Tracking Vessels in Tissue Culture Laboratory using RFID System and LDR Sensor

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Abstract— **Tissue culture laboratory at Malaysian Palm Oil Board (MPOB) is a place that involved in producing superior planting material through tissues culture or cloning process. In the tissue culture laboratory, a lot of vessels for cloning process are located in several racks with different growth rooms. All the data specification of vessels such as date, the person who doing the cloning process, and number of racks are recorded manually on log book for the future references. Besides that, the data of tracking the vessel such as time and who take out the vessels also done manually. This project proposed a Radio Frequency Identification (RFID) system with Light Dependent Resistors (LDR) sensor to replace the current method of data tracking vessels. This project consists of two main parts which are hardware and software. In hardware part, the main component is RFID card, PIC 16F877A, and Light Dependent Resistors sensor to detect the vessels. Meanwhile, for the software part, visual basic software is used to display the information or data. Tested has been performed and the result show the improvement of the tracking vessel system in the tissue culture laboratory.**

Keywords— **Radio Frequency Identification, LDR Sensor, Tissue Culture Laboratory, Visual Basic.**

I. INTRODUCTION

Radio Frequency Identification (RFID) is an acronym for radio frequency identification, which is a wireless communication technology that is used to uniquely identify tagged object or people [1]. Besides, RFID also is an automatic identification method, relying on storing and remotely retrieving data using devices called RFID tags or transponders [2]. The basic function of a RFID tag is to store data and transmit data to the interrogator. The tag and the interrogator communicate information between one another via radio waves. When a tagged object enters the read zone of an interrogator, interrogator signals the tag to transmit its stored data [3]. The tag is composed of two important elements and one optional component. Those are integrated circuit microchip for store and process data, an antenna for transmitter and receiver and memory as the optional component. RFID has many applications such as in coming year, new RFID applications will benefit a wide range of industries and government agencies in ways that no other technology has ever been able [1].

In the tissue culture laboratory, there are hundreds of vessels containing the seeding placed on the laboratory experiment rack. This laboratory provides the oil palm industry with innovations of the production of improved planting materials and information on the molecular biology of tissue culture process [4]. Normally, the data of tracking vessels is recorded manually and this can reduces the efficiency and reliability of the process. The advantages of applying the RFID system are to make the systematic laboratory without participating of worker.

A. RFID Tag / Card

The three basic components in the RFID tag are an antenna, a microchip (memory) and the encapsulating material [5]. Some tags provide the ability to remember information sent by the reader. The memory used for this purpose. They can be read-only or provide read-write capability [2]. In the read only tag, the microchip or memory can be written only once during manufacturing process. The information along the serial number on the read only tag can never be changed. In the read write tag, only serial number is written during manufacturing process. The remaining blocks can be re-written by the user [5]. There are four main frequency bands commonly in use for RFID tags. They are categorized by their radio frequency, low frequency tags are 125 or 134.2 kHz, high frequency tags are 13.56 kHz, UHF tags are 868 to 956 MHz and microwave tags are 2.45 Hz or 5.8 GHz [6].

There were comes in three main basic flavor, passive to RFID tags which are no build-in power source. Their power is provided purely by the RFID interrogator or reader tags, active tags and semi-active tags. The passive tags refer that includes in the antenna. While the active tag refer to RFID tags which have their owns power source or internal source (battery). Because they use an internal battery, their signal strength is a lot higher than passive tags and therefore can be read from a further distances [2]. Meanwhile semi-active tag is a combination of a passive and an active tag. Semi Passive tags refer to tags with a power source commonly is a laminar, flexible, low cost battery, which can be used for on tag sensing such as temperature, but not to increase the range. Some semi-active tags sleep until they are shocked up

by a signal from the reader, therefore conserving battery life [1].

B. *Antenna and RFID Reader*

An RFID antenna chief responsibility is to transmit and receive radio waves for the purpose of communication. The antenna is also known as the coupling mechanism. In the case of RFID, the transfer of energy is in the form of electromagnetic radiation, which is the way the tag and reader communicate. Some antennas are also designed to collect energy from radio waves [2]. Readers are the electronic components that transmit and receive the radio frequency wave used to communicate with the tags. Readers have two main elements, an antenna and reader IC board. Antenna is required to conduit to receive and transmit radio frequency waves. The critical important of the used of the appropriate antenna cannot be understated in a specific environment for the success or failure of the communication between the tags and the readers. Many otherwise great RFID deployments have failed because of the selection of improper antenna. Besides that, the IC boards in the reader processor the necessary information to communicate with the tags. It also used it transponder to handle the radio frequency communication with the tags [1].

