

raf

TJ223.P76 .M60 2008.



0000066070

Portable dragon fruit grade sorter sensor and automation
design / Muhammad Hidayat Suhaimi.

66070

**PORTABLE DRAGON FRUIT GRADE SORTER
SENSOR AND AUTOMATION DESIGN**

MUHAMMAD HIDAYAT BIN SUHAIMI

MAY 2008

PORTABLE DRAGON FRUIT GRADE SORTER
SENSOR AND AUTOMATION DESIGN


MUHAMMAD HIDAYAT BIN SUHAIMI

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


Faculty of Electrical Engineering
Universiti Teknikal Malaysia Melaka

MAY 2008

“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)”

Signature :  -----
Supervisor's Name : PN Aliza Bt Che Amran
Date : 7 MAY 2008

“I hereby declared that this report is a result of my own work except for the excerpts that have been cited clearly in the references.”

Signature : -----
Name : MUHAMMAD HIDAYAT BIN SUHAIMI
Date : 7 MAY 2008

APPRECIATION

First of all praises be to Allah S.W.T, The Most Merciful for His Guidance and Blessing. I am indebted to the numerous people who have contributed their time, effort, advice, help and constructive criticism throughout my research and development of my Bachelor Degree Project 2 and progress report for my Final Year Project 2(PSM 2).

I would like to express my sincere gratitude and appreciation to my beloved family for their unending support since I studying in UTeM. Not forgotten the my PSM supervisor Pn Aliza Bt Che Amran who helped and guide me in fulfilling and understand the task to be done.

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

ABSTRACT

The main objective of this project is to design and implement of a Portable Dragon Fruit Sorter which will focus more on sensor and automation design. The controller used for this Portable Dragon Fruit Sorter is Programmable Logic Controller (PLC). The function of this system is to detect the Dragon fruit grades using suitable sensor for high system performance. Then, the system should automatically sort the dragon fruits according to the grades. The output signal from sensor is transmitted to PLC. PLC will control the sorting station which will use electro-pneumatic as actuators.

ABSTRAK

Objektif utama projek ini adalah untuk merekabentuk seterusnya menghasilkan mesin mudah alih, pengasing buah naga mengikut gred. Projek ini memberi penekanan terhadap aspek sensor dan rekabentuk mesin. Pengawal logik aturcara (PLC) merupakan satu kaedah kawalan yang digunakan di dalam projek ini. Sistem yang dibangunkan ini berupaya untuk mengenalpasti gred bagi setiap buah naga dengan mengaplikasi penggunaan sensor, seterusnya dapat dipastikan prestasi sistem berada pada tahap yang terbaik. Sistem ini juga berupaya untuk mengasing buah naga mengikut gred secara automatik. Isyarat keluaran bagi sensor akan di hantar kepada PLC. PLC akan mengawal stesen pengasing yang terdiri dari penggerak elektro-pneumatik.

TABLE OF CONTENT

CHAPTER	CONTENT	PAGE
	APPRECIATION	iii
	ASBTRACT	iv
	ABSTRAK	v
	TABLE OF CONTENT	vi
	LIST OF TABLES	ix
	LIST OF FIGURES	x
	LIST OF ABBREVIATIONS	xii
	LIST OF APPENDICES	xiii
I	INTRODUCTION	
	1.1 Introduction	1
	1.2 Project Overview	1
	1.3 Problem Statements	2
	1.4 Project Objectives	2
	1.5 Project Scope	3
II	LITERATURE REVIEW	
	2.1 First Review: Precision Weight Sizing	4
	2.2 Second Review: Single Lane Sorters (SLS)	5
	2.3 Third Review: Dual Lane Sorters (DLS)	6
	2.4 Fourth Review: Lele Group Grader For Fruit	6
	2.5 Conclusion	7

2.6	Equipment Theory	8
2.6.1	Programmable Logic Control (PLC)	8
2.6.1.1	Parts of PLC	9
2.6.1.2	User Interface	12
2.6.2	Pneumatic Solenoid Valve	13
2.6.3	Pneumatic Cylinder	14
2.6.4	Photo Electric Sensors	15
2.6.5	Conveyor	18
2.6.6	Load Cell	19
2.6.7	Relay	20
2.6.8	Programming Language	21
III	METHODOLOGY	
3.1	Project Methodology	24
3.2	Literature Review	28
3.3	Project Implementation	28
3.3.1	Project Design and Drawing	28
3.4	Software Development and Implementation	29
3.4.1	Programming Language	30
3.4.1.1	KV Ladder Builder for KV Software	30
3.5	Hardware Development and Implementation	35
3.5.1	KEYENCE PLC	35
3.5.1.1	Technical Guide	38
3.5.2	Pneumatic System Equipments	40
3.5.3	Photo-Electric Sensors	42
3.5.3.1	Technical Guide	42
IV	PROJECT IMPLEMENTATION	
4.1	Project Background	43
4.2	System Overview	45
4.3	System Concept and Algorithm	46
4.3.1	Loading Station: Loading Process	46
4.3.2	Station 2: Sorting Process	49
4.3.3	Station 3: Storing Station	50

