UNIVERSITI TEKNIKAL MALAYSIA MELAKA

SMART MONITORING SYSTEM FOR VEGETABLES GREENHOUSE USING RASPBERRY PI

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Computer Engineering Technology (Computer Systems) with Honours

by

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DECLARATION

I hereby, declared this report entitled "Smart Monitoring System for Vegetables Greenhouse Using Raspberry Pi" is the results of my own research except as cited in references.

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Computer Engineering Technology (Computer Systems) with Honours. The member of the supervisory is as follow:

……………………………….

(Project Supervisor)

ABSTRAK

Laporan ini berkenaan dengan pembangunan Sistem Pemantauan Bijak bagi Tumbuhan Rumah Hijau dengan menggunakan Raspberry Pi. Tanaman tanah rendah pada masa kini kelihatan agak sukar untuk tumbuh berikutan beberapa faktor termasuk kekurangan kadar air, suhu persekitaran yang kurang sesuai, cahaya, kelembapan dan banyak lagi. Pada masa yang sama, terdapat banyak kaedah penyelesaian yang ada untuk mengatasi masalah utama ini. Sistem ini diwujudkan untuk membantu para petani dalam usaha memantau tanaman tanah rendah mereka secara manual menggunakan sistem automatik yang dikawal oleh aplikasi Android. Sebagai tambahan, tujuan bagi projek ini adalah untuk mengkaji kadar pertumbuhan tanaman tanah rendah dalam rumah hijau di samping menganalisis keadaan rumah hijau apabila diaplikasikan pada tanaman tanah rendah. Dua jenis sensor digunakan untuk melengkapkan projek ini termasuklah sensor suhu dan kelembapan (DHT22), dan sensor LDR. Kesemua sensor-sensor ini mempunyai fungsi spesifik yang tersendiri dalam usaha untuk mengawal kadar pertumbuhan tanaman tanah rendah. Sebagai keputusannya, kedua-dua sensor ini berupaya untuk membaca dan mengenal pasti suhu, kelembapan dan kehadiran cahaya dalam usaha untuk mengawal tumbesaran tanaman tanah rendah. Nilai-nilai suhu dan kelembapan juga telah berjaya disimpan dalam pangkalan data supaya aplikasi Android boleh mengambil data tersebut untuk dipaparkan di telefon mudah alih Android. Tanaman tanah rendah juga telah berjaya membesar berdasarkan suhu, kelembapan dan kehadiran cahaya di persekitaran yang mencukupi.

ABSTRACT

This report present the development of Smart Monitoring System for Vegetables Greenhouse using Raspberry Pi. The lowland plants nowadays are hard to grow due to many surrounding factors including lack of water, unsuitable surrounding temperature, light, humidity and many more. On the other hand, there are also many solutions that has been come out in order to overcome these main problems. This system were developed to help the farmers to monitor their lowland plants manually by using automatically system controlled by Android"s application. In addition, the purposes of this project is to study the growth of lowland plants in the greenhouse as well as to analyze the performance of greenhouse when applied to lowland plants. Two main sensors used for completing this project including the temperature and humidity sensor (DHT22), and LDR sensor. These sensors have their own specific functions in order to control the growth of the lowland plants. As the result, these two sensors were able to read and detect the temperature, humidity and the presence of light in order to control the growth of the lowland plants. The values of temperature and humidity also have been successfully stored in the database so that the Android application may fetch the data to display it on the Android phones. The lowland plants also successfully grow based on the suitable temperature, humidity and an enough presence of light at the surrounding.