C. *Supporting Infrastructure*

In RFID systems, the supporting infrastructure includes software and hardware that related each other are required. The software monitors the interaction between the RFID reader and the RFID tags. The application of software on the host is to processes the data, and may perform various filtering operations to reduce the diversity that is often redundant reads of the same tag to a smaller and more useful data set. Then for hardware which any device, such as a laptop computer, an electronic scale head or a hand-held computer, that is capable of communicating with a transceiver and accepting the information from it [7].

D. *Light Dependent Resistor*

The Light Dependent Resistor (LDR) is made from a small part of semiconductor material such as cadmium sulfide. LDR changes its electrical resistance from a few thousand Ohms in the dark to only a few hundred Ohms when light falls upon it by creating hole-electron pairs in the material. The net effect is an improvement in its conductivity with a decreasing in resistance for an increase in illumination. Also, photo resistive cells have a long response time requiring many seconds to respond to a change in the light intensity [9].

E. *PIC 16F877A*

PIC16F877A is a small portion of semiconductor integrated circuits. The type of package for these integrated circuits is DIP package. DIP stand for Dual Inline Package for semiconductor IC. This package is very easy to be soldered onto the strip board. However, by using a DIP socket is much easier so that this chip can be plugged and removed from the development board. This IC can be reprogrammed and erased up to 10,000 times. Therefore it is very good for new product development phase. This PIC16F877A is very cheap and apart from that it is also very easy to be assembled [10].

F. *Visual Basic*

The "Visual" part refers to the method that used to create the graphical user interface (GUI). The "Basic" part refers to the Beginners All-Purpose Symbolic Instruction Code (BASIC) language, a language used by more programmers than any other language in the history of computing [8].

Visual Basic has developed gradually from the original BASIC language and now contains several hundred statements, functions, and keywords, many of which relate directly to the Windows GUI. Visual Basic is occasionally called a Rapid Application Development (RAD) system because it allows programmers to quickly build prototype applications. It is combination of basic functions and commands with visual controls, so it is a renewal of the Basic programming language. Visual Basic, also known as "VB," is designed to make software development easy and competent, while still being powerful enough to create advanced programs. Visual Basic (VB) 6.0 allows to quickly creating professional applications for Windows 32-bit operation. Launched in 1998, and is available in three editions (Learner, Professional and Enterprise) into the programming language most used in the world because it is easy to learn and use [8].

II. METHODOLOGY

RFID system that implement in oil palm tissue culture is divided into two parts, hardware and software part. The hardware part consist of electronic components connections while for the software part, it discuss the development of visual basic program. Then combination of hardware and software are tested to visualize the result.

Fig. 1 shows that the overall process in hardware. When RFID card touch to RFID reader, it data will sent to PIC analyze. Then, for LDR sensor will send data based on the sensitivity of light. The LDR sensor function same as a button. For this project, when vessels take out from rack, the light will pass through the LDR sensor, so the PIC received 5v. PIC received the data and then sends it through RS232 to Transistor Transistor Logic (TTL) converter. The

function of this converter is to convert from 0v until 5v to -8v until +8v. This is because the PIC only used 5v maximum voltage but the visual basic needed until 8v maximum voltage. The data received will save in visual basic database.

Besides that, PIC16F877A is needed 5v voltage. However, this project used 12v from the adaptor. So, voltage regulator 7805 is used to decrease the value of voltage from 12v to 5v. PIC microcontroller will be programmed using C programming software. The function of the receiver is to gather the data process and display it on the computer.

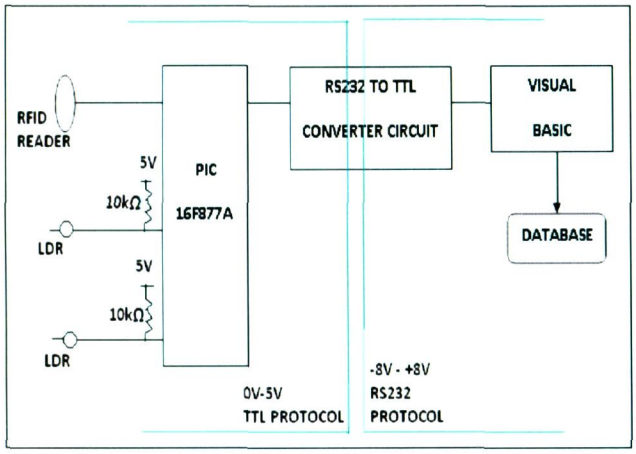

Figure 1: Block diagram of hardware part

Fig. 2 shows the flow chart of the software part. First, the process performed to determine the communication port that connects with USB serial converter cable to received information from the hardware part. Analyzed the error occur whether it can received the information or not. While there is no error, continue with register the RFID card and key in all the data of ID specification for each vessel. If the vessels not register their ID specification, the visual basic cannot detect it and cannot display any things.

