Self Power Temperature and Humidity Data Logger

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***Abstract*—Detecting, monitoring, collecting, and wirelessly logging data of temperature and humidity in the hospital's or pharmacy's medication storage room are the four main purposes in this project aim. This project includes implementation of DHT11 sensor into the conventional temperature and humidity detection. The system will reduce the workload of the medical staff to monitor temperature and humidity condition in the medicine room. Medical staffs are no longer needed to enter the room to read and collect temperature and humidity manually, this project provided automatically detected data by a sensor call DHT11 sensor. These temperature and humidity are display digitally at the Liquid Crystal Display (LCD) and wirelessly display in the computer by using a pair of Xbee transmit/receive module. The Xbee wireless technology is used to send the data automatically to the Graphical User Interface (GUI) in computer for monitoring and data logger purpose. Data logger used to collect and logged data into text document (txt) and Excel file (xls) as data set for future analysis and studies.**

Keywords—temperature; humidity; data logger; Xbee; GUI

I. INTRODUCTION

Temperature and humidity are the two main concerns in order to keep drugs in medication stores in good condition as well as preventing it from decaying. The fluctuation of temperature and humidity of the storage location may cause some changes in the medicine physically as well as losing its effectiveness [1] [2]. Therefore, temperature and humidity monitoring is a very important to keep the medicines in good condition [3]. This project would automatically collect the temperature and humidity data for monitoring regardless in weather change. In addition, a monitor panel was developed to display the collected data wirelessly on the staff's computer. This panel will help staffs to monitor the condition of the room more easily and effectively.

The main objective of this project is to develop a data logger system using Arduino MEGA module and DHT 11 sensor to detect temperature and humidity in medical storage room using RF wireless Xbee series 1 module to wirelessly transmit data.

The XBee wireless RF antenna is able to transmit the data wirelessly from the medical storage room to the user's computer within a specified distance [4]. Furthermore, data can be automatically collected for future reference and monitoring purposes. In addition, the alarm system is developed as out of optimum range indicator of temperature and humidity levels.

II. TOOL

A. Hardware

DHT11 sensor, Arduino Mega 2560, XBee module, and DC fan are the main components of this project development. DHT11 sensor detected temperature and humidity in medication storage room and wirelessly transmit to the user computer by using a pair of XBee module. Arduino ATMega 2560 are chosen as a microcontroller to program and supply power to the DHT11 sensor via USB cable.

1) Arduino Mega 2560: Arduino is an open-source physical that provides multi analog and digital input/output board. Arduino uses C program language in open-source IDE and just simple upload the programming into the Arduino module through the USB B type cable. Arduino provide develop stand alone interactive object or can be connected to software in the computer. Fig. 1 shown the Arduino Mega 2560 module.

2) DHT11 Sensor: DHT 11 sensor is a two-in-one sensor that can detect temperature and humidity synchronously [5]. DHT11 element has very accurate humidity calibration. DHT11 sensor is a single-wire serial interface and this makes the system integrate more easily. This sensor is small in size and has 4 pins single row pin package that allows easier connection to the microcontroller (Arduino module). Single-bus data is used for communication between microcontroller and DHT11. The DHT11 sensor showed in Fig. 2.

Fig. 1. Arduino Mega2560 module

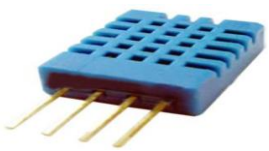


Fig. 2. DHT11sensor

3) RF Wireless Xbee Module: XBee modules provide wireless end-point connectivity to devices. Xbee uses IEEE 802.15.4 network protocol as function of point-to-multipoint or peer-to-peer networking [6]. They are designed for high-throughput applications and the XBee is using the Zigbee standard protocol. Fig. 3 showed RF XBee module.

B. Software

Arduino IDE programming, X-CTU, Realterm and Java Programming are used to ensure the successfulness of this project. Java programming is used to develop the GUI and warning system. While, Arduino IDE programming to build and generate the coding for the Arduino ATMega (microcontroller), that also used in this project to make the whole system operated. Meanwhile, X-CTU software used to setting Xbee module address and Realterm is to collect receiving data.

