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AUTOMATED CONTROL SYSTEM FOR TOMATO PLANTATION

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Abstract: This project is designed with the aim to facilitate the farmer or gardener to engage in greenhouse systems and improve agricultural technology. The main focus of this project is planting tomatoes and at the same time to promote the cultivation of cold climates plants, especially in Malaysia. Basically, the project consists of two parts; development of program code and mechanical design (prototype). The system will operate only when the input (rain detector, temperature sensors, and humidity sensors) is triggered. The maximum temperature specified for planting tomatoes in this project is 21°C while the minimum soil moisture was 25%RH. This means that if the current temperature reading is below 21°C, the cooling system will stop cooling the greenhouse and if the humidity range is above 25%RH, then the water pump will stop channeling water into the soil. In addition, the system designed is also equipped with indicators that serve to determine either bright or dark surroundings. When it rains, the system will shut the tomato plantation farm by pulling the transparent roof automatically. The purpose of this is to control the water level inside the greenhouse and thus prevent rain from destroying the tomato plants. The entire system is controlled by using Programmable Integrated Circuit (PIC) technology.
Keywords: Cold climate plants, tomato plant, greenhouse, temperature, humidity, moveable roof, PIC.

I. INTRODUCTION

MALAYSIA climate is hot and humid all year round. It was reported that the average temperature in Melaka (one of the states that are in Malaysia) in 2013 is 29°C [1] while the humidity was between 60% - 70%RH [2]. A plant that grows in Malaysia is very encouraging with such a climate in Malaysia. However, the climate in Malaysia is not very suitable for any cultivation of cold climate plants. Hence, this project was designed to encourage the planting of cold climate plants in Malaysia.

A plant that grows in cold climates requires very different temperature and humidity from a plant that grows in hot climates. The average temperature for the plant to grow is about 10°C - 20°C while moisture is needed is around 70% -80%RH. This project is designed with the

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aim to maintain the temperature and moisture of the soil for planting tomatoes. The concept adopted for this project is based on the cultivation of the cold climate plants in Cameron Highlands, Malaysia. With this project, then planting cold climate plants in hot climates countries have not become a common issue because the system designed can be developed in any area regardless of the surrounding temperature and humidity.

System can be operated in two ways; from solar energy and Direct Current (DC) supply voltage. Solar energy is used when the sun shine, but the DC supply voltage will be used when solar energy is no longer supplying power to the system. A solar panel used in this project is made of photovoltaic (PV) and it is used for converting solar energy into electricity. An effectiveness of solar panels is influenced by the size and quality of the solar cell. Activities which being process in this system will be displayed on Liquid Crystal Display (LCD). For example, when the system is running automatically to flush water to the plants, "watering" will display. Moreover, Programmable Integrated Circuit (PIC) programming is the main software for this project. Buzzer or Light Emitting Diode (LED) will represent for any failure in this system. The buzzer or siren will alert the operator that the system has error at that time. The temperature and humidity sensors will detect the heat and humid of the system. The LCD is used to display the process which going on the system. The DC fan is used as the cooling device in the system. For example if the temperature increased in sudden within the system this DC fan will operate and decrease the temperature of the system. DC motor is used to operate the roof of the system.

The organization of this paper is as follows: Section I introduce the background of the project, the problem statement, and the purpose of developing the project. This section also mentions the importance's of the project. The background study and the related research have been discussed in section II. The methods or approaches used in the project have been discussed in section III. In section IV, operating principle, design details, and experimental results of magnetic current limiter has been presented. The analysis and simulation results have been discussed in section V. The project has been concluded in section VI.

II. RESEARCH BACKGROUND

This section contains the literature review on theoretical concepts applied in this project. It contains the information gathering of the project in order to complete the whole project. There will be some discussion of the research background related to the project. The overall result in the concept literature framework shows that the link between research projects with

the theory and concepts in the figure or an appropriate model. The research background for this section is about Cameron Highlands, solar energy, motor, and sensors.

