Arduino Based Humidity and Temperature Sensor Logger for Environment Monitoring

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Abstract**—**This project is to develop a Humidity and Temperature Sensor Logger and Monitoring using Arduino. The device is used to measure and store data of temperature and relative humidity of a particular area. Monitoring is performed automatically using this system so that no manual operation is applied to the instruments during whole period of observation. The three pins on the sensor connect the two devices. The pins are inserted into the Arduino through the two-wire digital serial interface, and digital data is transmitted here. The Arduino will be programmed with the specific Arduino software. After the setup a coding is inputted to Arduino boot loader chip and the sensor is ready to be run and measure. It will read out the humidity and temperature values which then are stored into the SD card and displayed on the LCD. Based on the sensor, the accuracy of the temperature should be within ±2^{0}C, while the relative humidity is ±5%. Real time clock (RTC) is used to record time for every data taken and 10kΩ resistor as a pull up for the sensor. The red and yellow LED will indicate whether data taken is saved into SD card or not.

Keywords**— DHT 11 Sensor, SD Shield Data logger, Arduino Uno, Real Time Clock (RTC), Temperature, Relative Humidity**

I. Introduction

Data logger is an electronic device which based on a digital processor or computer. It records data over time or in relation to location either with a built in external instruments and sensors or via active sensor. Usually this device is portable, battery powered and small equipped with a microprocessor, sensors and internal memory for data storage. Some data loggers have a local interface device like keypad or LCD and can be used as a stand-alone device, whereas others interface with a personal computer and use software to activate the data logger. It then view and analyze the collected data. Data logger in general purpose types for a range of measurement applications is different with a very specific device for measuring in one environment or application type only. The general purpose types are common to be programmable. One of the main advantages of using data loggers is the ability to collect data on a 24-hour basis automatically. Data loggers are left unattended and typically deployed to measure and record information for the duration of the monitoring period after being activated. This will allow for an accurate, comprehensive picture of the environmental conditions being monitored, such as relative humidity and air temperature.

Humidity and temperature affects a lot of things in many ways, thus having too high or low humidity can have negative effects. The sensor is used to keep monitoring the humidity and temperature to the right level so that it doesn't affect human's health too much, plants not growing diseases, electronics and housing does not get damaged.

The main objective of this project is to develop a humidity and temperature sensor using Arduino which could be displayed on the LCD shield. To monitor any changes, the data is saved into SD card. Hence, this project will be dealing with the Arduino microcontroller. The Arduino is capable of sensing its environment by receiving an input from a humidity and temperature sensor and perform the output. The software used to write the source code for the programming development is Arduino v1.0.1. Meanwhile, the main components include Arduino Uno board, DHT 11 sensor type, 10kΩ resistor, real time clock (RTC), LCD shield and SD card shield.

II. METHODOLOGY

The hardware development consists of main components like microcontroller, 10kΩ resistor, RTC, SD shield, LCD display and sensor. Meanwhile the software development involves programming language, compiling the instructions and uploading it to the board. Figure 1 shows the flowchart operation between development of hardware and software.

The Arduino Uno board is used as a microcontroller to process the data from input and sent to the output devices. Arduino board is preferred because it is easier to integrate the humidity and temperature sensor on the board while the other shield can be attached on it by level. The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (which 6 can be used as PWM outputs), 6 analog inputs, a USB connection, a power jack, a 16MHz crystal oscillator, an ICSP header, and a rest button. It contains everything needed to support the microcontroller. To get started simply connect it to a computer with a USB cable or battery or power it with AC-to-DC adapter. Figure 1 shows the flow chart of the software operation inside the device.

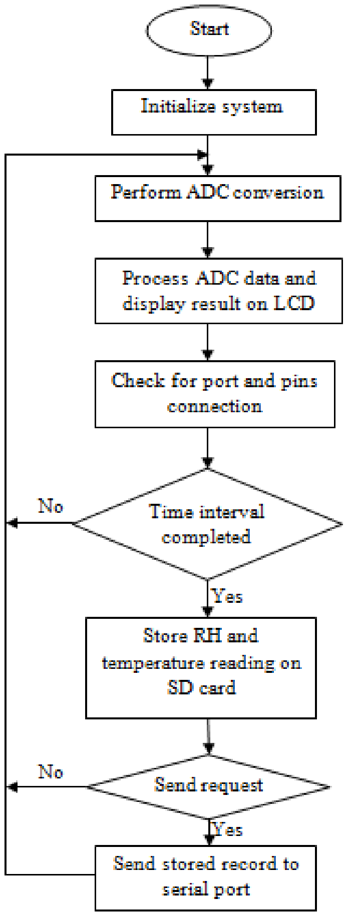


Figure 1. Flow chart of the monitoring device software

A. Pins Connection

Before the attachment of the shield on the Arduino board being done, it is necessary to understand the I/O pins usage to avoid overlap. Table 1 shows the pin usage for shields and sensor probe of DHT11 sensor, LCD shield, SD card shield, RTC and also LED. Figure 2 shows the circuit connection after being assembled.