1) X-CTU: X-CTU software is a Windows-based application provided by Digi. This software provide user to test the functionally and operation of RF wireless Xbee module and setting configuration of Xbee.

2) Realterm: This software can capture and control incoming data and store the data collected in text document. The capture run time can be setting by user through the capture menu in realterm Capture Tap.

3) Java Programming: One of tool that allow user to write a set of instruction as well as program coding to call computer to do and accomplish instruction task. Java programming can create, compile, and execute instruction in computer system by using command prompt [7]. In Java programming, the code is written in simple text document platform and does not need to be recompiled in order to run it on another attached software regardless of computer architecture.

III. Data Logger Development

Fig. 4 describes the basic operation of wireless temperature and humidity sensor. While Fig. 5 shows the technical flow of the data logger development. The sensor is used to detect and keep track on the temperature and humidity in the medical storage room. The digital signal from the sensor is transmitted to the microcontroller unit that is attached to the Xbee module. The wireless communication is established between the Xbee transmitter module and Xbee receiver module. When the Xbee receiver unit receives the digital signal, the signal will be sent to the PC for monitoring purposes and perform data collection for future analysis and study. GUI (graphical user interface) was developed to this project by using Java Programming software. It display the temperature and humidity in user's computer and provided warning system to alert user when data out of acceptable range.

