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Development of sensor and automation system for a fruit sorter machine (using PLC keyence) / Mohd Sariza Abdul Gani.

DEVELOPMENT OF SENSOR AND AUTOMATION SYSTEM FOR A FRUIT SORTER MACHINE (USING PLC KEYENCE)

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MAY 2009

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"I hereby declared that I have read through this report and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Control, Instrumentation, & Automation)"

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Supervisor's Name : CIK AZIAH BTE KHAMIS

Date : 13/5/09

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DEVELOPMENT OF SENSOR AND AUTOMATION SYSTEM FOR A FRUIT SORTER MACHINE (USING PLC KEYENCE)

MUHAMMAD NURKHAIRI BIN SUKIMI

This Report Is Submitted In Partial Fulfillment Of Requirements For The Degree of Bachelor In Electrical Engineering (Control, Instrumentation, & Automation)

Fakulti Kejuruteraan Elektrik
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ACKNOWLEDGEMENTS

First of all, praise to Allah s.w.t, Most Merciful for His guidance and blessing. I would like to express my deep and sincere gratitude to my lovely supervisor; Cik. Aziah Bt Khamis. Her wide knowledge and her logical way of thinking have been of great value for me. Further more, she always helps and guides me in fulfilling and understands the task to be done. Her understanding, encouraging and personal guidance have provided a good basis for the present proposal.

During this work I have directly or indirectly collaborated with friends and other people for whom I have great regard, and I wish to extend my warmest thanks to all those who have helped me with my work in the Faculty of Electrical Engineering, Universiti Teknikal Malaysia Melaka.

I cannot end without thanking my family, on whose constant encouragement and love I have relied throughout my time at the university. Their unflinching courage and conviction will always inspire me, and I hope to continue, in my own small way, the noble mission to which they gave their lives. It is to them that I dedicate this work.

Finally, I would like to express appreciation to all my members and friends as appreciation for their cooperation, support and encouragement. Thank you.

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ABSTRACT

The objective of this project is to design and develop of sensor and automation system for a Fruit Sorter Machine. The system of this Fruit Sorter Machine is controlled by Programmable Logic Controller (PLC) Keyence. This sorter machine is design to sort three different sizes of fruits (oranges). Sensor has been used in this machine. When the switch is turned on, motor will start to operate and give force to the roller that carries the fruit. Three sensors used to sense the fruit that fall into the container and count it up until 10. All the signals are transmitted to PLC.

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ABSTRAK

Objektif utama projek ini adalah untuk merekabentuk dan seterusnya menghasilkan mesin pengasing buah dengan menggunakan sensor dan system automasi Pengawal Logik Aturcara (PLC) Keyence merupakan satu kaedah kawalan yang digunakan dalam system ini. Mesin pengasing buah ini direkabentuk untuk mengasingkan buah oren mengikut tiga spesifikasi saiz yang telah ditetapkan. Suis pengehad adalah sensor yang telah dipilih dalam projek ini. Apabila suis utama ditekan, motor akan mula beroperasi dan memberi daya kepada roller yang membawa buah-buah ini. Tiga sensor digunakan untuk mengesan kehadiran buah yang jatuh ke dalam bekas yang disediakan dan mengiranya hingga sepuluh kiraan. Kesemua signal yang diperolehi dihantar ke Pengawal Logik Aturcara (PLC).

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LIST OF ABBREVIATION

PLC	-	Programmable Logic Controller
PWS	-	Precision Weight Sizing
SLS	-	Single Lane Sorter
DLS	-	Dual Lane Sorter
I/O	-	Input and Output
PSM	-	Projek Sarjana Muda
S	-	Small
M	-	Medium
L	-	Large
XL	-	Extra Large
DC	-	Direct Current
CPU	-	Central Processing Unit
PC	-	Personal Computer

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CHAPTER 1

INTRODUCTION

1.1 Introduction

High technology was applied to big industrial and company. Their used automation system in the sorting process because computerized or machine are capable to do many works or tasks sequent and effectively. Machine is the important to sort the fruits according to the specification and grades without or less in mistakes. In this project, used of Programmable Logic Controller (PLC) as a controller and automation system are good ideas. This machine is suitable for small industry because it is less in size, inexpensive, easy to troubleshoot and portable.

1.2 Project Overview

This project has been proposed to develop of sensor and automation system for a fruit sorter machine. The controlled system for this machine is by using Programmable Logic Controller (PLC) Keyence. Keyence PLC will be used to control all parts of the

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systems that has been program in ladder diagram by using KV Ladder Builder Software Version 1.51.

1.3 Problem Statement

Nowadays, a used of human in agriculture is decrease. Furthermore, people who work in this environment will lost their focus in working because they will do the sorting work for maximum hours. The quality of sorting work decrease. This is the reason why the Fruit Sorter Machine has designed. This sorting machine can take the human place in sort the fruit. These machines provide the packing staff with useful information from the sorter control software, such as the size and grade of the fruit they are packing, to save time and reduce packing mistakes. It can work for a long time unless the stop button has been push. The precision of this machine is not a problem.

1.4 Project Objectives

Main objectives of this project are to develop of sensor and automation system for a portable Fruit Sorter Machine using hardware development and software development by PLC Keyence. To make sure project success, below objectives has to be achieved:

Hardware Development:

1) To study the sensor characteristic to perform the task.
2) To design and develop the prototype of the machine.
3) To troubleshoot the prototype of the machine.

