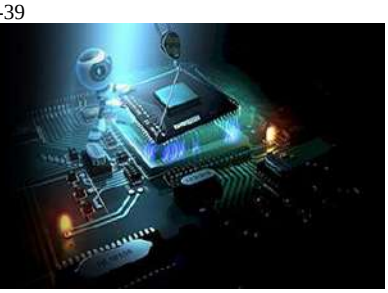
International Journal of Engineering in Computer Science



E-ISSN: 2663-3590
P-ISSN: 2663-3582
IJECS 2019; 1(2): 33-39
Received: 10-05-2019
Accepted: 12-06-2019

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Automated relative humidity and temperature control system for banana tissue culture laboratory with monitoring system and SMS notification

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DOI: https://doi.org/10.33545/26633582.2019.v1.i2a.17

Abstract
The challenged to developers is to automate relative humidity and temperature which control and monitoring approaches is using SMS based on the notification as part of the technology innovation. Thus, it complicates in the banana tissue culture laboratory implementation to have efficient monitoring system supplements the concept of the study that makes it more interesting and timelier in the implementation of Internet of Things Approach. The project intent to help the owner to automatically control and monitor temperature and humidity in banana tissue culture laboratory to provide appropriate temperature and relative humidity for banana which is the basic requirements to maintain the fast growth and resistant to diseases and infection. The prototype was tested with a white-box testing approach which surpass the requirements to the real laboratory. A survey questionnaire was also being used as part of evaluating the functionality and usability of the prototype that a very agree on both are the result.

Keywords: Automated laboratory, humidity, temperature, monitoring, SMS notification

Introduction

Banana tissue culture is very sensitive in term of temperature and humidity, temperature and humidity are needed to be maintained for faster growth and resist diseases infection, the main objective of this study is to automate the temperature and humidity with a graph for temperature. The prototype will start from temperature and humidity sensor then send data to Arduino Uno if critical status Arduino Uno triggering the leadlight to determine the critical status the same time relay open the current in order to turn on the fan and GSM module will send notification to the owner.

A banana tissue culture laboratory consists of four rooms washing room, media preparation room, culture room and transfer room. The washing room is used for washing the body of banana tree for remove dirt from the soil. The media preparation room is used to prepare all the medium. The culture room is where the banana tissue culture is conducted and lastly the transfer room is used to transfer the banana seedling to the seedling bags [6].

Temperature and Humidity Level is very important for banana tissue culture because life of banana tissue culture depend on temperature and humidity when temperature and humidity are critically high or critically low depend on whether, the banana tissue culture life is in danger so the banana tissue culture temperature and Humidity must maintain in specific temperature according to [9] Bananas require a warm, humid, frost-free climate with optimum temperatures between 26 and 28 ^{0}C. Plant growth slows below 16 °C and stops at 10 °C. Temperatures below -2 ^{0}C may kill plants at laboratory level. However, new growth usually sprouts from the underground rhizome with the return of warm weather.

Banana tissue culture is very sensitive in term of temperature and humidity, temperature and humidity are needed to be maintained for faster growth and resist diseases infection [2]. Manual monitoring for banana tissue culture laboratory risking lives to monitor the temperature and humidity in banana tissue culture laboratory because any time temperature will change it depend on weather.

The main objective of this study is to automate the temperature and humidity with a graph for temperature. The prototype will start from temperature and humidity sensor then send data to Arduino Uno if critical status Arduino Uno triggering the leadlight to determine the critical status the same time relay open the current in order to turn on the fan and GSM module will send notification to the owner.

This study proposes some recommendations to further increase the acceptance of banana tissue culture technique in the country.

Project description of the study

The development of automated relative humidity and temperature control and monitoring system automated relative humidity with SMS notification for banana tissue culture laboratory is very important acquiring efficient monitoring system for the laboratory of banana tissue culture, this project intent to help the owner to automatically control and monitor temperature and humidity in banana tissue culture banana very sensitive in term if temperature and relative humidity, temperature and humidity are needed to be maintained for fast growth and resist disease infection.