2.1 Research on Cameron Highlands's Environment

The Cameron Highland's is one of Malaysia's most extensive hill stations. The average temperature in Cameron Highlands is 20°C. The humidity level is 50-60%RH. Normally, the temperature seldom rises above 25°C while at night it can sometime drop until as low as 6°C. Cameron Highland's low temperature is conducive to plant a wide variety of fruits, flowers, and vegetables. Many varieties of daisies, roses, and chrysanthemums thrive in this environment. Figure 2.1 shows the example of plants in Cameron Highlands.

Figure 2.1 Plants in Cameron Highlands

2.2 Sustainable Greenhouse System

Greenhouse system improves the growing of vegetables, fruits and flowers. Greenhouse coverage protects plants from the effect of environment. Sustainability of a greenhouse is a vital concept in order to run a greenhouse, especially one of the method used for is the growing of the plants. Besides that making a suitable sustainable greenhouse is very simple. In order to build a greenhouse building it uses the greenhouse effect as in the sense the by trapping needed temperature inside [3].

Most of greenhouse is made of glass and plastics which allow the sunlight to go through the building and helps the building to keep hold of the heat more efficiently. Using a greenhouse concept in Malaysia will allow a gardener or farmer to extend the growing of cold climate plants. The main challenge of sustainable greenhouse is to maintain with the issue of heat or in other words the temperature and humidity of the system. The temperature low indicates that the humidity is high whereby when the temperature high the humidity level is low.

2.2.1 Greenhouse productivity

The sustainable greenhouse productivity as in Figure 2.2 helps to produce a variety of plants such as grapes, tomatoes, rose plants, vegetables and just to list a few. The greenhouse facilities range is from industrial to large commercial production. The greenhouse industry is quickly becoming a very high technology industry with embedded systems, robotics, and innovations of agriculture [5].

Figure 2.2 Greenhouse technology

III. MATERIALS AND METHODS

The project design involved software, hardware, and mechanical design part. The project will be completed once the hardware development part is successfully completed. Once the hardware part is done, then it will be integrated with the whole system of the project. In hardware process there is part whereby need to do troubleshooting and testing. The procedure will go on until reach yes part for the testing process. Lastly, the software and hardware will be integrated into mechanical design of the project. Figure 3.1 shows the flowchart of the overall project development.