DEDICATION

A special thank you to my beloved parents Encik Zakfar bin Osman and Puan Norsiah binti Shaffee for your unconditional support regarding my studies. I am very honoured to have both of you as my parents. Thank you for trusting me and giving me chance to proving my success in study and improving myself through my life.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

ADC	-	Analog-to-digital converter
ARM	-	Acorn RISC Machine
CCD	-	Charged-coupled Device
GND	-	Ground
GPIO	-	General-purpose input/output
GPRS	-	General Packet Radio Service
GPS	-	Global Positioning System
GSM	-	Global System for Mobile Communications
HD	-	High-definition
LED	-	Light-emitting Diode
MHz	-	Mega Hertz
NOOBS	-	New Out Of the Box Software
PIC	-	Peripheral Interface Controller
SDRAM	-	Synchronous DRAM
SMS	-	Short Message Service
SPI	-	Serial Peripheral Interface
USB	-	Universal Serial Bus
VCC	-	IC power-supply pin
WSN	-	Wireless Sensor Networks

CHAPTER 1

INTRODUCTION

1.1 Project Background

In general, the lowland plants nowadays are so hard to grow healthy due to many surrounding factors such as lack of water, unsuitable surrounding temperature, light and humidity and many more. On the other hand, there are also many solutions that has been come out in order to overcome these main problems. This means, there should be a system that can help the farmers to monitor their lowland plants manually by using automatically system controlled by Android‟s application. Smart monitoring system for vegetables greenhouse was introduced to compensate with the many excuses of why farmers cannot handle their plants carefully, especially when they are spending most of their time out of their premise finding a living to sustain their family. Raspberry Pi use in the system as the main part and some sensors use to provide the specific inputs to the Raspberry Pi in order for the smart monitoring system to communicate with the environment which is the lowland plants. The system able to controls three aspects which are the temperature, humidity and light existence in order to grow.

1.2 Problem Statement

Numerous cases has been recorded such as the lowland plants did not succeed to grow, unharvest lowland plants caused by unsatisfied quality of the yield and much more (Financial Analysis of Lowland Plants, 2011). The farmers have been attempting to enhance the yield of plants developed, yet they will suffer huge losses. This situation shows that the farmers will experience enormous misfortunes and this will lead to many problems such as they cannot contribute to the nation"s economy. Insufficient time for the farmers to monitor their lowland plants regularly is one of the main factors for the problem. The lowland plants cannot live appropriately because the farmers do not have enough time to check whether there are enough water or suitable temperature, light and humidity for their lowland plants. Hence, the farmers that facing this problems supposed to have simpler techniques to ensure their plants grow healthy and there will be continuous burden for the farmers if the system is not built. Therefore, the smart monitoring system for vegetables greenhouse using Raspberry Pi will be created to overcome numerous problems and also helping the farmers.

1.3 Objectives of The Study

The main objective of this research in deeply concentrated on aspect as listed below:

i. To develop a smart monitoring system for vegetables greenhouse using Raspberry Pi.
ii. To study the growth of lowland plants in greenhouse.
iii. To analyze the performance of greenhouse when applied to lowland plants.

1.4 Scope of Project

There are two main sensors that have been choose which are temperature and humidity sensor, and an LDR sensor. Generally, the temperature sensor"s part will detect the temperature and activate the water pump to balancing the temperature to normal temperature. For the humidity sensor"s part, it will be used to check the suitable humidity that are needed to ensure the lowland plants grows healthy. Then, the LDR sensor will be used to detect whether there are an enough light or not at the surrounding of the lowland plants. Raspberry Pi use in this project as the main part to control all the sensors and give better result to user using an Android application.

1.5 Significant of Study

Living in the globalization era, most of the people are spending most of their time out of their home to earn a living for themselves. This situation will lead to lack of time to monitor their plants in order to keep the plants grow healthy. This smart monitoring system will helps the farmers to monitor their lowland plants whether they are at their home or not. It will use Android application in order to monitor the lowland plants from far away, at once giving the instructions from the user so that the system can perform its function independently. The smart monitoring system will be able to help both farmers and lowland plants happy; the farmers will experience the easiest way to monitor their lowland plants meanwhile the plants will grow healthy even without the farmer existence around them.

1.6 Conclusion

In conclusion, this chapter provides the introduction part of this project including the project background, problem statement, objectives, scope of project and significant of study. This chapter will helps by gaining the idea to construct the system easier. Also, this chapter helps to avoid the misunderstanding concept in order to complete the project.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Crop cultivation has been around for a long time ago. In the continuous development of human civilization, it plays a crucial role. Tradition crop cultivation that has been worked by our great grandfathers and grandmothers requires a tremendous amount of hard work and attention. There are several advantages in implementing traditional cultivation techniques includes the weather dependent factors and also the pests and diseases. This means, the plants growth and development are primarily governed by the weather conditions. Plants will also growing under cultivation technique that are significantly affected by pests and diseases.