Objective of the study

The study discusses the following topics that give highlights to the result on each of the scenario that made the project successful. The following topics are (1) Development of the prototype system (2) Temperature control system (3) Development of monitoring system (4) Development of SMS notification System (5) Performance of the developed system.

Scope and limitation

This project will focus on developing prototype and design humidity and temperature control system with SMS notification for banana tissue culture laboratory, developing a prototype aquarium box style for the banana tissue culture, Arduino will control the humidity and temperature sensor, leadlight color using for determine the temperature status, and fan will turn on when temperature status is critical high then GSM module will automatically sent SMS notification to the owner when temperature is critical. Design monitoring system using the windows form application.

Results of this study will provide an electronic repository for restoring journal references that can help the students or the faculty browse the references conveniently. This can help secure and store reliable documents. This proposed website has the same relevance to students in providing Electronic repository for their capstone and research project for retrieval of information purposes. Also, this website is useful and helpful for all the students and faculties as this will serve as basis or guidelines in creating a research and capstone projects.

Literature review

This chapter will have focused on different variable related to the study and provides sufficient knowledge and application for designing and in constructing a prototype box for banana tissue culture to monitoring and control system.

Development of low-cost and rapid multiplication techniques of tissue cultured Musa acuminate

Tissue culture is now a standard practice in banana propagation according to the study on [7] Mass Propagation of Banana, New Delhi. Among which is meristem culture that offers an efficient method in producing virus-free materials and germplasm in plants, technique of tissue culture, South Africa. At MMSU and in other institutions, in-vitro propagation techniques for banana have already been established using the Morishige and Skoog's (MS) media formulation with the addition of 5 ppm Benzyl Amino Purine (BAP), 2% sucrose and 4.5g distilled water to volume one liter of culture media. The effectiveness of BAP over other cytokines in inducing multiplication has been reported in different banana cultivars Substitution of chemical formulation was done to obtain the same quality and quantity of plantlets that incur lower production cost. Culture media were incubated in a laboratory room with 20 °C to 25 °C for a 16hour photoperiod. Healthy lactam plants were selected and grown to produce maiden suckers, which served as initial explants. A tissue-culture technique in which prop gules are cloned from tissue taken from a single plant is known as micro-propagation. Micro-propagating the banana Preparing Tissue-Cultured Banana Plantlets for Field Planting Eden A. Perez and Cerotic R2 Hooks Department of Plant and Environmental Protection Sciences [8].

Shoot tip is the main method used for fast propagation of banana plants. However, once a plantlet has been developed through the tissue-culture technique, care must be taken in moving it from its sterile, artificially controlled environment to the more exposed greenhouse and less protected field conditions. This final phase takes 7–10 weeks, shoot growth is best between 26 and 28 °C. Plant growth slows below 16 °C and stops at 10 °C. Temperatures below -2 °C may kill plants at laboratory level. However, new growth usually sprouts from the underground rhizome with the return of warm weather [9].

Project report on plant tissue culture

Light and temperature requirements vary from species to species and sometimes during the various stages of developments. The cultures are observed daily for growth and any signs of infection/ contamination. Cultures, that do not show good growth or infected, are discarded. The healthy cultures grow into small shoot buds. Due to very high humidity inside the culture vessel and artificial conditions of development. The plants removed from the sterile medium are washed and are maintained under intermittent mist or are covered with clean transparent plastic.

After 10 to 15 days under high humidity, the plants are transferred to green house and maintained for another 4 to 6 weeks. When the tissue culture plants are sold at this stage, the plants are washed in sterilized water to remove the agar medium. The washed plants are sorted into 2 to 3 grades and packed in corrugated plastic boxes lined with sterilized tissue paper as per specifications of the Plant Quarantine Authority, Government of India for exports.

The number of plants per box depends on the customer's requirement. Depending on the final destination and the preference of the customer, the plants are treated with specific fungicides and antibiotics to avoid infection [3].

