this project. The system controls the feeder is a servo motor in this project. The color-based sorting system will improve innovation using less human power and production errors. After this project completed, the output production will increase further due to the improvements made in this project. In this project, the camera will be developed to detect the colour of the product to provide the Raspberry Pi program. If the information was a Raspberry Pi program, the mechanical part of this project would react. The mechanical part required in this project is the servo motor, which moves the mechanism to select the product of the collapse. Next, the Raspberry Pi will be supported by a camera sensor to scan the product colour, providing the microcontroller with information. In addition, the camera detects only three types of green, blue and red colours. The software Raspberry Pi is a program to monitor and meet the system requirements of the project. Finally, for smartphone devices, Blynk apps are being used to extract product information, such as the number of products being sorted, the types of product colours sorted and the time taken to complete a cycle system.

1.2 Problem Statement

Industry trial system automation gave a lot of advantage to the industry's production. The automation industry uses the sorting system to trial its product followed by its class holistically around the world. The output production of each industry is also increasing because of customer demand. Next, the sorting system helps most people to continuously sort the product without reducing its performance. Besides that, nowadays the sorting system has a minor problem. Many sorting systems in the industry use manual systems which make output production very difficult. The quality of workers can be influenced by their performance. As a result, the human power in the sorting system industry is exposed to a risk, which can lead to several possibilities.

The previous solution proposed by the engineer is to try to implement the PLC system, which offers industry many benefits. The functioning principle of PLC is the sorting system in which the project uses pneumatic cylinders with colour sensors to automate the system in its entirety. Next, the system includes a product conveyor belts and a colour sensor to feel the product colour type. The system then uses 2 pneumatic cylinders with solenoid valves to push the product into its respective collection station. The PLC system component could be very expensive to implement in the automation sorting system.

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The next problem with using PLC in the sorting system is the power problem because the PLC devices will need the high power needed to consume the system. PLC system maintenance could be very expensive because the PLC device component is difficult to repair. Therefore, the Raspberry Pi will be implemented to improve the current problem in this system.

By using the colour sensor on the sorting system and implementing Raspberry Pi in the system, production will increase. The component that is low cost and easy to carry out in this project. By using Python language in the coding of the Raspberry Pi, employees can easily check for system errors. The Iot system in the sorting system will allow the system to operate far from the system.

1.3 Project Objective

For this project to be succeeded, the objectives which need to be achieved are:

- To design and develop microcontroller-based circuits and hardware for a colour-based sorting system.
- To apply an IoT technology on the sorting system via a smartphone for control and monitoring purposes
- To analyse the performance of the sorting system in terms of its detection effectiveness of colour-based products.

1.4 Scope of Project

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For this subtopic, the scope had been laid out to achieve an expected outcome and accomplish the given task.

- The system is using Raspberry Pi as microcontroller and microprocessor
- Just three type of coloured will be sorting in this system (Green,Red,Blue)
- Smartphone will be used as sorting system monitoring.
- To link the smartphone and Raspberry Pi, Blynk will be used.
- Only round-shaped object will be sorted

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Things are usually arranged by hand, which requires human labour. Identifying and ordering a particular item is a difficult task. Based on this paper, the system takes account of the above considerations and offers a cost-effective solution. Using the Raspberry Pi, an open board powered by intelligence. Raspberry Pi technology has now played an important role in a variety of automation applications. The production line is an industrial production line equipped with industrial robots and industrial IP cameras(Szabo and Gontean, 2016) . The aim of this project is to evaluate its usefulness and effectiveness as a mechanical device for the sorting of objects. Identifying and arranging a specific object is a difficult task, especially in the industry, where many objects must be sorted within a short period of time, while also bearing in mind that the weight of the items is much larger than the average person could bear. Using a Raspberry Pi, a Linux-based open-source board, in this project. Raspberry Pi has played a major role in a wide range of automation applications in today's technology. The objective is to assess its usefulness and effectiveness as a mechanical device for the sorting of objects. Sensor or detector provides a way to collect data on operations and approaches(Yadav *et al.*, 2019)

2.2 Review of The Current Situation

Automation is the use of control systems to handle various processes and machines in order to replace human efforts. A sophisticated algorithm is used by an automated system to increase the value of the planning. However, this not only reduces manual efforts and time consumption, but also allows for more time to consider factors such as aesthetics. Using automation also eliminates the danger that could occur when humans are forced to work in hazardous environments. As a result, the use of automation is extremely beneficial in the manufacturing industry. Automated sorting also reduced labour costs and, as a result, production time. The use of an automated system by color-based sorting employing a colour sensor eliminates errors caused by human negligence. Errors occur because of fatigue and subjectivity associated with manual colour sorting of components, and productivity is also reduced. Figure 2.1 showed the worker do sorting task that need repetitive task to do,

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Figure 2.1: The Worker Sorting the Product

2.2.1 Review of Sorting System

The sorting system is the process by which the product is separated by certain specific characteristics such as size, shape, and weight. In the manufacturing industry, human power is used manually to save machine cost maintenance. Because of this, people have their faintness, such as human error, fatigue, and emotional control. To reduce the error, the system needs to be improved day after day to increase the product output in the industry. To increase production, the industry must employ workers to sort the product manually. It gives more to the cost of the company which affected human health's performance. The colour-based product sorting system will be improved if this project complies with all the requirements. Sorting is currently primarily carried out artificially, but there is no effective automated production machine. (Tian *et al.*, 2017)

2.3 Theory

2.3.1 Microcontroller Devices

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Microcontroller devices are the main integrated compact circuit for the operation. A microcontroller needs the 5V energy supply. The electronic device usually needs the microcontroller to calculate the entire system program. Chip CPU (Central Processing Unit) RAM (Random Access Memory), ROM are all microcontrollers (Read Only Memory). Microcontrollers shall be used in products and devices such as automotive motor control, medical equipment, actuator program and remote control automatically. The base internal bus width, the memory and the instructions can be classified as 4-bit, 8-bit, 16-bit and 32bit microcontroller. The 8-bit microcontroller chip implemented in the system is mainly used in electronic devices. A digital computer can monitor the various signals in a system and decide smartly on how to implement a control strategy Global automation has grown so rapidly every day in the 21st century to increase production. Extensive mixed signals are used to integrate the analogue components necessary for the control of non-digital electronic systems. Microcontrollers were famous and were a cost-effective way to collect, recognise and react to physical worlds on the internet. For low power consumption, different microcontrollers can even use four-bit words or ramp it up to 4 kHz. Usually, the system can process functions while waiting for a keypress or other interrupt to create a majority of them for long term applications. These microcontrollers can play an important role in performing similar DSPs with higher clock rates and higher power consumption. There are many different types of microcontrollers like Arduino, PIC, Raspberry PI and more in this stream. It shows the functional system working on the basis of the figure 2.2.

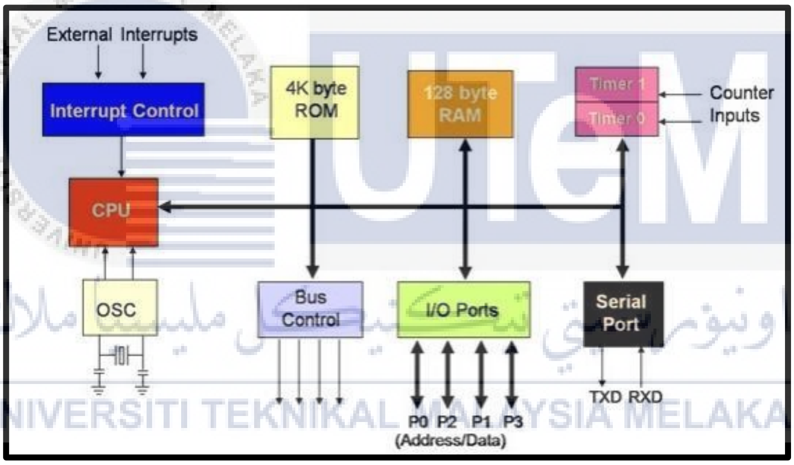

Figure 2.2: Parts of Microcontroller

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2.3.2 Comparison Microcontroller and Microprocessor

Table 2.1 shows the comparison between microcontroller and microprocessor.

Table 2.1: Comparison Microcontroller and Microprocessor

Microcontroller	Microprocessor
A compact integrated circuit designed in an embedded system for a specific operation.	A component that can performs the instruction and task involved in computer processing
Used for application that performs task	Used for application that require intensive processing
CPU and all other elements are intetrated into a single chip board	Memory, I/O ports, and timers are connected to the CPU
Performs a single task. Therefore, it does not rewuire more memory and I/O ports	Microprocessor based application performs multiple tasks. There, it required more memory
Has a lower clock speed (Hz) 1 MHz to 300 MHz.	Has high clock speed (Hz) 1GHz to 4 GHz

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2.3.3 Raspberry Pi

The Raspberry Pi is a low-price credit card-sized device that can be connected via HDMI to a monitor or TV and uses a fundamental mouse and keyboard. This is a small tool that allows people of all ages to learn computers and programming languages such as Scratch and Python. It can do all a computer can to surf the internet and play high-definition video games. The Raspberry Pi is a hard drive SD card inserted into a slot. A conventional RCA TV display, a more modern monitor, or even a TV can be connected to a video output via the HDMI port and can be powered by a USB. This offers all the basic functions of the machine. It also uses very little electricity, only about 3 watts. The Raspberry Pi can be set up with the installation of a keyboard, mouse, and display monitors adaptable with HDMI, directly or converted from HDMI to an alternative form.(Yamanoor and Yamanoor, 2016)

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The Raspberry Pi comes with a 64-bit microprocessor, which processes more information and sends more memory to the Random-Access Memory (RAM). The following is the Raspberry Pi with 1 GB of RAM. A Raspberry Pi with video output, HDMI port, port for SD cards, Audio jack, CSI camera port, DSI display port, 4 USB 2.0 ports, Gigabit, Wireless LAN, Bluetooth 4.2, and I/O pins, is much more advanced in this respect (GPIO). The raspberry Pi offers the enormous technology of invention which facilitates human life. It will be more efficiently studied for future use. The Raspberry Pi Computer Board will focus on comparing its performance and limitation with popular prototyping platforms (Maksimović *et al.*, 2014). Figure 2.3 shows the label diagram of Raspberry Pi component.

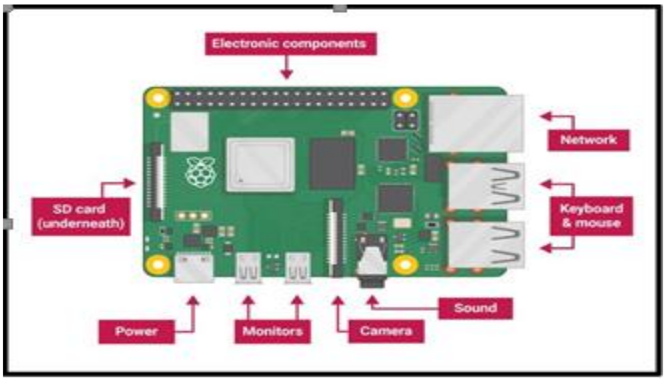

Figure 2.3: label diagram of Raspberry Pi

2.3.4 Arduino Uno

Arduino is an open-source microcontroller that can be program, deleted and reprogramd at any time. Arduino has been designed to provide hobbyists, students, and professionals with a cost-effective and easy way of creating devices that interact with their environment using sensors and actuators. It is an open-source computing platform used for building and programming electronic devices, based on simple microcontroller boards. It can also operate like other microcontrollers as a minicomputer by taking inputs and controlling the outputs of several devices for electronics.

With the help of different Arduino shields mentioned in this paper, data may also be received and transmitted over the internet. The Arduino development board is a hardware piece, and the Arduino IDE is a software piece for code writing (Integrated Development Environment). Built using the 8-bit AVR microcontroller or other Atmel-based microcontroller or using the 32-bit Atmel ARM, Arduino IDEs C or C++ language can be easily programd. These trends have their advantages and additional opportunities directly linked to the integration of new technologies (Lita *et al.*, 2019).