Shields/ Sensor Description	Digital Pins														Analog Pins					
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	0	1	2	3	4	5
DHT 11															■					
LCD			■			■	■	■	■	■										
SD Card									■			■	■	■						
RTC																			■	■
LED													■	■						

Table 1. Pin usage of the Arduino shield

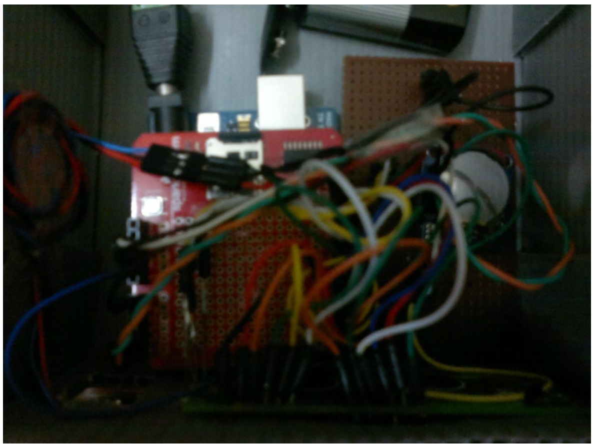


Figure 2. Connection of the circuit

B. Principle of operation

Figure 3 shows the flow chart and Figure 4 shows the block diagram of overall operation system. The 3 pins of probe sensor are connected to ground, 5V power supply and analog input as reader for the microcontroller. The LCD shield is used to display the string value of the temperature and percentage of relative humidity. For the data logger, SD card is used as storage to collect and save the data from the sensor reading. If red LED turns on, data is being saved into SD card. The data is saved in text document (.cvs) format and can be accessed for the process of analyzing data. Otherwise, the yellow LED will turn on. The relative humidity measured should be in a range of 20-90% while the temperature is 0-50°C.

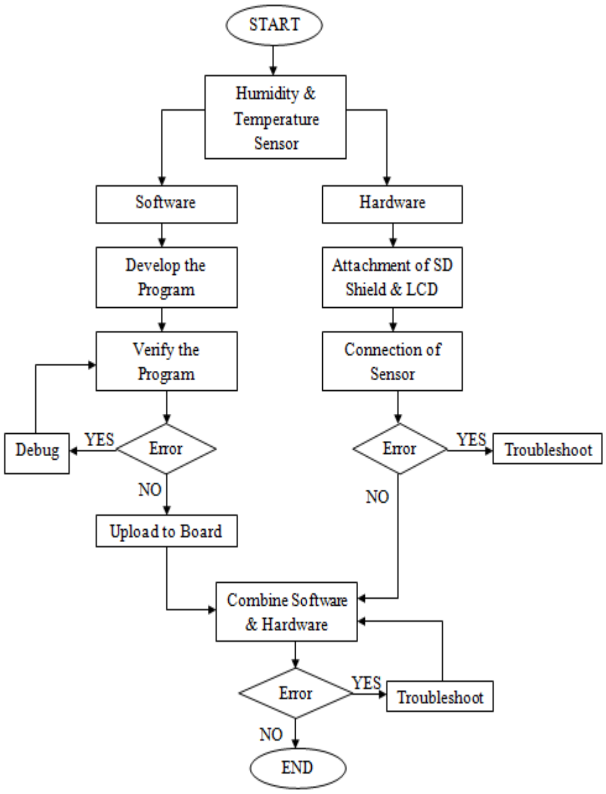


Figure 3. Flow chart operation of hardware and software

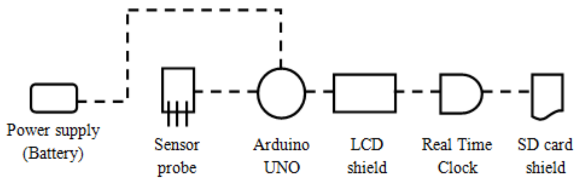


Figure 4. Block diagram of overall operation

Figure 5. Design case of the device

Figure 5 shows the picture of the sensor device after all of the processes are being completed.