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Software Development:

1) To design and develop the controller programming by using PLC Keyence.
2) To test the program by using appropriate software.
3) To test and troubleshoot the system (controller with hardware).

1.5 Project Scope

Generally, any projects have it own limitation or scope. The main scopes of this project are:

1) Conducting some research on sensor characteristic. Sensor which accurate, low cost and suitable will be considered.
2) Design and develop the system controller programming by using PLC (Keyence).
3) Build the logic diagram by using Ladder Builder for KV software.
4) Test the ladder logic program in order to prevent faulty operation.
5) Test and troubleshoot the system (PLC with hardware).

1.6 Thesis Outline

This thesis contains five chapters which are Introduction, Literature Review, Methodology, Result and Discussion. Chapter 1 contains the introduction of overall project. Besides, it's also explain about the problem statement, objectives and scope of the project which are important to make sure that process flow are in track.

Second chapter is Literature Review. This chapter tells about study that had been done based on existing product that already use in market. It's also talk about theory of the equipment and technology that will be used in this project.

Third chapter explain on the project methodology. In this part, the entire flow of the project from the beginning until to the end will be explained. This methodology was

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follow to in order to make sure the planning is not disturbed and the projects progress is well going.

Next chapter is Result, which are cover and explained about implementation of the project from the beginning until it was finish. It's cover for both in software development and hardware development. For the last part of the chapter, it will cover on the cost of the product.

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CHAPTER 2

LITERATURE REVIEW

This chapter base on reviewing and explaining on the past project that have been done in industry. It includes the product that already use in market or industry. Besides, this chapter will briefly talk about the component and technology that will be used in this project.

2.1 First review: Precision Weight Sizing

The compact sorting machines use an electronic weighing system to grade fruit. Different shape of fruit is not the problems. It has 2 load cells per lane. This machine will gather weigh information and process approximately 250 reading in less than 1/10 second for each fruit. Design for high speed weighing and can produce about 20 to 2000 grams fruit per hour. All the information is recorded and updated every time. Figure 2.1 shows the example of Precision Weight Sizing machine.

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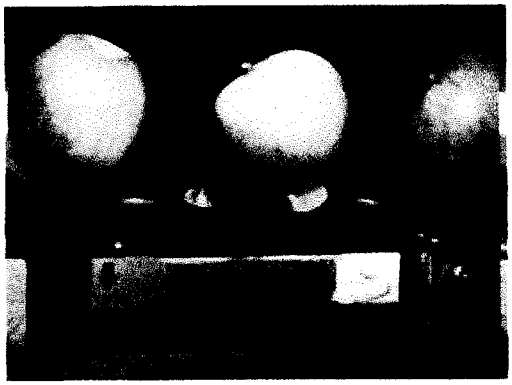

(a) Weighing apple

(b) Weighing pears

Figure 2.1: Precision Weight Sizing machine.

2.2 Second review: Compac Single Lane Sorter (SLS)

This machine has a capacity from 1 to 5 kg per hour. It can be pact in both sides to maximize flexibility with a minimal floor space required. To increase the performance of sorting efficiency, minimum transfer distance used for the best possible fruit handling. High quality stainless steel is used to make sure that it can withstand the load while powder coat is used to protect the fruit.

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The function of this machine is to pack fruit in line with a large sorter. Besides, it's also act as a main grader so that it can grade fruit according to specification. Compac SLS machine has specialty line to handle small batch of a different packaging.

Figure 2.2: Single Lane Sorter

2.3 Third review: Compac Dual Lane Sorter (DLS)

Dual Lane Sorter machine is similar from SLS machine, but it was design in two lanes. This machine is able to reach capacity of 2 to 10 kg per hour. It is more economical solution because it has double lane compared with SLS. This Compac DLS are ideal for packing requirement:

- 2 qualities or grade of fruit can be packed in one machine.
- It can allow continuing use of existing pack house.

2.4 Programmable Logic Controller (PLC)

2.4.1 Introduction of PLC

Programmable Logic Controller is a specialize computer used to control machine and process. It uses a programmable memory to store instruction and execute specific

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functions that include On/Off control, timing, counting, sequencing, arithmetic and data handling. The common abbreviation used in the industry for the devices, PC, can be confusing because it also the abbreviation for personal computer.

This is actually a control device that consists of a programmable microprocessor, and is programmed using a specialized computer language. Before, a programmable logic controller would have been programmed in ladder logic, which is similar to a schematic of relay logic.

PLC was used to replace relay logic, but its ever-increasing range of functions means that it is found in many and more complex application. As the structure of the PLC is based on the same principle as those employed in the computer architecture, it is capable of performing not only relay switching tasks, but also other application such as counting, calculating, comparing and processing of the analog signal.