It was discovered that there are indications that already many thousands years ago civilizations in countries for example Egypt, India and China employed means of protection against cold, wind and excessive solar radiation (Vu 2011). These methods of protection were implemented only to provide a short-term protection for plants against harsh climate conditions. However, when European explorers brought back exotic plants acquired in the course of their travel, no further development occurred until the late 15th century and early 16th century. There are many tropical plants that cannot endure the cold of the European climates. The result was the creation of greenhouses and these early greenhouses were originally referred to as "*giardini botanic*". It also known as "botanical gardens" (Vu 2011).

A greenhouse represents a strange kind of agricultural environment characteristics also with the presence of several input output devices and control devices. Requirement of human involvement is less compared to open air agriculture for providing water for irrigation and manures. In order to provide best conditions for the growth of plants, greenhouse represents a closed environment which can be strictly controlled by human. Wireless sensor networks (WSN) in agriculture have recently received great attention. Other than that, their use also has been intensely investigated. By the use of sensors, it is possible to monitor several environmental parameters such as the temperature, humidity, light intensity and also water level. Knowledge of this parameters helps the farmers in order to perform the most suitable operations for improving the growth of plants and productivity and low cost, crops are grown within a short time duration in greenhouse.

Table 2.1: Summary of financial flows vegetables plant in 2016 (Malaysia, 2016)

RINGKASAN ALIRAN KEWANGAN TANAMAN SAYUR-SAYURAN TAHUN 2016

BIL	TANAMAN	PENDAPATAN		KOS (RM)						PENDAPATAN BERSIH (RM)	ANALISIS		JANGKAMASA PENANAMAN
		KG	RM	KOS PEMBANGUNAN	KOS BAHAN INPUT	KOS TENAGA KERJA	KOS PELBAGAI	KOS LUAR JANGKA (5%)	JUMLAH		HARGA PULANG MODAL (RM/KG)	B/C RATIO (RM)	
1	Bayam	15,000	19,500	1,051.25	4,842.13	4,800.00	600.00	564.67	**11,293.38**	7,641.95	0.79	1.64	4 MINGGU
2	Bendi	20,000	50,000	3,364.00	12,795.33	15,600.00	2,400.00	1,707.97	**34,159.33**	14,132.70	1.79	1.39	4 BULAN
3	Cili Merah	12,450	62,250	4,205.00	15,511.17	22,800.00	3,600.00	2,305.81	**46,116.17**	13,828.02	3.89	1.29	6 BULAN
4	Halia Tua	33,000	264,000	8,410.00	40,312.50	31,800.00	10,900.00	4,571.13	**91,422.50**	168,006.38	2.91	2.75	8 BULAN
5	Kacang Buncis	14,000	49,000	2,803.33	12,029.44	12,000.00	1,800.00	1,431.64	**28,632.77**	18,935.59	2.15	1.63	3 BULAN
6	Kacang Panjang	18,000	36,000	2,803.33	10,519.44	12,000.00	1,800.00	1,356.14	**27,122.77**	7,521.09	1.58	1.26	3 BULAN
7	Kailan	15,000	33,000	1,401.67	14,622.22	8,400.00	1,150.00	1,278.69	**25,573.89**	6,147.42	1.79	1.23	6-7 MINGGU
8	Kangkung	12,000	14,400	1,051.25	3,871.13	4,800.00	600.00	516.12	**10,322.38**	3,561.50	0.90	1.33	4 MINGGU
9	Kobis	35,000	42,000	2,803.33	13,891.44	12,000.00	1,800.00	1,524.74	**30,494.77**	9,980.49	0.91	1.31	3 BULAN
10	Petola	22,000	33,000	3,364.00	10,368.33	10,800.00	2,400.00	1,346.62	**26,932.33**	4,721.05	1.29	1.17	4 BULAN
11	Sawi	18,000	27,000	1,051.25	6,307.13	4,800.00	600.00	637.92	**12,758.38**	13,603.70	0.74	2.02	4 MINGGU
12	Terung	23,000	46,000	4,205.00	13,225.56	15,600.00	3,600.00	1,831.53	**36,630.56**	7,537.91	1.67	1.20	6 BULAN
13	Timun	36,000	32,400	2,803.33	11,655.00	6,600.00	1,800.00	1,142.92	**22,858.33**	8,398.75	0.67	1.35	3 BULAN
14	Tomato*	2,640,000	4,224,000	1,030,300.00	2,124,210.00	288,000.00	22,600.00	173,255.50	**3,465,110.00**	585,634.50	1.38	1.16	10 TAHUN
15	Cili*	240,000	1,200,000	58,875.00	312,387.50	360,000.00	149,100.00	44,018.13	**880,362.50**	275,619.38	3.85	1.30	5 TAHUN
16	Jagung	30,000	18,000	2,803.33	6,364.44	4,800.00	1,660.00	781.39	**15,627.77**	1,590.84	0.55	1.10	3 BULAN
17	Keledek	23,000	27,600	2,803.33	10,764.44	4,800.00	1,860.00	1,011.39	**20,227.77**	6,360.84	0.92	1.30	3-4 BULAN
18	Labu Air	23,000	46,000	3,364.00	12,361.67	10,800.00	2,400.00	1,446.28	**28,925.67**	15,628.05	1.32	1.51	4 BULAN
19	Labu Manis	24,000	28,800	2,270.00	7,726.44	6,600.00	1,800.00	919.82	**18,396.44**	9,483.74	0.80	1.49	3 BULAN
20	Ubi Kayu	31,500	31,500	2,010.00	8,967.00	5,100.00	4,600.00	1,033.85	**20,677.00**	9,789.15	0.69	1.45	9 BULAN
21	Kucai*	189,000	567,000	8,410.00	42,868.00	87,600.00	7,200.00	7,303.90	**146,078.00**	413,618.10	0.81	3.70	1 TAHUN
22	Peria	23,000	46,000	3,364.00	14,527.44	10,800.00	2,400.00	1,554.57	**31,091.44**	13,353.99	1.42	1.41	4 BULAN