V	RESULT	
5.1	Software Implementation	52
5.1.1	I/O Assignment	52
5.1.2	PLC Programming (Coding)	55
5.1.3	PIC Programming	60
5.2	Hardware Implementation	62
5.2.1	Loading Station	62
5.2.2	Sorting Station	64
5.2.3	Controlling System (PLC)	65
5.3	Financial Costing	66
VI	DISCUSSION AND CONCLUSION	
6.1	Discussion	67
6.2	Problem Encountered	67
6.2.1	Mechanical	67
6.2.2	Software Development	68
6.2.3	Electrical	69
6.3	Conclusion	69
6.4	Recommendation	69
	REFERENCES	70
	GANTT CHART	71
	APPENDICES	72

LIST OF TABLES

NO	TITLE	PAGE
3.1	KV Series Super-small PLC Specifications	37
4.1	Fruits Grade Table	49
5.1	Input I/O Assignment	53
5.2	Output I/O Assignment	53
5.3	Internal Relay Assignment	54
5.4	Timer Assignment	54
5.5	Equipment Financial Cost	66

LIST OF FIGURES

NO	TITLE	PAGE
2.1	Sized operation screen	5
2.2	Weighing apples (load cell)	5
2.3	Single Lane Sorters	6
2.4	Fruit Grader Machine	7
2.5	PLC Block Diagram	9
2.6	Parts of PLC	10
2.7	Programmable Logic Controller Diagram	10
2.8	PLC System Overview	11
2.9	Protection Diagram	12
2.10	Pneumatic Solenoid Valve	13
2.11	Electro-Pneumatic system connection	13
2.12	Pneumatic Cylinder	14
2.13	Single-Acting with spring returns	14
2.14	Photoelectric Sensors with Separate Digital Amplifier	16
2.15	Photoelectric Sensor Components	18
2.16	Conveyor system	18
2.17	Wheatstone bridge Diagram	19
2.18	A Relay Providing Isolation Between Two Circuit	20
2.19	Ladder Logic Programming	22
2.20	GRAFCET / Sequential Function Chart	23
3.1	Methodology Flowchart	27
3.2	Machine Prototype	29
3.3	Ladder Builder for KV Version 1.5.1	30
3.4	KV Ladder Builder Programming	31
3.5	Instruction Word	32
3.6	Auto-Save Function	33

3.7	Usage List	33
3.8	KV Ladder Builder software	34
3.9	PLC KV Series	35
3.10	Installation Direction	38
3.11	Installation Distance	38
3.12	Wiring for DC Type Basic Unit	39
3.13	Solenoid Valve with Manifold	40
3.14	CKD Cylinder Specification	41
3.15	Photo-Electric Sensor	42
3.16	Connection Diagram for Sensor NPN and PNP Type	42
4.1	System Flow	45
4.2	Machine Prototype	46
4.3	Loading Station	47
4.4	Loading Station Connection Diagram	48
4.5	Block Diagram for Fruit Grade C Process	50
4.6	Process Algorithm Flow Chart	51
5.1	Software User's Interfacing	55
5.2	Ladder Logic Diagram (Loading Station)	56
5.3	Ladder Logic Diagram (Sorting sensor for grade A)	57
5.4	Ladder Logic Diagram (Sorting cylinder for grade A)	58
5.5	Ladder Logic Diagram (Cylinder 4 - Loading Station)	59
5.6	PIC Programming	60
5.7	PIC Programming (continue)	61
5.8	Portable Dragon Fruit Grade Sorter	62
5.9	Loading Station	63
5.10	Cylinder 4	63
5.11	Loading Station Panel	63
5.12	Sorting Station	64
5.13	Pushing Cylinder	64
5.14	Photo Electric Sensors	64
5.15	PLC Input and Output	65
6.1	PIC Circuit	68

