Portable Humidity and Temperature Sensor Monitoring System with Logger

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Abstract— **This project presents the design of the portable humidity and temperature sensor monitoring system with logger. The objective of this project is to design a system that can collect data from humidity and temperature sensor and stored in the microSd card by using microSd shield. The humidity and temperature can be measured by using the Sht11 sensor and the data will send through the Arduino microcontroller (Arduino Mega 2560). The data read in programming time by using the real time clock module (DS1307) and record the data with actual date and time. The data collected from the sensor (Sht11) will be converted into digital data and the Arduino microcontroller will send the data to microSd shield and stored in the microSd card. The user will be able to download the saved data when needed. The data can be viewed by using software like Microsoft Excel, web browser and others. The sensor will display the data in a friendly manner on a computer display system. Intelligent device called Arduino microcontroller is used in this project in order to perform some processing on the data collected from the sensors. This device can be used in other application and it is smaller and cheaper than a computer. The portable monitoring system with logger operated using battery to monitor humidity and temperature. The portable humidity and temperature monitoring system with logger also have a system to save battery energy usage and also have the system to detect microSd card placed in the microSd shield. The light emitting diode (led) will alert user with blink when the microSd not place in the microSd shield. Relative humidity, temperature measurement and monitoring are very useful for the purpose of analysis.**

Keywords- humidity and temperature sensor, *Data Logger, Arduino microcontroller*

I. INTRODUCTION

As science and technology have developed, so the need for data collection and analysis has grown. This is fulfilled, at least in part, by dedicated, microprocessor driven data loggers. The modern data logger is typically a handheld, battery operated device with a large memory, powered by the latest microprocessor technology and capable of acquiring, processing, storing and analyzing electrical signals at high speed from a wide range of sensors at regular intervals or in response to an event such as a threshold being crossed or a switch being activated.

The data logger is an invaluable tool to collect and analyze experimental data, having the ability to clearly present real time analysis with sensors and probes able to respond to parameters that are beyond the normal range available from the most traditional equipment [1].

A data logger is an electronic device that records information over a period of time for later reference. The data logger contains a sensor to receive the information and a computer chip to store it [2].

Then the information stored in the data logger can be transferred to a computer for further analysis. This part is just like a central-processing unit in the computer. The data logger has to be stand-alone so that remote sensing of relative humidity and temperature is possible. A micro controller is used for this purpose [3].

This project is therefore carried out to design a portable humidity and temperature monitoring system with logger by using Arduino microcontroller. The advantage of using a dedicated portable data logger compared to a computer is that the logger hardware and software are specifically designed for portable data logging applications. This means that it is easy to connect and set up sensors and the logging system is more rugged and less power hungry, making it capable of running on batteries for longer periods of time, often in hostile environments. These data are valuable for quality verification.

II. METHODOLOGY

A. Overview

The design of the project can be divided into hardware and software. Hardware is referring from the circuit simulation until the troubleshooting while the software is referring to the programming constructed to instruct the microcontroller to control the output of the circuit. The hardware comprises the control unit (Arduino Mega 2560), sensor (Sht11), MicroSD shield to save data to microSd card, real time clock module (DS1307) to set a time and date with actual time and output on the LCD display to display the result from the sensor. The software applied in this project is Arduino 0023 software. At first, the sensor (Sht11) will be tested with the Arduino microcontroller (Arduino Mega 2560) and LCD display to display the humidity and temperature result. The next step will combine arduino microcontroller (Arduino Mega 2560) and microSd shield with the sensor (Sht11) and troubleshoot to save data collected into microSd card. The Arduino

microcontroller will process and collect data from sensors (Sht11) to save on MicroSD card. The data read in programming time by using the real time clock module (DS1307) and record the data with actual date and time. The user will be able to download the saved data when needed. Then all parts and component will be combined to make the system function and operated using battery to monitor humidity and temperature.

B. Design and Development

The project's hardware is divided into three parts which are the input including the on/off button, reset button, Sensor (Sht11), Arduino microcontroller (Arduino Mega 2560) and output included LED, LCD display, Micro SD card.

