# Temperature and Humidity Alert System in Tissue Culture Laboratory via SMS and Email Notification

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*Abstract* – **Malaysian Palm Oil Board (MPOB) is currently undertaking the latest technology on the establishment of a tissue culture laboratory for production of high yield clone oil palm. The main purpose of the tissue culture laboratory was to produce superior planting material through tissue culture or cloning process. This project is expected to be implemented in monitoring the growth of oil palm seedlings by using appropriate method. Furthermore, the usage of wires needs to be minimize as highly as possible to create a well organized and a systematic laboratory. The application of SHT11 sensor on oil palm tissue culture equipped with an alert system is the best solution to overcome the problems that currently occurred in MPOB laboratory. Information such as temperature and humidity can be obtained as the SHT11 sensor is used as the single-chip relative humidity and temperature multi-sensor module. For this purpose, SMS alerts and email notifications are developed by using SMS Gateway and mail server to enable the user to monitor the parameter data. Once the normal range of temperature and humidity is exceeded, the user will be triggered via SMS and email. An accomplishment of the system has been carried out by using open source softwares such as Mail Server, Apache, MySQL and PHP. Test has been performed and results clearly showed the capability and the potential of the alert system itself.**

*Keywords* – **MPOB, SHT11 sensor, Temperature, Humidity, SMS Gateway, Mail Server.**

## I. INTRODUCTION

Oil palm (*Elaeis guineensis* Jacq.) is one of the most important oil bearing crops in the world. However, genetic improvement of oil palm through conventional breeding is extremely slow and costly, as the breeding cycle can take up to 10 years. Tissue culture is the propagation of plants through the placement of small amounts of undifferentiated tissue or single cells in an artificial environment. The tissue is placed in a nutrient medium that favors the production of roots and shoots, and is later planted normally. By using tissue culture, the favorable qualities of plants can be precisely controlled, so that each plant is identical for the particular quality. To provide high quality seedlings, the most critical parameter that should be observed thoroughly are temperature (range between 25°C to 30°C) and humidity (range between 45% to 90%), since these two factors have a great influence to the performance of tissue culture. A well oriented monitoring system should be performed and requires man power to observe each vessel in the laboratory. As the solution, an alert system is developed. Users will be notified through SMS and email if the temperature or humidity within the growing room or the vessel is out of the normal range. The user will receive an instant notification about the parameter data and the current reading, so the user can monitor the room or the vessel and take further action as required.

### A. Tissue Culture

The progress in the development of the technologies of plant tissue and cell culture over the past decades has been remarkable. Tissue culture is the most fundamental technique in any plant cell biologist's toolbox [1]. Basically the technique consists of taking a piece of a plant such as a stem tip, node, meristem, embryo, or even a seed and placing it in a sterile, (usually gel-based) nutrient medium where it multiplies. Plant tissue culture comprises a set of in vitro techniques, methods and strategies that are part of the group of technologies called plant biotechnology. Tissue culture has been exploited to create genetic variability from which crop plants can be improved, to improved the state of health of the planted material and to increase the number of desirable germplasms available to the plant breeder [2]. This technology can be expected to have an ever increasing impact on crop improvement as an approach to the new millennium.

### B. Alert System

The definition of 'alert' is a condition or period of heightened watchfulness or preparation for action. Alert system is originally based on telemetry system. Telemetry is a highly automated communications technique with the help of which measurements and data collection are done at remote locations and transmitted for monitoring [3]. The most important uses of telemetry include weather-data collection, monitoring power generation plants and keeping track of space flights. A telemetry system typically consists of a transducer as an input device, a transmission medium in

the form of wired lines or radio waves, signal processing devices, and devices for recording or displaying data. The transducer converts a physical quantity such as temperature, pressure or vibration into a corresponding electrical signal, which is then transmitted over a distance for the purpose of measurement and recording. There is normally a sound or vibration that will indicate that the message has come in. The receiver may be able to see the sender's telephone number, name and also date and time[4].