Then, if the LDR sensor detects the light, means there are no vessel on the racks. While someone take out the vessel, VB display the name of person, name of vessel, time and the date when it take out. And if someone wants take out the same vessel, visual basic display it did not return back again. The data of tracking the vessel are display in visual basic, and at same time will saved in database. It is very useful, because admin can check the transaction of the vessels.

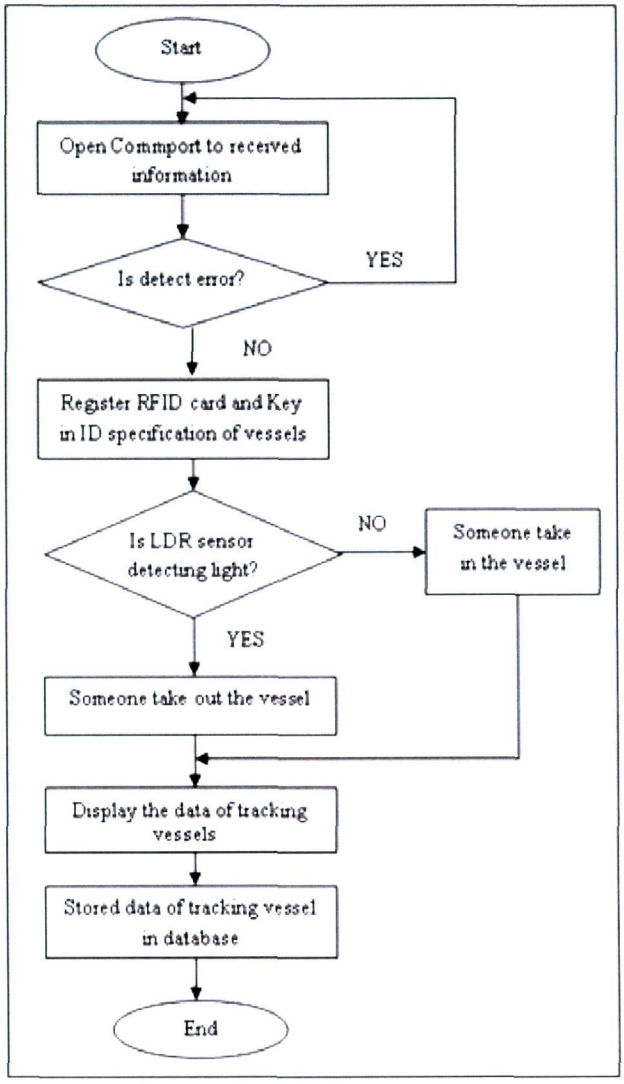

Figure 2: Flow chart for software part

III. RESULTS AND DISCUSSION

Tissue Culture Laboratory at MPOB consists of 4 different rooms, which are 2 types of light rooms and 2 types of dim rooms. Each room have around 15-17 racks whereas placed a lot of vessels. Fig. 3 and Fig. 4 show the light room and dim room. The growth room 4 is the bigger room compare than others.

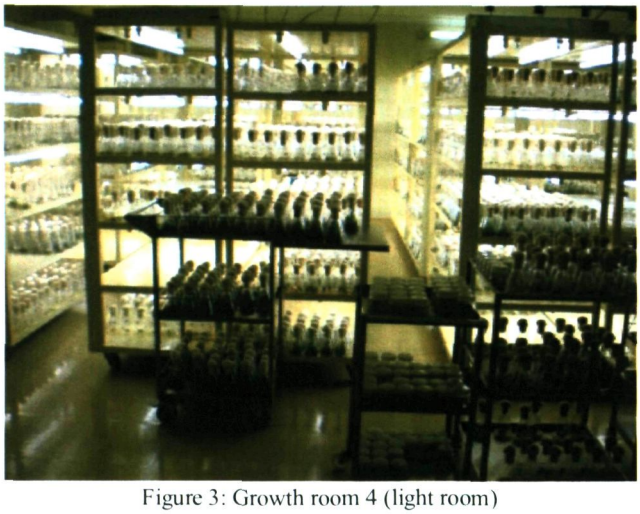

Figure 3: Growth room 4 (light room)