* Tomato - secara fertigasi berdasarkan 1 ha (50 SPH) bersaiz 20' x 100'
* Kucai - Jangkamasa penanaman setahun (tuaian pertama 3 bulan selepas tanam - 9 kali tuai)

Table 2.1 shows the summary of financial flows vegetables plant in 2016. It is stated that the specific incomes and costs for 22 types of vegetables that has been harvested in Malaysia including chillies, cucumber, corn, cabbage and many more. The table also stated the development costs and the labour costs. On the analysis column, it shows the net profit for every types of vegetables followed by the time investment which in average from 4 weeks to 10 years. For instance, the cabbage produces RM42,000 per 35,000 kg for it incomes over the year. RM2803.33 was needed to develop the basic requirements in order to help the healthy growth of the cabbage. For the labour costs, RM12,000 was used to taking care the growth of the cabbage which produced a net profit as much as RM9,980.49. The time investment for the cabbage is only for 3 months.

2.2 Introduction to Raspberry Pi

Figure 2.2: Raspberry Pi

The Raspberry Pi was stated as a low cost, credit-card sized computer that need to be plugged into a computer monitor or TV. It uses a standard keyboard and mouse. This capital little device enables people of all ages to explore computing, and also to learn how to program in languages like Scratch and Python. It"s capable of doing almost everything users expected for a desktop computer to do, starting from browsing the internet and playing high-definition video, to making spread sheets, word-processing and also playing games. The Raspberry Pi also has the ability to interact with the outside world. It also has been used in a wide array of digital marker projects, from music machines and parent detectors to weather stations and tweeting birdhouses with infra-red cameras (Wable n.d.).