LIST OF ABBREVIATIONS

PLC	-	Programmable Logic Controller
SLS	-	Single Lane Sorters
DLS	-	Dual Lane Sorters
AC	-	Alternate Current
DC	-	Direct Current
ROM	-	Read Only Memory
RAM	-	Random Access Memory
CPU	-	Central Processing Unit
I/O	-	Input/Output
IL	-	Instruction List
SFC	-	Sequential Function Chart
LS	-	Limit Switch
Cy	-	Cylinder
LED	-	Light-Emitting Diode
SAC	-	Single Acting Cylinder
DAC	-	Double Acting Cylinder

LIST OF APPENDICES

NO	TITLE	PAGE
A	PLC Ladder Diagram (Ladder Builder for KV)	72
B	Mnemonic List (Ladder Builder for KV)	77
C	Double Acting Cylinder	79

CHAPTER 1

INTRODUCTION

1.1 Introduction

Nowadays usage of human power in agriculture sector are critically and widely use. Usually high technology system applies only by big company. Industrial automation increasingly important in the sorting process because computerized or machines are capable of handling repetitive task quickly and effectively. Thus machines are also capable to sorting fruit according to the grades without mistakes. In this project, simple automation system which comprises of automation machine and programmable logic controller (PLC) are designed to be applying in a small agriculture industry.

1.2 Project Overview

This project is to design hardware of Portable Dragon Fruit Sorter which will focus on sensor and automation design. The mainly part of this project is the integration of Programmable Logic Controllers (PLC) as main control system with electro-pneumatic system. KEYENCE's PLC will be used to control the sequences of the system. This project divided into two major sections. First is mechanical part and another one is electrical. The mechanical part are including mechanical drawing of the system, welding and fabricating process while the electrical part consist of electrical wiring and system programming.

1.3 Problem Statements

The system designed is prototype to automation machine. There are several reasons to need this machine as a solution for agriculture industrial problems. Nowadays, usage of human power especially in agriculture sector is critically and widely use. One of these project objectives is replacing man power with machine. Usually a lot of human error happened during sorting fruit process. Therefore this project is built to minimize or overcome those errors. Usually peoples can work around 7-8 hours per day. Basically more than the period, they will loose their focus and to concentrate on the job becoming difficult. Automation systems chose to overcome thus problem and moreover the designed system will produce efficient and high productive system. Usually in industry, designed machines are in big size therefore it is not portable. That's why in this system, it is designed in smaller size.

1.4 Project Objectives

The main objective of this project is to design and develop a portable Dragon fruit grade sorter. The objectives also can be dividing into two parts:

Hardware Development

- 1) To study the characteristic of sensors appropriate to perform the task.
- 2) To develop the conveyer system.
- 3) To design actuator system includes of electric motor and electro-pneumatic system.
- 4) To examine and troubleshoot hardware system.

Software Development

- 1) To design and develop the system controller programming (PLC).
- 2) Test the controller programming for a controlled environment.

1.5 Project Scope

Generally, all the projects have their own scope or limitation as a guideline. The scopes for this project are:

- 1) Conducting some research on sensor characteristics that can fulfill a task on grading Dragon fruits. Sensor which is accurate, low cost and suitable will be considered.
- 2) Design the conveyor structure. The conveyor must be able to withstand the dragon fruits' weight.
- 3) Study and research for suitable electric motor which can roll the conveyor at the desired speed.
- 4) Design and develop the system controller programming by using PLC (KEYENCE). Build the ladder logic diagram by using Ladder Builder for KV software.
- 5) Test the ladder logic program (simulation) in order to prevent faulty operation and to make sure the system operates according to the program designed.
- 6) Interface PLC with components of the system, sensors and motors.
- 7) Test and troubleshoot the system (PLC with hardware).

CHAPTER 2

LITERATURE REVIEW

This chapter base on reviewing and explaining on the past projects that have been done in industry. It is including the review on the product used in market. Besides, this chapter will also briefly talk about the theory of the equipment and components.

2.1 First Review: Precision Weight Sizing

The Compac sorting machines use an electronic weighing system for the fruit grading system. The Compac sorting machines feature four individual weigh points. This is very important to compensate for fruit shape or position. Therefore, the different of the fruit's shape such as pears, avocados, kiwi fruit, dragon fruit and etc. is not a problem. There are two load cells per lane used. It will gather weight information from each weigh point and process approximately 250 readings in less than 1/10th of a second for each fruit. This system is specifically designed for accurate high speed weighing of produce from 25 to 2000 grams fruit per hour. The fruit carriers and load cell runners are designed so that each carrier is being measured for over 95% of the weigh cycle, giving maximum time for precision weighing even at high speeds of 10 to 15 fruit per second per lane. The weight of every single empty carrier is recorded and updated every time. This will compensates for changes through the packing day and effectively calibrating itself automatically.