There are several advantages of using PLC. This is why many industries use PLC as their controlled system. Advantages of PLC:

- Increased Reliability
- More Flexibility
- Lower Costs
- Communications Capability
- Faster Response Time
- Easier to Troubleshoot

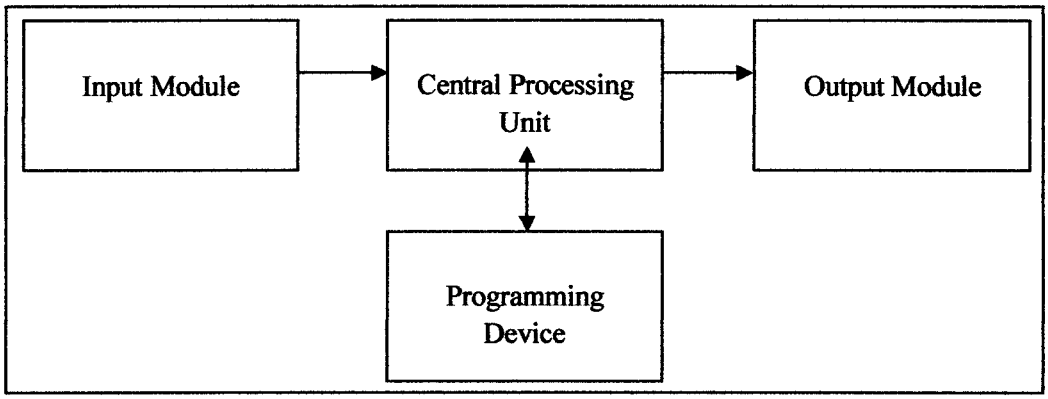

Figure 2.3: PLC Block Diagram

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CHAPTER 3

METHODOLOGY

This chapter will explain about project methodology. In this part, the entire flow of the project from the beginning until to the end will be explained. It describes every step in the project life cycle in depth. Every selection and action that has been done while implementing the project must be explains in stages. The very important of this methodology is to make sure the project will consist of hardware and software development with systematically and successfully.

3.1 Project Methodology

To make sure that the objective will be achieved, several methods must be taken. The first method is to get all information about this project. For example, group discussion must be done every week to get information and to discuss each other. Furthermore, by referred to journal and manual also can get information. Second method is to get through the software. In this method, all the programming must be done by PLC. Whole of this system has been control by this programming. Third and the last

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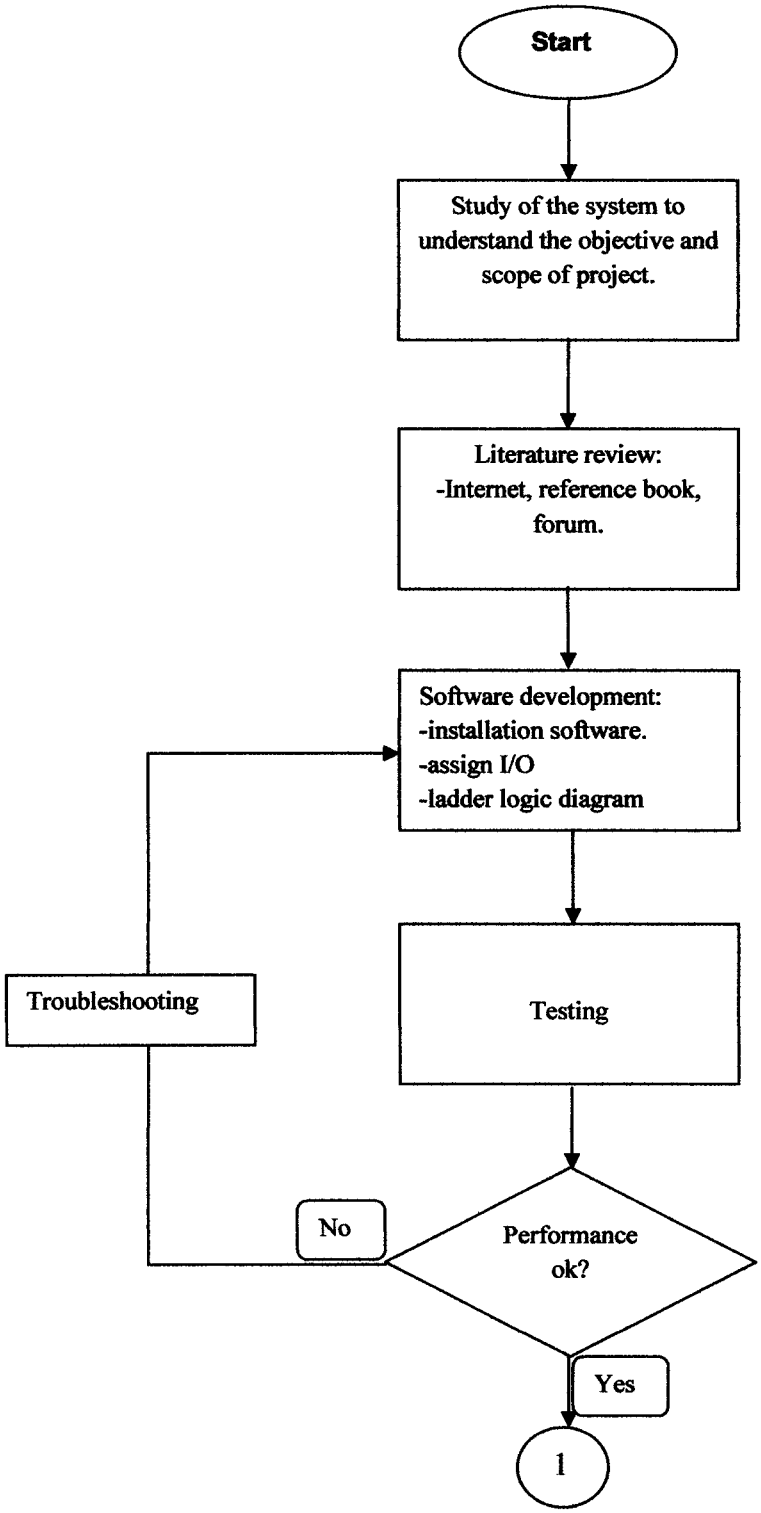
method are to develop the hardware. Components like motor, sensor and roller are assembling in this method.