2.3.5 Comparison between Arduino and Raspberry

Table 2.2 shows the comparison between Raspberry pi and Arduino.

Table 2.2: Comparison Between Arduino and Raspberry Pi

Raspberry Pi	Arduino
Stronger, quicker processor and multitasking available	Easier to connect to analog sensors, motors, and another electronic component.
Built in Ethernet port, Wi-Fi, and Bluetooth capability	can run one code at a time. Due to that point, the arduino cannot do multitasking activities
Good for online project that need to connect online and have multiple activities going on	Bigger learning curve since C or C++ language
The clock speed can reach to 700 MHz	The clock speed can reach to 16 MHz
Have SD card (2 to 16 Gb)	Flash ROM (32 Kb)
Raspberry Pi is the linux OS	Does not have operating system.

2.4 Wireless Module

2.4.1 Bluetooth

Bluetooth is the industry standard for wireless short-range connections between electronic devices. Instead of using a cable to send data over radio waves. A Bluetooth connection typically works within a 100-meter radius. Broadcom (a major Bluetooth manufacturer) provides a full software implementation in C++ that includes the majority of the main protocol functions in relation to the seven OSI layers.(Uludag and McBride, 2010)

2.4.2 Wi-fi

Wi-Fi is the name of the popular wireless system that uses radio waves to deliver high-speed wireless Internet and network connections. With radio frequency technology, Wi-Fi networks do not have a physical weird connection between sender and receiver. Whenever an antenna receives an RF current, an electromagnetic field is formed which can propagate through space. The invisible and indeterministic nature associated with WiFi signal propagations leads to uncertainties in matching the mobile devices detected by sniffers and pedestrians to be monitored.(Huang *et al.*, 2021)

2.4.3 Zigbee

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Zigbee communication is the Zigbee-alliance product and is especially designed for IEEE 802.15.4-based control and sensor networks for wireless personal area networks (WPANs). This communication standard specifies the layers of physical and media access control (MAC) required to handle many devices at low data rates. These Zigbee WPANs operate at 868 MHz, 902-928 MHz, and 2.4 GHz frequencies. The data rate of 250 kbps is best suited for periodic and intermediate two-way data transmission between sensors and controllers. ZigBee data rates with ranges from 10m to 70m could reach 250kbps.(Firdaus, Nugroho and Sahroni, 2014)

2.5 Comparison Between Wireless Modules

Based on the table 2.3, it shows three wireless module of Bluetooth, Zigbee and Wi-fi.

Table 2.3: Comparison between wireless modules

	Bluetooth	ZigBee	Wi-fi
Data rate	1 Mbps	250 kbs	11-54 Mbs
Distance range	10 meters	300 meters	100 meters
Power needed to energize	Medium power consumption	Low power consumption	High power consumption
Cost	Medium cost	Low cost	Medium cost

2.6 HARDWARE COMPONENT

2.6.1 Servo Motor

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A servo motor is a closed-loop system consisting of multiple spinning units based on the principle of servomechanism. Unlike stepper motors, it offers a feedback system with angular accuracy that allows us to achieve a suitable rotation based on the input signals applied. It is designed so that its output shaft can be moved to a certain angle at a specified speed and not with a standard motor. The electric signal applied, which may be analogue or digital, corresponds to the movement required to place the shaft. The controller receives speed and position information as a feedback unit from either an encoder or a solver. The motor speed is proportional to the input voltage applied.

Figure 2.5: Servo motor

The most important servo motor is the servo motor positional rotation. It is therefore the most common servo motor. The output shaft rotates about 180 degrees. Indeed, due to the closed-loop system which implements a PID control in the circuit servo, the noise and vibration of the servomotor is very low. The servo motor speed is faster than the stepper motor which can reach a maximum speed of between 3000 and 5000 rpm. The servo motor will also rotate if the load is heavy. As the servo motor is composed of Pulse with modulation (PWM), the servo motor rotates accurately. Modulation of pulse width is used to control the servos (Kulkarni and Singh, 2018). Based on the figure, 2.5, example of servomotor component.

2.6.2 Stepper Motor

The stepper motor is a brushless, simultaneous electric motor, which translates digital pulses into mechanical shaft rotation. When powered by a sequentially switched DC power source, the normal shaft movement consists of discrete, almost uniform angular motions. Stepper motors are widely used in a variety of industries(Aranjo, Soori and Talukder, 2012) . Based on the figure 2.6, the example pf stepper motor .

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Figure 2.6: Stepper motor

The stepper motor is the simple conducting motor system. The user just can fabricate it by crates a control circuit and start the motor to rotating. The noise and vibration that the stepper motor obtain is often due to the system of the stepper motor is open-looped system. The rated speed of the stepper motor is just 1000 rpm to 2000 rpm. Next, the out of step condition is possible which, the system will not run if the load is too heavy. The price of the stepper motor quite cheaper than servo motor. The resolution of the stepper motor is based on its type, but it cannot be more precise than servo motor because it does not required encoder.

2.6.3 Comparison Type of Motor.

Based on the table 2.4, the comparison of stepper motor and servo motor.

Table 2.4: Stepper motor vs Servo motor

	Stepper motor	Servo motor
Drive circuit	The user can fabricate it	Since the design very complicated, it is not possible to fabricate
Noise and vibration	Are significant	Not significant
Speed	High torque in low speed	High torque in high speed
Control method	Open loop because does not have encoder	Closed loop because uses an encoder
Price of motor and driver	Quite cheap	Expensive
Resolution	Tuning or gain adjustment not required	Tuning or gain adjustment are required

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2.7 Journal Related

2.7.1 Raspberry Pi as Internet of Things hardware: Performances and Constraints

The Internet of Things, or IoT, is a highly complex and widely distributed networked framework. IoT, can be looked as a highly dynamic and radically distributed networked system. In other words, it consists of many smart objects capable of communicating and interacting, forming networks of interconnected objects, end-users or other network entities. The Raspberry Pi uses an operating system, like any other computer. Raspbian is an excellent match for the Raspberry Pi, a free and open-source Linux distribution. Based on the figure 2.7 the building Internet of thing by implement Raspberry Pi.

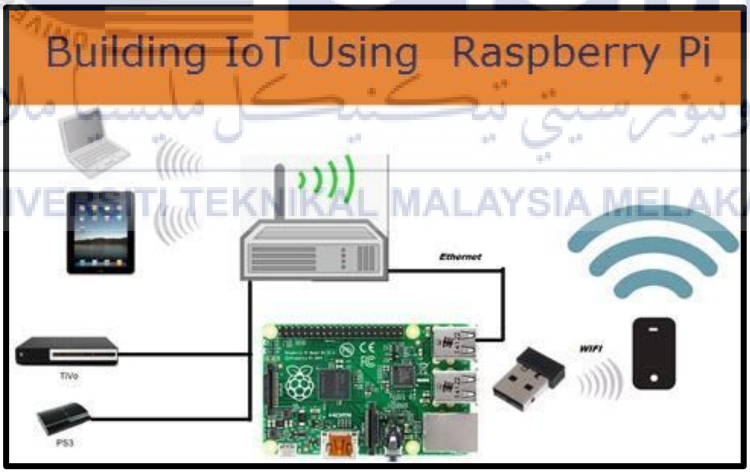

Figure 2.7: Iot of Raspberry Pi

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On a broad scale, the output of Raspberry Pi is compared with that of some common boards and platforms in terms of computing capacity, scale, and total cost. The results of the review show that the Raspberry pi is quite expensive. On the other hand, detailed Raspberry Pi studies have shown that it is the ideal platform for interfacing with many devices and using it as an ultra-cheap yet usable computer board for numerous input and output peripherals and network communication in a wide range of applications.

2.7.2 Object Sorting Automated System using Raspberry Pi

Automation is very popular, and it is used to do most of the work in order to increase productivity and save time. It is less expensive to use an Open-Source platform, and the Linux-based operating systems used in Raspberry Pi, OpenCV, and Python are simple to use and develop on[10]. Digital image processing is the use of computer calculations to perform image processing on digital images in software engineering. Image processing is becoming more popular in today's technology. Image processing is a subset of signal processing in which the input is converted to an image, which is then processed to obtain values, parameters, or features associated with the image.

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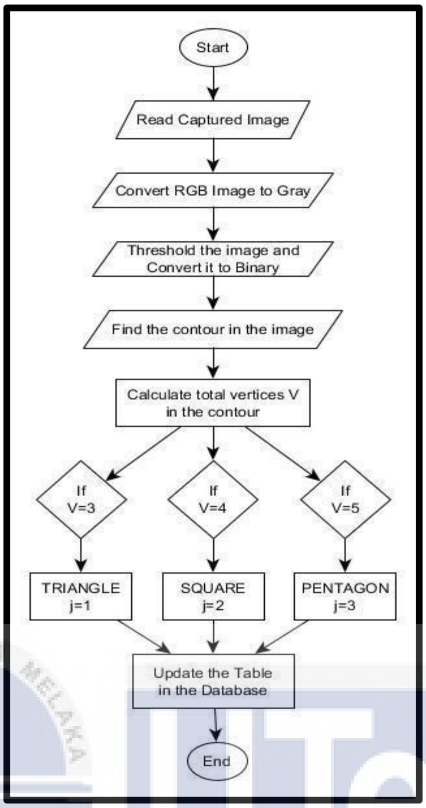

Figure 2.8: Flowchart of Image Processing by Shape

For pure Red, Green, and Blue coloured items, the device provides accurate results. Human efforts are minimised because of the use of automation in a method that requires object sorting based on colour and form, resulting in increased accuracy as well as time and money savings.

2.7.3 Color-Based Sorting System for Agriculture Applications

Incredible advances in the field of microcontrollers and sensors have opened new avenues for developing innovative technologies that can significantly improve the performance of traditional systems used in various industries and agriculture. Agriculture is undergoing a significant technological transformation, which is being influenced by the development of new concepts such as the Internet of things (IoT) and self-driving machines . Sorting is a repetitive and time-consuming task that does not necessitate a high level of qualification and is thus amenable to automation using dedicated machines. In this context, the idea of implementing automated machines for sorting objects based on colour characteristics arose. Based on the figure 2.9, the gardener sorting the fruit based on its bin.

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Figure 2.9 :Gardener sorting Plant

Color-sorting systems have become indispensable in many fields where this time-consuming and repetitive task can be automated. Because it is based on an advanced colour sensor and an enhanced set of software algorithms, the proposed sorting system has good detection performance as well as improved reconfigurability and adaptability. The detection area must be isolated from external influences because the colour detection process is highly sensitive to the quality of light used to illuminate the analysed object. A high colour rendering index light source is ideal for improving the performance of the proposed sorting system.

2.7.4 Real-Time Image Processing Method Using Raspberry Pi for a Car Model

This paper describes the creation of a car model that can detect the edge, line, and corner of a road image, as well as the red colour of a traffic light image. The car model is outfitted with a camera that is used for the purpose of computer vision. The image was captured by a camera. The Raspberry Pi single-board computer is used to read the data. The algorithms for image processing methods are chosen to detect the colour of the road model's edge, line, corner, and traffic light. The algorithms are created in Simulink diagram blocks and then embedded in the Raspberry Pi with the Simulink Support Package for Raspberry Pi Hardware. The embedded algorithms for detecting traffic light lines, edges, corners, and red colour will be tested. Based on the test results, the embedded image processing algorithms can successfully detect line, edge, and corner of the road images, and detect the red color of traffic light image(Ariyanto *et al.*, 2019)

Figure 2.10 :The original image of Traffic Light Detection

2.7.5 Color's Influence on the Workplace

Color is one of the elements that plays an important role in interior design, particularly in the workplace. Colour is discussed in the field of environmental psychology as another environmental factor that has a significant impact on human perception and behaviour. A warm colour stimulates people, while a cool colour calms them.