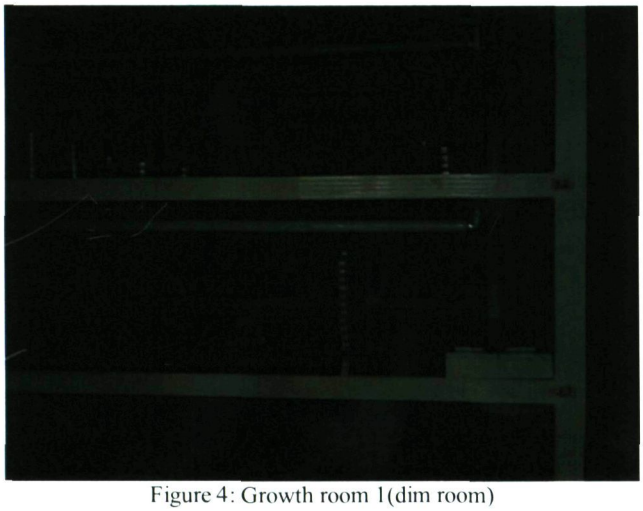

Figure 4: Growth room 1(dim room)

Fig. 5 shows the different types of vessels which are placed in tissue culture laboratory. Inside the vessels have different medium such as small seed, medium plant, plant in dark base and so forth. Besides that, the vessels are placed with different types in the same growth room. LDR sensor was tested in different types of vessels and different types of medium but at the same room. This is because to make the data of resistance consistence and more efficiencies.

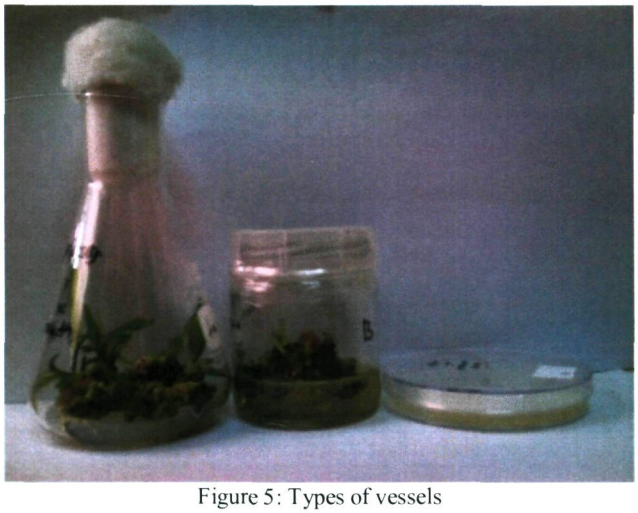

Figure 5: Types of vessels

Fig. 6 shows the acquired data of each value of resistance from different types of vessels with different types of medium. This measurement is at same condition whereas the same distance between the fluorescent lamp and the LDR sensor. The value of resistance depends on the level of light can pass through the LDR sensor. At the very low light level, the values of resistance become highest. The resistance in circle vessel is lower than the other vessels because the level of light is highest. This is because the circle vessel has large diameter and small thickness. However, the cone vessel has largest resistance because it is tallest and small diameter at the top. Unfortunately, the cylinder vessel did not have the dark condition.

Besides that, by using different types of medium inside the vessel, value of resistance increased for all types of vessels. This is because the level of light pass through the LDR sensor decreased. For the dark medium, the value of resistance increased drastically for each vessel.

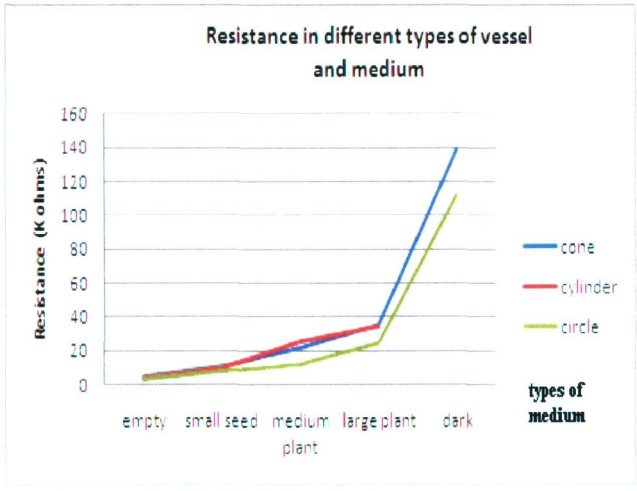

Figure 6: Resistance in different vessel and medium

Fig. 7 shows the acquired data for the value of resistance in cone vessel with different types of medium. The value of resistance increased unexpectedly with the level of light become lowest. In the vessel with dark base the resistance extends to 138.9kΩ. While in the empty vessel the value of resistance only 4.9kΩ.

