DESIGNING OF AN INTELLIGENT TEMPERATURE-CUM-HUMIDITY MONITORING DEVICE

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SUBMITTED BY

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Dated: 1st DECEMBER, 2014

CERTIFICATE

This is to certify that the thesis entitled "**DESIGNING OF AN INTELLIGENT TEMPERATURE-CUM-HUMIDITY MONITORING DEVICE**" submitted by **Mr. Ripunjay Chachan** in partial fulfillment for the requirements for the award of Bachelor of Technology Degree in Biotechnology at National Institute of Technology, Rourkela is an authentic work carried out by him under the supervision of the undersigned.

To the best of my knowledge, the matter embodied in the thesis has not been submitted to any other University / Institute for the award of any Degree or Diploma.

(Dr. KUNAL PAL)

Assistant Professor

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Date: Ripunjay chachan

CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

The present study that is described in designing of a temperature-cum-humidity monitoring system. This designed system can be used for alarming the user via short message sending (SMS) in the wake of a criticality of an event; which is predefined by the user. The system can also be used to log data in a remote computer. There is an urgent need for this type of devices for different industries that include agricultural biomedical and pharmaceutical industries. In these industries mentioned above there is a need for controlled environmental conditions which mainly include temperature and humidity. Any deviation or change in the environmental controlled conditions can lead to financial loses in agricultural and pharmaceutical industries and can be life threating to the users of biomedical industries. By the alerting the user in immediately this loses can be prevented. The controlled environment can help in preventing any kind of loss by immediate alarming.

CHAPTER 1
INTRODUCTION

1. INTRODUCTION

The major industries in India include biomedical, agricultural and pharmaceutical which forms backbone of countries economy. The continuous monitoring of temperature and humidity is a major criteria in all the above mentioned industries[1]. The controlled environment forms a foremost criteria in all of the above industries. Any kind of deviation in the environmental conditions or the preset parameters can cost heavy financial losses due to alterations in productivity in the pharmaceutical and agricultural industries. A precise monitoring of humidity and temperature is required in biomedical industry sue to the screening of drugs and use of various cell culture methods. While providing life support in healthcare sectors the environment controlled conditions is required. The variations in environment i.e. temperature and humidity of patients could be life threatening. Taking the above factors in consideration the current paper was designed to develop intelligent temperature-cum-humidity monitoring[2]. The technological advancements in various field including instrumentation is kept in mind and care was taken to utilize it. This improves the functionality of the device proposed. Wireless system using ZigBee was implemented so as to reduce the complexity of the device during handling. The ZigBee module which consists of a transmitter and receiver was utilized to record data to the monitoring station from the sensor[3]. Additionally a GSM module was used to alarm the user in the wake of a critical event.

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CHAPTER 2
LITERATURE REVIEW

2. LITERATURE REVIEW

A large amount of research works are being carried out in various institutions across the world to provide a better managed, efficient and cost effective way for simultaneous measurement of temperature and humidity. Temperature and Relative humidity both are very important parameters of the environment in many industrial such as food, medicine, papermaking, textile, meteorological, semiconductor, services etc. In recent years, optical fiber sensors have attracted more and more attentions in sensing and measurement areas due to their many advantage over their conventional electronic counterparts. Similar works in this particular area make use of the Short Message Service (SMS) facility so as to alert the user as seen in the paper[4].The temperature-humidity sensor could be also used in tissue culture lab use this particular mechanism and use a GSM module to send a message which displays the present status of the temperature and humidity and displays the message "Tissue Culture lab parameters exceeded". But majority of times such an alerting message could easily go unnoticed, the user or the person in charge is sleeping in case if the intended person in sleeping.so it is better to log the data in a remote computer in case of such an event so that he can keep an track of the data. Another work in [5] use the alarming system for the Attending staff. This temperature and humidity measurement sensor can fail if the user of the in charge is Away for the situation where the emergency is taking place[6]. A temperature and humidity rise and alarm following it would be unnoticed.so a robust device combining an alerting and data logging system is needed to avoid this kind of situation. The paper [7] deals with sending the values of temperature of the environment the sensor is exposed to, by SMS for the user or the person in charge. Also, by creating microcontroller database, this design described in the paper can be used as a modification for alerting the user by giving an "ALERT SMS" when the temperature have a deviation from a critical value preset by the user[8]. The system of server guard maintenance mechanism presented in this current paper is totally different as it doesn't take into consider any software which has to be run in personal or any computer[9]. The final product doesn't take into consideration any high power consumption devices like laptop or personal computer. The response of our design when the temperature or humidity is out of range as defined by the user or the critical value preset by the user is better and more advanced as we have the provision for data logging as well as to alert the user in case of an alarming event.