Plant cell and tissue culture

A constant ambient temperature of 25 more or less 2C is maintained in the incubation room by an air. A Temperature recorder may be installed externally to monitor temperature fluctuation. To ensure good air circulation, a ceiling fan at low speed may be fitted, it may be not practicable to maintain strict photoperiodic diurnal cycles. Provision may be made to blow cool air downward over the fluorescent tubes. And elaborate set up would be to have independent walk-in controlled environment chamber fitted with heavy

flush door, for temperature varying from 15-30 ^{0}C at intervals of 5C for, growth of tissues under different temperature regimes as needed through the year.
Culture of isolated plant tissues is carried out under controlled environmental conditions of temperature. Relative humidity (range 20-98%), photoperiod and uniform air circulation, with cells suspension cultures, agitation and aeration is secured by the use of shaker systems, facilities for housing a wide variety of liquid culture apparatus like tier reciprocating and gyratory shakers, roller tube and tumble tube apparatus as well as nipple flask culture apparatus including a variety of bioreactor units are provide. Many of procedures and state of the art of plant cell culture have their basic foundation in the field [11].

Technical manual on banana and plantain seed production

Plantain and banana are important staples and source of income for the smallholders that grow them in the humid forest and mid-altitude agro ecologies of sub-Saharan Africa. Farmers usually depend on natural regeneration of plants for the supply of planting materials. This is a very slow process that often produces small numbers of planting materials that are usually contaminated by various soil-borne pathogens such as nematodes. The alternative methods can be classified into two categories: field techniques based on complete or partial decapitation and detached corm techniques practiced away from the field. The two decapitation techniques involve stimulating lateral bud production by destroying the active growing point (meristem) in the pseudo stem. Both techniques increase sprouting and sucker multiplication in the field [4].
Propagation is by meristem manipulation. Propagation is by bud manipulation. Harvested sucker is trimmed off its roots and washed to remove plant and soil debris. Outer leaf sheaths are removed 2mm above the corm at leaf base with a sharp knife to expose all buds and/or meristem. With excised buds, buds are cut out in mini sets of about 50-100g each before sterilization and planting. With corm drilling, the meristem is drilled while in PIF, the corm is pared, sterilized and apical meristem scarified or fragmented longitudinally into 2 or 4 bits before planting. Prepared corms are planted at 10cm interval and cover with 2cm layer of saw dust [4].

Plant tissue of banana in laboratory

Banana is fundamentally a tropical product, develops well in temperature scope of 13°C to 38°C with RH administration of 75% to 85%. Higher temperature causes sun searing. In India banana is developed under creation frameworks and assorted conditions. Shoot tips of youthful suckers ought to be of 40 cm to 100 cm stature are utilized as an explant for fast *in vitro* duplication of banana. For these shoots, tissue of around 1 cubic cm to 2 cubic cm containing the apical meristem is isolated from the banana suckers. Whenever microbes or infection end is required, meristem tip society is the main favored alternative. Meristem societies have the impediment that they may have an underlying slower development and a higher death rate. Into the lab the readied suckers are taken for further process. To expel or kill parasitic spores and growth, suckers are absorbed Bavistin for 18 hours. Later they are initially washed in running water. Next they are again plunged into water containing cleanser (Teepol) for 60 minutes Media is poured in a glass container where suckers are started. Their proportion and focus decide the development and morphogenesis of the banana tissue [1].

Preparing tissue-cultured banana plantlets for field planting

A tissue-culture technique in which prop gules are cloned from tissue taken from a single plant is known as micro-propagation. Micro-propagating the banana shoot tip is the main method used for fast propagation of banana plants. However, once a plantlet has been developed through the tissue-culture technique, care must be taken in moving it from its sterile, artificially controlled environment to the more exposed greenhouse and less protected field conditions. During the last phase of banana micro propagation, steps are taken to grow individual plantlets and prepare them for adaptation to the external environment. These plantlets are small and not yet capable of surviving in the soil. Mostly, the imitated shoots are in clusters, and roots are absent. To encourage root development and shoot elongation, the clusters are separated and transferred to a special media that promotes root development. This final phase takes 7–10 weeks. Hardening of plantlets in cultured vessels, and preparing them for transplanting the hardening, or acclimatization, process begins while the plantlets are still *in vitro*, i.e., growing in the culture vessels. Acclimatization is the physiological adaptation of an animal or plant to changes in climate or environment, such as light, temperature, or altitude. In this case, banana plantlets are being acclimated from cultured vessels to greenhouse and outdoor environments. Just prior to acclimatization, the plantlets have shoots and roots but are not yet capable of supporting themselves in the soil. The rooted shoots are about 6–8 cm (2.5–3 inches) tall and receive nutrients from an artificial medium that contains major nutrients [5].