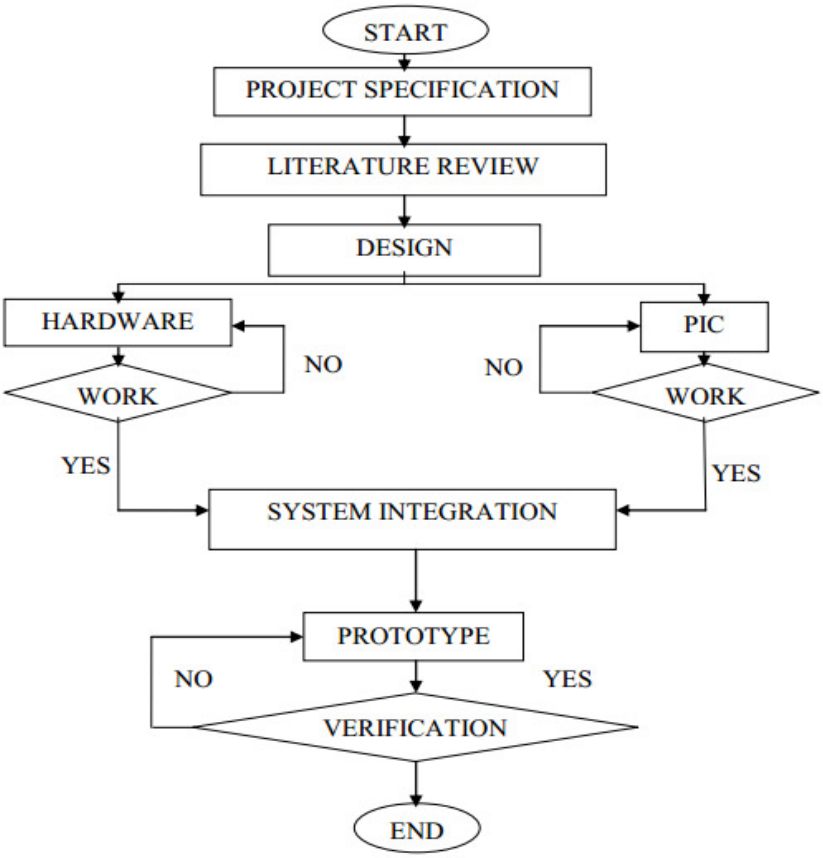

Figure 3.1 Flowchart of the overall project development

IV. RESULTS AND DISCUSSION

In this section, the results based on the program code and mechanical design (prototype) will be presented and discussed.

CCS C compiler is used to produce the coding for the entire system. This means the functionality of each sensor and the system is completely dependent on the coding produced. This coding will then be incorporated into a component known as PIC16F877A which is available in Proteus software. Proteus is software that is used entirely for circuit design for the entire project. In addition, Proteus also has many advantages as well as circuit simulation and can directly design a Printed Circuit Board (PCB). The schematic diagram of the project circuit using Proteus software is shown in Fig. 4.1, while Fig. 4.2 shows the PCB design of the project circuit.