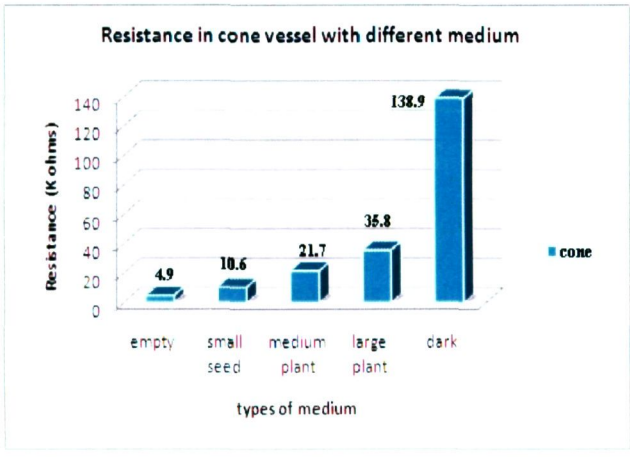

Figure 7: Resistance in cone vessel with different medium

Fig. 8 shows the acquired data for the value of resistance in cylinder vessel with different types of medium. The values of resistance are increased smoothly because of characteristic of the vessel. The cylinder vessel have same diameter so it not affect the level of light pass through the LDR sensor too much.

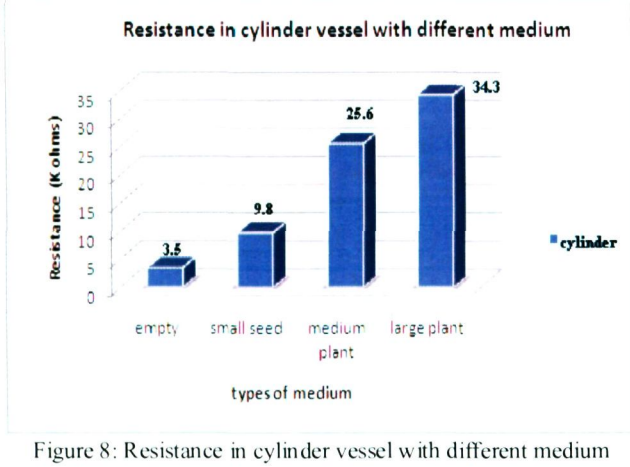

Figure 8: Resistance in cylinder vessel with different medium

Fig. 9 shows the acquired data for the value of resistance in cylinder vessel with different types of medium. The value of resistance increased drastically with the level of light become lowest. The diameter of the circle vessel is same but it diameter larger than cylinder vessel. For the empty circle vessels, the resistance is very small because the thickness of vessel is also small.

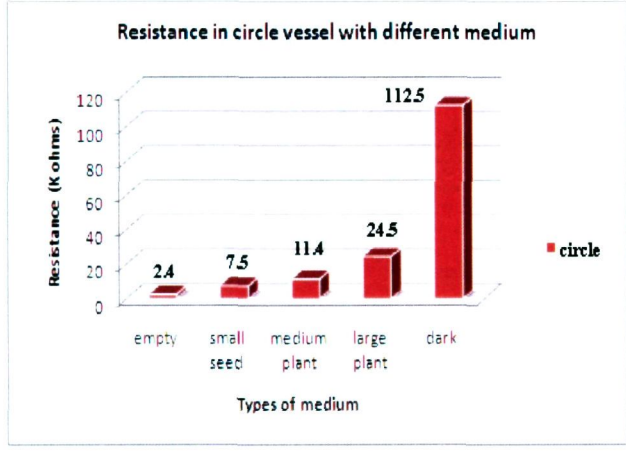

Figure 9: Resistance in circle vessel with different medium

Fig. 10 shows the position of rack in same room which is growth room 4. The position of rack is randomly chosen to test the level of light pass through the LDR sensor. But the level of rack is same, which is level 3 from bottom. This is because to be fair for all value of resistance has been taken.