Natural light as an alternative light source for the vitro culture banana

The concept of using sunlight for micro propagation systems is proposed as a way of reducing tissue culture costs. Shoot tips of Musa acuminate cultivar were cultured in a non-controlled natural light environment at the IAEA Laboratories, Austria during summertime. Significantly more shoots were produced by plantlets cultivated in a sunlit room with photosynthetic photon flux densities (PPFD) fluctuating temperatures between 23 and 30 ^{0}C and photoperiods of 12 to 16-h, than by plantlets under artificial light in a growth chamber providing controlled conditions of a constant PPFD of temperatures ranging from 23 to 29 ^{0}C and a 16-h photoperiod. Highest multiplication rates were achieved in a greenhouse with temperatures of 18 – 43 ^{0}C, but browning of leaves and loss of turgor occurred. The diurnal fluctuations of 23 to 29 ^{0}C were similar in the growth chamber and the sunlit room. In the greenhouse and the growth chamber, the mean temperature was 27 ◦C, but the locations differed largely in their minimum and maximum temperatures, 23 – 29 ^{0}C in the growth chamber vs [12].

Micropropagation of ginger using mature and immature coconut water as growth hormone

Ginger is one of the earliest well-known orient spice crops having significant commercial value for its use in various medicinal and culinary preparation. It is usually propagated

vegetative trough underground rhizomes, with a very low multiplication rate.

Plant tissue culture techniques have been useful in conservation of germplasm of vegetative crops and considered as an alternative to conventional field gene banks to safeguard against pest and environmental vagaries. There are some early reports on vitro culture of ginger. It is important to note that as in the case with ginger, the absence of seed made conventional breeding methods ineffective. Traditionally, ginger was propagated by using rhizome [2].

Methods and Materials

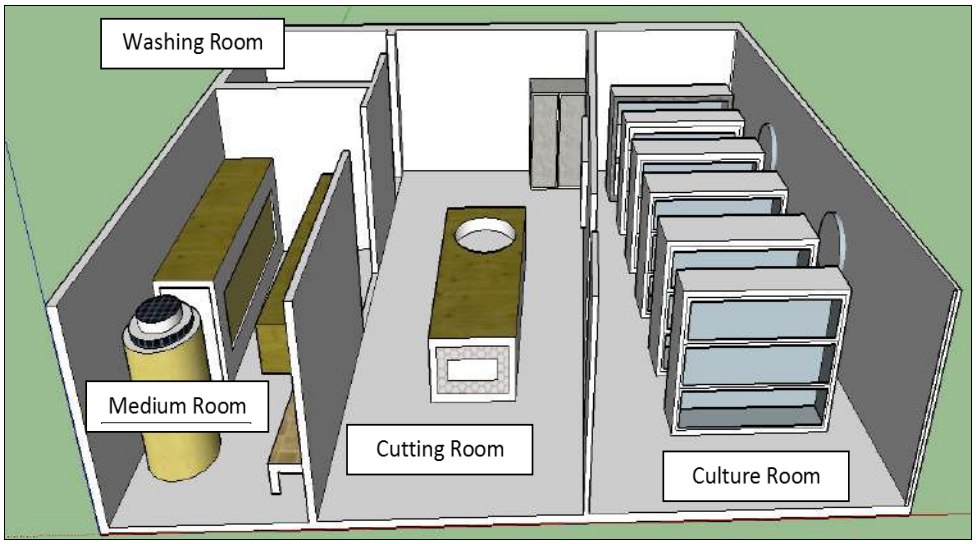
The project entitled "Automated humidity and temperature control system for banana tissue culture laboratory with monitoring system and SMS notification" will deployed the prototype for banana tissue culture to automate the monitoring system so the user will always know the situation on his/her laboratory using humidity and temperature sensor the prototype will always detect the real time situation in laboratory.