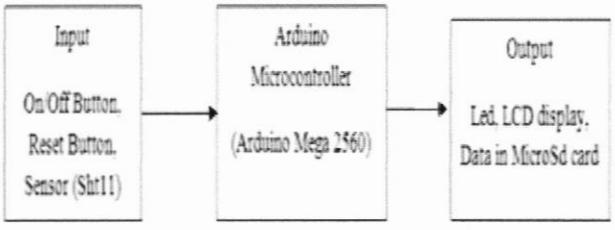

Figure 1. Block Diagram of Portable Humidity and Temperature Monitoring System with Logger

Fig. 1 above shows the flow of this project design. First, sensor (Sht11) will detect the humidity and temperature. The data measured and collected will be sent to send to Arduino microcontroller. The humidity is measured in percentage and temperature is measured in Celsius. The data from the sensor will be converted into digital and sent to the Arduino microcontroller (Arduino mega 2560). In Arduino microcontroller, this data will be displayed in the LCD display and sent to microSd shield to be logged and saved into microSd card.

There are several hardware needed to build this portable humidity and temperature sensor monitoring system with Logger. The system consists of many hardware that can be build-in and combined with the sensor. The most important hardware are Arduino Mega 2560 and Sht11 Temperature and Humidity Sensors.

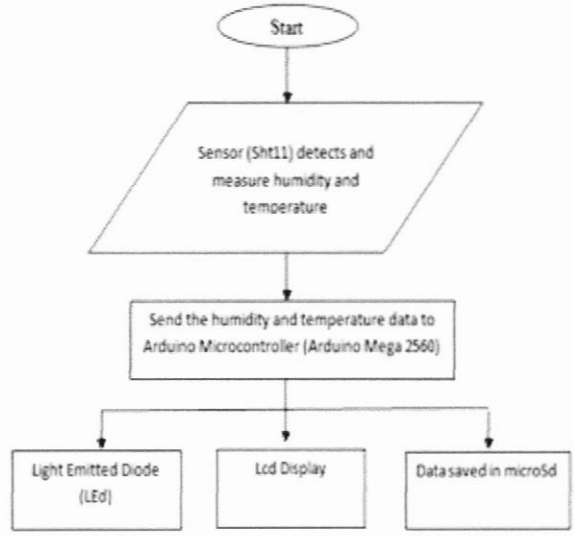

Figure 2. Flow chart of Portable Humidity and Temperature Monitoring System with Logger

Fig. 2 shows the flow chart of hardware design and the components involved in the hardware parts. The light emitting diode (LED) and liquid crystal display (LCD) are common components. The light emitting diode (LED) functions as an indicator to show whether the system is on or off. The liquid crystal display (LCD) will always display the humidity and temperature reading from sensor (Sht11). The liquid crystal display (LCD) shows the reading of humidity and temperature data without LCD display lamp to save battery energy usage. The liquid crystal display (LCD) lamp will be turn on when the user pushes the button on the liquid crystal display (LCD). The data will start logging when the switch is turned on and the next 30 minutes of data will be recorded again in the microSd card.

C. Hardware

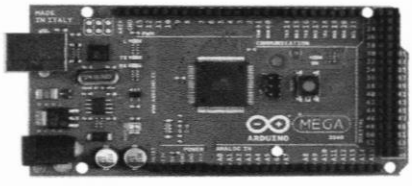

Figure 3. Arduino Mega 2560

The Arduino board is a microcontroller that will be utilized to compile the programming. Arduino has many megaAVR series of chips. For this project the Arduino Mega 2560 is used. The table below shows the specifications detail of Arduino Mega 2560.

TABLE 1. Specification of Arduino Mega 2560

Specification	Arduino Mega 2560
Voltage	5V
Frequency	16MHz
Digital I/O pins	54
Analog input pins	16
PWM	14
Flash Kb	256k

The Arduino microcontroller has no big difference with other microcontrollers. Microcontrollers only can receive a voltage of up to 5V. The differences lie on the way they are assembled and the amount of analog and digital input output pins.