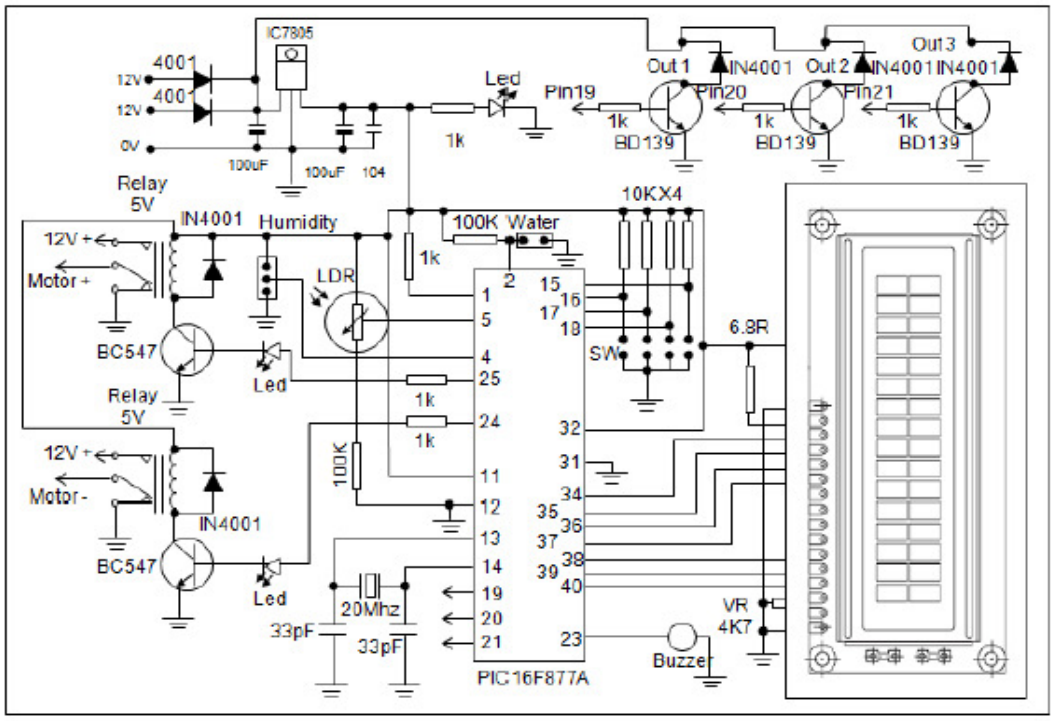

Fig. 4.1 The schematic diagram of the project's circuit

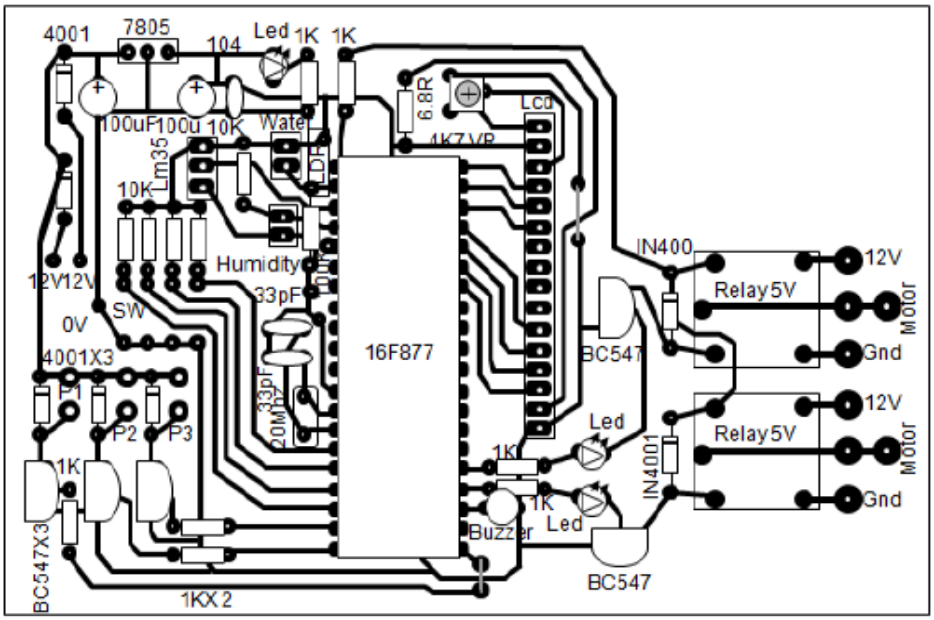

Fig. 4.2 The PCB design of the project's circuit

As mentioned earlier, the concept of this project will lead to the cultivation of tomatoes in Cameron Highlands, Malaysia. This system can also be developed in any location in Malaysia because the temperature and humidity levels are not yet a major problem when using this system. Fig 4.3 shows the basic concept of the project.