## C. SMS in GSM Networking

SMS is an acronym standing for Short Message Service. It is commonly referred to as text messaging or "texting" as well. SMS is a method by which messages can be sent to a cell phone via another cell phone, a computer connected to the Internet or a regular land line [5]. SMS messages may be sent either from one point to another point, or may be sent to all devices within a specific geographical region. SMS is a communication service component of the GSM (Global System for Mobile Communications) system, using standardized communications protocols that allow the exchange of short text messages between mobile phone devices. SMS text messaging is the most widely used data application in the world. SMS as used on modern handsets was originally defined as part of the GSM series of standards in 1985 as a means of sending messages of up to 160 characters. GSM is the most popular standard for mobile telephone systems in the world. GSM also pioneered low-cost implementation of SMS, which has since been supported on other mobile phone standards as well.

## D. Email

Electronic mail, most commonly abbreviated as email or e-mail, is a method of exchanging digital messages [6]. E-mail systems are based on a store-and-forward model in which e-mail server computer systems accept, forward, deliver and store messages on behalf of users, who only need to connect to the e-mail infrastructure, typically an e-mail server, with a network-enabled device for the duration of message submission or retrieval. An electronic mail message consists of two components, the message header, and the message body, which is the email's content. The message header contains control information, including, minimally, an originator's email address and one or more recipient addresses [7]. Email messages are posted electronically to individuals at specific. The address denotes the computer that the individual employs as a mail server. A mail server is like a computer that sends and receives electronic mail for a specific network. Like regular mail, when messages are delivered, the user may read them at his or her convenience and like postal letters, email may be saved or discarded, according to the user's needs during that time.

## II. METHODOLOGY

Besides expanding the range of applications in wireless technology, the objective of this project also focusing on developing an alert system that provide a new application of SMS in order to quickly provide urgent information to the user. In this project, a mobile phone is connected to the computer and act as a GSM modem to replace a common modem that requires a higher cost. Fig. 1 shows the process involved in monitoring the oil palm tissue culture which is begin with hardware development to collect the data, data monitoring and acquisition and finally, an alert system. In addition to the SMS service, the user also will receive an email notification about the parameter data that can be kept as the track record.
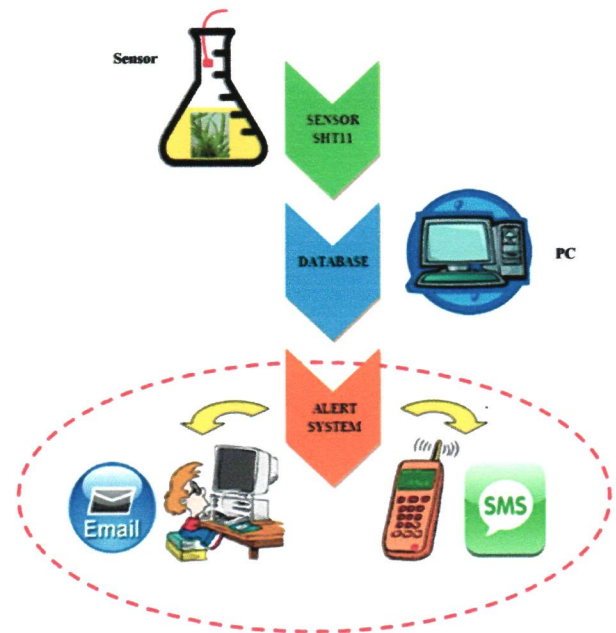


Figure 1: Process Involved in Monitoring the Oil Palm Tissue Culture

Fig. 2 shows the flowchart for an alert system. The process starts with connecting to the database. Database contain all the data regarding the temperature and humidity of tissue culture in the vessel or in growing room. The system will first automatically read the parameter value of temperature and humidity. Then the system will read the current value of both parameter. Alert system will compare the value of current readings with the parameter value. If the value is within its normal range, there will be no notification message will be sent to user. Alert system is idle during this time. But, if the value of current reading is beyond the parameter range, then the alertbsystem is activated. The system will obtain the phone number and email address of the user and alert system will be triggered instantly. SMS and email notification will be sent to user.
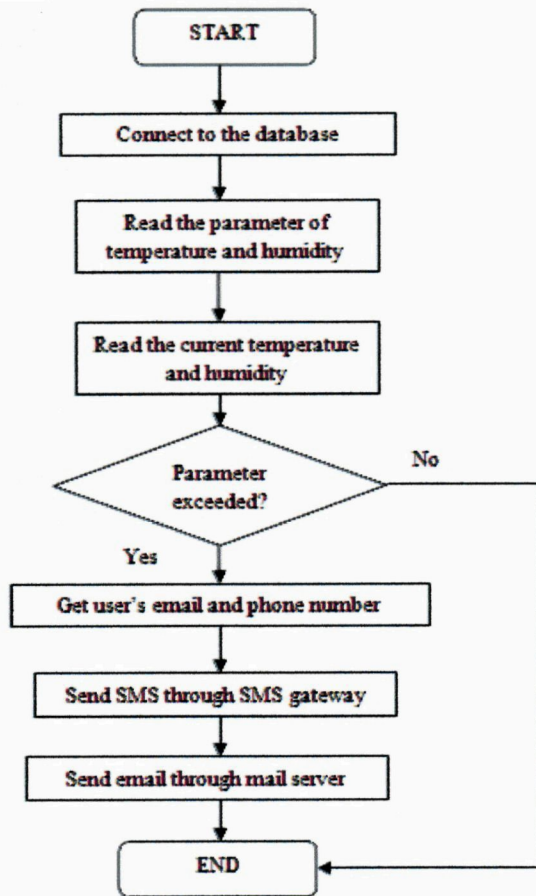
Figure 2 : Flowchart for the Alert System