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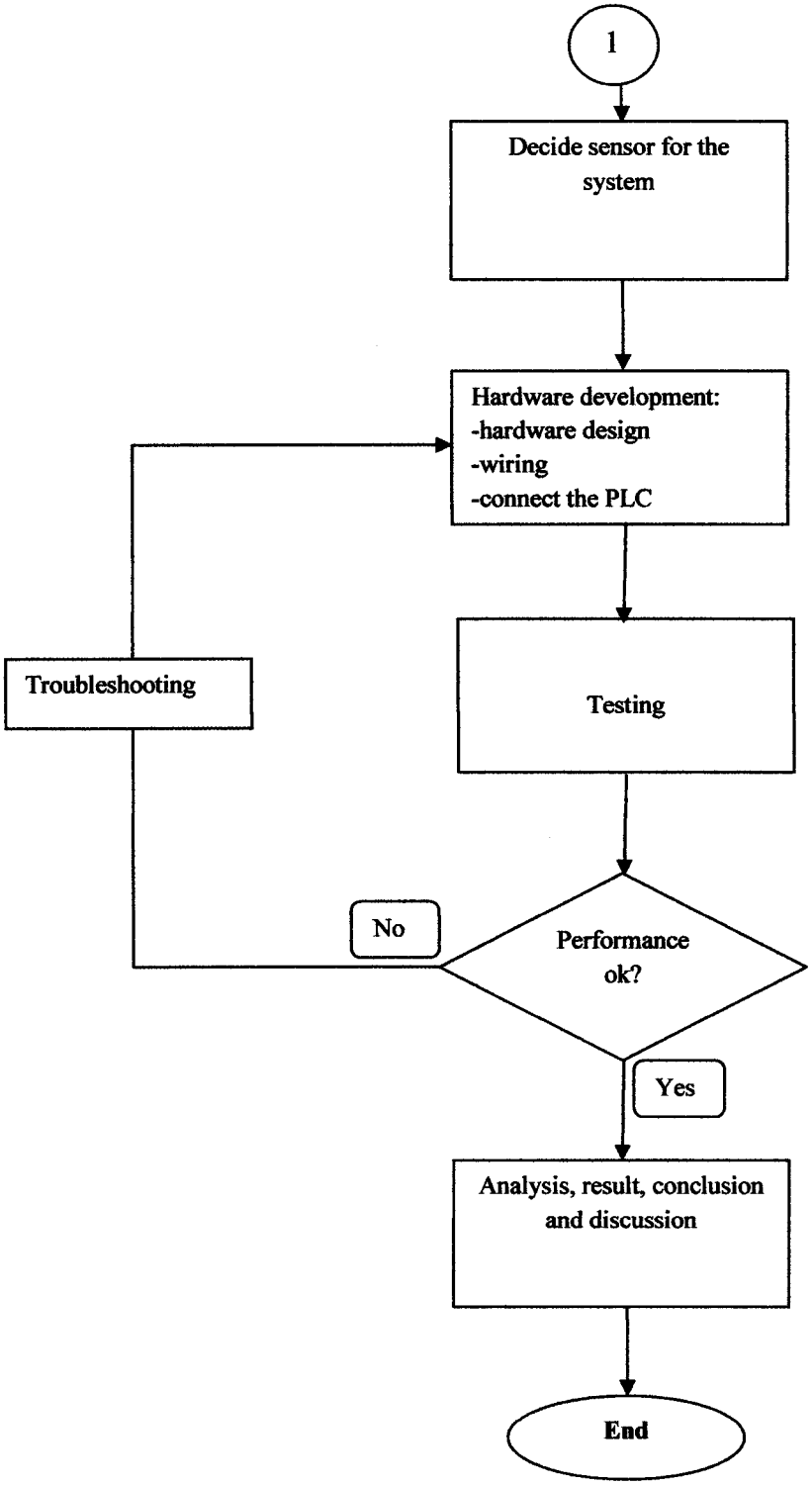

Figure 3.1: Project Flowchart

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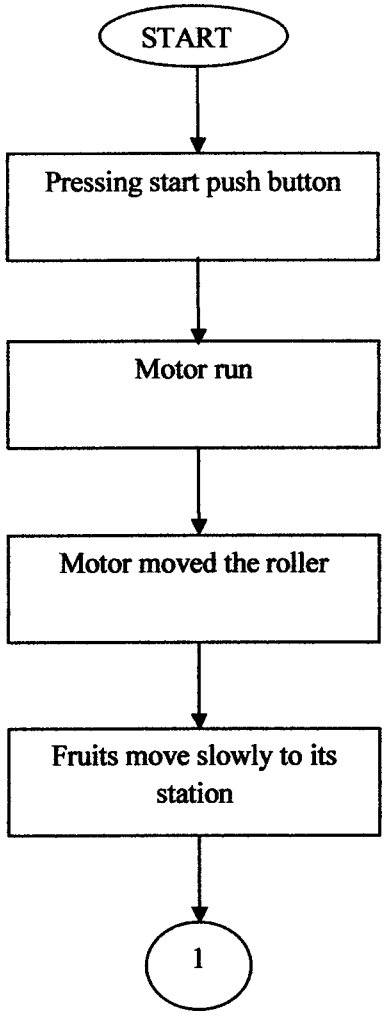