Most of the studies observed the red, yellow, green, and blue based on the journal relate. Most of the studies were cross-cultural in nature. Blue and green are consistently voted as the most popular colours(Angela, Sergiu and Petru, 2017).Working in the red or colourful room with visual complexity put the brain into a more exciting state, caused the slowing of the heart rate and overload(Savavibool, Gatersleben and Moorapun, 2018)

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2.8 Summary

Based on the literature revie, a lot of reference and journal that were related with this project. By doing the research every journal, Sorting system colour based can be improved by review this chapter. The objective of the literature review is for collect all the information for past project to makes improvement. For the next chapter, the project will be used one of the components from the literature review to fulfil all the requirement and objective of the project

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CHAPTER 3

METHODOLOGY

3.1 Introduction

For this chapter, the project will be combined by selected part from the research that have made. The flow of this entire project will be explained clearly in this chapter. This chapter will be deliberate to combine all detail and endorsement of how this project was success. The design and improvement of development of an iot-based sorting system for colour-based products will be combine in this chapter. In this chapter, discussion on how method that will be used to achieve the objective. This chapter will start with the flow chart of the system and will follow by the software and hardware component. To make the user satisfied with the selection of the component, the justification will be explained in every component advantage.

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3.2 Flowchart

The flowchart was created to fulfil the project method and make the system easier to run. In either diagram shape, almost every step of the pattern is visible. Steps relate to connecting lines and directional arrows, allowing everyone to view the flowchart and follow the instructions logically from beginning to end. It could also be used to document, study, plan, improve, and explain complex processes in very clear and simple ways. The flowchart for detecting the colour of an object is shown below. Flowchart capturing image to Raspberry Pi

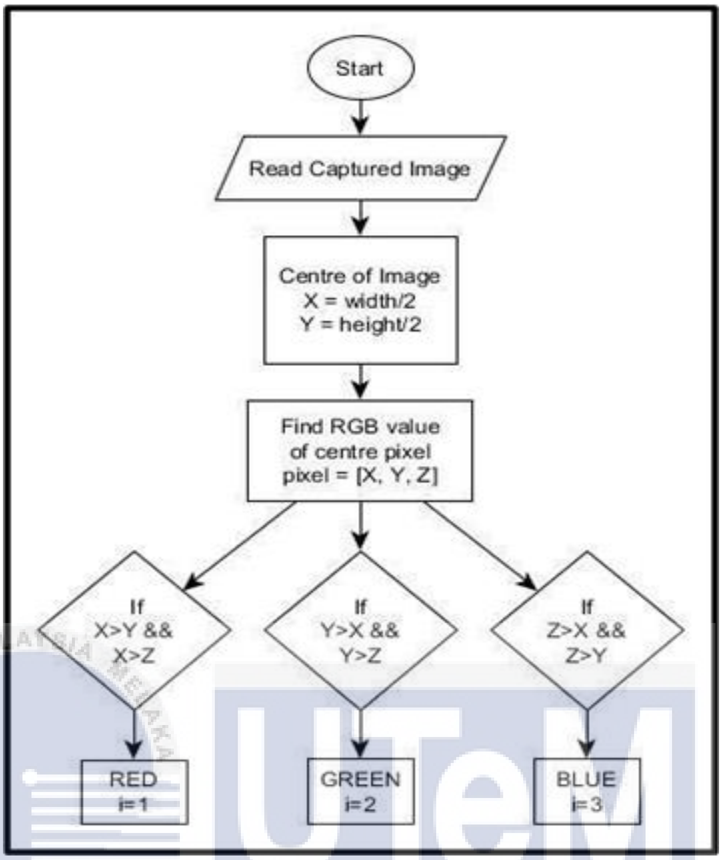

Figure 3.1: Image processing flowchart

From the flow chart above, If pixel = [76 177 34], then 76 corresponds to blue, 177 to green, and 34 to red. After obtained these values, compare the elements of the variable pixel to see which is greater. Because 177>76 and 177>34 in this case, the object whole image is captured is green. Similarly, if pixel = [36 28 237], 36 corresponds to blue, 28 to green, and 237 to red. After getting these values, compare elements of the variable pixel to find out which is greater. In this case 237>36 and 237>28, so the object whose image is captured is red in colour. Next, total number of different objects based on their colour and shape is to be found out hence, initialize the variable 'i' as either 1,2 or 3 which is later used during shape detection. The process of converting the RGB image to intensity is conducted using Color space conversion block. Based on the figure 3.1, the process images processing separate the colour by 3 colours.

3.2.1 Flowchart of the whole system

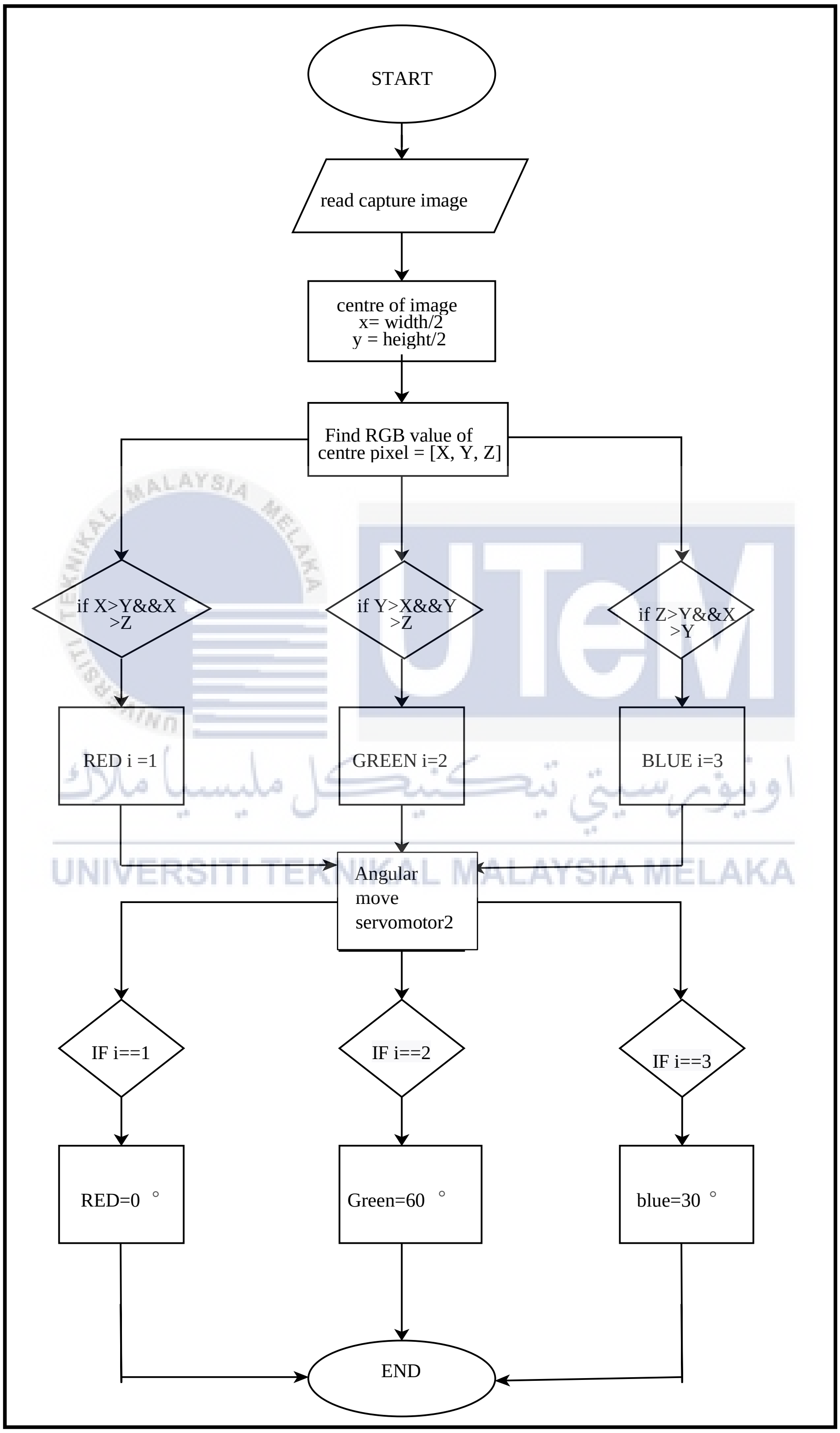

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Figure 3.2: Flowchart whole process

Based on the figure 3.2, the flowchart shows the whole process sorting system of this project. This flowchart will help the system operate smoothly without any compilation. To help the system monitoring easily, the flowchart will shows the whole system process.

3.2.2 Problem statement

The problem statement is important before deciding on a project title because it shows the benefits and reasons why the project was proposed, as well as the objective that could be used to overcome the problem. First of this matter, the sorting system coloured base has been become the new wireless innovation that developed the industrial automation in this world. Coloured based sorting system might be newly developed in this world according to the technologies current.

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In this project, the camera will capture the image of the object to process the colour. In industrial automation, the less the error that output production, the better for the company. To make the output product based on the colour based more effective, a lot of components were implemented in this task. Human power might be not consistent as the technology productivity.

According to that the problem stated, the Development of an iot-based Sorting System for Colour-based Products is more effective to replace the nowadays technology. It is also eco-friendly which it just needs electric power which is can reduce the pollution. Finally in this task, the objective will be achieved by doing a lot of data collection and analysis. The main idea of sorting system coloured based by using Raspberry were proposed to solve the problem faces by industrial automotive.

3.2.3 literature Study

A literature study was conducted from previous reports and research done by other countries or universities to gain an idea and knowledge about the development of sorting products by color-based system. To begin, sources were gathered using keywords, and the results must be reviewed. According to that, if the gathered sources are unrelated or insufficient, the process must be redone.

The information from published journals and articles was used to develop the scopes for this project to narrow the research scope. This literature study yielded a wealth of information that will aid in the design of a tongue-driven system that is based on reliable sources. Find as much information as possible about previous journals relevant to the title, for example at the figure 3.3

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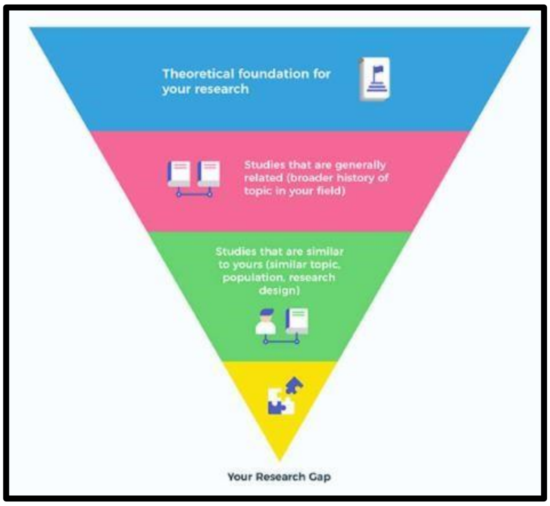

Figure 3.3: Triangle Process of Literature Review

3.3 Review On Selected Component

3.3.1 Raspberry Pi

The main advantage of Raspberry Pi is that it can do everything a computer/laptop can do with a Linux operating system. For example, creating servers, creating programs with a wide variety of languages, especially high-level languages such as Python. For advanced use, Raspberry Pi has virtually no limitations. There are many possibilities of application development that can be done using Raspberry Pi. Raspberry Pi runs using an open-source operating system, Linux. Raspberry Pi can also relate to a regular computer monitor, and additional ports to connect it to the mouse and keyboard. For data storage, Raspberry Pi does not use Hard Disk, but Raspberry Pi can use SD Card to store data, be it Operating System data or for long-term data storage media.