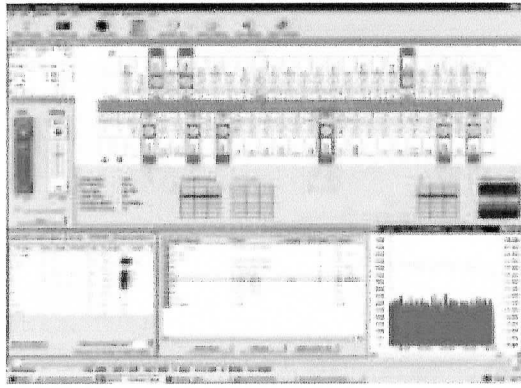


Figure 2.1: Scaled operation screen [10]

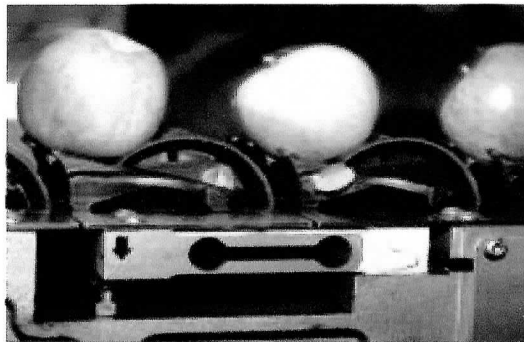


Figure 2.2: Weighing apples (load cell) [10]

2.2 Second Review: Single Lane Sorters (SLS)

Compac SLS (Single Lane Sorters) have the unique ability to pack off both sides to save valuable floor space. With capacities from 1 to 5 kg per hour, SLS solutions are ideal for smaller packers or to add flexibility to larger facilities. SLS is options to suit budget, capacity and fruit requirements. It will pack off both sides to maximize flexibility with minimal floor space required. To increase the performance of fruit sorting efficiency, minimum transfer distances used for the best possible fruit handling. This machine coming in modular design, so that will make it suit for many workspace. To make sure it can withstand the load, high quality stainless steel is used and at the finishing part, powder coat is used to protect the fruit. Compac SLS have been used in many ways; it can be use as a main grader. Besides, it is also can be installing with multiple machines for larger facilities to improve flexibility,

packaging logistics and labor efficiencies. The function of this machine is not limited to the fruit sorting job only, but it is also can be use as a specialty line to handle small batches or different packaging such as bags, and plastic case.



Figure 2.3: Single Lane Sorters [10]

2.3 Third Review: Dual Lane Sorter (DLS)

Compac DLS (Dual Lane Sorters) are based on the Compac SLS design but it is coming with 2 lanes. This unique design delivers fruit on the right lane to the packing systems on the right and the fruit on the left lane to the packing systems on the left. The Compac DLS can be a more economical solution. This machine performance is able to reach of capacity from 2 to 10 kg per hour. Compac DLS solutions are ideal for the following packing requirements:

- Qualities or grades of fruit required can be packed on one machine (such as first and second grade fruit).
- When the machine operates in multiple packing processes, it will only require limited length of floor space.

2.4 Fourth Review: Lele Group Grader For Fruit

The machine offer a wide array of grader machines that helps in grading fruits. These grades use electric power of 5 HP and are available in set dimensions of 4300x830x1000. It has electronic load cell that are fed to PLC. PLC records and registers the weight of each fruit and on the basis of their weight decides grades for

fruits. The desired grade opens the gate for fruit to drop. These are available at industry leading prices.

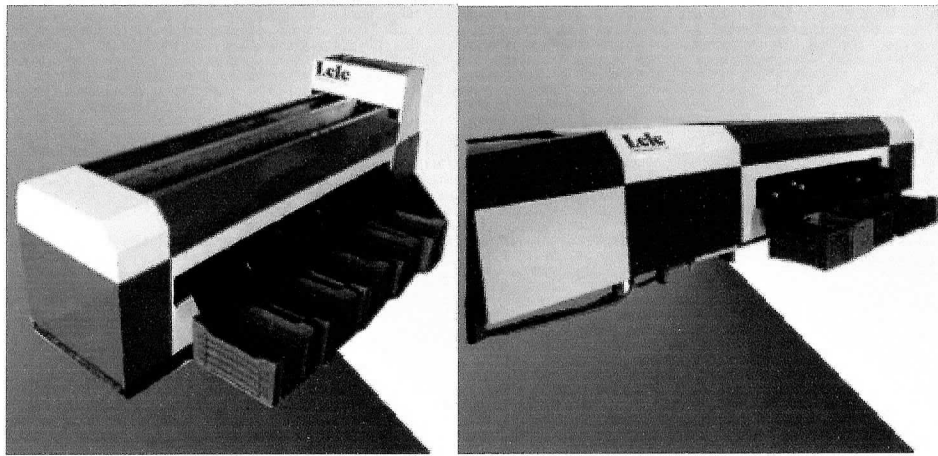


Figure 2.4: Fruit Grader Machine [10]