Fig. 3. RF XBee module

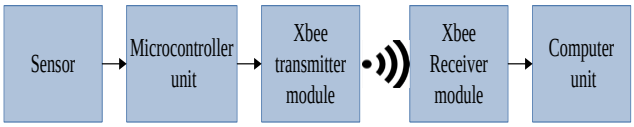


Fig. 4. Block diagram operation

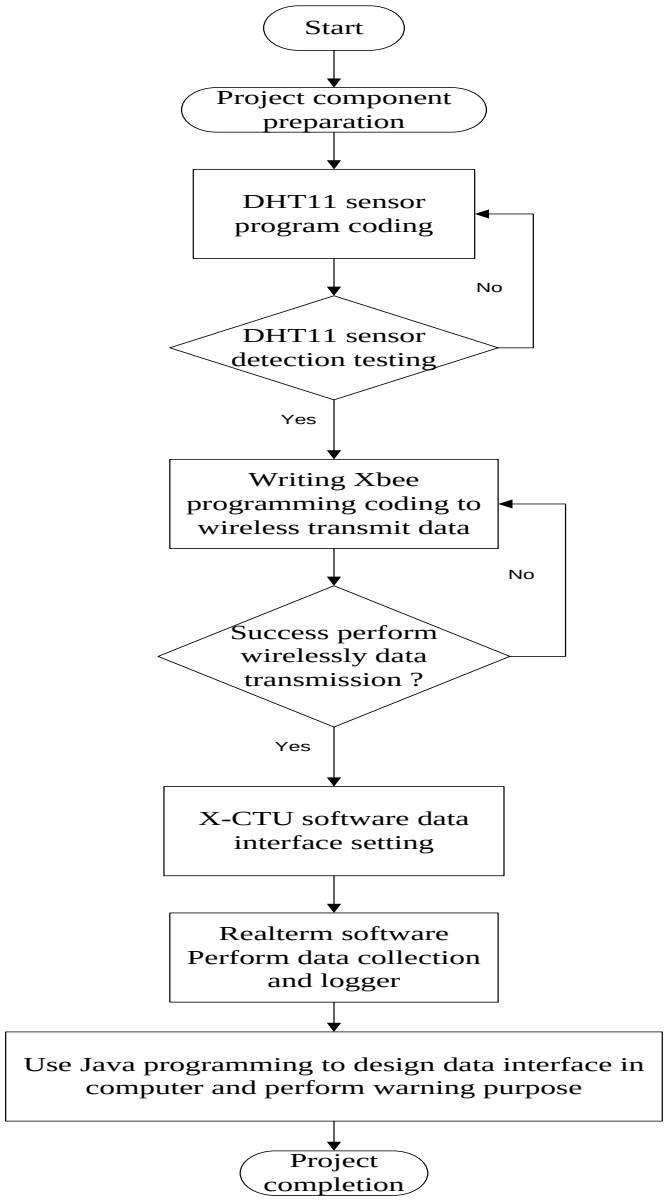


Fig. 5. Flowchart Process of Project Development and Implementation Procedure

A. DHT11 Sensor Circuit

The basic DHT11 sensor provides with simple connection to the microcontroller. This sensor operates in 5V which supply by microcontroller. Besides, the second pin of DHT11 sensor is sending the digital data to the digital pin 2 in the

microcontroller. The pin 3 in DHT11 sensor is null. The circuit connection is shown as in Fig. 6.

B. X-CTU Operation

The X-CTU is a software that is used in computer in order to communicate with Xbee module to change the configuration of the Xbee transmitter or Xbee receiver communication. The settings of COM port and baud rate are necessary in X-CTU in order to match with the Xbee configuration. Moreover, X-CTU also provides interface of data display in monitor screen. Normally, Xbee module can only connect with the Xbee module. Therefore, a pair of Xbee (transmitter and Receiver) is required for these devices to work. In this part, the transmitter ID and receiver ID have to be configured in order to secure a smooth connection between them. The configure of transmit and receive ID as in Table 1.

C. Realterm Operation

The realterm software enable data monitoring, capture, collect and store in text file. The COM port and baud rate of realterm are the main settings that has to match with the device's COM port and baud rate in order to receive data.The COM port and baud rate setting in Realterm software was showed as in Fig. 7.

D. Java Programming Operation

Java programming allows programmer to write coding instruction task in text document and uses command prompt to compile and execute the source code. A task that used Java programming source code to display "Hello world" that was run, compile and display in command prompt screen. Fig. 8 showed step of the program task that executed by command prompt. Table 2 describes the meaning of command execution of each line in command prompt.

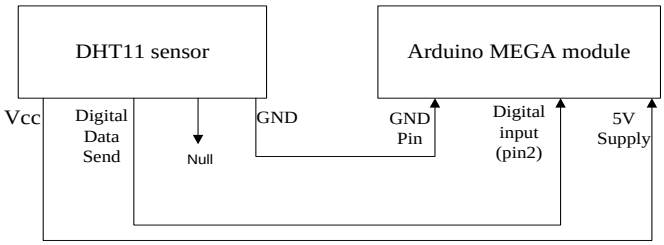


Fig. 6. Connection of DHT11 Sensor to the Microcontroller (Arduino MEGA pins)