Based on this project, the Internet of Thing (IoT) were developed to increase the access to control the or monitor the project, Raspberry pi were required both Bluetooth and wi-fi module. Next, the Raspberry Pi also have a lot of pins to connect by wire which are very suitable to being brain in this project task. Next, by have SD card to save the whole library on python language, it is easy to bring anywhere without bring the module board. By having SD card, it is simplest way to change the task of project. Figure 3.4 showed the functional every port of the Raspberry Pi 4 B.

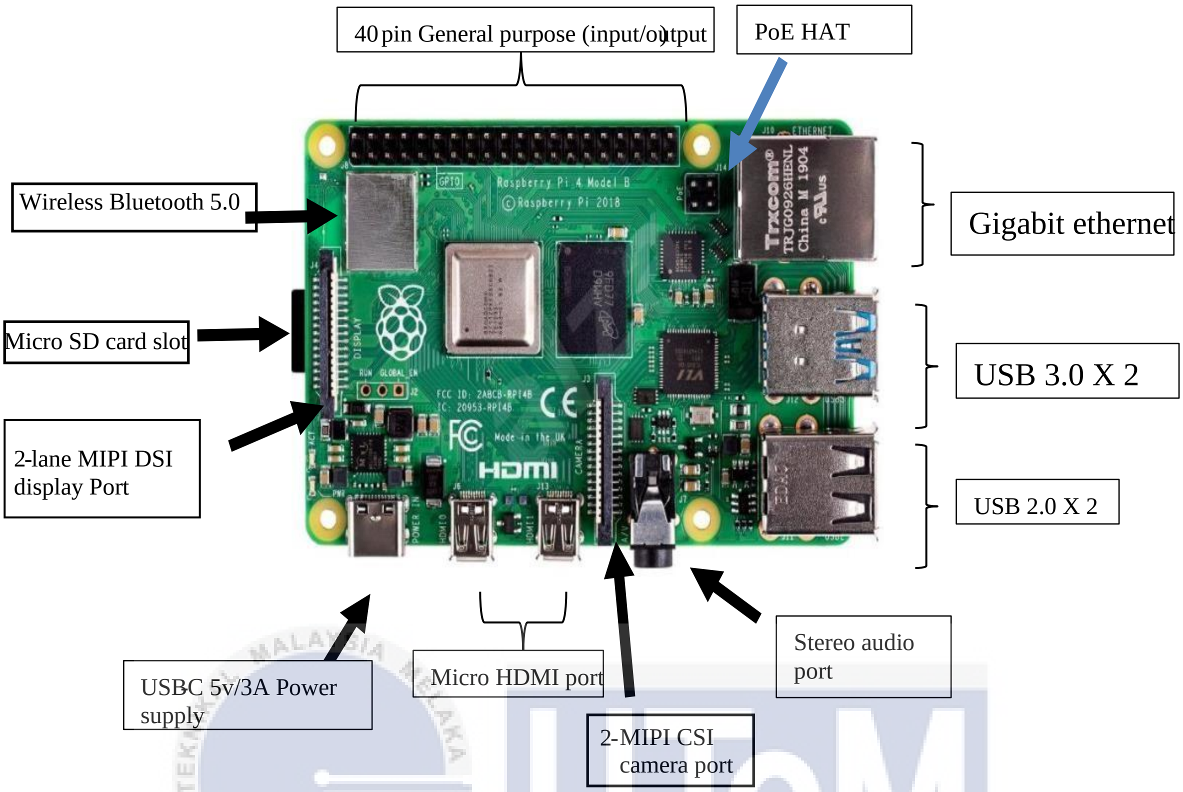

Figure 3.4: Input/Output Raspberry Pi 4 model B

3.3.2 Camera

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Camera using in this task is for capturing the image of the product. It is very important to capturing the image to gives the data to microcontroller to analysis the pixel. The places of the camera will be place above of the product. The python programming will collect the data of the image captured. The eights Megapixels camera will be implemented in this project to capture the image. The camera Raspberry will connect to 2-Lane MIPI CSI camera port at the Raspberry Pi. Based on the figure 3.5, the raspberry camera that will be use in this project.

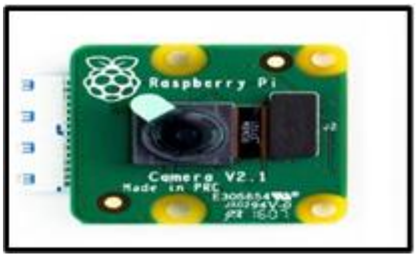

Figure 3.5: Camera Raspberry Pi

3.3.3 Servo motor

Servo motor also is the main component to being a feeder that moves the shaft connector to sorting the product. Servo motor was chose because the high torque and high speed will gives a lot of power to move the shaft. The servo motor can moves the load with 3 KG. Next, the servo motor also has encoder that the user can implement Proportional, Integrated, differentiate (PID) to improve the location of sorted. Due to that reason, the circuit of Servo motor were categories as Closed-loop system. To makes the motor no robust and easily broken, the servo motor is not a lot of noisy and vibration. Noisy and vibration can distract the performance of the motor rotating due to this project need accurate degree of rotating. In this project, tow servo motor was used. First servo motor will be programmed 0°- 40° to capture the image. After the images of the product were captured, the motor continues to rotate 40 ° -90 ° to flow the product into sorting process. This project has three floor of process which is first floor will get the information of the image (pixel). Next, the second floor the product will be sorted. The second servo motor will sort the product into bin which is Red, Blue or Green based on the colour of product.

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Figure 3.6: Servo motor with Shaft

3.3.4 Feeder (Shaft connector and bed frame)

The main feeder in this project is the shaft and bed frame. The functional of the bed frame is to flow the product into the selected bin, which is Red, Blue or Green. Shaft connector must be fit to the servo motor to avoid the servo motor rotating exceeded load. Next, the bed frame was divided into two parts which is the first servo motor and the second servo motor. The material that uses is PVC because it so light and does not require high load to rotating the motor. Based on the figure 3.7, the bed frame uses are for to connect the servomotor rotation

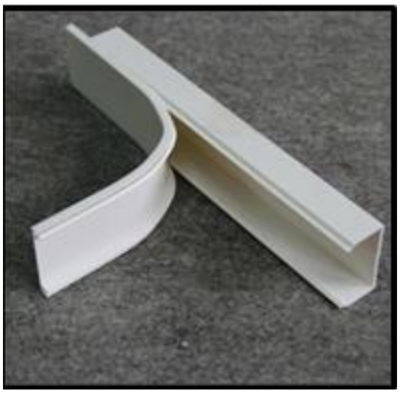

Figure 3.7: Bed Frame

3.3.5 Supporting frame

Supporting Frame design in this project rectangular solid with 45cm x 45cm x 60cm. The material used to build the supporting frame is prospect material with transparent colour. By using the transparent colour, the user can see the process flow of the project. Before to build this supporting frame, the designed have been done at the AutoCAD first. All the dimension and measurement were made at the AutoCAD software. On figure 3.8 are the example of supporting frame use.

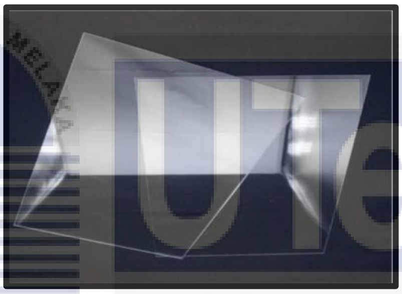

Figure 3.8: Acrylic material of Prospect

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3.4 Software development

3.4.1 AutoCAD

AutoCAD was designed to design the project that gives the body a suitable dimension. At AutoCAD software, the body frame of the project is all hardware-components except electronic devices. The AutoCAD gives the actual hardware component output of the project and shows how the process flowed. The ability to explain complex processes and principles easily using animations and interactive 3D models is one of the most significant advantages of virtual education.

The body frame was separate into three sectors. For the first sector, the product will flow into the hollow cylinder. Second sector, after capture processing was done, it will flow to the feeder. Third sector, the bedframe will rotate into desire degree to flow the product into its colour bin. Based on the diagram below, the dimension of the design of the project were designed to fulfil all the required tasks. Based on the figure 3.9, plan dimension for the first layer. Next, figure 3.10 the multiple viewports of the first layer. Then, the view 3.11 is the three layers of the bed frame project.