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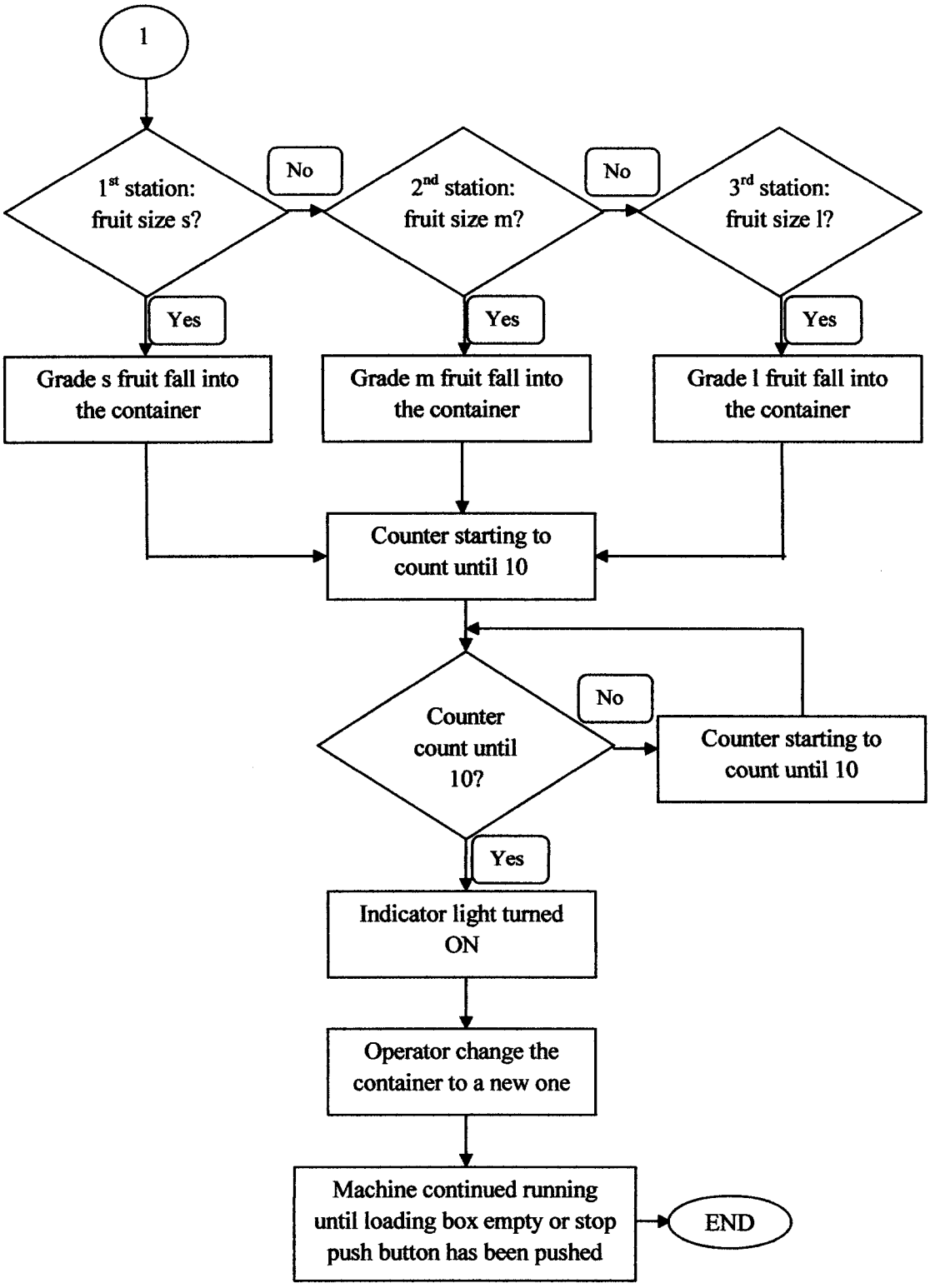