Figure 4. Humidity And Temperature Sensor(SHT11)

Fig. 4 shows the humidity and temperature sensor (Sht11) used in the portable monitoring system data logger. The sensor (Sht11) has good reliability, stability and security.

Sensor (Sht11) is individually calibrated in a precision humidity chamber. The calibration coefficients are programmed into an OTP memory on the chip. These coefficients are used to internally calibrate the signals from the sensors. The 2-wire serial interface and internal voltage regulation allows for easy and fast system integration. The tiny size and low power consumption makes the sensor useful in this portable monitoring system data logger. [4]

Specification

Interface Type: Serial (I2C non standard)

Humidity Ranger:0-100%RH

Temperature range: -40-128.8℃

Humidity accuracy:±4.5%RH

Temperature accuracy:±0.5℃（25℃）

Size: 32x17mm

Weight:5 gram

D. Software Implementation

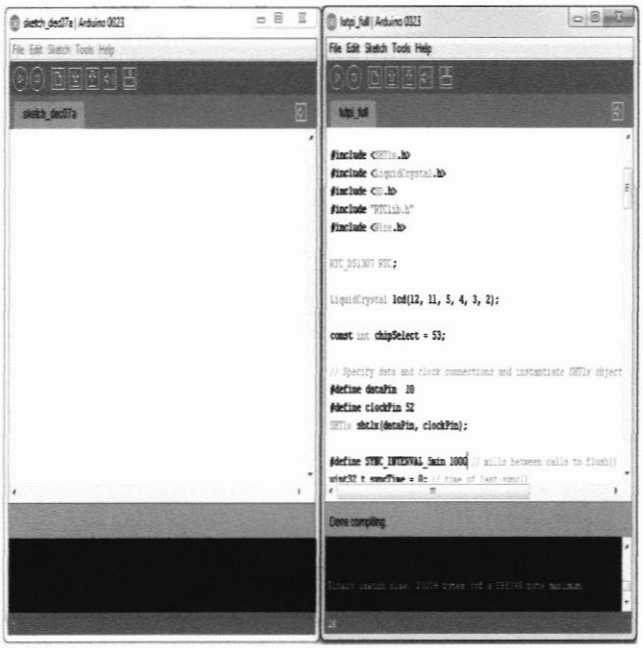

Figure 5. Arduino software 0023

Fig. 5 above shows the programming used in this portable humidity and temperature monitoring sensor with logger applying Arduino 0023 Microprocessor as a compiler to compile the programming. These input and output pins must have the right connection between the Arduino board and project main board.

Arduino 0023 is a software that compiles the program. As other microcontroller, this Arduino has to declare first the input and output pins used. Next, it is divided into two parts comprising of void setup and void loop. In void setup, the pinMode is declared as either output, input or on the other void loop which is the main body of the program.

E. Flow chart of the programming

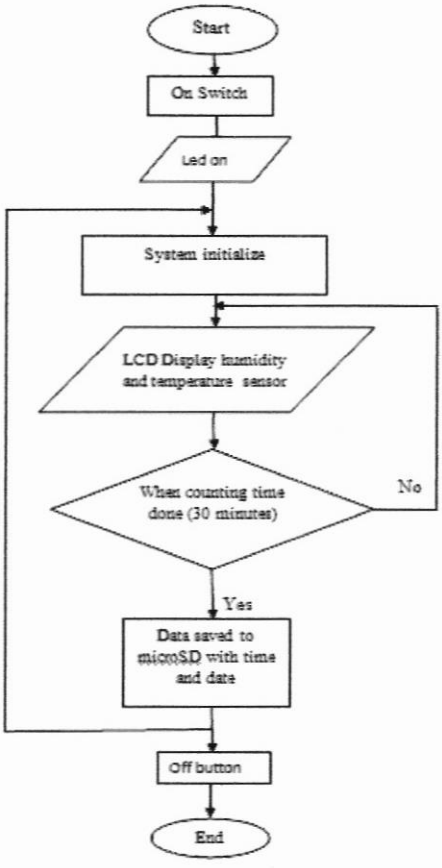

Figure 6. The Main Programming of Flow Chart

Fig. 6 shows the flow chart of portable humidity and temperature monitoring system with a logger. The system starts when the switch is ON and causes the LED to be ON. The Arduino microcontrollers initialize the sensor and running the program. The sensor reads and the reading is displayed by LCD display with two reading humidity and temperature. The data of humidity and temperature are stored and saved in microSd card. The system will wait until 30 minutes to repeat the process of stored and saved data. The system will stop when the switch is off.