Figure 3: XAMPP Control Panel Application



Figure 4: MySQL Database

The intention of this project is to implement the application of an alert system into the technology of palm oil tissue culture. To provide an efficient monitoring method, the system is develop to meet the technology's requirements. The combination between Apache, PHP and MySQL is the most important tools to develop an alert system. Apache is used as a web server that is connected with MySQL database manager and PHP scripting language. Fig. 3 shows the control panel application where Apache and MySQL service is running and ready to be used. When used in combination, they represent a solution stack of technologies that support application servers. Fig. 4 illustrates the list of tables that are available in "finale" database.
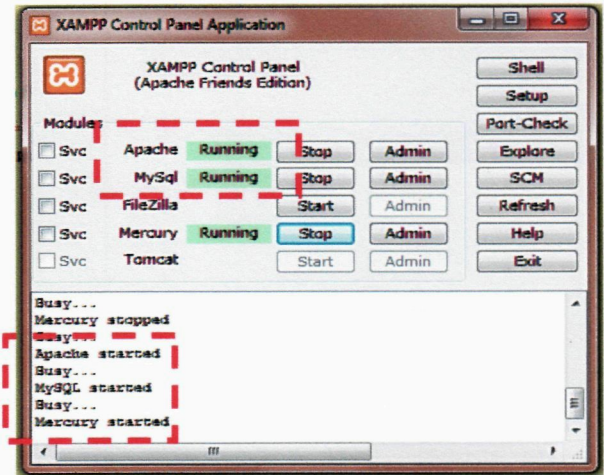
A new email account is created for MPOB's user using Google internet service provider. Google mail or Gmail is leading all the email services and has many advantages over others. Gmail has storage capacity up to 1GB and it is surprising to see how fast the email is delivered in Gmail. Fig. 5 shows the username and password created for MPOB's user account. Email notification will be kept as track record and can be accessed anytime since email will not be deleted automatically. It will remain in the inbox as long as the user did not erase the data or make any modification to it.



Figure 5: Google Email Account

SMS alert is developed by using SMS Gateway software called NowSMS. NowSMS is a scalable solution that is affordable for development and testing, with scalability to support mobile operator systems. Fig. 6 shows the application of NowSMS is activated. The format of the received email and SMS are including the address of the recipient, address of the sender, the present date and time, the parameter value and also the current value of temperature and humidity that triggered the alert system. Fig. 7 shows a diagram on how SMS and emails are sent from PHP through MySQL database.
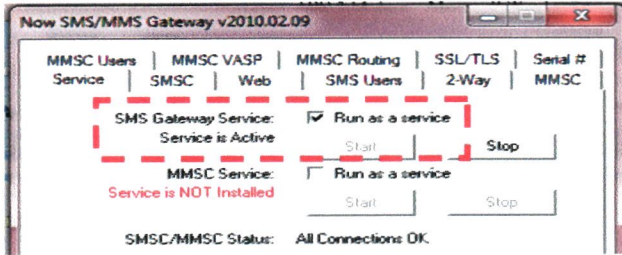