Figure 3.2: System Flowchart

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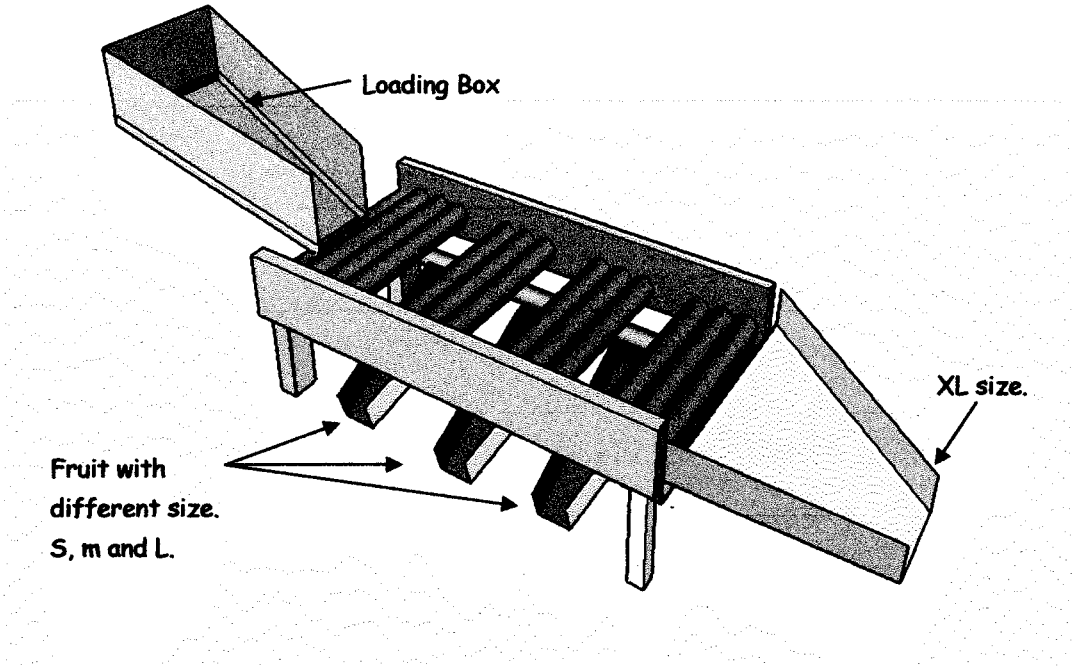
3.2 Project Design and Drawing



(a) Right View

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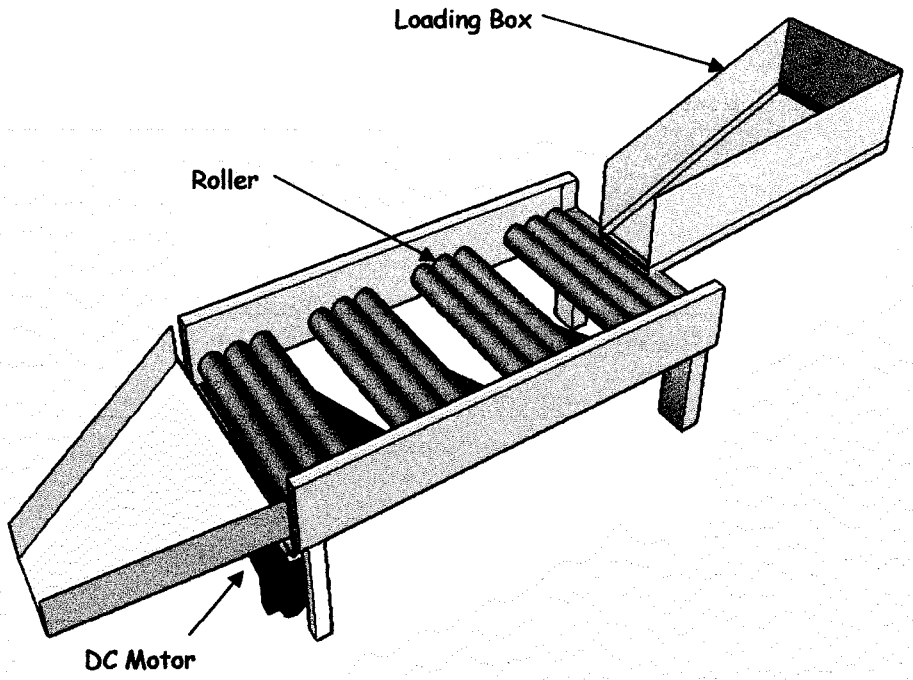

(b) Left View

Figure 3.3: Machine Prototype

3.3 Keyence PLC

Keyence PLC has been choosing as the controlling system in this project. This PLC coming in a small size which is suitable to be attach at the machines. Beside that, it will not disturb the main objective of this project because the Keyence PLC is very light in weight. Keyence PLC has many advantages. Below are the features of Keyence PLC:

3.3.1 Smallest PLC in the world

KV-10 (with 10 I/O) is about the same size as three general-purpose relays. The KV-80 is a small as VHS video tape. KV series PLC required little space on a controlled panel.

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3.3.2 Analog I/O units with 12-bit resolution

The KV-DA4 (D/A converter) and KV-AD4 (A/D converter) expansion units with 4 channels I/O are also available.

3.3.3 Support software for Windows

New Ladder Builder support software enables to debug the program on PC screen without connecting to a PLC or other devices.

3.3.4 Interrupts and counter

The interrupt input instruction receives pulse signals as short as 25μs regardless of the program cycle time, thus allowing real time processing. The KV Series also provides two 10 kHz counters that are suitable for counting pulses with a high frequency.

3.3.5 Many function

Useful during start up, the analog timer trimmer enable to adjust the values for timers and counters, in real time, base on the actual operating conditions, with a range from 0 to 249. There are two analog timers in the KV-80, KV-40, and KV-24, and one timer for KV-16 and KV-10.