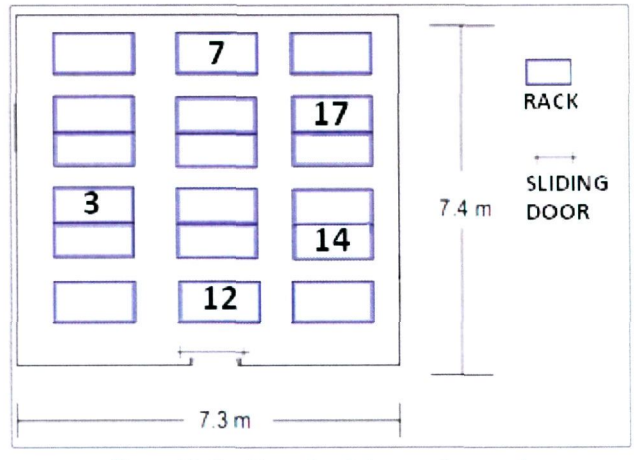

Figure 10: Position of rack in growth room 4

The resistance between different racks is not too distinguishing each other as shown in Fig. 11. This is because every level of rack is required fluorescent lamp themselves. So, the resistance is in average 7.9kΩ to 8.5kΩ.

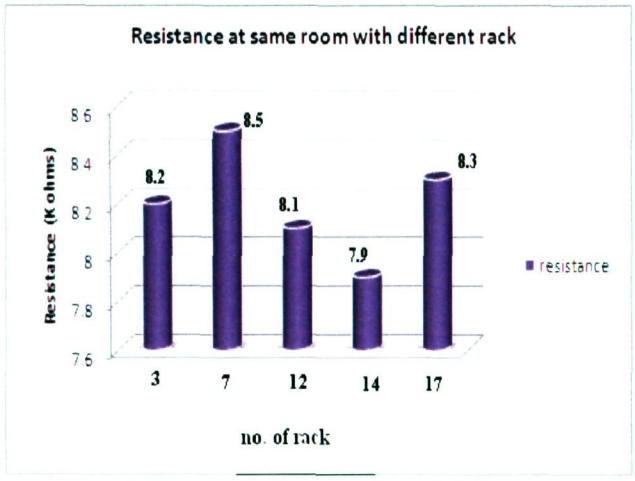

Figure 11: Resistance at same room with different racks

The distance between the vessels and the LDR sensor also affect the measurement of resistance. The measurement are using cone vessel as shown in Fig. 12 below. The maximum distances of vessel until 6cm only while the maximum of the sensitivity of LDR sensor is 198.4kΩ. This is because the height of cone vessel is 15cm and the distance of LDR sensor with the base rack is 2cm. the overall height of level rack is 24cm as shown in Fig. 13. The sensitivity of LDR sensor detect the vessel is 2cm only.

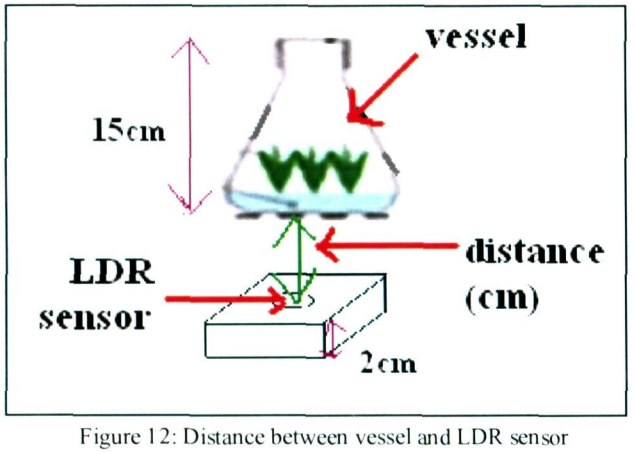

Figure 12: Distance between vessel and LDR sensor

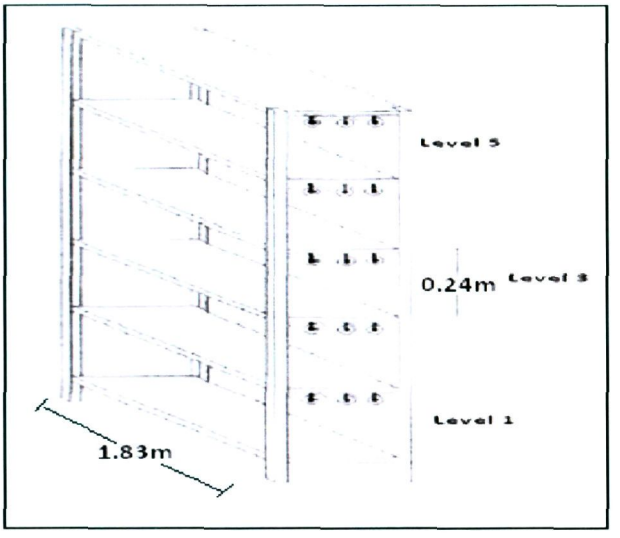

Figure 13: Rack

Fig. 14 shows the acquired data of each value of resistance at different distance of vessels between LDR sensor and the vessel. The distances also affect the level of light because the farther distances, the higher level of light pass through the LDR sensor. In the other hand, the value of resistance is become lowest.