The wide range of size fruit grader comprises of horizontal flat area table. Its downward slopes help in sizing and sorting of fruits. The whole system is mounted on M.S. Tube and covered by powder coated CRCA sheets. It has a diverging conveyor system that carries fruits and sorts them appropriately in baskets as per size. The product grade has a capacity of producing 6000 per hour.

The improved system helps in classifying and sorting vegetables and fruits in accordance to their weight as well as electro optical parameter. The conveyor has two bicones that are joined by a frame and its set is embedded in a transporting chain. These bicones then turn due to friction against a motor belt with moderate speed.

2.5 Conclusion

After going through the reviewing job on the existing machine, a lot of benefit and information are gains. The lacks of the system from the previous sorting machine must be overcome, in order to do that; the designed of the Dragon Fruit Sorter Machine must be modified with considering the idea from the all three

systems that had been reviewed and researched before. The main element of this project is to integrate the hardware with the controller PLC.

2.6 Equipment Theory

2.6.1 Programmable Logic Control (PLC)

A programmable logic controller is a computer design for used in machines. Unlike computer, it has been design to operate in the industrial environment and is equipped with special input/output and control programming language. The common abbreviation used in the industry for the devices, PC, can be confusing because it also the abbreviation for personal computer. Therefore some manufacturers refer to their programmable controller as PLC, which is an abbreviation for programmable logic controller.

Initially the 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 principles 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'.

Programmable controller offer several advantages over a conventional relay type of control. Relays have to be hard-wired to perform a specific function. When the system requirements change, the relay wiring has to be changed or modified, which requires time. In extreme case, such as in automaton industry, complete control panels had to be replaced since it is not economically feasible to rewire the old panels with each model changeover. The programmable controller has eliminated much of hand wiring associated with conventional relay control circuits. It is small and in expensive compared to equivalent relay-based process control systems. Programmable controller also offers solid-state reliability, lower power consumption and ease of expandability. If an application has more than a half dozen relays, it is

probably will be less expensive to install a PLC-Simulating a hundred relay, timers and counters is not a problem even on small PLCs.

The advantage of PLC:

- Smaller physical size than hardwire solutions.
- Easier and faster to make programming changes.
- PLC has integrated with diagnostics and override functions.
- Diagnostics are centrally available.
- Application can be immediately documented.
- Applications can be duplicated faster and less expensively.

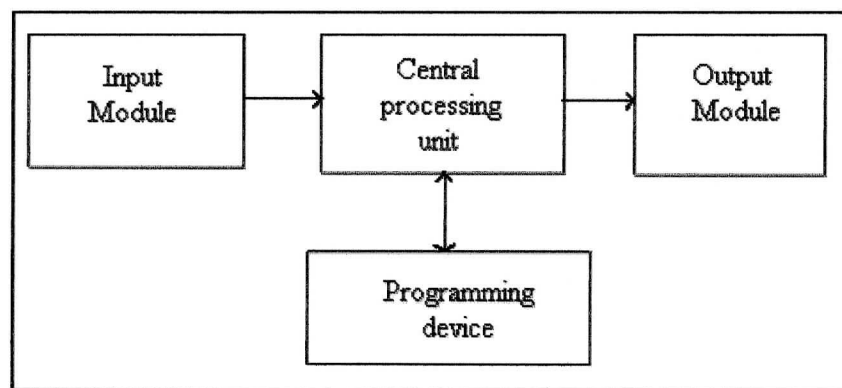


Figure2.5: PLC Block diagram

2.6.1.1 Parts of PLC

- **Digital Input Modules**

Digital modules are also called as discrete modules because it is either ON or OFF. The inputs are attached to devices such as switches or digital sensors. Input modules usually have fuses for module protection. It is typically have light-emitting diode (LED) for monitoring the inputs [5]. Most modules have plug-on wiring terminal strips where all wiring is connected there. Input modules usually need to be supplied by power. The power must supply to a common terminal on the module,