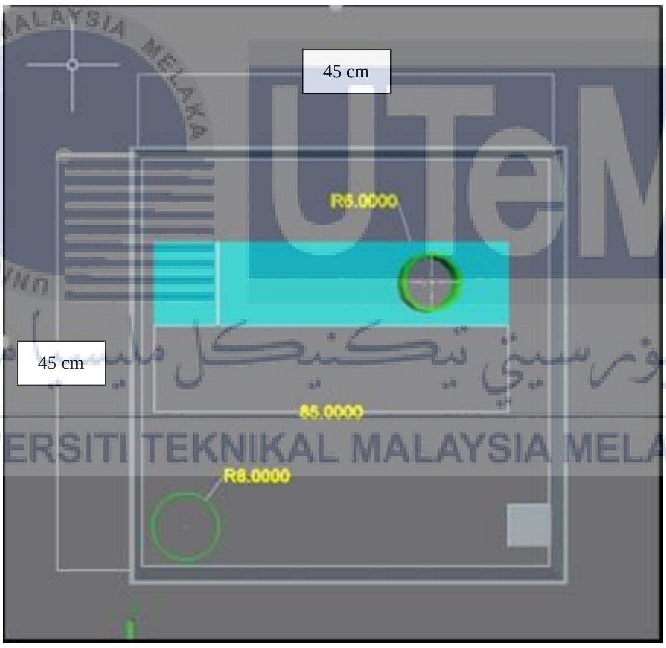

Figure 3.9: view of plan and dimension

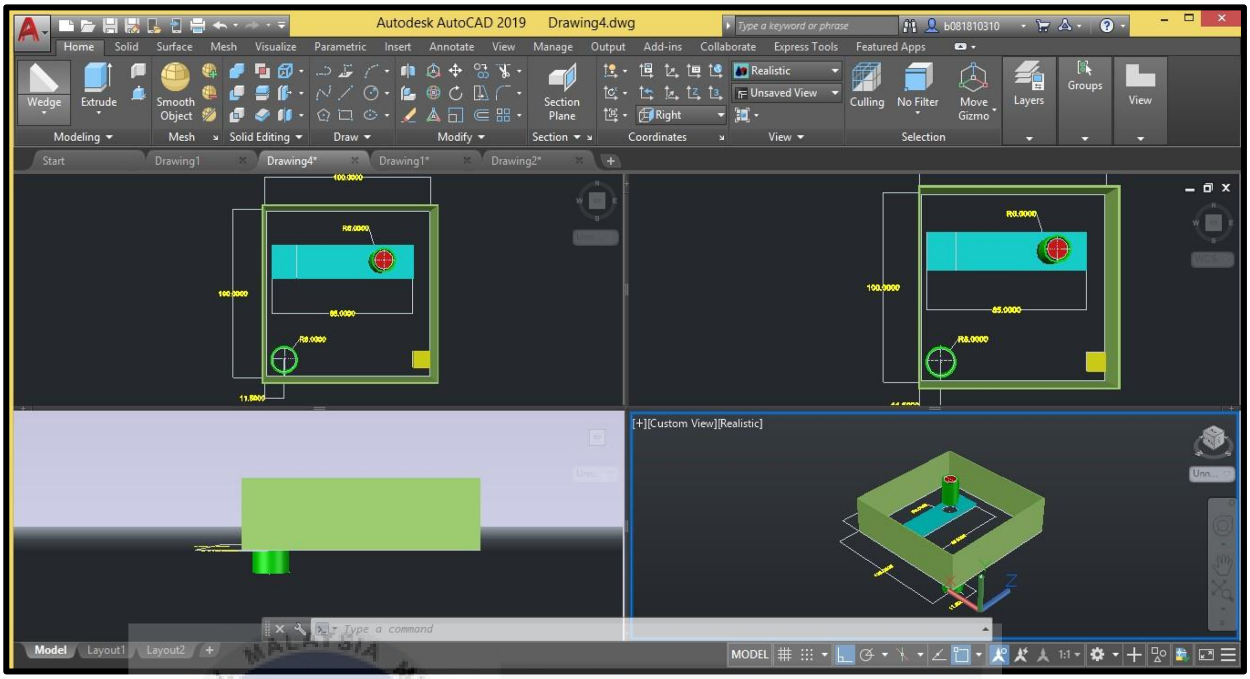

Figure 3.10: Multiples viewport

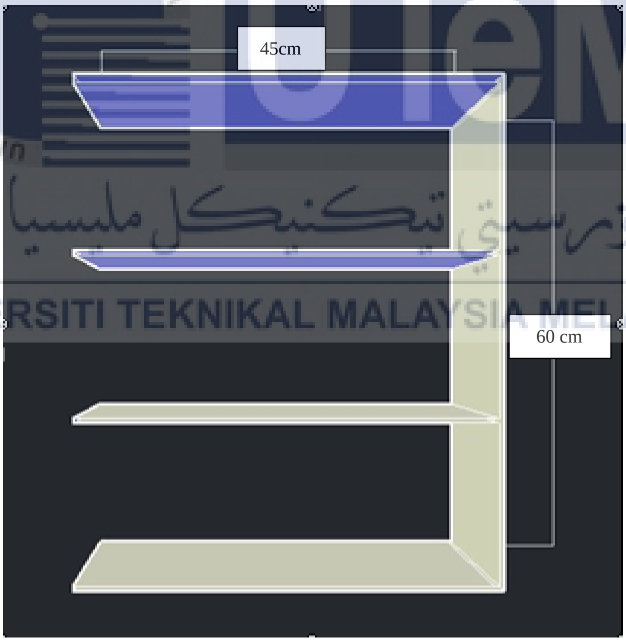

Figure3.11: The whole design of the product

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3.4.2 Python coding

Python is a high-level, interpreted, interactive, and object-oriented scripting language. Python is designed to be highly readable. It frequently substitutes English keywords for punctuation, and it has fewer syntactical constructions than other languages. It easily integrates with C, C++, COM, ActiveX, CORBA, and Java.

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Figure 3.12: Python

3.4.3 Proteus 8 Professional

Proteus Design Suite is a proprietary software tool suite that is primarily used for electronic design automation. Electronic design engineers and technicians primarily use the software to create schematics and electronic prints for the fabrication of printed circuit boards. The advantages of using the Proteus 8 professional are to save cost of the component before it run in project. The simulation of Proteus will help the project to detect the circuit if it cannot run. Based on the figure 3.13, to run the simulation of the circuit, must be use Proteus 8.10 professional.

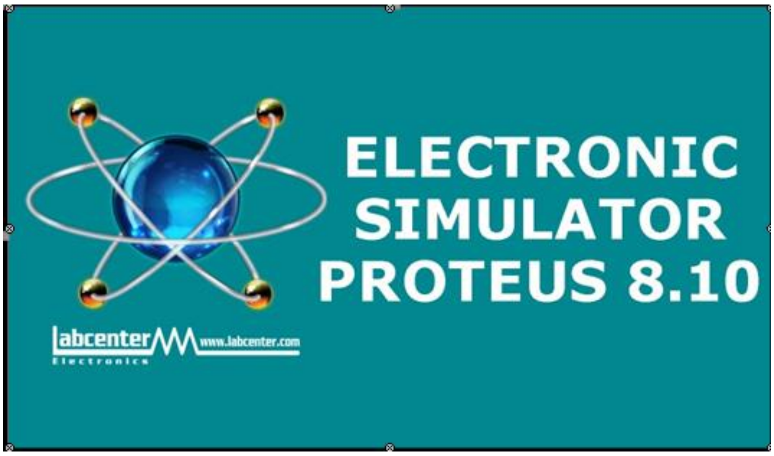

Figure 3.13: Proteus 8 Professional

3.4.4 Blynk apps

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Figure 3.14: blynks application

Based on Figure 3.14, the Blynk platform enables a rapid interface to control and monitor the hardware of IOS and Android devices projects. The Google Play Store or Appstore can simply download the Blynk app. Blynk is compatible with hardware platforms like Arduino, Raspberry Pi, and other microcontroller boards in order to build hardware for projects. Blynk provides the following connection types to connect the hardware (Ethernet), WIFI and Bluetooth to the Blynk Cloud and Blynk personal server.

The Blynk app developer allows the creation of project-specific apps with a variety of widgets. It's both compatible with Android and iOS. The Blynk server handles all communication between the app's mobile device and the hardware. It can host a private server in Blynk locally or use the Blynk Cloud. It supports thousands of devices and can even run on an open-source Raspberry Pi. Blynk libraries allow server connectivity and perform all Blynk and hardware commands incoming and outgoing. It can be used on all major hardware platforms

3.5 Framework Project

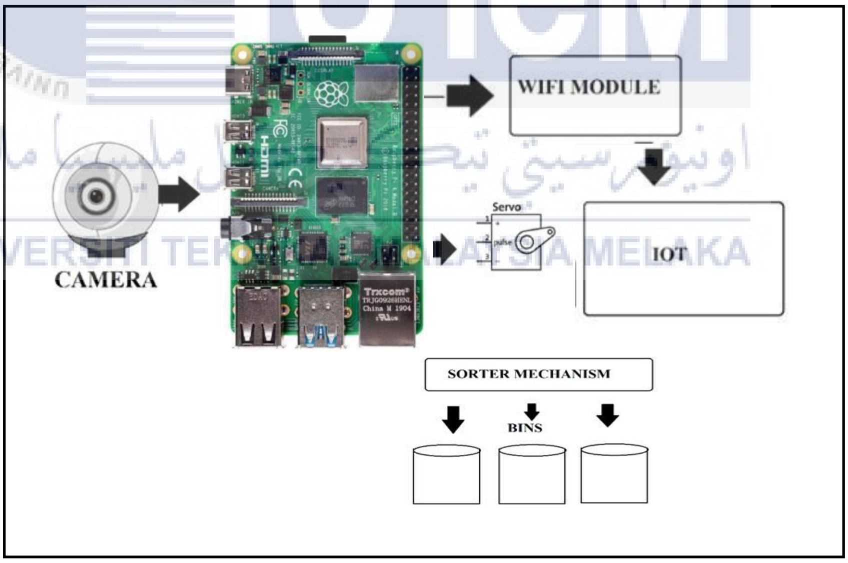

Figure 3.15: Framework project

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Based on the figure 3.15, it shows the camera will capture the the colour of the product to analyze the amount of pixel that will raspberry consider. As the raspberry Pi 4 consider the colour of the product (if Red), then the servo motor (second layer) for the feeder will rotate to 30 degrees with a step. Before all of these processes occur, the push button need to energize first. After that, the first layer of the servo motor will rotate to 70 degree to have image processing whether the product is Red, Blue or Green. After the product is recognize, it will flow the process which has been described. Finally, the product will be sorting by its colour categories. If the user is not around the machine sorted system, they could continue monitoring the system their smartphone at Blynk apps.

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CHAPTER 4

RESULT AND DISCUSSION

4.1 Introduction

This section describes the overall analysis and discussion of all the data required to determine the project's performance and achievement. The results were obtained based on the previously mentioned objectives and scope. Analysis was carried out based on the method used and the results obtained. To makes the system operate smoothly, various data are be taken to be analyze. The cameras will capture the image and send the data images to raspberry pi to process the data taken. Various data are needed to consider to be taken such as, the time taken the whole process will complete. To get the ideal images, the input of th data need to be calibrate manually according to the source of the light. The data analysis to be consider for improve the system is the masked image and the original image of the product. Next data to be analyze is the blynks application. Blynks application will be monitor and count every product that will be sorting. Lastly, the data time taken the Blynks application receive the data from the hardware process.

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4.1.1 hardware implementation

For the hardware implementation, the figure 4.1 show the top section of the hardware project. The top section of the hardware is to insert the product into the tube. Next, the second section is the place of the microcontroller, and the camera were placed. Servomotor 1 was place at the third section, which is the servomotor 2 will sort the product below the camera to capture the image product. The last section of the hardware part is the servomotor2 were placed to sort the product by its categories.

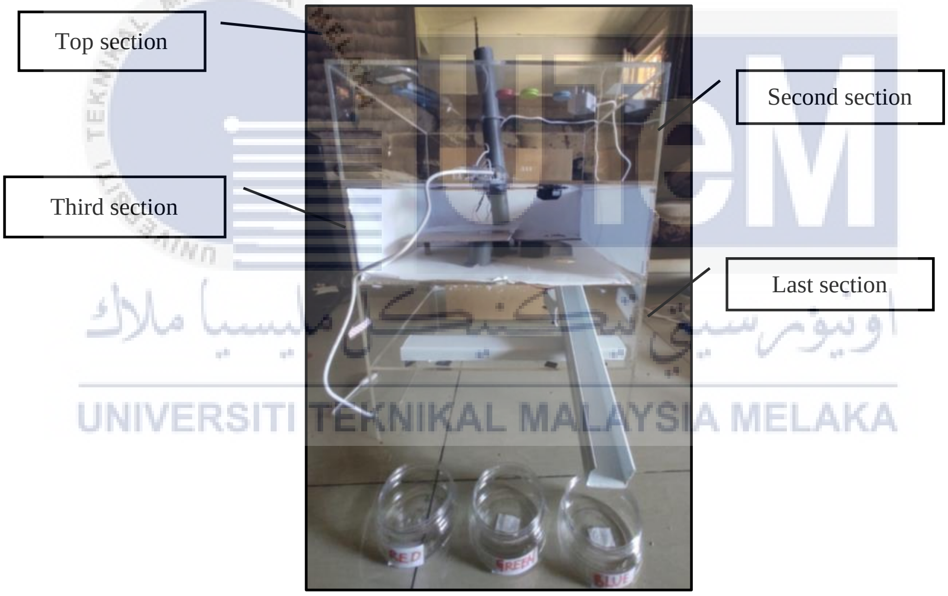

Figure 4.1: full hardware implementation

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4.2 Data analysis for image of three types of colours

Data analysis are needed to make the system operate correctly while the hardware process run. Image processing is the main part in this system to operate. The image will give the output at the frame at the Raspberry Pi OS. Method used in this process is the masking. Masking is an image processing technique in which a small 'image piece' is defined and used to modify a larger image. Masking is a process that is used to underpin many types of image processing, such as edge detection, motion detection, and noise reduction. Get the mask images, there is six data are needed to calibrate manually. The six data are need to calibrate is highHue,lowHue, highSaturation, low Saturation, highValue and lowValue. From six data, the three types of colours will be get the different value of input.

4.3 Data analysis for colour product

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For data analysis red product, the red chip was place below the camera module with the different source of the brightness. To setting the data manually, it needs to adjust at the trackbar at the Python IDE. For the red chips product, the data will change due to the brightness surround the space change drastically.

```
cv2.createTrackbar('lowHue', 'colorTest', icol[0], 255, nothing)
cv2.createTrackbar('lowSat', 'colorTest', icol[1], 255, nothing)
cv2.createTrackbar('lowVal', 'colorTest', icol[2], 255, nothing)
# Higher range colour sliders.
cv2.createTrackbar('highHue', 'colorTest', icol[3], 255, nothing)
cv2.createTrackbar('highSat', 'colorTest', icol[4], 255, nothing)
cv2.createTrackbar('highVal', 'colorTest', icol[5], 255, nothing)
```

Figure 4.2: Coding for pop out the trackbar

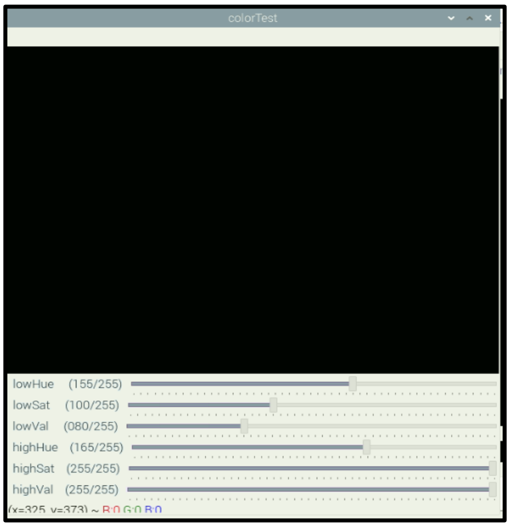

Figure 4.3: Trackbar for calibrate the image

Based on the figure 4.3, the image is needed to mask first before calibrating the data. There are six component data are needed to set manually to gained the ideal data to delivered to combined programmed. The range of the pixel value is from 0-255, so the point of trackbar can drag from 0 to 255 values. The RGB value goes up from 0 to 255 because it takes up exactly one byte of data. One byte is equal to 8 bits, and each bit represents either a 0 or a 1.