Table 1: Hardware to be used in the project.

Device Name	Picture	Description	Specification
Arduino		The Microcontroller that assigns all electronic devices use.	Arduino Uno R3
GSM Module		A device that is used to send SMS notification.	SIM900 SIMCOM GPRS/GSM Shield
Fan Cooler		A Device that use to supply air to cooler the high temperature	OEM SLM OE721- OEM
Relay		Relay is used for give the current to the water pump with specific time	OEM Single Relay 5v
Temperature and Humidity sensor		Temperature and humidity sensor is using for detection of temperature and humidity	OEM DHT11
LCD		LCD using for displaying the temperature and Humidity	LCD1602 16x2 HD44780
LED Diode		Led Light use for determine if temperature is critical or normal	LED Diode

Table 2: Software to be used in the project.

Software	Image	Recommendation
OS		Windows OS 7/8/10 (32bit/64bit)
Visual Studio 2012		Windows Application C#
Arduino Compiler		Arduino Uno Compiler
MySQL Administrator		MySQL Administrator
Photoshop		Photoshop CC 2014



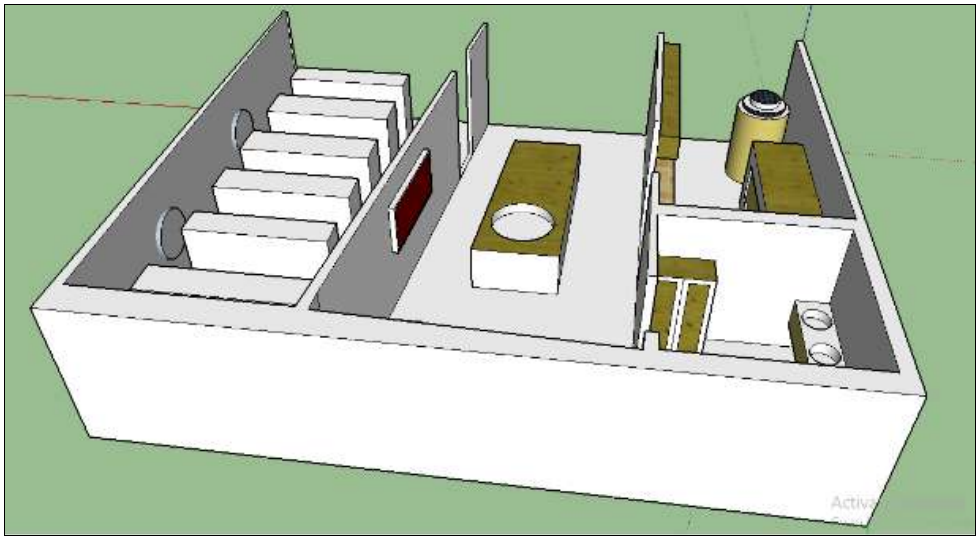


Fig 1: Proposes Prototype Design.