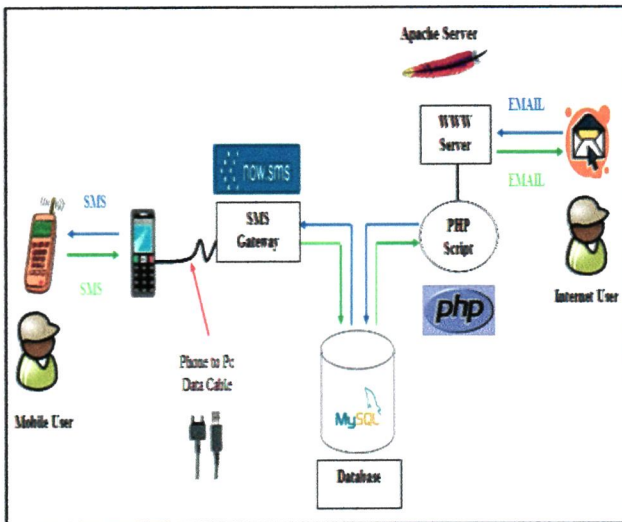Figure 6: Activate SMS Gateway Service



Figure 7: Sending SMS and email from PHP through a MySQL database

## III.    RESULTS AND DISCUSSION

The applications of the SMS gateway can be searched and downloaded from the internet. One of the most popular gateway is NowSMS since it can work very well with both operating system either Windows or Linux. For this project, the mobile phones that is used as GSM modem is Sony Ericsson k800i. Configuration process is important to make sure that SMS gateway can work well with the mobile phone that soon will operates as a GSM modem. First, mobile phone must be connected to the laptop or computer by using USB cable as shown in Fig. 8.
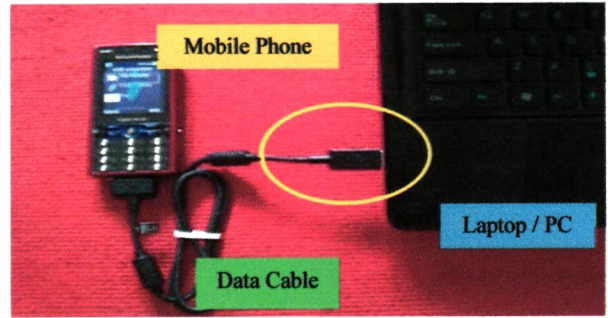


Figure 8: Mobile phone act as GSM modem

When the system read the value from the database, it will compare the value of current data with the parameter data. Alert system will be activated only if the normal parameter range is exceeded. Normally, the temperature and humidity of tissue culture did not change rapidly. In many cases, the next reading will be more or less the previous reading.

It is quite troublesome since monitoring process is done manually by using thermometer and hydrometer. The problem always occurred during weekend or holidays since there is nobody available to perform the monitoring process. Worst case scenario is electrical supply failure. If the electrical power is unavailable during this period, the tissue culture will definitely damaged, due to the inconsistency of temperature and humidity. Since the value for each tissue culture is around RM2000.00 per vessel, it is critical to maintain the parameter data within the normal range. Table I shows the data of temperature and humidity which is taken from tissue culture growing room at Malaysian Palm Oil Board (MPOB).

TABLE I.    DATA OF TEMPERATURE AND HUMIDITY

| DateTime | Temperature (C) | Humidity (%) |
|---|---|---|
| 4/5/2010 10:37:39 AM | 28 | 56 |
| 4/5/2010 10:42:18 AM | 28 | 56 |
| 4/5/2010 10:42:20 AM | 28 | 55 |
| 4/5/2010 10:42:22 AM | 28 | 48 |
| 4/5/2010 10:42:24 AM | 28 | 48 |
| 4/5/2010 10:43:02 AM | 27 | 44 |
| 4/5/2010 10:49:02 AM | 28 | 49 |
| 4/5/2010 10:49:04 AM | 28 | 49 |
| 4/5/2010 10:49:08 AM | 28 | 49 |
| 4/5/2010 10:49:10 AM | 21 | 49 |
| 4/5/2010 10:49:12 AM | 28 | 49 |
| 4/5/2010 10:49:14 AM | 28 | 48 |
| 4/5/2010 10:50:14 AM | 28 | 48 |
| 4/5/2010 10:50:16 AM | 28 | 48 |
| 4/5/2010 10:50:48 AM | 28 | 48 |
| 4/5/2010 10:50:50 AM | 28 | 48 |
| 4/5/2010 10:50:52 AM | 18 | 97 |
| 4/5/2010 10:50:56 AM | 18 | 93 |
| 4/5/2010 10:50:59 AM | 19 | 92 |
| 4/5/2010 10:51:01 AM | 28 | 48 |
| 4/5/2010 10:51:03 AM | 28 | 48 |
| 4/5/2010 10:51:05 AM | 28 | 48 |
| 4/5/2010 10:51:07 AM | 26 | 52 |

Since the normal parameter range is exceeded, alert system will be activated.