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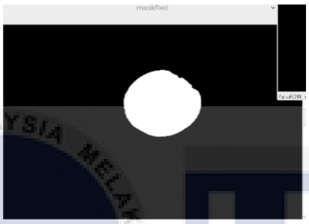
4.3.1 Data analysis for Red Product

Based on the table 4.1, the ideal data were taken after do repeatedly calibrate. The data were taken by with switch on the light and not switch on the light. By switching off the light, the brightness of the surrounding space getting dimmer whereas with switch on the light, the brightness of the surrounding space getting brighter. Based on the table 4.1, the six data been taken to be analyze.

Table 4.1: Result for red product

Types of data	With source of light	Without source of light
workspace		
Masked image		
lowHue	150	20
lowSat	65	0
lowVal	65	73
highHue	213	202
highSat	213	37
HighVal	213	214

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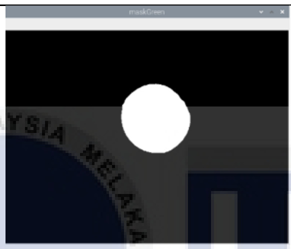
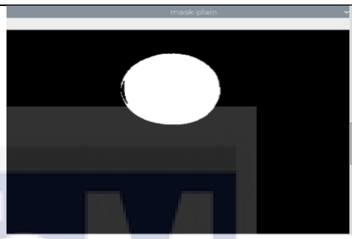
4.3.2 Data analysis for Green Product

Based on the table 4.2, the spot for the product were placed below the camera module to makes the camera captures and process the image. The same result gained with the different input six component to analyze the picture. Based on the table 4.2, the source of light came with the different brightness.

Table 4.2: Result data for Green Product

Types of data	With source of light	Without source of light
workspace		
Masked image		
lowHue	40	27
lowSat	100	62
lowVal	100	49
highHue	65	64
highSat	200	255
HighVal	255	255

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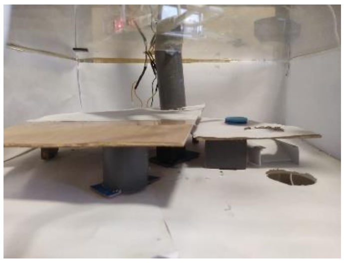
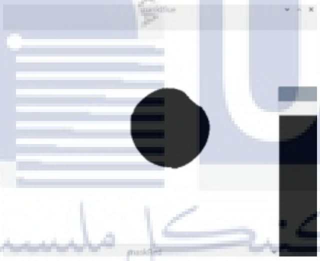
4.3.3 Data analysis for Blue Product

Table 4.3: Data analyse for blue product

Types of data	With source of light	Without source of light
workspace		
Masked image		
lowHue	100	22
lowSat	100	131
lowVal	100	32
highHue	120	215
highSat	220	184
HighVal	220	133

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4.3.4 Ideal data for image processing image

Table 4.4: Ideal Data for Three Colour

	RED	GREEN	BLUE
lowHue	150	45	100
lowSat	65	100	100
lowVal	65	100	100
highHue	213	65	120
highSat	213	200	220
HighVal	213	255	220

Based on the table above, the ideal data were collected and ready to insert into Python IDE program. The ideal data above are important because it will affect the whole program status. The data above will be written in the Thonny platform in the Raspberry Pi module.

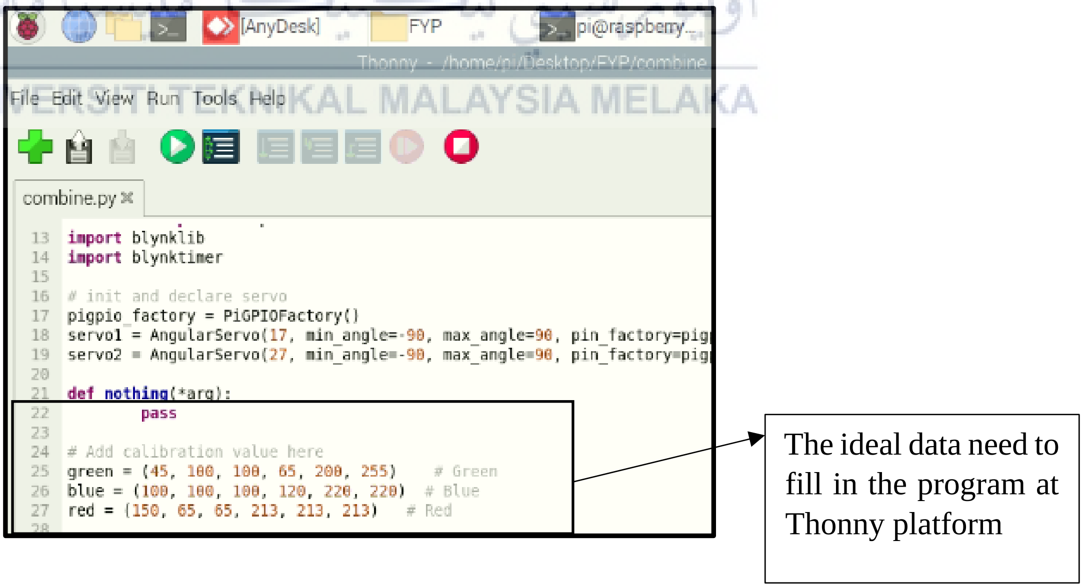

Figure 4.4: input data for three colours

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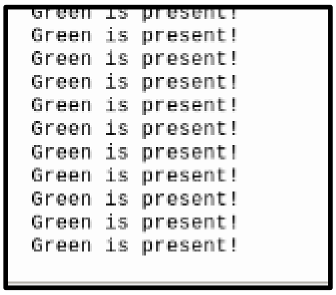
The output of the program will display the types of colours. After insert the data taken into the Thonny platform, the camera only will detect the green, blue and red colour. The example output forms the process will shows as figure 4.5.



```
Green is present!
Green is present!
Green is present!
Green is present!
Green is present!
Green is present!
Green is present!
Green is present!
Green is present!
Green is present!
Green is present!
```

Figure 4.5: output for green display

4.4 Take the data for Servomotor

In this project, the functional of servomotor is the sorting the product into their types of colours and sorting the product below the camera. The product needs to sort below the camera because the product is needed to analyze the image and gives the feedback to servomotor2 to sort the object based on its categories. The Servomotor1 are programmed to sort the product below the camera module. The Servomotor2 are programmed to sort the product into its categories (RED, GREEN, BLUE). By changed the number of step movement servomotor, it can control the speed of the servomotor. Based on the figure 4.6 the connection of the Servomotor1 link with Raspberry pi. there are three wires consist of, for yellow represent as signal that will connect to GPIO 17. The source supply connects to GPIO 2, and the ground wire will connect to GPIO 39.

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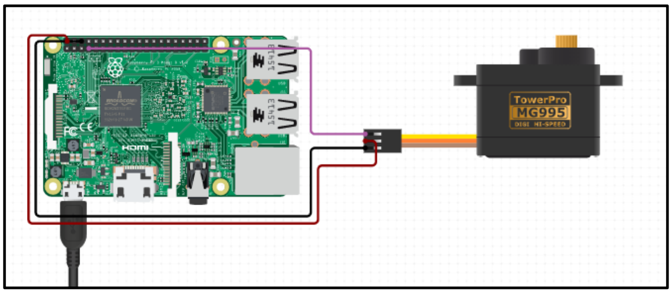

Figure 4.6: connection of Servomotor1

For the connection of the Servomotor2, the power source servomotor wire will connect ro the GPIO 5 with five volts supply. Next, the yellow wire consist of signal cable will connect the at GPIO 27. The signal cable will deliuvered the signal to the servomotor with desire program. For the ground section of the Servomotor2, the wire will connect to the GPIO 6. Figure 4.7 shows the connection of the Servomotor2 linked with the Raspberry pi

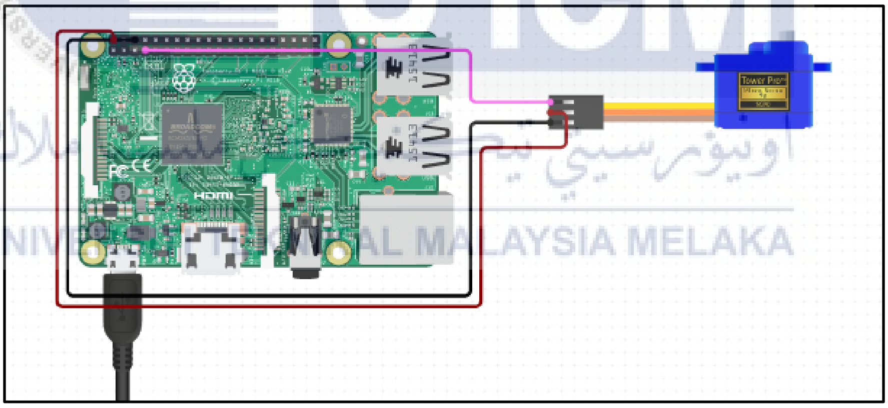

Figure 4.7: Connection of Servomotor2

4.4.2 Change the step of Servomotor1

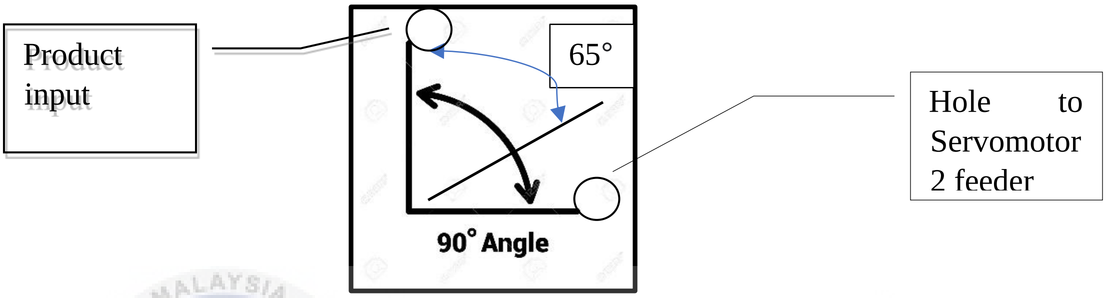

Figure 4.8: Angle Movement Servomotor1

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The movement of the Servomotor1 is from 0° to 90° degree, the servomotor1 will sort the product to 65 degrees to makes the camera module captures the images. After the camera were capture the images, it will continue sort into the hole and delivered the product to Servomotor2 feeder. The speed Servomotor1 can be varied by changing the number of step servo. Figure 4.8 shows the angle of the Servomotor1 will sort the product.