TABLE 1. XBEE MODULE TRANSMITTER ID AND RECEIVER ID SETTING

	Xbee1	**Xbee2**
ATDL (Transmit ID)	1111	2222
ATMY (Receive ID)	2222	1111

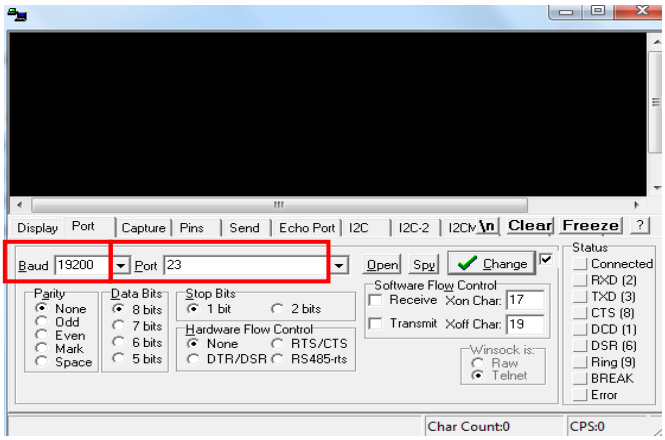


Fig. 7. COM Port and Baud Rate Setting to Match with Xbee Module

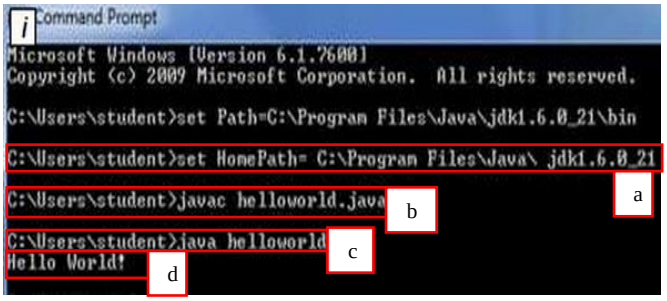


Fig. 8. Execution of Java Programming in Command Prompt

TABLE 2. DESCRIPTION OF THE COMMAND EXECUTION IN EACH LINE IN THE COMMAND PROMPT

Label	**Description**
a	Enable Java programming to recognize Java program file location.
b	Running and Compile java class file with the file name "javac helloworld.java".
c	Execute java programming with Java file name "java helloworld".
d	Result "Hello world" printed in screen command prompt.

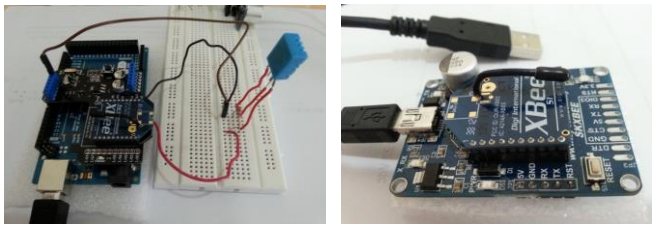
IV. RESULT AND ANALYSIS

A. Hardware Part

DHT11 sensor would detect the surrounding temperature and humidity and pass the information to Arduino for processing. An analysis had done by heat up the temperature using hair dryer and lighter to test the condition change in relationship between temperature and humidity as showed in Table 3.

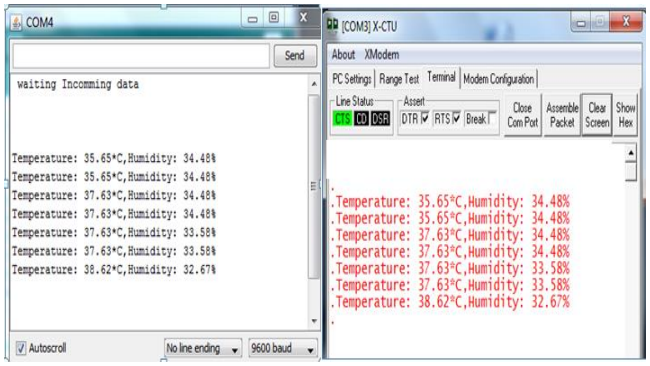
A pair of RF wireless Xbee module is used as transmitter and receiver for transmitting data from DHT11 sensor to GUI in user's computer. Fig. 9 shows connectivity of Xbee transmit/receive module with Arduino microcontroller and SKXBee module. Detected and displayed data in serial port

monitoring screen (microcontroller) is shown as in Fig. 10(a) and data transmitted wirelessly in X-CTU terminal is shown as in Fig. 10(b). It is clearly seen that the data were successfully transmitted wirelessly to the X-CTU software by using Xbee module. While Fig. 11 and Table 3 show the analysis of XBee RF power transmission measurement.