The valid parameter for temperature is between 25°C to 30°C while for humidity is between 45% to 90%. If the parameter value is exceeded, alert system will notify the user by sending SMS and email notification. Fig. 9 and 10 show the graph of temperature and humidity of tissue culture in growing room 1.
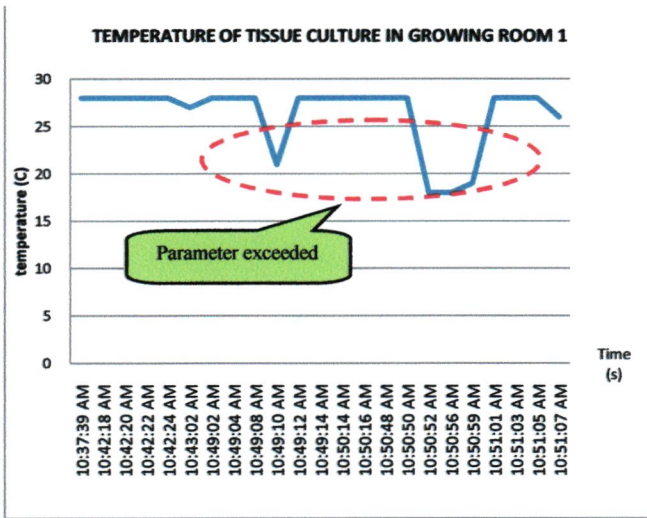


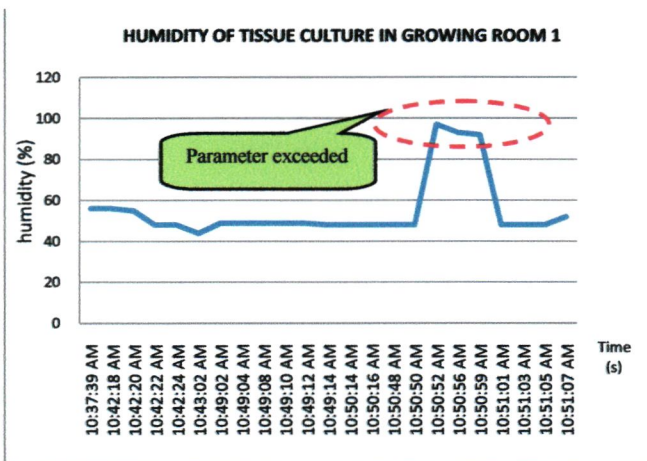Figure 9 : Graph of Temperature vs. Time



Figure 10 : Graph of Humidity vs. Time

The result will be shown through SMS and email notification. The format of incoming SMS is displayed in Fig. 11(a) and 11(b). The information that will be displayed are including the subject, parameter value, date and time as well as the current value of temperature and humidity. The phone number that appeared at the end of the message is the mobile phone number of GSM modem.



Figure 11(a) : The format of SMS notification when both temperature and humidity are exceeded
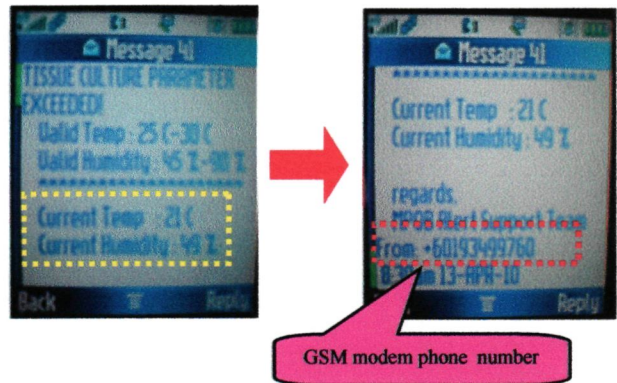


Figure 11(b) : The format of SMS notification when either temperature or humidity is exceeded