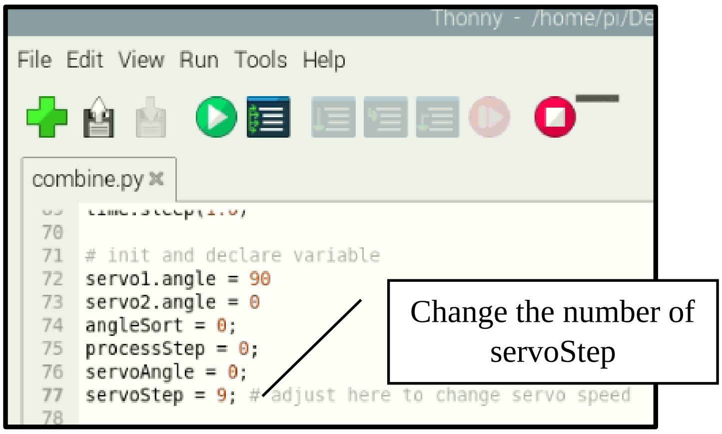

Figure 4.9: Method change speed Servomotor1

Figure 4.9 shows, by changing the “servoStep” at Servomotor1, the data for the Servomotor1 can be taken and analyze. Some values of number are being not able to insert because the program need to get the whole number value. Calculation is made to prove whereas some values are valid to set as input or not. The time taken also were taken to observe by changing the value of ServoStep can improvise the time taken for a product to complete the one cycle of system operate. Table 4.5 shows the method data calculate for every value. Formula to count number step of the sorting product as below: -

$$\frac{number\ of\ degree}{input\ ServoStep} = Number\ of\ Step$$

Table 4.5: Time taken to complete one cycle process

Number input for ServoStep	Calculation (Calculate of step to reach the hole)	Time taken to complete one cycle (s)
1	$\frac{90}{1} = 90\ steps$	38
2	$\frac{90}{2} = 45\ steps$	24
3	$\frac{90}{3} = 30\ steps$	13
4	$\frac{90}{4} = 22.5\ steps$	Programmed error
5	$\frac{90}{5} = 18\ step$	8
6	$\frac{90}{6} = 15\ steps$	6
7	$\frac{90}{7} = 12.86\ steps$	Programmed error
8	$\frac{90}{8} = 11.25\ steps$	Programmed error
9	$\frac{90}{9} = 10\ steps$	3

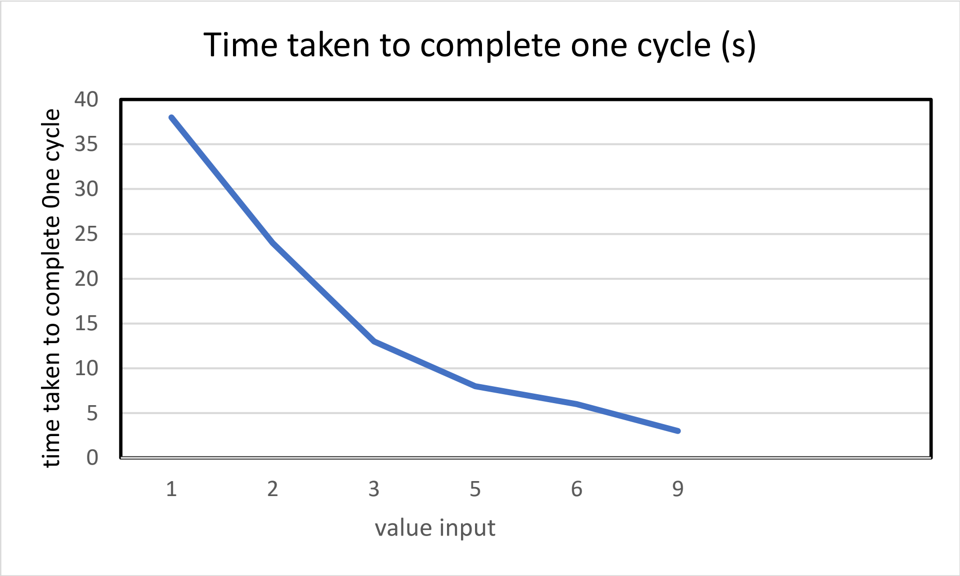

Figure 4.10: Time taken one cycle process by change value Servostep input

From the figure above 4.10, when the number of the value input for the servostep increase, the number of times taken for the one cycle process will decrease. Due to that reason, the data conclude that the servostep can improve the time taken for one cycle process of the product. When the number of step increase, the time taken for the one cycle process also increase.

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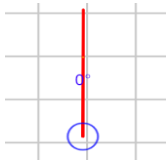
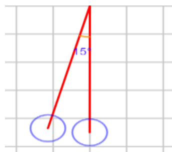
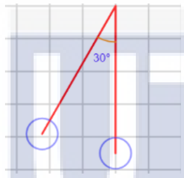
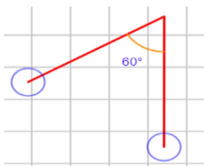
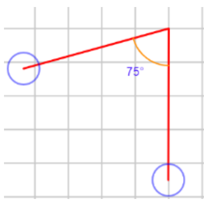
4.4.2 Angular data analysis for Servomotor2

Servomotor 2 is to be sorting the product into three categories bin, red, green and blue. Servomotor2 is linked with the trunking as feeder to sort the chip size into it categories. Various angle was tested to find the ideal spot for to locate the product into its categories. After do the test repeatedly with different angle, the data was taken to create the program for runs the process for project smoothly. Table 4.6 shows the data were taken for every 15 degree of trunking movement.

Table 4.6: Data angle selected

Angle (°)	Figure	Selected angle data
0		✓
15		
30		✓
45		
60		✓
75		

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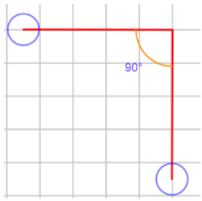
90		

Based on the data above, the ideal angular data for servomotor2 is 0 ° ,30 ° ,60 °. the value was taken to insert into the program at Thonny with using python language. The data ideal because it suitable for three types of colours being sort into it categories. For red colour, the ideal angle is 0 °. Green types of colours, ideal angular for sort this type is 30 ° and for blue colour is 60 °. Those data will be programmed and combine with previous data analysis.

4.5 Blynks Application

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Blynks application is the main part of the internet of Thing (IoT) in this system. The blynk application can be monitor or controlled by smart phone. Blynk is a new platform that lets you quickly create interfaces for controlling and monitoring your hardware projects from your iOS or Android device. The Raspberry pi 4 was implement Wi-Fi module as to connect raspberry pi to wi-fi internet. To makes the system operate smoothly, the Raspberry Pi 4B support until the new 5G connection. Figure 4.11 shows the raspberry pi connected to 5G Wi-Fi. To run the system, the smartphone need Data and Wi-Fi Connection and Raspberry Pi must connect to Wi-Fi.

Figure 4.11: 5G connection support

4.5.1 Count the output product with categories

In this project, after the product were sorting, the output of the product will be counted. The blynks application is programmed to count the product output based on the types of colours. The program was created to makes the user easily monitor the output process of the product. The data for this section is to analyze the program from blynks application run smoothly. The figures 4.12 shows the example for green product programmed was created count the product and gives the output at monitor smartphone. Based on the figure 4.13, the output display at smartphone

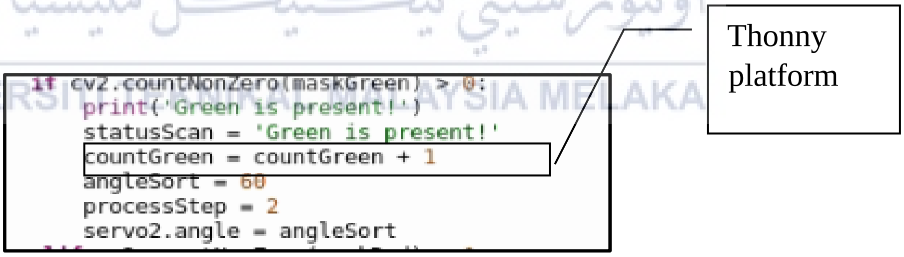

Figure 4.12: Counter product program

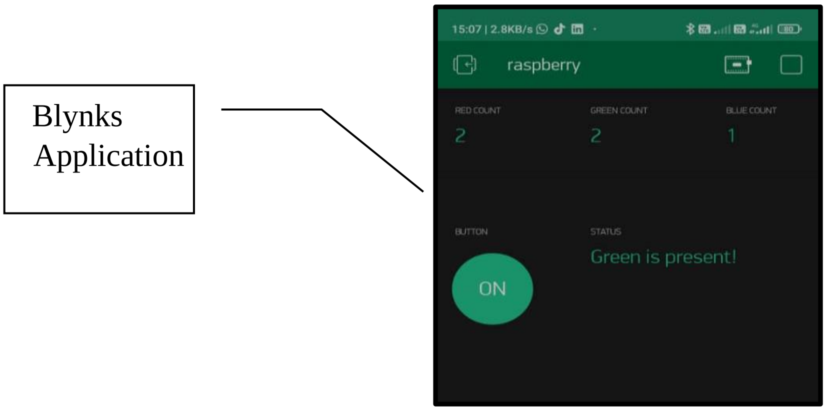

Figure 4.13: Thonny platform and Blynk Application

4.5.2 Control switching ON and OFF system

In this system, the switching can also be control at the blynks application. To analyse the switching is functional correctly, the programmed must be runs first. Figure 4.11 shows he initial condition of the programmed is the system in OFF system status. After the programmed was run, push the button OFF at the blynks application to run the whole system in the program. Figure 4.14 show the response after the button OFF were pressed and sthe status at Thonny platform.

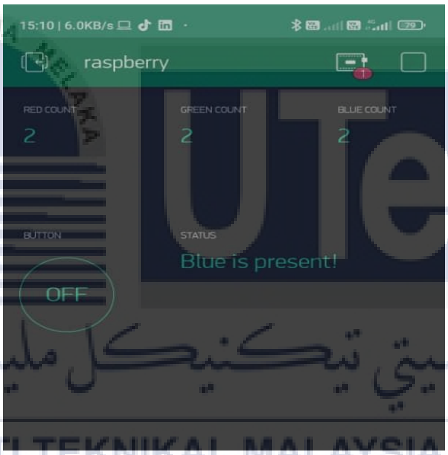

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Figure 4.14: initial condition

```
Heartbeat time: 1641386199946
Response status: 200
Heartbeat time: 1641386210238
Response status: 200
Event: ['write v3'] -> (3, ['0'])
System Off
Heartbeat time: 1641386223067
Response status: 200
```

Figure 4.15: Switch OFF status Thonny Platform

After the switch at the blynks application pressed, the whole system will be run accordingly to the programmed was create. Figure 4.16 shows as the button were push to ON status at the blynks application. Figure 4.17 shows at the Thonny Platform which the system is correctly connected with system.

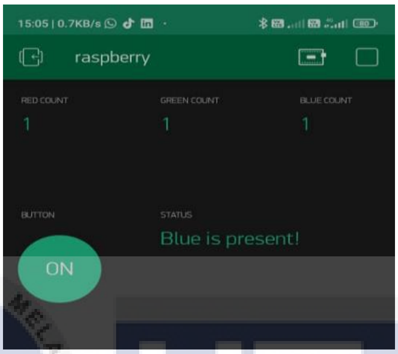

Figure 4.16: ON status at Blynks application

```
Response status: 2
Event: ['write v3'] -> (3, ['1'])
System On
Response status: 2
Response status: 2
Response status: 2
```

Figure 4.17: System on at Thonny Platform

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4.6 Summary

From the all analysis were made, Development of an IoT-based Sorting System for Colour-based Products can be analyze detailly to makes the whole system runs smoothly. For the image processing, the methos used in this system is masking image. By use this method it can underpin many types of image processing, such as edge detection, motion detection, and noise reduction. Masking is the best method for collect data and create the program. Masking method use convolution matrix that have set up in Thonny Program.

For servomotor1, the speed of the servomotor to sort the product below the camera also can be improve by increase the stepServo in the program. By increasing the stepservo, it can cut time taken to process the image based on colour. For Servomotor 2, the angle to sort the product by it categories can be change manually at the program. The suitable angle is the ideal spot to place the product by it colours categories. Finally, the blynks application can controlled the system in status ON or status OFF. The counting process are made to makes the user easily monitor to watch via smartphone.