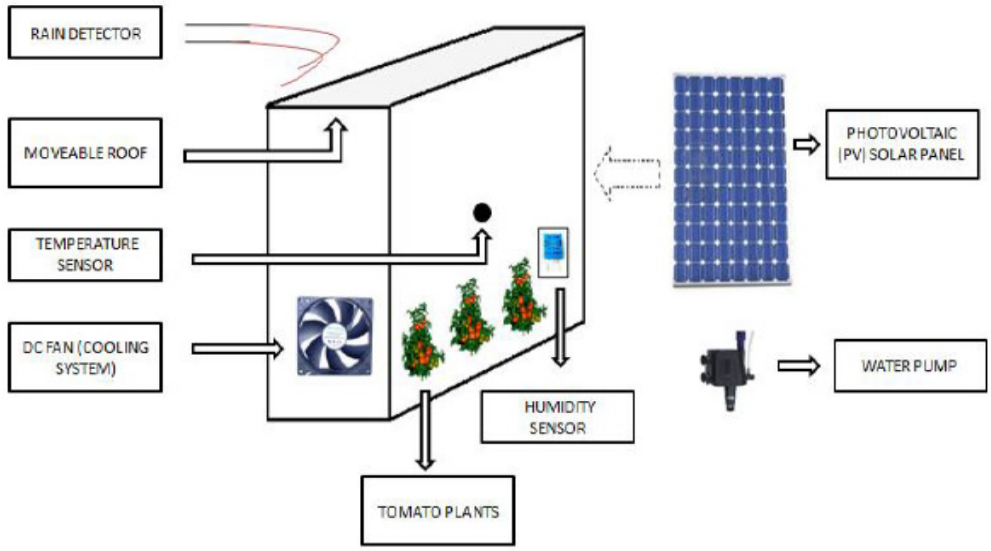

Fig. 4.3 The basic concepts of the project

The temperature for tomato plantation system is controlled by the cooling system using a DC fan. If the current temperature recorded in the greenhouse is less than 21°C, the cooling system will not run, the reverse occurs if the current temperature recorded was 21°C and above. Soil moisture rates play an important role for tomato cultivation. In this project, the rate of soil moisture is automatically controlled using a water pump that works to bring the water to the ground by the demand needed by the soil. In this project, the pump will bring the water to the ground when humidity is recorded below 25% and the pump will stop when the reading is above 25% and above. Tomato cultivation system also has a display that is able to determine if the weather is sunny or dark (night). If it rains, the system will pull the transparent roof automatically. This for control the water level as well as to prevent rain from damaging the tomato plants. Users also have the option either want the system works by using a solar panel or DC supply. Fig. 4.4 shows the mechanical design (prototype) for the project.

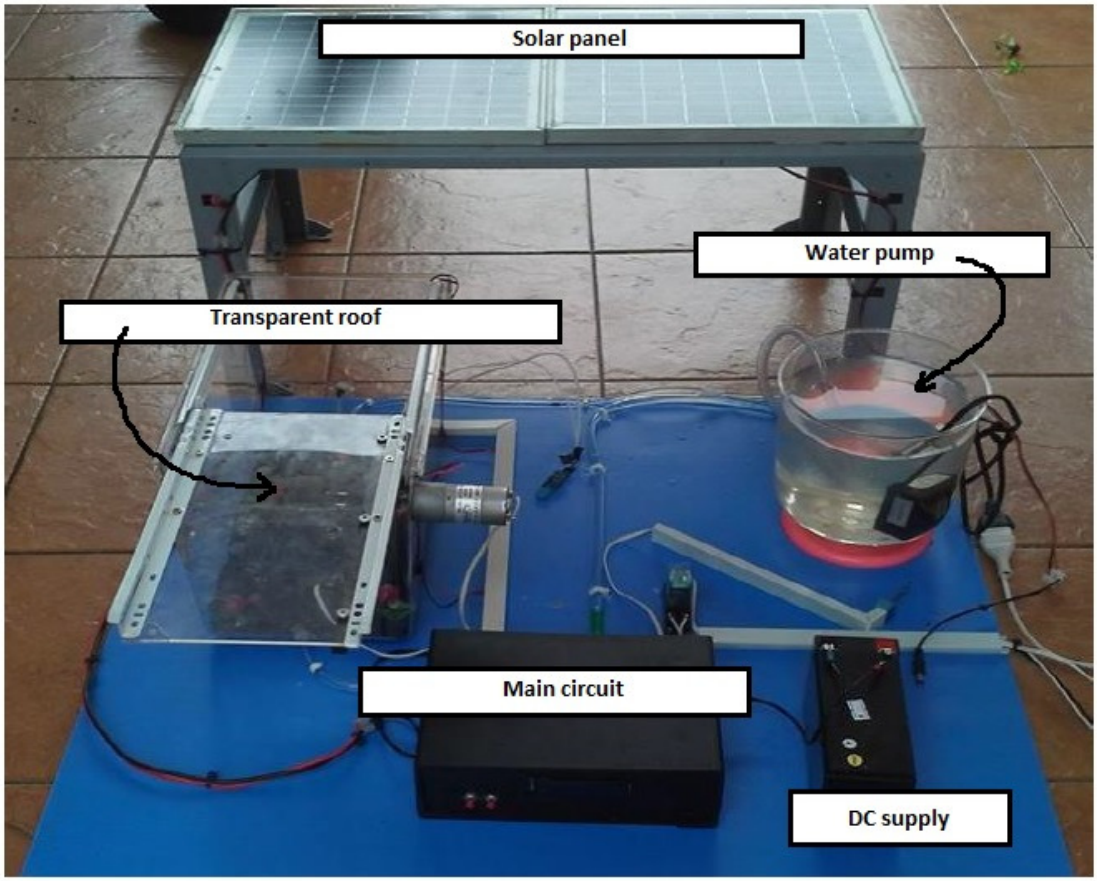

Fig. 4.4 The mechanical design (prototype) for the project

Analysis of Sensors:

(A) Temperature Sensor

The temperature sensor is in this project to measure the current temperature in the greenhouse. Based on the observation, when the temperature decreases, the voltage goes up. That is means the voltage is inversely proportional to the temperature inside the greenhouse. Recorded highest voltage is 5V and Fig. 4.5 shows the analysis for temperature sensor for this project.