III. RESULT ANALYSIS AND DISCUSSION

A. Field Test Measurement

The results are collected by performing a field test for humidity and temperature monitoring starting from 8.00 am to 5.30pm. The portable monitoring system with logger are collected the humidity and temperature readings every 30 minutes and the result will be compared with the actual humidity and temperature result in two different places. Actual humidity and temperature are recorded in two different locations in two days. Day 1 and day 2 are recorded at Bandar Botanic, Klang location and day 3 and day 4 are recorded at Seksyen 7, Shah Alam location. Actual reading data for humidity and temperature are recorded from the web site on internet at http://www.wunderground.com [5].

From the result, we could say that the portable logger is working in satisfaction in term of its functionality. The reading data from portable monitoring system and the reading data from web site will be compared for analysis. The accuracy is calculated using the following formula,

$$\text{Accuracy} = \frac{\text{(Actual value - (Actual value - Measurement))}}{\text{Actual value}} \times 100\% \quad (1)$$

The following example shows how the accuracy is calculated

$$\text{Accuracy} = \frac{(31 - (31 - 30.52))}{31} \times 100\% = 98.45\%$$

Accuracy = 98.45%

B. Result Temperature and Humidity

TABLE 2. Temperature data day 1, day2, day 3, and Day 4

		Day 1			Day 2			Day 3			Day 4		
Time	Reading (Celsius)	Actual (Celsius)	Accuracy (%)	Reading (Celsius)	Actual (Celsius)	Accuracy (%)	Reading (Celsius)	Actual (Celsius)	Accuracy (%)	Reading (Celsius)	Actual (Celsius)	Accuracy (%)
8.00 am	29.53	29	98.17	29.85	29	97.06	28.64	28	97.71	27.12	26	95.69
8.30 am	29.57	29	98.03	29.89	29	96.93	28.24	28	99.14	27.99	26	92.34
9.00 am	29.56	29	98.06	29.72	29	97.51	28.29	28	98.96	28.48	28	98.28
9.30 am	29.53	29	98.17	29.27	29	99.06	29.15	29	99.48	31.64	28	87.00
10.00 am	29.54	31	95.29	29.14	29	99.51	30.15	29	96.03	29.6	28	94.28
10.30 am	30.52	31	98.45	29.25	29	99.17	29.36	29	98.75	29.25	29	99.13
11.00 am	30.39	31	98.03	31.55	31	98.22	29.25	29	99.13	29.5	29	98.27
11.30 am	31.43	31	96.61	31.46	31	98.51	29.6	29	97.95	29.95	30	99.83
12.00 pm	31.53	31	98.29	31.49	31	98.41	29.82	29	97.17	30.01	30	99.96
12.30 pm	31.39	31	98.93	31.45	31	98.54	30.15	30	99.50	30.25	30	99.16
1.00 pm	31.43	32	98.21	31.54	31	98.25	30.54	30	98.86	30.58	30	98.06
1.30 pm	31.15	32	97.34	31.28	31	98.12	30.54	30	98.86	30.68	31	98.96
2.00 pm	31.26	32	97.68	32.56	32	98.25	31.22	31	98.32	30.61	30	97.96
2.30 pm	31.27	33	94.75	32.67	32	97.96	30.94	31	99.80	30.37	32	94.90
3.00 pm	32.21	33	97.60	32.28	32	98.18	31.67	31	97.83	29.68	26	85.84
3.30 pm	32.35	33	97.96	32.09	32	98.15	31.17	31	99.65	29.69	27	90.83
4.00 pm	32.43	33	98.27	32.74	32	97.68	31.18	31	99.41	29.23	27	91.74
4.30 pm	32.25	33	97.66	32.69	32	97.21	31.33	31	98.93	27.68	26	93.53
5.00 pm	33.31	33	99.06	33.76	33	97.69	31.41	31	98.67	28.22	26	91.46
5.30 pm	33.15	33	99.54	33.81	33	97.54	31.48	31	98.46	27.73	26	93.34