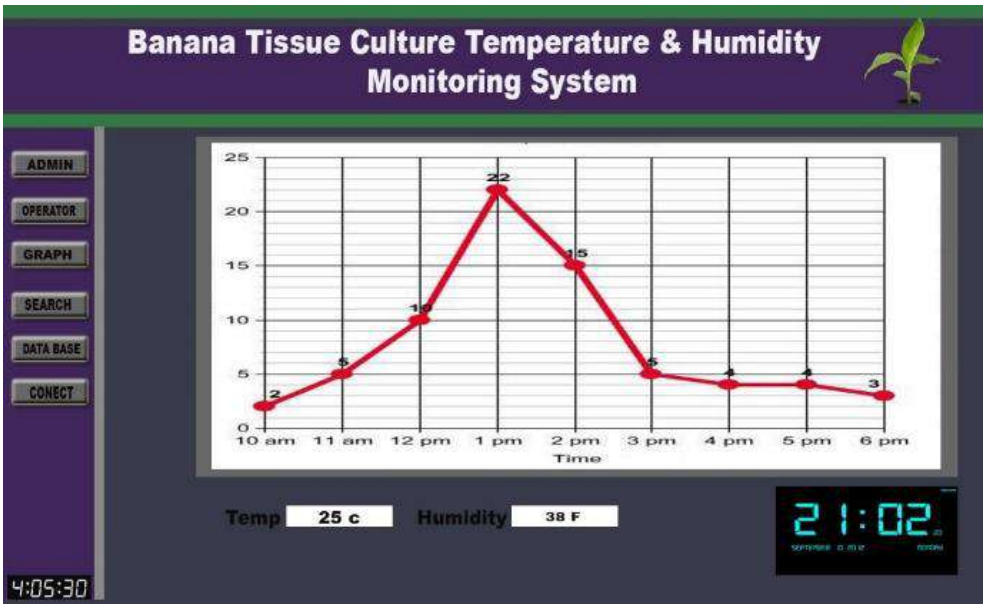


Fig 2: Proposes Monitoring System.

The developers formulate theoretical framework to know the flow of the device and to determine what are the independent, dependent controller and the output device. The project consists of dependent and independent variable. Dependent variables will be the data cord from Arduino to pc because we need to pull out or input the data cable. Moreover, independent variable, will be the temperature and humidity sensor which will detect the situation in laboratory then send the data to windows application as monitoring system, if temperature is critical the Arduino will trigger the relay and give current supply to the fan.

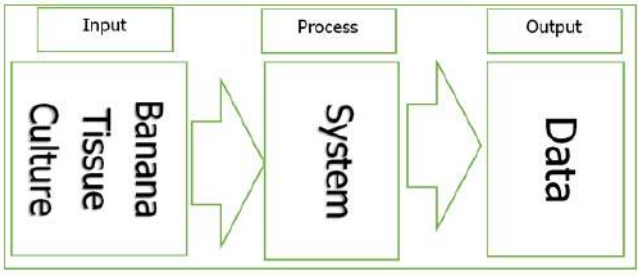


Fig 3: Conceptual Framework of the Proposed System.

Table 3: Budgetary Requirements.

Particulars	Cost (Php)
Arduino Nano	800.00
Relay	600.00
GSM module	1,300.00
Humidity Sensor	500.00
Temperature Sensor	600.00
Fan cooler and heater	1,400.00
Led Light	100.00
LCD	500.00
Banana miniature	2,000.00
Other Materials	2,000.00
Total	9,800.00

Data, Results and Discussion

Development prototype contains LED

To determine the temperature using LED the researcher use two LED with different color that is white and red LED, white LED to determine the normal temperature inside the tissue culture laboratory prototype and the red one is to determine the abnormal temperature inside the laboratory to make it work the researcher create connection between sensor to microcontroller and microcontroller to LDE, the

sensor will send data to Arduino Uno and process the data according the code inside the Arduino Uno.

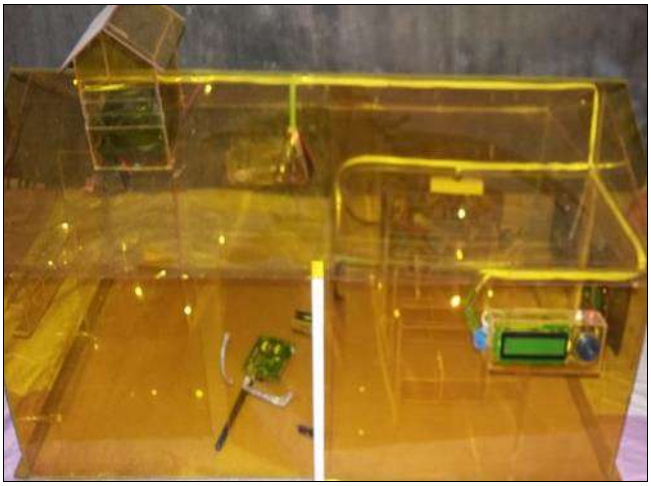


Fig 4: Prototype design

Automate temperature control system

The main function of this system to automate control system of the banana tissue culture laboratory and to monitor the temperature and humidity using desktop application on computer or laptop to create easy way for the owner or the user of the tissue culture laboratory.