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3.3.6 I/O Specification

Table3.1: Input Specification

Model	KV-16	KV-24	KV-40
No. of inputs	10	16	24
Input common	COM is connected internally		
Maximum input rating	24.6 VDC		
Input voltage	24 VDC, 5.3 mA/5 VDC, 1,0 mA		
Input time constant	10 ms (Typical) 10μs when HSP instruction is used Variable in 7 steps from 10μs 10 ms while special utility relays 2813 is ON (Set by DM1940)		
Interrupt input response	10 μs (Typical)		
High-speed counter input response	30 kHz (24V ± 10%)		

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Table 3.2: Output Specification

Model	KV-16T	KV-20T	KV-40T	KV-16R	KV-20R	KV-40R
No. of outputs	6	8	16	6	8	16
Output common	1 common			Each common terminal is independent		
Output type	Transistor output			Relay output		
Rated load	30VDC 0.3 A (503 and other) 0.1 A (500 to 502)			250 VAC/30 VDC 2 A (Inductive load) 4 A (Resistive load)		
Peak load current	0.2 A (500 to 502) 1 A (other)			5 A		
Relay service life	-			Electrical service life: 100,000 times or more (20 time/min) Mechanical service life: 20 million times or more		
Relay replacement	-			Not allowed		
Output frequency	50 kHz (500 to 502)			-		
Built-in serial resistance	1.6 kΩ 1/2W (R500 to R502)			-		

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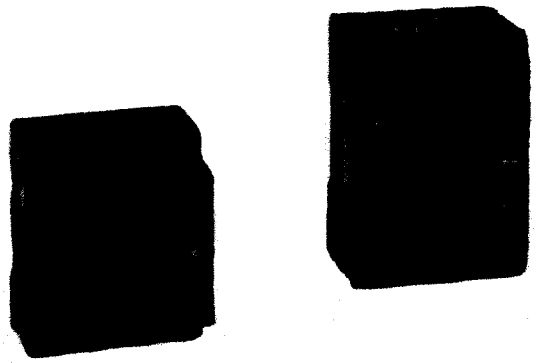

Figure 3.4: Keyence PLC

3.4 Programming Language (KV Ladder Builder)

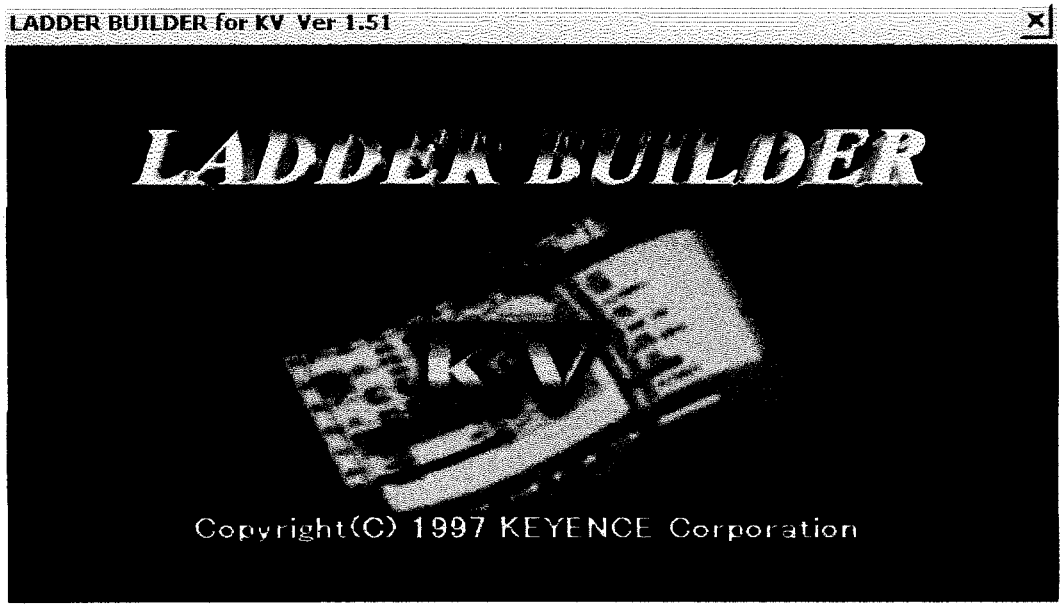

Figure 3.5: Ladder Builder for KV Version 1.5.1

PLC programming of this system can be done by using KV Ladder Builder Version 1.51. This software also can be debugging and simulate without connecting to the other devices such as PC. This software is easy to learn and it is suitable for beginner

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in PLC programming. KV Ladder Builder is able to directly connecting to the PLC via computer.

KV Ladder Builder software can be used for all type of Keyence PLC such as KV-10, KV-16, KV-20, KV-40 and more. Below are the features for KV Ladder Builder software.

3.4.1 Suitable for all KV models

We can probably design a ladder diagram for all type of KV Keyence PLC. When this software has been run, we can choose which type of PLC that want to be used.

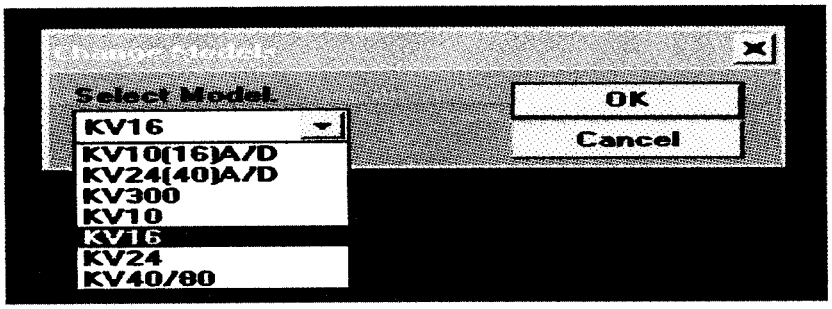

Figure 3.6: Change models

3.4.2 Monitor All Function

Timer, counter and data memory can be checking simultaneously in a same time in monitor all windows. All devices can be check even not in ladder diagram.