TABLE 3. Humidity data day 1, day2, day 3, and Day 4

		Day 1			Day 2			Day 3			Day 4	
Time	Reading (%)	Actual (%)	Accuracy (%)	Reading (%)	Actual (%)	Accuracy (%)	Reading (%)	Actual (%)	Accuracy (%)	Reading (%)	Actual (%)	Accuracy (%)
8.00 am	83.57	84	99.48	84.48	84	99.42	80.81	82	98.54	82.91	85	97.54
8.30 am	83.43	84	99.32	84.56	84	99.33	80.9	82	98.65	79.29	82	96.69
9.00 am	83.48	84	99.28	84.72	84	99.14	81.25	82	99.06	77.25	82	94.20
9.30 am	77.27	77	99.28	84.64	84	99.23	78.12	78	99.84	66.9	70	95.57
10.00 am	63.43	67	94.67	82.59	82	99.28	75.16	76	98.89	73	73	100
10.30 am	63.56	67	94.86	80.57	82	98.25	76.9	76	98.81	74.9	79	94.81
11.00 am	63.59	67	94.91	64.43	64	99.32	76.79	76	98.94	73.01	74	98.66
11.30 am	63.57	67	94.88	64.76	64	98.51	76.03	76	99.96	71.62	74	96.78
12.00 pm	63.93	67	95.41	64.78	64	98.78	74.53	74	99.28	72.56	72	99.22
12.30 pm	64.75	67	96.61	63.57	64	99.32	72.77	72	98.93	69.98	70	99.97
1.00 pm	65.53	67	97.80	62.46	60	95.90	71.69	72	99.56	69.25	60	84.58
1.30 pm	67.44	67	99.34	62.39	60	96.01	70.85	72	97.26	68.27	70	97.52
2.00 pm	69.41	69	99.68	61.45	60	97.61	64.22	66	97.30	71.95	70	98.07
2.30 pm	68.95	69	94.71	62.72	60	95.46	66.84	66	98.72	73.71	70	94.70
3.00 pm	67.44	69	97.73	63.29	60	94.51	64.51	66	97.43	77.14	75	97.14
3.30 pm	69.41	70	99.15	64.23	66	97.31	65.16	66	98.72	76.73	75	97.69
4.00 pm	73.35	70	95.21	65.57	67	97.86	70.06	70	99.91	77.93	76	97.46
4.30 pm	73.38	70	95.17	66.76	67	99.64	70.51	70	99.27	77.41	76	98.14
5.00 pm	70.43	70	99.38	67.32	67	99.52	69.98	70	99.97	76.88	76	98.84
5.30 pm	70.41	70	99.41	67.87	67	98.70	71.3	70	98.14	77.6	76	97.89

Table. 2 and Table. 3 shows the result of the humidity and temperature readings taken from the sensor (Sht11) and actual reading from the web site. The sensor (Sht11) can read the humidity and temperature value up to two decimal places. The data can be downloaded and view from the computer by using Microsoft Excel software. From the result, the accuracy of the data will be calculated.

TABLE 4. Average accuracy value

Temperature (%)				Humidity (%)			
Day 1	Day2	Day 3	Day 4	Day 1	Day 2	Day 3	Day 4
97.90	98.04	98.61	94.98	97.29	98.17	98.86	96.77

The average accuracy humidity and temperature reading shows in the Table. 4.