CHAPTER 3
MATERIALS AND METHODS

3. MATERIALS AND METHODS

3.1. MATERIALS

A. Arduino UNO (Arduino, Italy)

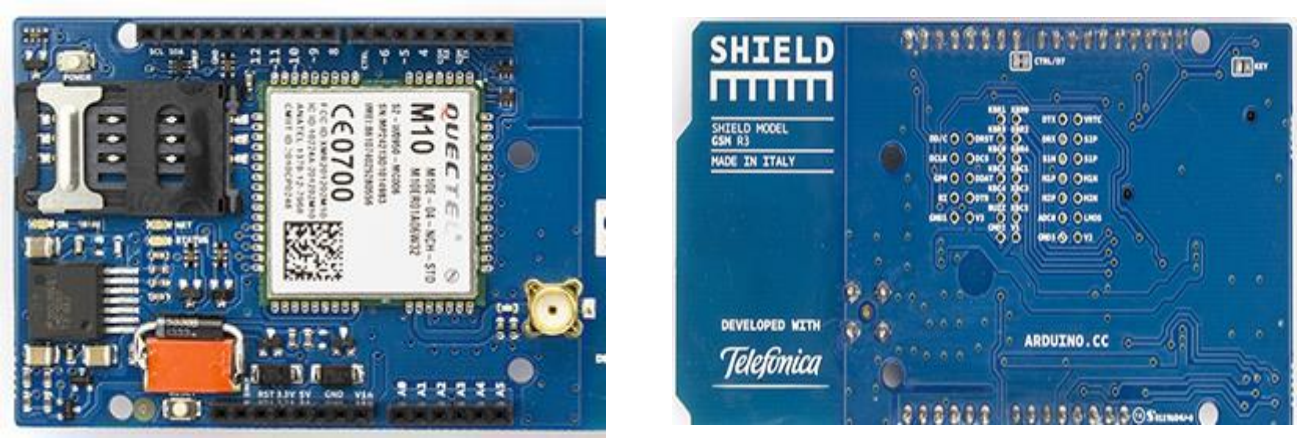
Arduino UNO is a microcontroller board which depends on ATmega32. It consists of 14 digital I/O pins in which PWM pin count is 6.for analog inputs there are 6 analog pins which are very useful[10].

Figure 1: Arduino UNO

Table 1: Specifications of Arduino UNO

Microcontroller	ATmega328
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limits)	6-20V
Digital I/O pin	14 (of which 6 provide PWM output)
Analog Input Pins	6
DC Current per I/O Pin	40mA
DC Current for 3.3V Pin	50mA
Flash Memory	32 KB (Atmega328) of which 0.5 KB used by boot loader
SRAM	2 KB (Atmega328)
EEPROM	1 KB (Atmega328)

B. Arduino GSM Shield



(a) **(b)**

Figure 2: Arduino GSM Shield (a) front side (b) back side

The primary use of the Arduino GSM shield is that it help to connect the Arduino or the GSM shield connects to the GPRS wireless network as a means of simple data packets[11]. For this GPRS shield to work we just need to plug the GPRS module onto the Arduino borad, than after inserting a SIM card from a general mobile operator which offers data packet connection or the GPRS coverage in that area we simply follow the instructions which helps in connecting the internet[12].

The Arduino platform is an open source platform which helps in the documentation software as well as the hardware modifications.

- Requires an Arduino board.
- The GPRS shield is powered by 5V which can be easily supplied from the Arduino Board.

C. DHT 11 Sensor

The DHT11 Temperature & Humidity Sensor consists of a temperature & humidity sensor which is calibrated against a digital signal output. The DHT11 ensures reliability, high efficiency and stability for a long time which is present with the help of this digital-signal-acquisition exclusive technique. This temperature and humidity sensor have an NTC temperature component for measuring the temperature and a very high-performance 8-bit microcontroller connected for humidity, which is cost effective and provides an excellent quality and fast response ability with anti-interference.