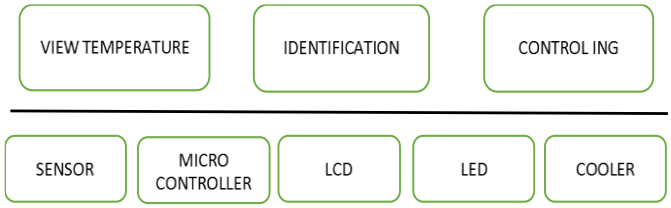


Fig 5: Shows the table of system activity

Development of monitoring system

This figure shows the button or the function of this system first button named connect port this function is to connect micro controller to desktop application to read serial of the micro controller next button gallery is to show the picture of the prototype then search button function to search data saved in data base chart shown the average of data every 10 minutes about system button shown the explanation of why this system build. Second level is shown the software used to build this system from operating system, visual studio, Arduino complier and adobe Photoshop, then third is MySQL data base saved all data read from micro controller serial.


```
con.Open();string insert1 = "INSERT INTO tbl_data (temp, hum, datee)
                                VALUES(?id, ?a, ?b)";
SqlCommand cmd1 = new MySqlCommand(insert1, con);
cmd1.Parameters.Add("?id", MySqlDbType.String).Value = txttempp.Text;
cmd1.Parameters.Add("?a", MySqlDbType.String).Value = txthumm.Text;
cmd1.Parameters.Add("?b", MySqlDbType.String).Value =
DateTime.Now.ToShortDateString();
cmd1.ExecuteNonQuery();
con.Close();
```

Fig 6: Save data flow diagram and code

Development of SMS Notification

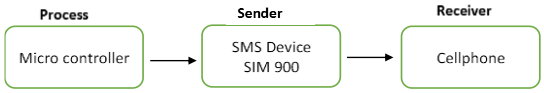


Fig 7: SMS Notification activity diagram.

Figure above shows the process of sending SMS notification for this project so first is process this step for process all code to execute on the electronic device so this case we use micro controller that is Arduino Uno then to execute the data to send we use GSM module this time we choose SIM 900 module, for receiver we can use cellphone to receive SMS from GSM module.

Performance of the Developed System

Figure above shown the print screen of the Arduino Uno code to calling the library of GSM module and set up the wire and pin we appointed to the micro controller, this code shown to executed the GSM module first is to converted the data to text then appointing the number or address where the message will send then set message to be sent as a notification and the last one is code for executing.

Table 4: Sequence of Evaluator

Evaluators	Quota	Percentage	Sample Size
IT Students	50	46%	23
Non-IT Students	50	46%	23
Faculty	7	7%	3
Owner	1	1%	1
Total	108	100%	50

The graphical below functionality has mean “4.3” verbal score is very agree and the usability of the system is “4.43” verbal score is very agree so conclude from the performance of the system is very helpful for the owner or the employee of the tissue culture laboratory for monitoring and control system.