C. Graph of Temperature and Humidity

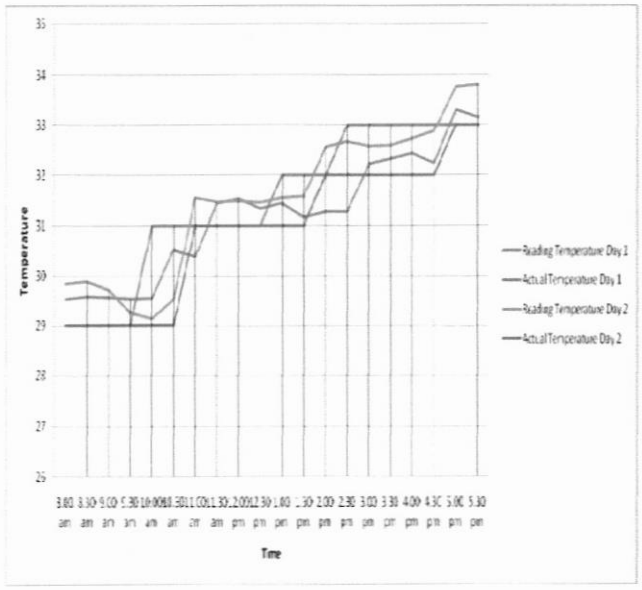

Figure 7. Graph of Reading and Actual Temperature Day 1and Day 2

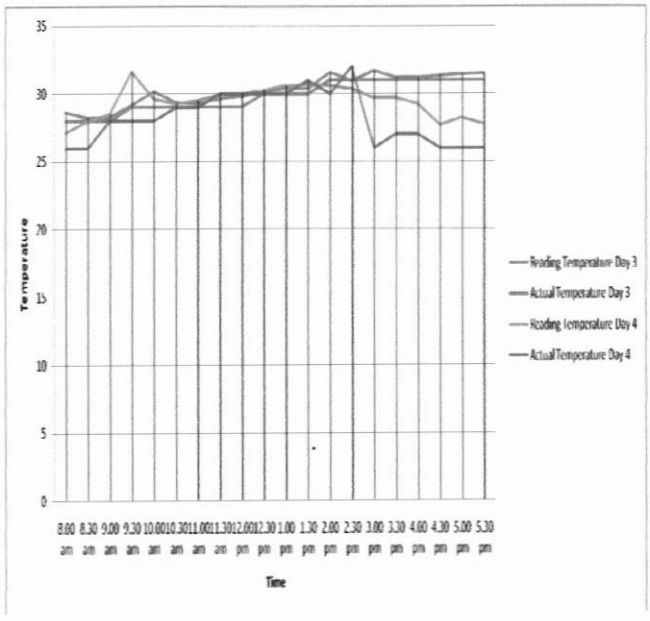

Figure 8. Graph of Reading and Actual Temperature Day 3 and Day 4

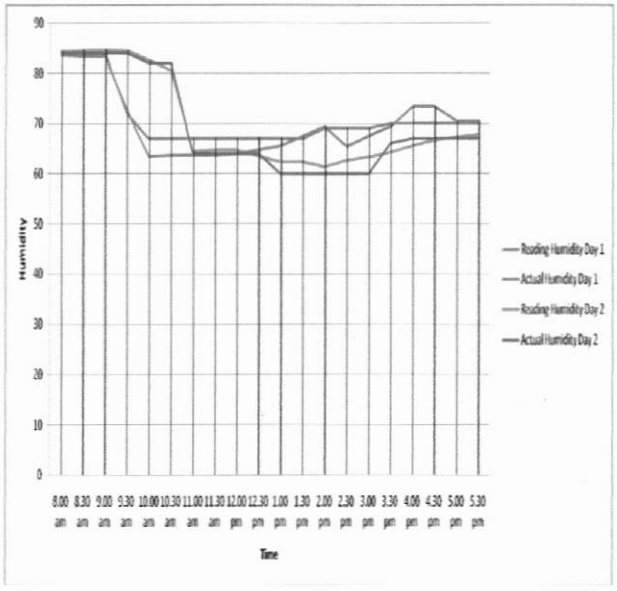

Figure 9. Graph of Reading and Actual Humidity Day 1 and Day2

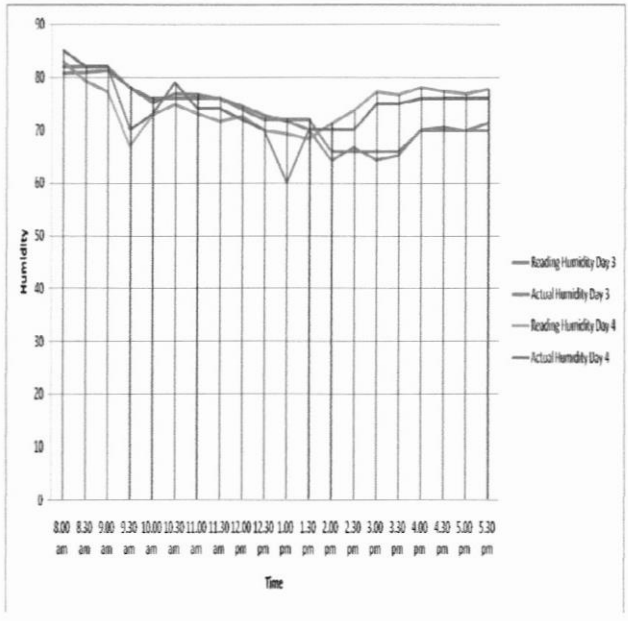

Figure 10. Graph of Reading and Actual Humidity Day 3 and Day 4

Fig. 7 and Fig. 8 shows the graph of readings temperature and actual temperature for day 1, day 2, day3 and day 4. From the graph it shows that when the actual reading of temperature increased, the reading of temperature from the sensor is also increased.

Fig. 9 and Fig. 10 shows the graph of reading humidity and actual humidity for day 1, day 2, day3 and day4. The graph shows that when the actual reading of humidity increased, the reading of humidity from the sensor is also increased.

IV. CONCLUSION

This project presents a Portable Humidity and Temperature Monitoring System with Logger with capability to record data automatically. The use of the Arduino microcontroller (Arduno mega 2560) and the use of sensors (Sht11) Temperature and Humidity Sensor for the temperature and humidity sensor make it easier to record the data.

Furthermore, the programming of Arduino 0023 is much easier to understand and learn compared to other programming tools. This project meets the objective of creating a portable humidity and temperature sensor with logger. The portable humidity and temperature sensor with logger can be used to detect temperature and humidity anywhere. It is easy to maintain due to its simple design, affordable hardware and portability. The hardware and software prototype of this system had been developed and functioning.