C. *Data Collection*

Data are collected by observing the outdoor relative humidity and temperature at eleventh floor of Kristal Condominium for five days. The range of time is set equally which is twelve hours, starting from 7a.m. until 7p.m. The gap between each plot is 30 minutes.

III. Result and Discussion

Relative humidity is a measure of the water vapour content of the air at a specified temperature. The amount of moisture in the air is compared with the maximum amount that the air could contain at the same temperature and expressed as a percentage. The graphs below show the temperature (°C) and relative humidity (%) readings for the final week of November.

A. *Graph of Humidity and Temperature vs. Time*

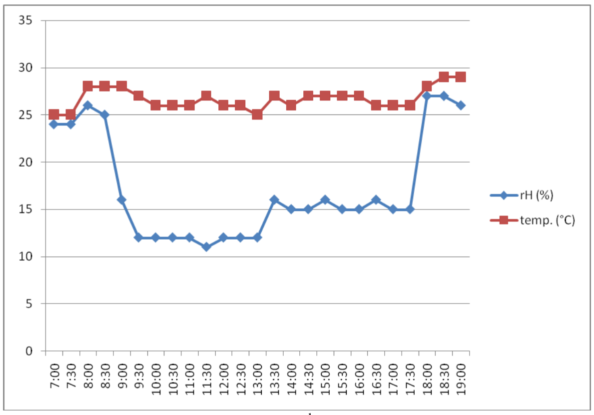


Figure 6. Day 1 (23rd November 2012)

Figure 6 shows the humidity and temperature taken on 23rd November. At the beginning, the temperature was a bit low. Then it started to increase slightly at 8a.m. However, the relative humidity dropped drastically from 9.30a.m. to 5.30p.m. This may be due to uncertain changes of temperature during the day, where there is some rain at 1.30p.m. The highest temperature is 29°C at 6.30p.m and 7.00p.m.. However, the lowest relative humidity is 11% at 11.30a.m.

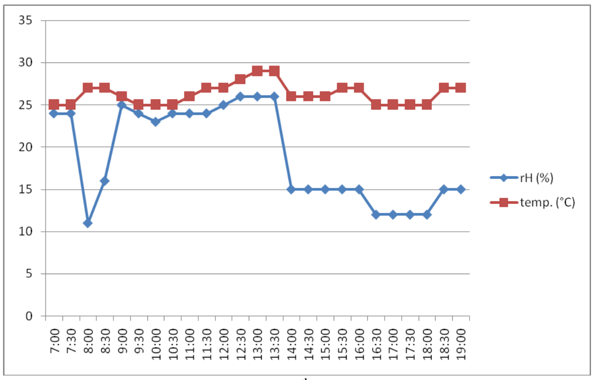


Figure 7. Day 2 (24th November 2012)

On second day which was 24th November, the morning started with a light rain carried resulting in low tempeature and high relative humidity. The temperature during the day was not much differ. However, the relative humidity was inconsistent. The result can be seen below in Figure 7. The highest temperature is 29°C at 1.00p.m. and 1.30p.m. However, the lowest relative humidity is 11% at 8a.m.

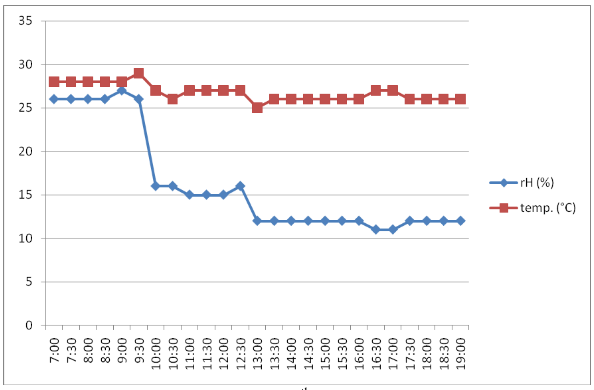


Figure 8. Day 3 (25th November 2012)

Figure 8 indicates graph for the third day observation. This following day plotted that the relative humidity and temperature are both decreasing. As in weather, the morning was bright and sunny but it turned cloudy in the evening. The highest temperature is 29°C at 9.30a.m. However, the lowest relative humidity is 11% at 4.30p.m and 5.00p.m.