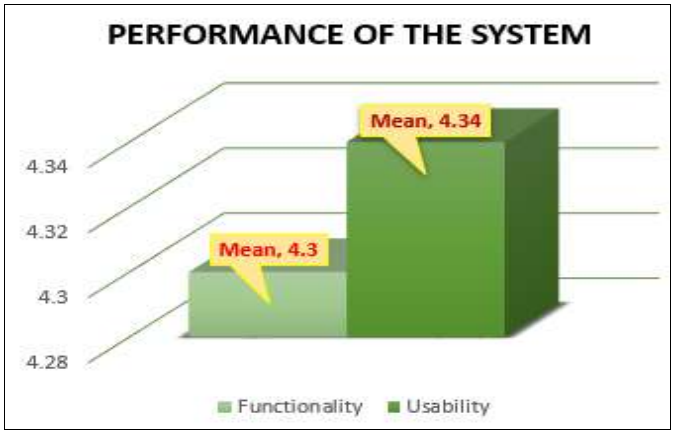


Fig 8: Graphical Representation of the Evaluators

Conclusions

With the result of testing, it is concluded that the system is working or functioning accordingly as what the developers expected, although there are few unexpected problems, but this does not affect the whole functionality and usability of the system. The system was given a 4.34 remark which given a positive outcome from the evaluators.

Acknowledgment

The researchers are very thankful to the Almighty God for making them believe that God is always on their sides ready to give help and blessings. Without Him, they could go somewhere else and could not be able to complete the research on time. They also wish to acknowledge the following:

To their family, who serve as the inspiration and motivation throughout the entire study; to their parents and siblings for the financial and moral support; and to Prof. Garnette Mae V. Balacy for her suggestions, pieces of advice, and many hours of consultations.

Acknowledgment is also extended to all friends, colleagues, mentors, and classmates who shared their ideas and time to the researchers for the analysis of this study most specifically to the research team who accompanied the researchers in this journey.

There are some people who are not mentioned herein but took big part in the researchers' mind. These important people made this research a meaningful endeavor.

References

1. Avvaru S. Plant Tissue Culture of Banana in Laboratory. Research and Reviews: Journal of Botanical Sciences. 2016; 5(3):54-62
2. Rahman S, Biswas N, Hassan M, Ahmed G. Micro propagation of banana (Musa sp.) cv. Agnishwar by *In vitro* shoot tip culture. International Research Journal of Biotechnology. 2013; 4(4):83-88.
3. Smith. Project Report on Plant Tissue Culture Part a : Primer on Plant Tissue Culture, (3rd Edition), 208. http//www.vitroplant.org. 2012.
4. Shiv Shankar C, Balaji P, Sathish Sekar D. Mass Propagation of Banana (Musa sp.) cv. Grand Naine through Direct Organogenesis by Benzyl Adenine Purine and Kinetin. Journal of Academia and Industrial Research. 2014; 3(2):92-97.
5. Perez EA, Sciences EP. For Field Planting. Tropical Agriculture, 2008.
6. Simmons HE *et al*. Frequencies of Seed Infection and Transmissions Seedlings by Potato Spindle Tuber Viroid (A Pospiviroid) in Tomato. J Plant Pathol Microb. 2015; 6:275.
7. Shiragi *et al*. Mass Propagation of Banana Grand Naine through Direct Organogenesis by Benzyl Adenine Purine and Kinetin. Journal of Academia and Industrial Research, 2014, 92-97.
8. Krishnamoorthy *et al*. Banana plantlet production through tissue culture. https://www.researchgate.net September. 2001; 6(6):211-250.
9. Rahman M *et al*. Transplanting by Uprooting Tillers from Dibbled Field: An Idea for Crop Intensification and Sustainable Rice Cultivation. J Rice Res. 2013; 1:109.89.
10. Dela Cruz FS, Gueco LS, Damasco OP, Huelgas VC, Dela Cueva FM, Dizon TO, Molina AB. Farmers' Handbook on Introduced and Local Banana Cultivars in the Philippines. Bioversity International. Retrieved from https://www.bioversityinternational.org. 2008.
11. Narayanaswamy. Plant cell and tissue culture. Emeritus Scientist Pachaiyapa's College University of madras, India, 2008; 1(1)1- 97.
12. Kodym A, Zapata-Arias FJ. Natural light as an alternative light source for the *in vitro* culture of banana (Musa acuminata cv. 'Grande Naine'). Plant Cell, Tissue and Organ Culture. 2008; 55(2):141-145. https://doi.org/10.1023/A:1006119114107. February 2008.