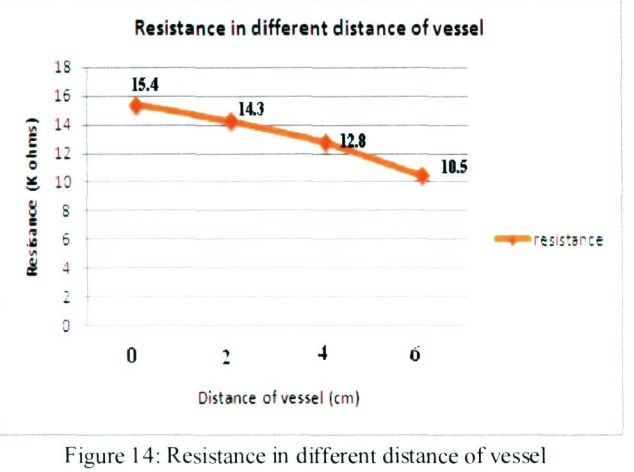

Figure 14: Resistance in different distance of vessel

Fig. 15 shows the database for the recording data of tracking vessel. The data display the date, time, ID specification of vessel and the person who have tracking the vessel.

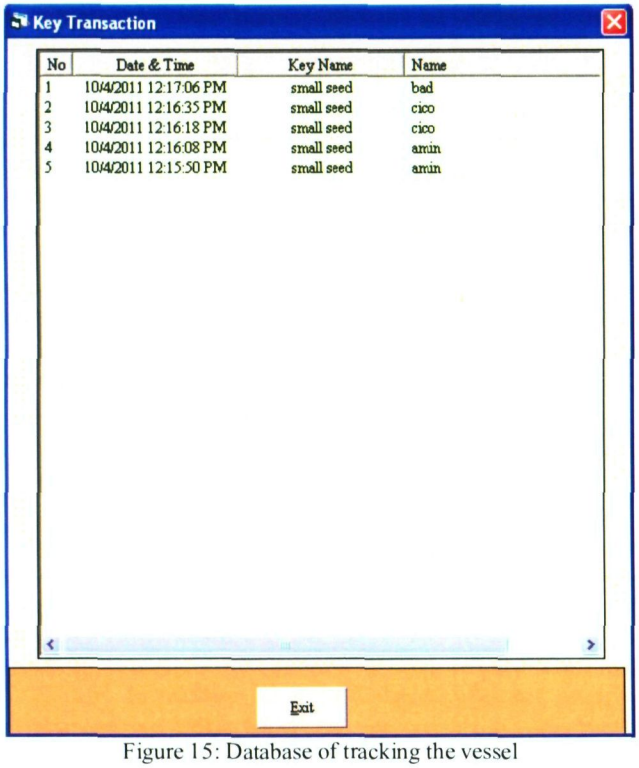

Figure 15: Database of tracking the vessel

Fig. 16 shows the LED is OFF because the LDR sensor did not detect the vessel. So, the light can pass through directly to the LDR sensor. Then the LED is ON when the LDR sensor detect the vessel as shown in Fig.17.

Fig.18 shows the overall system that consists of hardware and software. These have been tested in MPOB.