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CHAPTER 5

CONCLUSION & RECOMMENDATION

5.1 Conclusion

This project is for sorting system by colour based. By development of an IoT-bases sorting system for colour-based product, it can reduce the human power to doing the sorting system. Sorting system is the repetitive system which in this project, the system will continuously be sorting the product by its colour. Next, by implemented the Raspberry Pi 4 in this project, the system will automatically run by command was create at the python.

The user also can monitor the system by their smart phone. Blynk apps were chose in this project to monitoring the system. By using wi-fi module, user can monitor the system around 100 meters. To fulfil the project task, IoT development also were implemented in this project to following the Industrial Revolution (IR 4.0). In industrial automation, sorting system are frequently developed to isolate their product. By implement the Raspberry Pi with the Python language can increase the production of the industry.

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5.2 recommendation and feature

For the future recommendation in this project, the Development of an IoT-based Sorting System for Colour-based Products can be improved by adding the types of colour selection. When the number of types of colours been added, the manufacturing product of colour can be increase. When the number types of colour increase, the setting at the trackbar and the program coding need to be added.

Figure 5.1: various types of colours

At the Blynks application, the output monitor can be added to see virtual movement of the process run. by added that program in this project, the user can monitor the process by smartphone. Due to that reason, it will improve the system by according to Industrial Revolution 4.0 (IR4.0) requirements,

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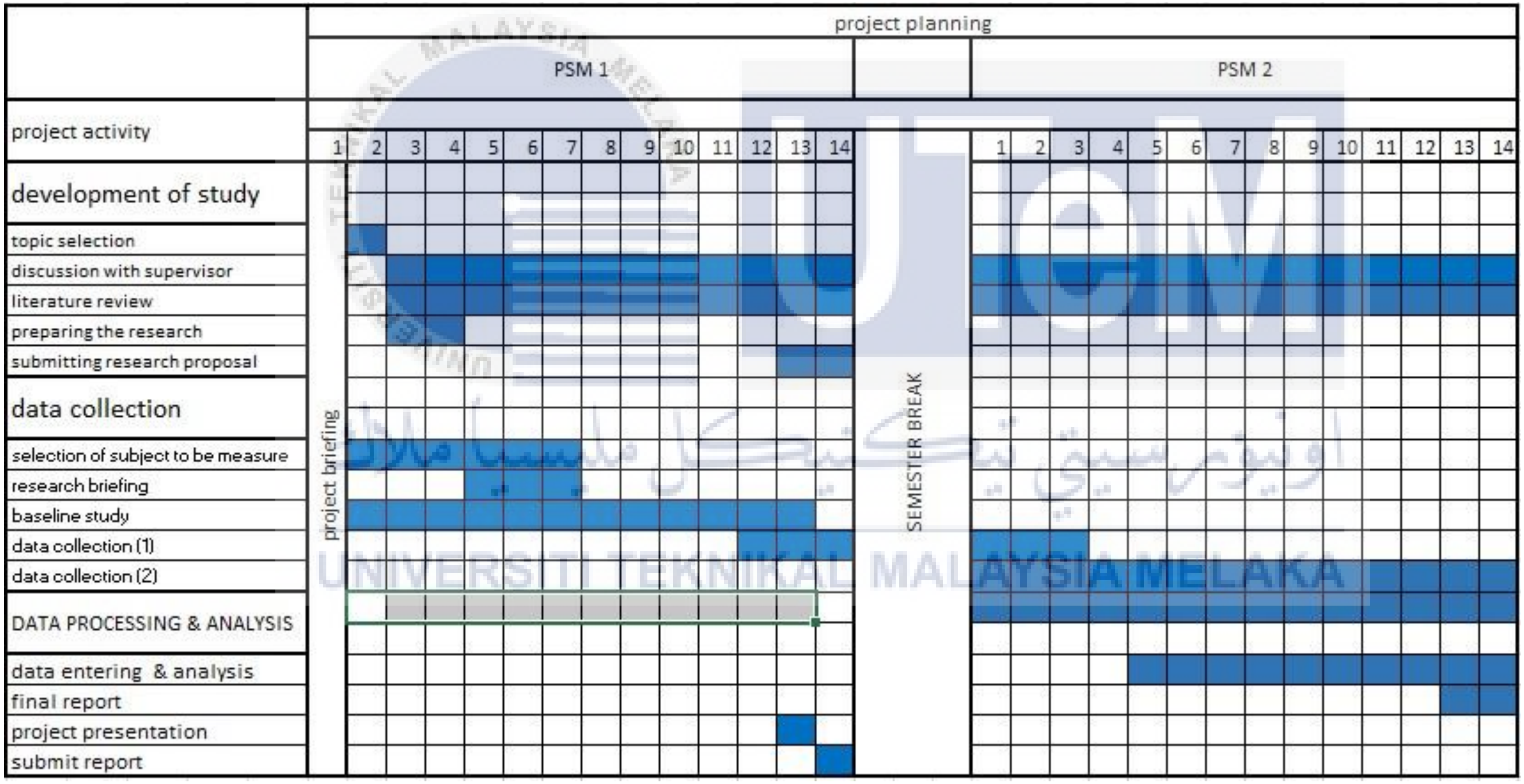
APPENDICES

Gantt Chart



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APPENDIX 2

```
# import library
from __future__ import division
from imutils.video import VideoStream
from imutils import face_utils
import imutils
import time
import dlib
import cv2
import numpy as np
from gpiozero.pins.pigpio import PiGPIOFactory
from gpiozero import AngularServo
from time import sleep
import blynklib
import blynktimer

# init and declare servo
pigpio_factory = PiGPIOFactory()
servo1 = AngularServo(17, min_angle=-90, max_angle=90, pin_factory=pigpio_factory)
servo2 = AngularServo(27, min_angle=-90, max_angle=90, pin_factory=pigpio_factory)

def nothing(*arg):
    pass

# Add calibration value here
green = (45, 100, 100, 65, 200, 255)   # Green
blue = (100, 100, 100, 120, 220, 220)  # Blue
red = (150, 65, 65, 213, 213, 213)   # Red

icol = (green, blue, red)

BLYNK_AUTH = 'U4wRn9Pjem9UJqUEjlBs9TeOR94Bmn9d' #insert your Auth Token here
blynk = blynklib.Blynk(BLYNK_AUTH, server='blynk-cloud.com', port=80, ssl_cert=None,
heartbeat=10, rcv_buffer=1024, log=print)
timer = blynktimer.Timer()

# init and declare variable
countRed = 0
countGreen = 0
countBlue = 0
system = '0'
```

```
statusScan = ''

# function to send data every 1 second trigger by blynk timer event
@timer.register(vpin_num=0, interval=1, run_once=False)
def write_to_virtual_pin(vpin_num=0):
    global countRed
    global countGreen
    global countBlue
    global statusScan

    blynk.virtual_write(0, countRed)
    blynk.virtual_write(1, countGreen)
    blynk.virtual_write(2, countBlue)
    blynk.virtual_write(4, statusScan)


@blynk.handle_event('write V3')
def write_virtual_pin_handler(pin, value):
    global system
    system = value[0]
    if system == '1':
        print("System On")
    else:
        print("System Off")


# start the video stream thread
print("[INFO] starting video stream thread...")
vs = VideoStream(src=0).start()
time.sleep(1.0)

# init and declare variable
servo1.angle = 90
servo2.angle = 0
angleSort = 0;
processStep = 0;
servoAngle = 0;
servoStep = 3; # adjust here to change servo speed

while True:
    # run blynk and timer event
    blynk.run()
```

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```
timer.run()

# read frame from video / read image from video
frame = vs.read()

# Show the original image.
cv2.imshow('frame', frame)

# Blur methods available, comment or uncomment to try different blur methods.
frameBGR = cv2.GaussianBlur(frame, (7, 7), 0)
# frameBGR = cv2.medianBlur(frameBGR, 7)
# frameBGR = cv2.bilateralFilter(frameBGR, 15 ,75, 75)
"""kernal = np.ones((15, 15), np.float32)/255
frameBGR = cv2.filter2D(frameBGR, -1, kernal)"""

# HSV (Hue, Saturation, Value).
# Convert the frame to HSV colour model.
hsv = cv2.cvtColor(frameBGR, cv2.COLOR_BGR2HSV)

# HSV values to define a colour range.
colorLow = np.array([icol[0][0],icol[0][1],icol[0][2]])
colorHigh = np.array([icol[0][3],icol[0][4],icol[0][5]])
maskGreen = cv2.inRange(hsv, colorLow, colorHigh)

colorLow = np.array([icol[1][0],icol[1][1],icol[1][2]])
colorHigh = np.array([icol[1][3],icol[1][4],icol[1][5]])
maskBlue = cv2.inRange(hsv, colorLow, colorHigh)

colorLow = np.array([icol[2][0],icol[2][1],icol[2][2]])
colorHigh = np.array([icol[2][3],icol[2][4],icol[2][5]])
maskRed = cv2.inRange(hsv, colorLow, colorHigh)

# define Kernal
kernal = cv2.getStructuringElement(cv2.MORPH_ELLIPSE, (7, 7))

# morphologyex close and open every mask
maskGreen = cv2.morphologyEx(maskGreen, cv2.MORPH_CLOSE, kernal)
maskGreen = cv2.morphologyEx(maskGreen, cv2.MORPH_OPEN, kernal)

maskBlue = cv2.morphologyEx(maskBlue, cv2.MORPH_CLOSE, kernal)
maskBlue = cv2.morphologyEx(maskBlue, cv2.MORPH_OPEN, kernal)
```

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```
maskRed = cv2.morphologyEx(maskRed, cv2.MORPH_CLOSE, kernal)
maskRed = cv2.morphologyEx(maskRed, cv2.MORPH_OPEN, kernal)

# Show morphological transformation mask
# cv2.imshow('mask', mask)
cv2.imshow('maskGreen', maskGreen)
cv2.imshow('maskBlue', maskBlue)
cv2.imshow('maskRed', maskRed)

if system == '1':
    if processStep == 0:
        servoAngle = servoAngle - servoStep
        servo1.angle = servoAngle
        if servoAngle <= -40:
            processStep = 1
    elif processStep == 1:
        # Determine if the color exists on the image
        if cv2.countNonZero(maskGreen) > 0:
            print('Green is present!')
            statusScan = 'Green is present!'
            countGreen = countGreen + 1
            angleSort = 60
            processStep = 2
            servo2.angle = angleSort
        elif cv2.countNonZero(maskRed) > 0:
            print('Red is present!')
            statusScan = 'Red is present!'
            angleSort = 0
            processStep = 2
            servo2.angle = angleSort
            countRed = countRed + 1
        elif cv2.countNonZero(maskBlue) > 0:
            print('Blue is present!')
            statusScan = 'Blue is present!'
            angleSort = 30
            processStep = 2
            servo2.angle = angleSort
            countBlue = countBlue + 1
        else:
            # print("no colour")
            statusScan = "no colour"
            servoAngle = servoAngle + servoStep
```

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```
            servo1.angle = servoAngle
            if servoAngle >= 90:
                processStep = 0
        elif processStep == 2:
            servoAngle = servoAngle - servoStep
            servo1.angle = servoAngle
            if servoAngle <= -90:
                processStep = 3
        elif processStep == 3:
            servoAngle = servoAngle + servoStep
            servo1.angle = servoAngle
            if servoAngle >= 90:
                processStep = 0
    else:
        servo1.angle = 90
        servo2.angle = 0
        processStep = 0;

    # exit program
    k = cv2.waitKey(5) & 0xFF
    if k == 27:
        break

cv2.destroyAllWindows()
```

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Development of an IoT-based Sorting System for Colour-based Products

by Muhammad Razin Bin Rozali

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