Fig. 12(a) and 12(b) shows an example of the email received due to the excessive value of parameter data. The email notification will display the sender's address, date and time, recipient's address, subject, the parameter value of temperature and humidity as well as the current value of temperature and humidity that triggered the alert system.
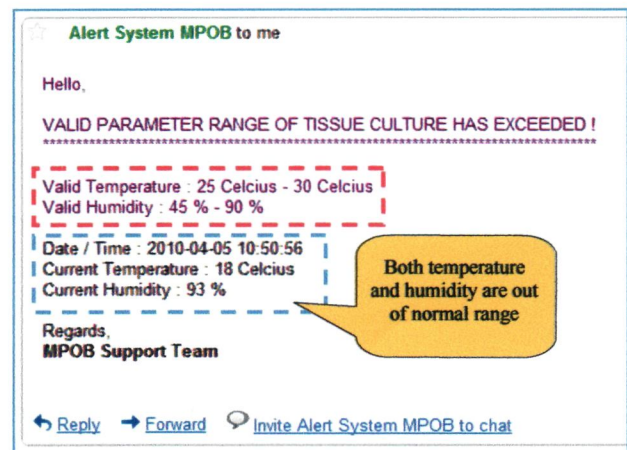


Figure 12(a) : The format of email notification when both temperature and humidity are exceeded
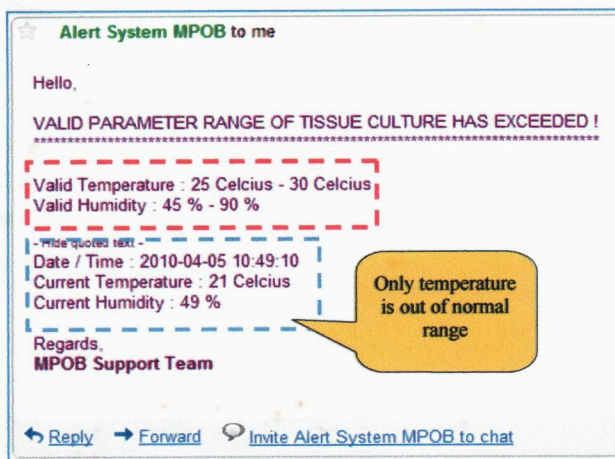
Figure 12(b) : The format of email notification when either temperature or humidity is exceeded

Based on the result obtained, the adoption of wireless technology together with the application of alert system in oil palm tissue culture will make it possible to create a technology that is feasible, and provides more secure access. In addition, monitoring process will be done much more effectively and the production of high quality seedling will be increased. The combination of both technology will create a great impact to crop improvement and it is expected that all information related to the temperature and humidity of the seedlings can be obtained successfully. Despite of that, if the sensor detects any abnormal temperature within the vessel in growing room, an alert system will be triggered and notification will be sent to the user via SMS and email. The usage of typical cabling (wires) can be reduced and definitely will overcome the situations where normal cabling is difficult or financially impractical.

## IV. CONCLUSION

As the conclusion, alert system successfully achieved the objectives of study. Alert system is capable to notify the user via SMS enquiry and email if the parameter value is exceeded. This system is developed by using open source software that can be accessed and downloaded from the internet. Since the software is a freeware, then the developing cost for an alert system is low.

SMS alerts and email notification are the backbone of alert system and each system stand out for their own benefit. The main advantages of SMS are it is often less time-consuming to send a text message than to make a phone call. SMS is cheaper when compared with voice messaging or web access. Furthermore, SMS is non-intrusive, hence SMS does not disturb anyone even though one person is busy with their important work. SMS is found as the most comfortable way to communicate.

Email is a message sent from one computer to another. Email has become the most widely used medium of communication within the business world. For this project, the email message typically contains text only, but it also can contain another features such as images or music. Email is easy, quick and a reliable service with no postage costs. It is more effective than any other method because of the ability to view documents without the cost and time constraint. It also can be stored in the inbox as long as the user did not delete those emails. The emails can be kept as track record for future use.

## V. RECOMMENDATION

The temperature and humidity alert system in oil palm tissue culture laboratory via SMS and email notification is a success. But, there are still some improvement that can be done to the system for future development. For example, a website that contains all the necessary information about tissue culture process can be developed. Through this website, only authentic user can access the database. Hence, a high security mechanism and validation process need to be done. In addition, a graphical display such as a graph that continuously record the value of temperature and humidity can be added into the website for monitoring process.

## ACKNOWLEDGEMENT

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