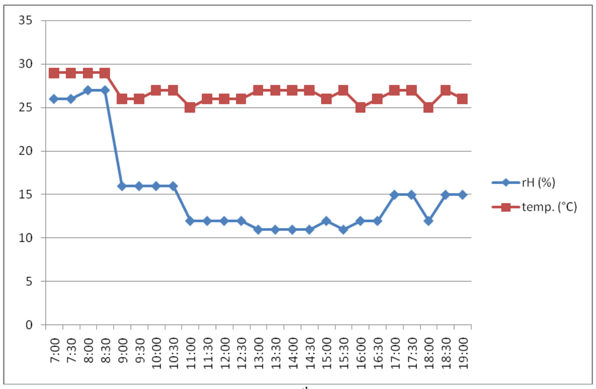


Figure 9. Day 4 (26th November 2012)

The observation is continued to the next day, 26th November. Just like before, it was sunny in the morning and cloudy in the evening. Figure 9 shows the related graph for that day. The highest temperature is 29°C from 7.00a.m. to 8.30a.m. However, the lowest relative humidity is 11% from 1.00p.m until 2.30p.m. and at 3.30p.m.

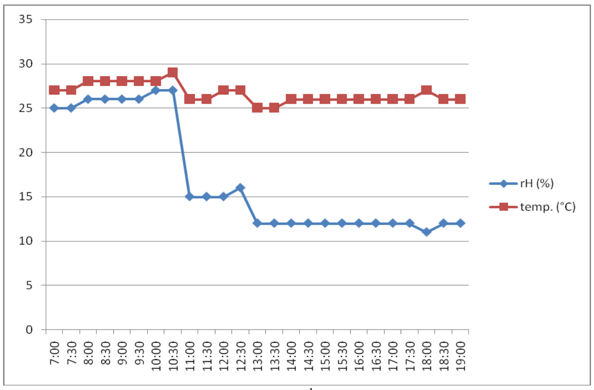
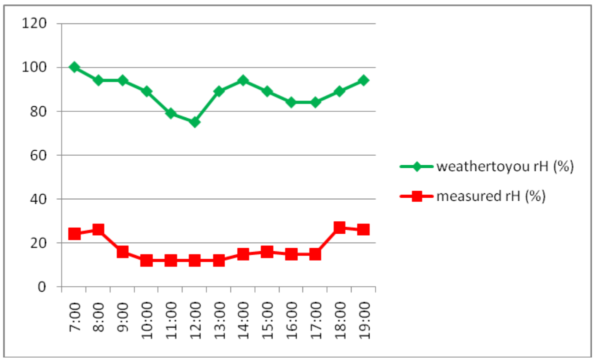


Figure 10. Day 5 (27th November 2012)

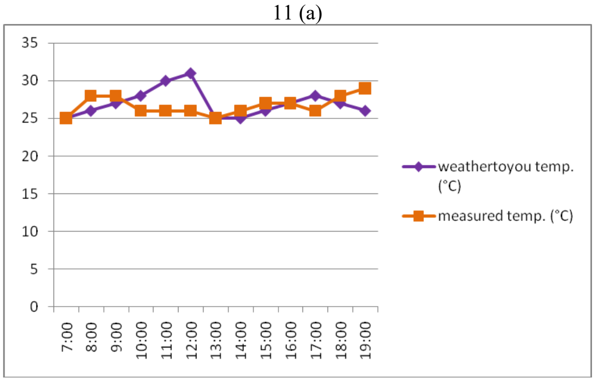
The graph in Figure 10 seems to be not really varied in the final day. It might be caused by the same weather for those whole three days. As a result, the relative humidity and temperature are in the same range. The highest temperature is 29°C at 10.30a.m. However, the lowest relative humidity is 11% at 6p.m.

B. Comparison of Relative Humidity and Temperature Reading

Readings are compared with data from weathertoyou.com, which records the climate changes in Selangor to analyze the accuracy of data collected. Graphs from 7a.m to 7p.m. with a gap of one hour are plotted as shown below. In the scope of relative humidity, there were huge differences for those five days. The temperatures also vary, but majority are still in the range of 20-30°C.