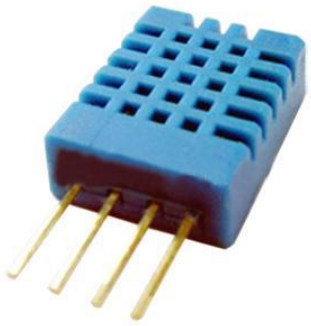


Figure 3: DHT11 Sensor

The DHT11 elements is calibrated strictly for humidity calibration in extreme laboratory conditions which focuses on humidity calibration[13]. The general internal sensor detection process is done by the OTP memory which is used for storing the calibration coefficients by storing the programs for it. The integration is made quite easy by the use of single wire serial interface[14]. Low power consumption and long distance signal transmission which can be up to
20 meter. The component consists of the 4 pin single row pin package.

Table 2: Specifications of DHT11 Sensor

Item	Measurement Range	Humidity Accuracy	Temperature Accuracy	Resolution	Package
DHT11	20-90%RH 0-50 ℃	±5％RH	±2℃	1	4 Pin Single Row

D. X-Bee

X-Bee or commonly known as ZigBee is a module manufactured by Digi international at USA which is used in connection with the Arduino. Here the X-bee module is used in connection with the Arduino UNO[15]. This X-bee module is used for the transmitting the data to the monitoring station. Hence, two X-Bee module is used one for transmitting the signal or the data other as a receiving unit in the base station which is further used for saving or data logging purposes. The manufacturer of Arduino X-bee shield is done by Arduino which is in collaboration with Libelium.
Model: S1
Manufacturer: Digi International
Country: USA

Figure 4: X-Bee

E. X-Bee Shield

For helping the X-bee in wireless communication with another X-bee shield the Arduino X-bee shield is used. Transmitting and detecting both are done in the X-bee shield[16].

The manufacturer of Arduino X-bee shield is done by Arduino which is in collaboration with Libelium.

Manufacturer: Arduino

Country: Italy and Spain

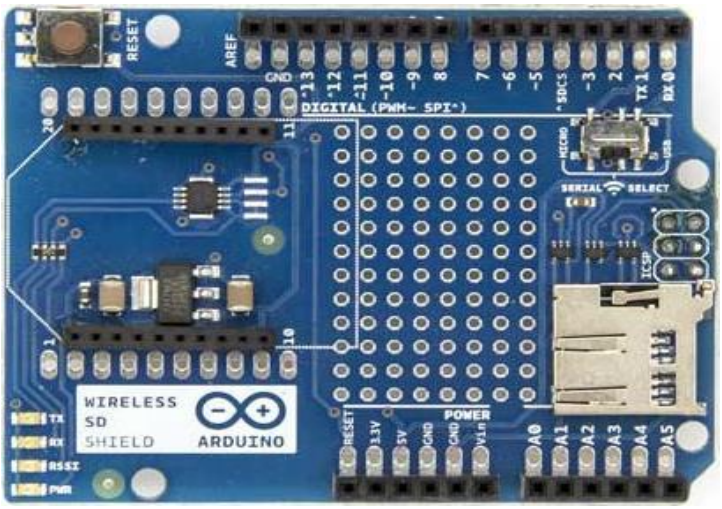


Figure 5: X-Bee Shield

F. Battery

A rechargeable typical 9V battery was used to power the device.