(a) (b)

Fig. 9. XBee Transmit/Receive Module Connection
(a)Transmitter and (b) Receiver



(a) (b)

Fig. 10. (a) Interface in Serial Port Microcontroller
(b) Output Data Wirelessly in X-CTU Terminal

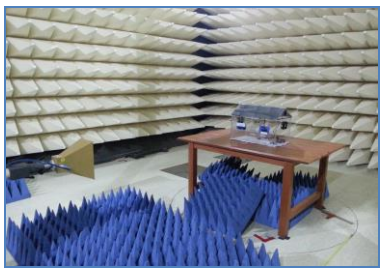


Fig. 11. XBee Transmitter Located in Anechoic Chamber

TABLE 3. XBEE'S FREQUENCY AND POWER MEASUREMENT

Distance between XBee to horn antenna	XBee Frequency Transmit [dB (µV/m)]	XBee Power Transmit (MHz)	XBee Frequency Receiver [dB (µV/m)]	XBee Power Receiver (MHz)
3 meter	86	24.1	83.3	24.4
2 meter	90.7	24.1	88.4	24.4

B. *Software Part*

Temperature and humidity data are wirelessly transmitted from serial port in microcontroller to realterm terminal by using a pair of Xbee transmit/receive module. Data received by Realterm is accurate as there are no losses of signal as the Xbee module is capable of transmitting data up to 10 meters in radius. Fig. 11 and Table 4 show both temperature and humidity data that is received by the microcontroller and Realterm wirelessly.

Received and displayed data were logged into text file (txt) or Excel file (xls) as database. Fig. 12 (a) and (b) showed database that saved in text and Excel file respectively.

While, interface panel developed by using Java programming, displays temperature and humidity value digitally. Data is updated every 5 seconds. Java programming also provides graph plotting for both temperature and humidity against time as shows in Fig. 13 and Fig. 14.

This warning system is develop by Java programming which can alert staff when temperature and humidity in medication storage room out of safety range (16 to 27 celsius) and (45 to 60%RH). The alert window appears and displays the warning word " Temperature out of range from 16°C to 27°C !!! " and " Humidity out of range from 45% to 60%RH !!! ". The alert window of temperature and humidity as shown as in Fig. 15 and Fig. 16 respectively.

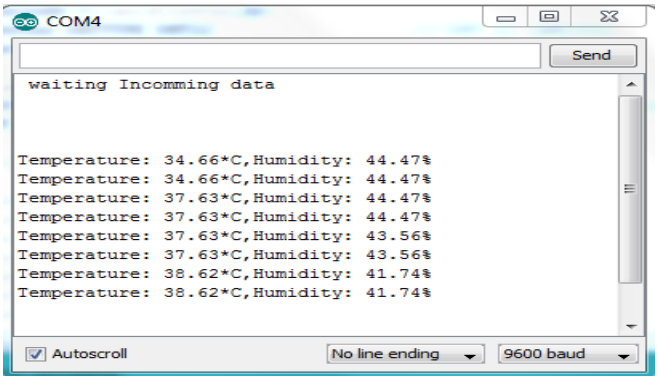


Fig. 11. (a) Serial Monitor Microcontroller

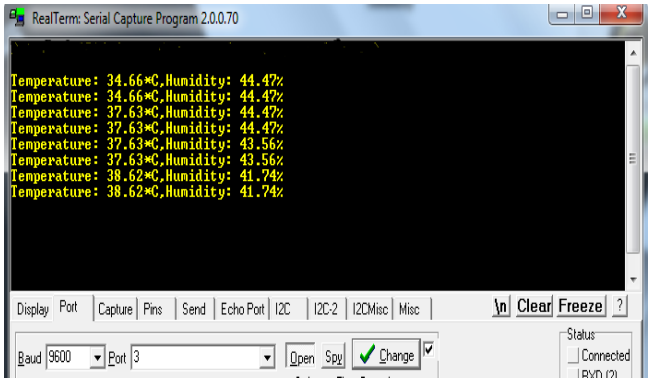


Fig. 11. (b) Realterm Monitoring Screen

TABLE 4. DATA CONDITION OF SERIAL PORT MICROCONTROLLER AND WIRELESS RECEIVED IN REALTERM TERMINAL

Time (every 2 Seconds)	Serial port microcontroller		Realterm teminal	
	Temp. (°C)	Hum.(%RH)	Temp. (°C)	Hum.(%RH)
1	34.66	44.47	34.66	44.47
2	34.66	44.47	34.66	44.47
3	37.63	44.47	37.63	44.47
4	37.63	44.47	37.63	44.47
5	37.63	43.56	37.63	43.56
6	37.63	43.56	37.63	43.56
7	38.62	41.74	38.62	41.74
8	38.62	41.74	38.62	41.74