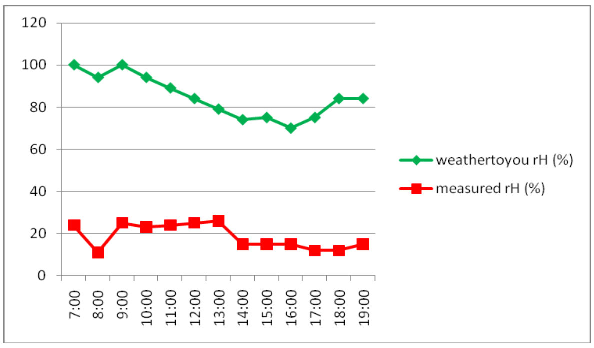
11 (a)



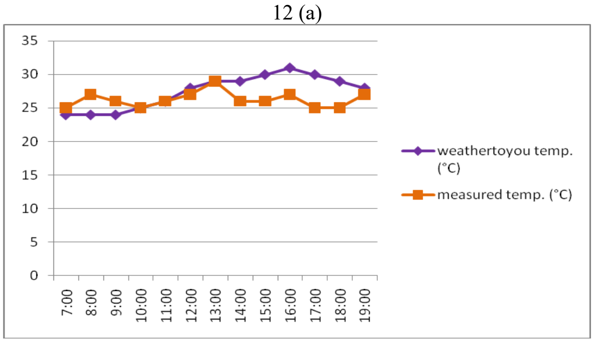
11 (b)

Figure 11. Comparison of relative humidity (a) and temprature (b) on day 1

In Figure 11(a), the lowest relative humidity is 75% at 12p.m. and comparing to the data measured, it is also the lowest value. Meanwhile in Figure 11(b) the temperature recorded is 31°C, which is the highest reading during the same time. Measured temperature shows a 5°C lower temperature than that value. When the relative humidity is at its highest value (100%) the temperature is at its lowest (25°C).



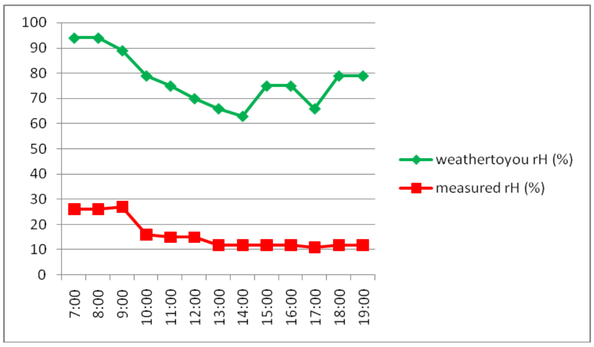
12 (a)



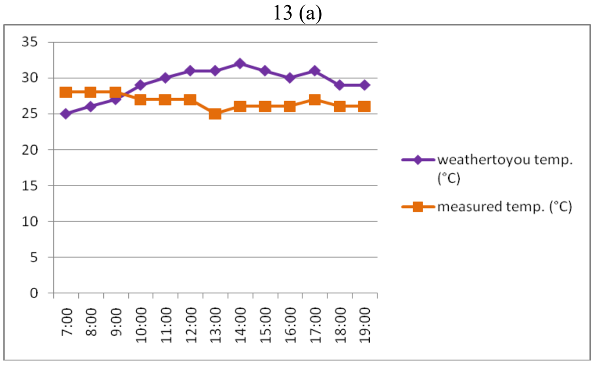
12(b)

Figure 12. Comparison of relative humidity (a) and temprature (b) on day 2

In Figure 12(a), the lowest relative humidity is 70% at 4p.m. but comparing to the data measured, it is not the lowest value. Meanwhile in Figure 12(b) the temperature recorded is 31°C, which is the highest reading during the same time. Measured temperature is also high which recorded 27°C. When the relative humidity is at its highest value (100%) the temperature is at its lowest (24°C).



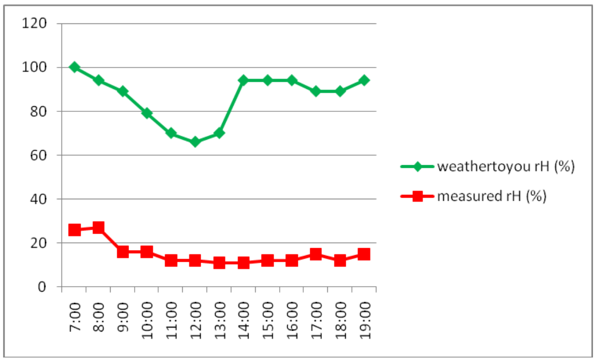
13 (a)