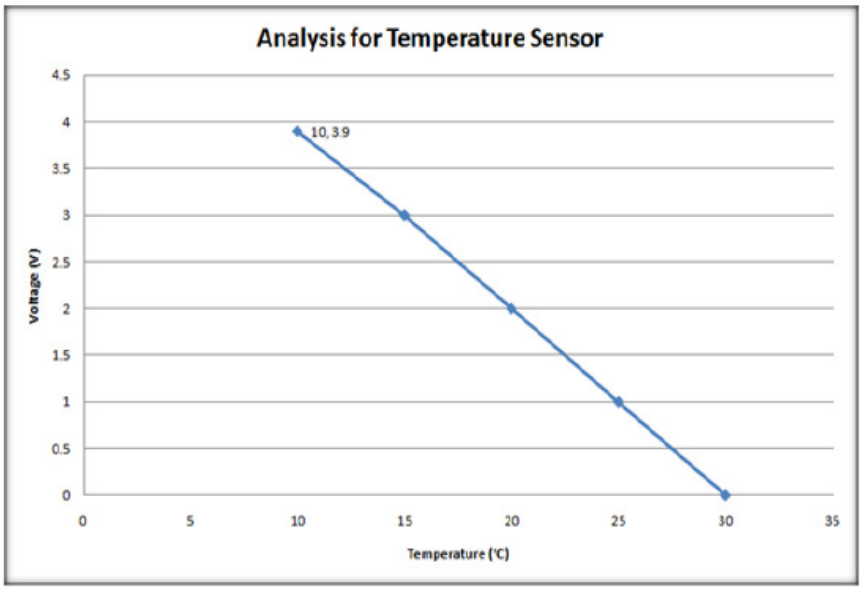

Fig. 4.5 The analysis for temperature sensor

(B) Humidity Sensor

To measure the humidity of the soil in the greenhouse, the humidity sensor is used. Based on the observation, the low humidity gives the highest voltage. Same as in previous case (temperature), the voltage is inversely proportional to the humidity of the soil inside the greenhouse. The recorded highest voltage is also 5V and Fig. 4.6 shows the analysis for humidity sensor for this project.