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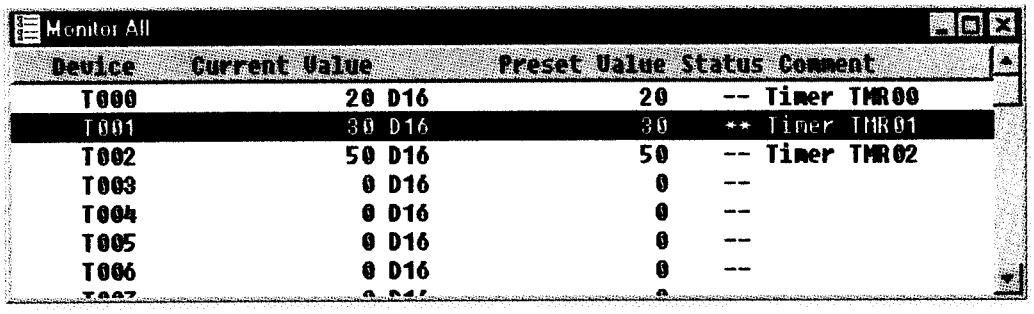

Figure 3.7: Monitor All windows

3.4.3 Allows Verification of Diagram Execution

To set or reset the element in ladder diagram (simulation), just double click the element.

3.4.4 Registration Mode

The registration monitor windows contain the data, current value, and set value for the devices as well the time chart and comment.

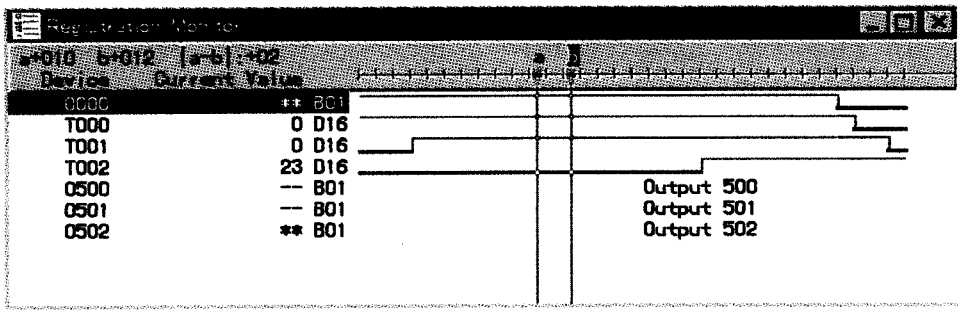

Figure 3.8: Registration Mode

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3.4.5 Auto-save Function

Auto-save function is important so that the programming can be saves automatically. It's like a backup mode if anything happen such as black out or power lost. The programming will be saving in specified time interval.

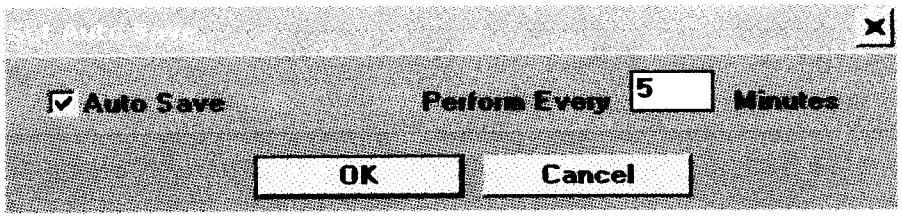

Figure 3.9: Auto-save Function

3.4.6 Users Help

KV Ladder Builder provide help function to help those who were beginner in this program. Its shows how to get start the programming mode, until simulation and transferring programming to PLC.

3.5 Sensor

Sensor is the devices that measure the physical quantity and convert it to the signal which can be read by an observer or an instrument. In this project, Limit Switch sensor has been choosing. Linear limit switches are electromechanical devices that require physical contact between a target object and switch activator to make the contact change stage.

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Figure 3.10: Limit Switch

The advantages for using limit switch are:

- Inexpensive
- Simple
- Reduce space requirement
- Easy to troubleshoot

3.6 Indicator light

To indicate either the box is full of fruits or not, 12V DC indicator light has been used. 4 indicators light have been chosen which are to shows that system is running and to indicate that the counter already count until 10^{th}.

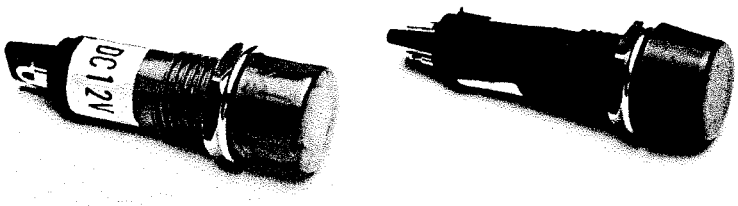

Figure 3.11: Indicator light

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CHAPTER 4

RESULT

This chapter will describe and explain about implementation of the project from the beginning until it was finish. For the software development, there is some changing in ladder diagram compare in PSM 1. It is because there are a problem occurs during simulation and after connecting to hardware. Beside, hardware development also has been described in this chapter. Hardware development has been done in PSM 2. Its include wiring, fix main machine troubleshooting. In the end of the chapter, it will cover with cost of the product that has been used to build overall machine.

4.1 Software Implementation

This part is about software programming. It consist of I/O assignment, PLC programming and mnemonic code. Programming is very important because it is the brain of all operation. Its control the conveyor, motor, indicator light and more.

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