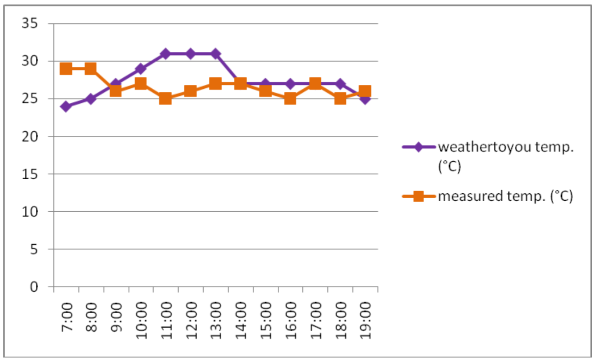
13 (b)

Figure 13. Comparison of relative humidity (a) and temprature (b) on day 3

Figure 11(a) shows the lowest relative humidity is 63% at 2p.m. but comparing to the data measured, it is not the lowest value. Meanwhile in Figure 11(b) the temperature recorded is 32°C, which is the highest reading during the same time. Measured temperature shows a 6°C lower temperature than that value. When the relative humidity is at its highest value (94%) the temperature are at their lowest (25°C and 26°C).



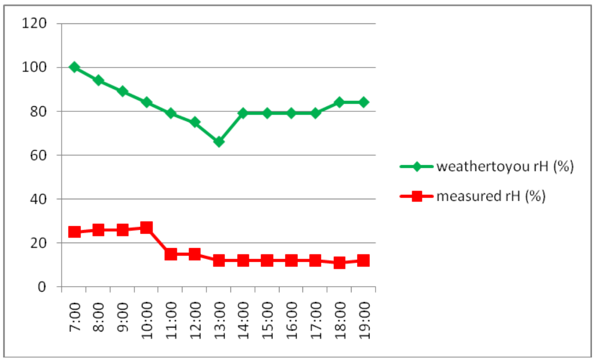
14 (a)



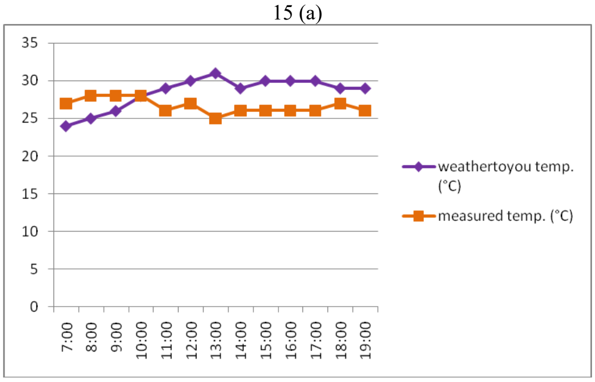
14 (b)

Figure 12. Comparison of relative humidity (a) and temprature (b) on day 4

Figure 14(a) shows the lowest relative humidity is 66% at 12p.m. but comparing to the data measured, it is not the lowest value. Meanwhile in Figure 14(b) the temperature recorded is 31°C, which is the highest reading during the same time. Measured temperature is 26°C. When the relative humidity is at its highest value (100%) the temperature is at its lowest (24°C).



15 (a)



15 (b)

Figure 15. Comparison of relative humidity (a) and temprature (b) on day 5

In Figure 15(a), the lowest relative humidity is 66% at 1p.m. but comparing to the data measured, it is not the lowest value. Meanwhile in Figure 15(b) the temperature recorded is 31°C, which is the highest reading during the same time. Measured temperature is only 25°C. When the relative humidity is at its highest value (100%) the temperature is at its lowest (24°C).

IV. CONCLUSIONS

The observations conclude that warm air can hold more moisture than cold air. Hence if the temperature of the air increases, its capacity to hold the moisture increases provided additional moisture is supplied to the air. Relative humidity decreases with a rise in temperature. This is because the relative humidity depends not only upon the amount of water vapour actually present but also on the air temperature. Thus, if no moisture is added, an increase in temperature will result in a corresponding decrease in the relative humidity.

This comparison indicates that the sensor might have to be calibrated before a reading is taken so it can generate more reliable data. Another way is to improve the software by adding or altering appropriate formula into the coding to measure these two elements correctly.

V. RECOMMENDATIONS

From the hardware concept, this device can be improved by adding more special features like push button to start the reading and display on the LCD. Meanwhile in developing the software, sleep mode instruction can be set to save the battery.

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