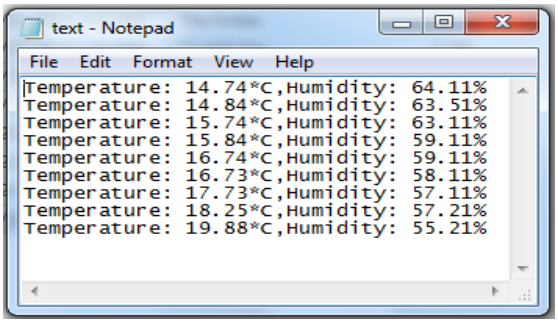


Fig. 12. (a) Database in Text File

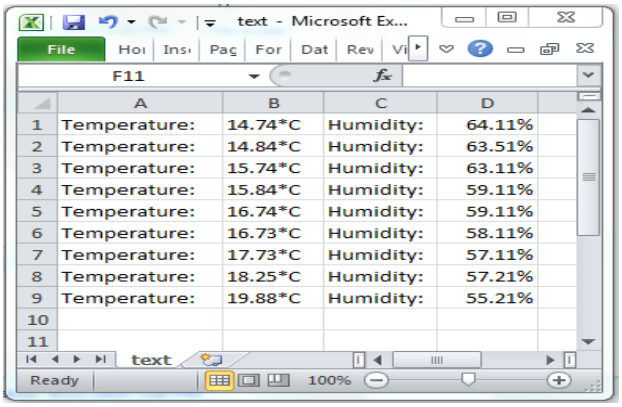


Fig. 12. (b) Database in Excel File

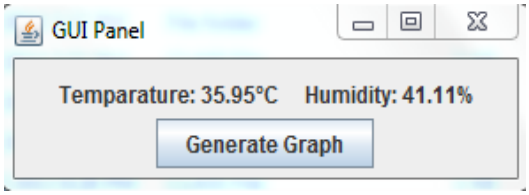


Fig. 13. Data Interface Panel Developed in Java Programming

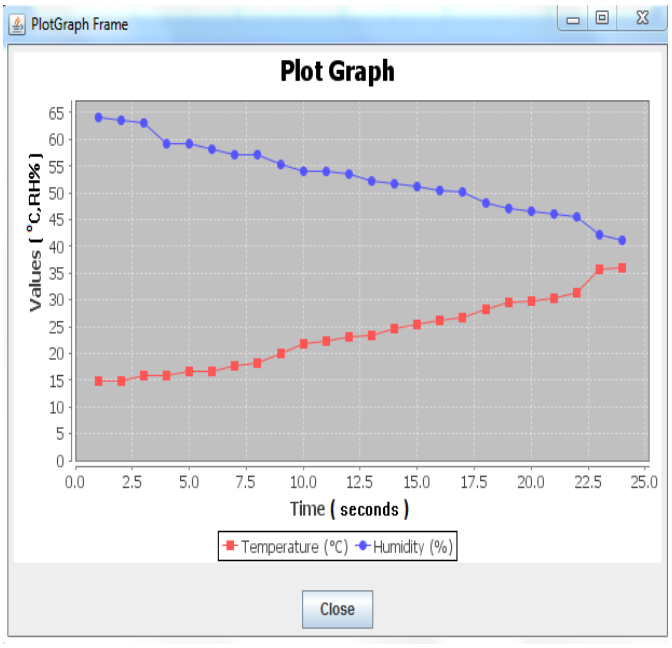


Fig. 14. Graph of superposition of value temperature and humidity against time (seconds)