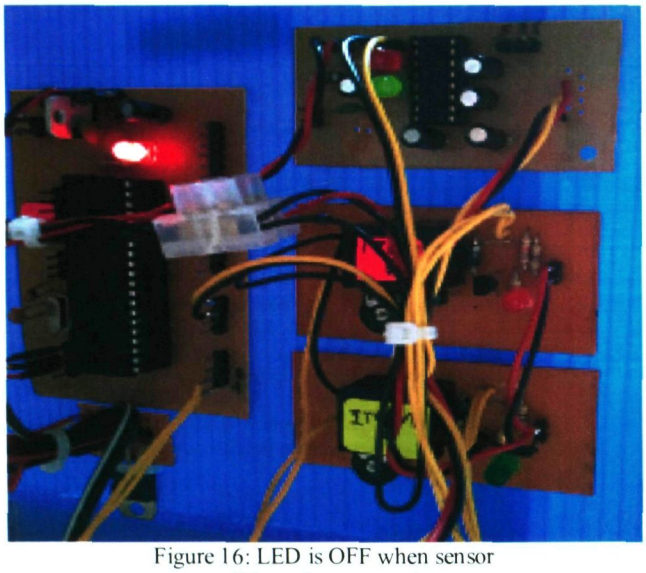

Figure 16: LED is OFF when sensor did not detect vessel

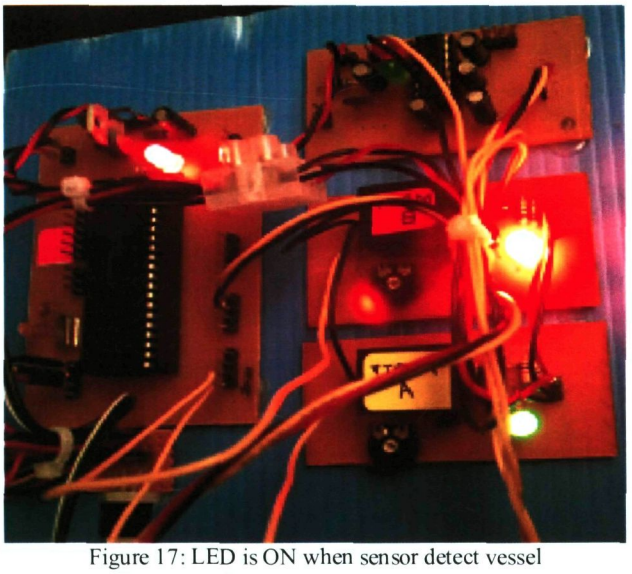

Figure 17: LED is ON when sensor detect vessel

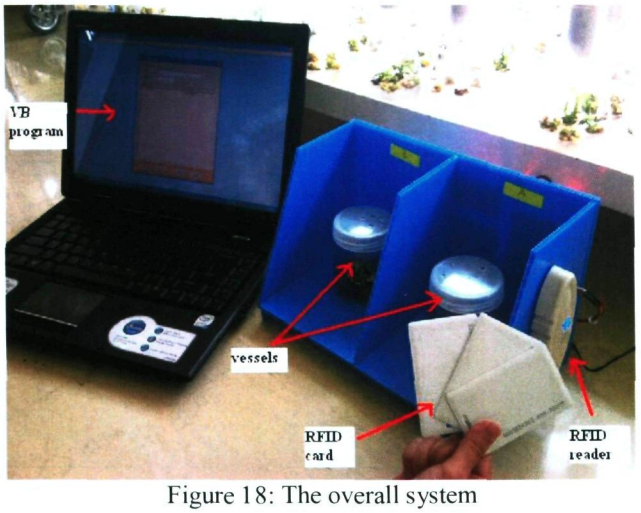

Figure 18: The overall system

IV. CONCLUSION

In the world of technology now a lot of things to be done automatically as well as in oil palm tissue culture laboratory in order to collect data tracking or search the vessels. The project RFID system using LDR sensor is tested in tissue culture laboratory and the objectives stated has been achieved. Both of the hardware and software parts of the project conducted very well. In this system, the RFID cards need to touch the reader in order to connect or access the information in the computer. The function of LDR sensor under vessel is to detect the position of vessel at which rack. And the visual basic software will receive the information and display it's in computer screen.

There are some hurdles need to be addressed before RFID technology becomes widespread in the world. One of the major problems is the high costs and the privacy issues. In the long run, the RFID technology completed would eventually be a big help to human. RFID's potential benefits are huge and we are sure to see many novel applications in the future, some which we cannot even begin to imagine. The components that go into RFID readers and tags are convenience radio communications medium, but their smaller size and broad deployment enhance the power of the technology and raise concerns about the privacy effects of RFID deployment. These concerns are often based on unlikely assumptions about where the technology will go and how it will be used.

FUTURE DEVELOPMENT

There are still some improvements that can be done in this system for the future development. Such as, RFID by using chips or stickers tag. It will more suitable because of there are many vessels in the racks. The RFID tag can be patch on vessel directly because this tag is very small and look nice. In addition, this RFID chips also not need to punch card in other to detect the vessels or the users. Besides that, the barcode system can be implemented in this laboratory. Like the library system, the users can search where the position of vessels directly. So, it's save their time for looking each rack.

ACKNOWLEDGMENT

Thanks to staff MPOB for the permission given during testing session is conducted. Nevertheless, a great appreciation is dedicated to all those who had contributed during the completion of the project.

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