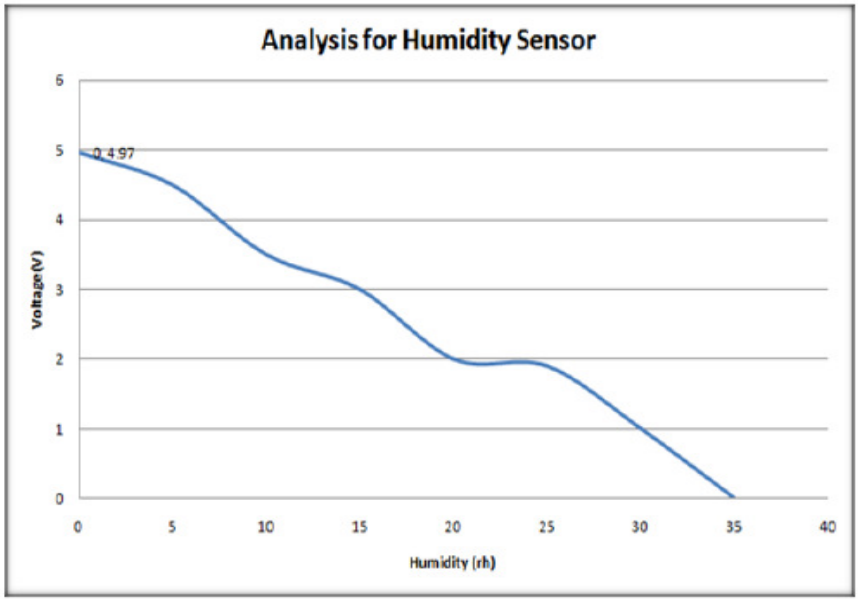

Fig. 4.6 The analysis for humidity sensor

(C) Rain Sensor

Rain sensor plays an important part in this project. As mentioned before, rain sensor detects the presence of rain on tomato plants. If it rains, the rain detector will send a signal to the motor to pull the transparent roof so that it will cover the entire tomato plants in the greenhouse. The readings of rain detector are measured using digital multimeter and the analysis is shows in Table 4.1. Based on Table 4.1, the voltage is 0V when the rain is detected while it has the value of 4.87V when the rain is undetected.

Table 4.1 Rain detector readings

Condition of Rain	Rain detector voltage (V)
Detected	0
Undetected	4.87

(D) Photocell Sensor

Photocell sensor is used in this project to determine if the weather is sunny or dark (night). The analysis result of photocell sensor is shown in Fig. 4.7. The voltage is directly proportional to the percentage of output light.

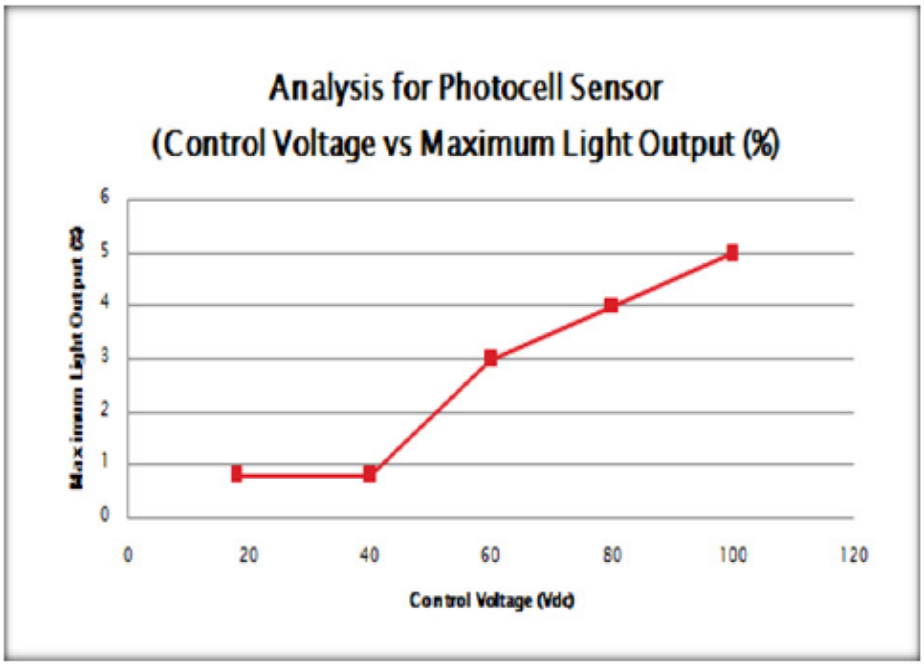

Fig. 4.7 The analysis for humidity sensor

The biggest problem that can be seen during the implementation of this project is to synchronize the program code and hardware. Besides, the voltage regulators are used in this

project is to lower down or regulate the voltage for PIC circuit and LCD display input. If seen, the output from the solar panel is 21V and the input required by the PIC circuit and the LCD display is only 5V. Thus, the voltage regulator is desirable to reduce and stabilize the 21V voltage to only 5V voltage.

V. CONCLUSION

This paper presents the application of the project in tomato plantation. The project designed should be developed in Malaysia because every year Malaysia has imported more than 22.1 million fruits, vegetables, flowers, and many more from other cold climate countries. Agricultural Research and Development Institute of Malaysia (MARDI) is one company that feels very appropriate to develop the project. The project is also seen will give a lot of benefits if commercialized in Malaysia because it can help improve the agriculture sector in Malaysia regardless of the hot climate in Malaysia.

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