Fig. 15. Alert of Temperature Out of Range

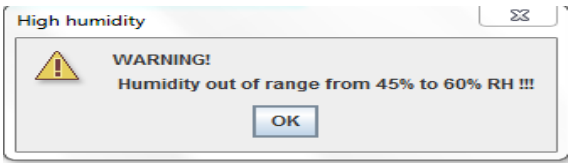
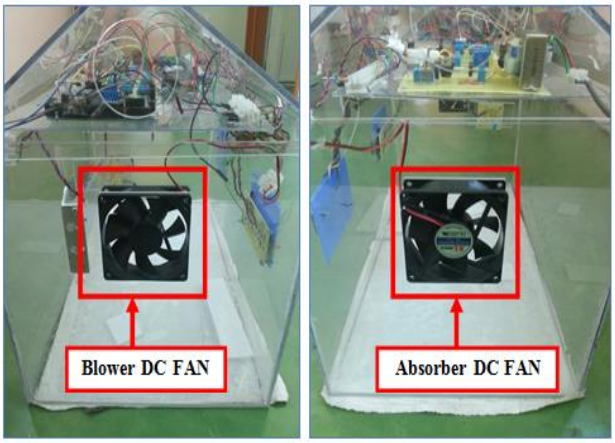


Fig. 16. Alert of Humidity Out of Range

C. Controller Part

Temperature and humidity in medication storage room can be control automatically by DC fans when the DHT11 sensor detecting temperature out of range in between 16 to 27 celsius. In this control situation, the humidity can also be controled since there is a relationship between temperature and humidity: inversely proportional. A pair of DC fans installation in the chamber as showed in Fig. 17.

An analysis had done to monitor how DC fans work in decreases temperataure in the chamber. Initially, the chamber temperature is heated up to 46 degree celsius by using hair dryer as showed in Fig. 18. In this analysis, a comparison on the usage of DC fan is made. The experiment lasts for 60 seconds. Values are taken at a regular interval of 10 seconds. The analysis result is shown in Table 5 and Table 6.



(a) (b)

Fig. 17. DC Fans Installation in the Chamber
(a) Blower, (b) Absorber

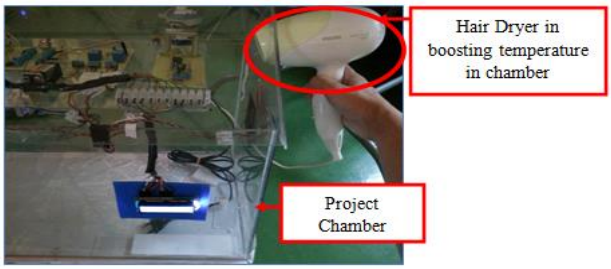


Fig. 18. Boost Up the Temperature in the Chamber by using Hair Dryer

TABLE 5: TEMPERATURE READING WITHOUT CONTROLLED BY DC FANS

Time (seconds)	Temperature (°C)	Humidity (%RH)
First 10 seconds	46.00	29.77
20 seconds	43.56	30.05
30 seconds	41.47	30.2
40 seconds	40.60	30.88
50 seconds	39.61	31.01
60 seconds	38.68	31.11

TABLE 6. TEMPERATURE READING WITH CONTROLLED BY DC FANS

Time (seconds)	Temperature (°C)	Humidity (%RH)
First 10 seconds	46.00	29.95
20 seconds	41.57	30.1
30 seconds	38.58	31.39
40 seconds	36.61	31.98
50 seconds	35.62	32.03
60 seconds	34.76	32.67

V. CONCLUSION

The project is developed for medical staffs to monitor temperature and humidity detection system in hospital or pharmacy's medication storage room. A pair of XBee transmit/receive modules is used for data transmission from medicine room to staff computer wirelessly. Besides, data of temperature and humidity can be store and logged in staff's computer using Realterm software. A warning system has been developed to alert medical staffs whenever the temperature or humidity levels are out of acceptable range (16 to 27 Celsius, 45 to 60%RH). This alarm system alerts staffs, so that staffs can make appropriate decisions to ensure the temperature and humidity of the medical storage room is in the suitable range in order to keep medicine in good condition.

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