2.2.1 Difference Between Different Raspberry Pi Models

The company had produces the different models of Raspberry Pi, from Raspberry Pi A which is the earliest version to the latest version of the module Raspberry Pi Zero throughout the history of the Raspberry Pi production. The following table will be discussed about the evolution in the specification between Raspberry Pi 2B and Raspberry Pi B+ which have categorized as the most used Raspberry Pi module in this era.

Table 2.2.1: Comparison between Raspberry Pi 2B and Raspberry Pi B+ (Nick, 2010)

Models	Raspberry Pi 2B	Raspberry Pi B+
Processor Chipset	Broadcom BMC2836 ARMv7 Quad Core Processor powered Single Board Computer running at 900 MHz	Broadcom BMC2835 ARMv6 SoC full HD multimedia applications processor
RAM	1 GB SDRAM @ 450 MHz	512 MB SDRAM @ 400 MHz
Storage	MicroSD card	SD card
USB Ports	4 x USB 2.0	4 x USB 2.0
Power Drawn	1.8 A @ 5V	1.8 A @ 5V
GPIO	40 pin	40 pin
Ethernet Port	Yes	Yes

2.2.2 GPIO Pins for Raspberry Pi

One of the powerful feature of the Raspberry Pi is the row of GPIO pins or as known as the general purpose input/output that can be seen along the top edge of the board.

Figure 2.2.2(a): GPIO pins (Foundation, 2016)

These pins are a physical interface between the Raspberry Pi and the other components. Of the 40 pins, 26 are GPIO are GPIO pins and the rest of the pins are power or ground pins. These pins can be programmed to interact in amazing ways with the greenhouse system. Inputs don‟t have to come from a physical switch which is it could be an input from a sensors (temperature, water level, light and humidity) or a signal from another computer or device, for example. The output can also do anything includes turning on an LED that related to the usage of light sensor for the greenhouse system and also can sending a signal or data to another device.

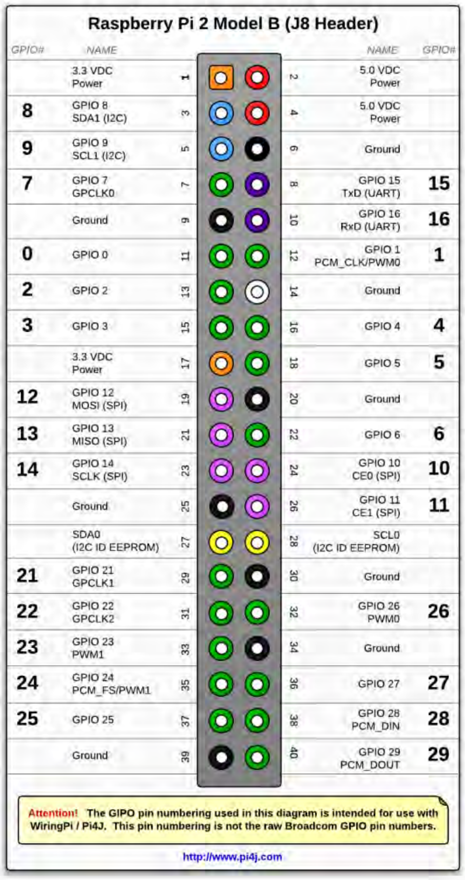

Figure 2.2.2(b): The J8 Pinout (40-pin Header) (Pi4J, 2015)

Figure 2.2.2(b) illustrate the GPIO pinout using the Pi4J/WiringPi GPIO numbering scheme. Every pins have their own specific name and descriptions.

2.3 LDR Sensor Module

Figure 2.3: LDR Sensor Module (Technologies, Light Sensor Module, 2016)

The basic components of the LDR sensor module is for the light detection. This sensor will detect the light brightness in the greenhouse‟s environment and it will decide to switch OFF or ON the light based on the suitable surrounding light intensity. Other than that, it also be able to adjust the brightness of LED for the greenhouse system. This sensor be able to interface with any microcontroller with digital input such as PIC, Arduino series and many more. It operates with a voltage of 3.3 to 5VDC. There are also several PIN assignment for this sensor. VCC is 5V, GND is 0V, DO is digital output from module and AO is an analog output from module.