There are several recommendations that can be applied to upgrade this Portable Humidity and Temperature Monitoring System with Logger. One of them is use solar panel. By adding solar panel on Portable Humidity and Temperature Monitoring with Logger, it can save the battery energy usage. Another recommendation that can be applied for this project is to use more sensitive and durable sensors to get more accurate result.

For future development, the devices can be improved by adding more special features like internet shield to link the data saved direct to website. This Portable Humidity and Temperature Monitoring with Logger can be made small in size and with ultra-low power consumption. Such small size system allows it to be placed in almost any location. It can collect data continuously over a period of time without having to change its battery.

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REFERENCES

[1] Inniss, T. R., "Seasonal clustering technique for time series data". European Journal of Operational Research, 175, 376–384. 2006.

[2] Peter Eredics "Short-Term External Air Temperature Prediction for an Intelligent Greenhouse by Mining Climatic Time Series"WISP 2009 • 6th IEEE International Symposium on Intelligent Signal Processing • 26–28 August, 2009 Budapest, HungaryNY, USA, 2003. ACM.

[3] Fix E, Hodges JL, Jr (1951) "Discriminatory analysis, nonparametric discrimination". USAF School of Aviation Medicine, Randolph Field, Tex., Project 21-49-004, Rept. 4, Contract AF41 (128)-31, February 1951.

[4] Feng xian ying,,ge rong yu,The Temperature/Humidity Measurement and Control System Based on Digital Temperature/Humidity Sensor SHT11[J]PROCESS AUTOMATION INSTRUMENTATION,2006.

[5] http://www.wunderground.com