Figure 6: 9V Duracell Battery

3.2.METHODS

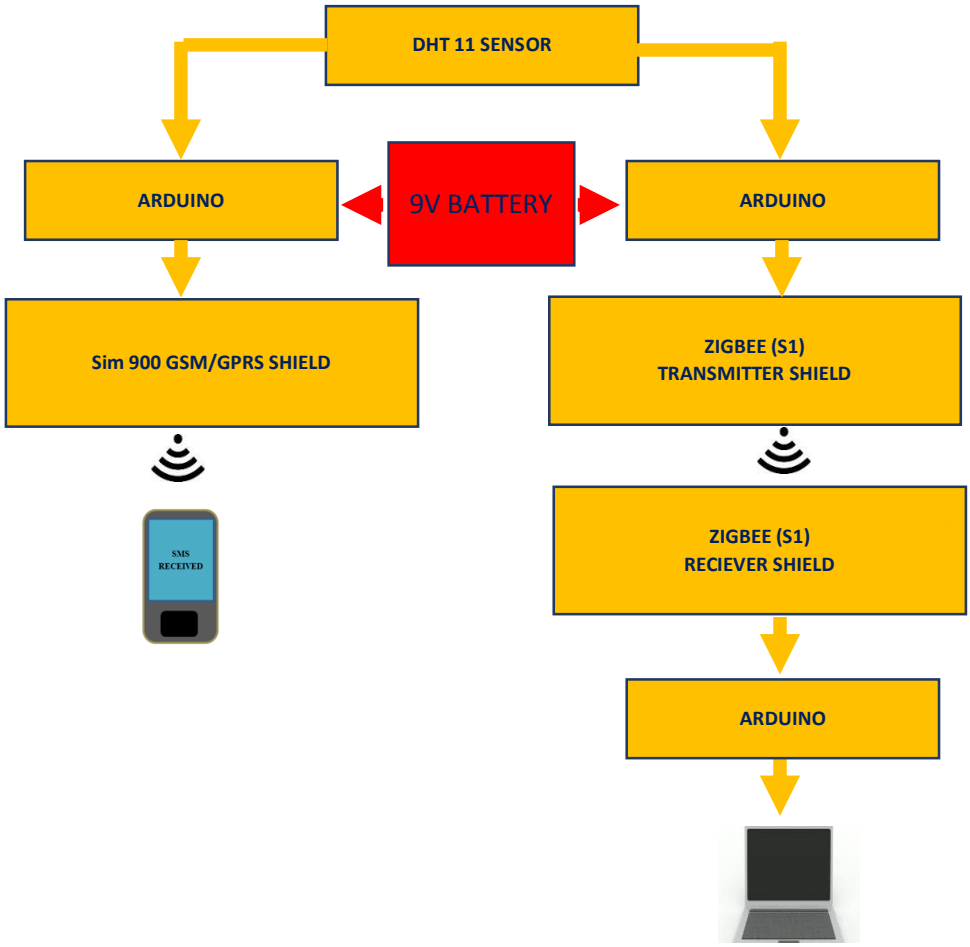


Figure 7: Flow chart of device

(a) Development of the device:

Device development was done using DHT11 which is a temperature-cum-humidity sensor. The Arduino UNO microcontroller development board is connected with the DHT11 sensor. For acquiring the signal from the sensor a program in Arduino sketch was made. Processing of the acquired signal was done by providing the temperature and relative humidity thresholds, these parameters were included in the program. when these parameters i.e. temperature and/or relative humidity deviated or go out of range of the threshold values the GSM module which is connected with the Arduino board is activated[17]. A process of sending SMS to a mobile number defined by the user which reports the current temperature and humidity. One additional connection is made to a second Arduino development board. Similarly, a program was made to acquire the signal to the microcontroller. ZigBee (S1) wireless module was connected in the second Arduino UNO. This transmitter unit was served by the ZigBee module[18]. Another receiver unit was connected to a second Arduino development board using the second ZigBee wireless module. A Matlab® program was used to acquire the signal.to display the data acquired a GUI program was provided. The displayed information will contain the information about the current temperature and humidity. The data logged in the monitoring station can be saved as the text file so that it will be easier for further analysis purposes. The schematic representation of the proposed device has been shown in figure 7.

(b) Testing of the device:

The device testing was carried out in variety of simulated conditions. Different cases which were considered for device testing are listed below.

Case 1: Microbial culture incubator

The prototyped device was put in a chamber of orbital shaker incubator (Remi, India).by using the interface which is user friendly the chamber temperature was varied.

Case2: environmental conditions alterations using electric iron

The prototyped device was placed on a table. A heating electric iron was kept in the vicinity of the device.

Monitoring of the temperature and the humidity is done for the above mentioned cases,

CHAPTER 4
RESULTS AND DISCUSSIONS

4. RESULT AND DISCUSSIONS

To build an intelligent temperature-cum-humidity sensor the temperature and the humidity measuring sensor (DHT11) sensor was used. The Arduino development board was used acquired the signal provided by the DHT11 sensor[19]. If there is any deviation in the neighboring environment of the sensor the measured parameters being temperature and humidity. If the preset range parameters gets out the GSM module is activated for sending messages. A mobile number is already predefined in the Arduino program. The GSM module send this messages to the mobile number mentioned in the program as soon as the GSM module is activated[20]. The next message will be send only after 10 minutes. Thus delay of 10 minutes is provided to give the user time to take care of the problem to bring back the normal environmental conditions fixed for that particular environment.so that the continuous messaging can be stopped. After 10 minutes another message will be send if the problem or the environmental conditions are not brought back. This process can be stopped by switching off the device or when the environmental temperature and humidity were restored.

A ZigBee (S1) transmitter connected with the Arduino development board is used to simultaneously send the signal that is acquired from the sensor[18]. The signal transmitted by the ZigBee module was send to the computer or the monitoring station where the data could be saved or graph plotting as text file can be done using the GUI program made in the Matlab®.

The Matlab®. GUI interface for the development of the device has been shown in the figure 9.

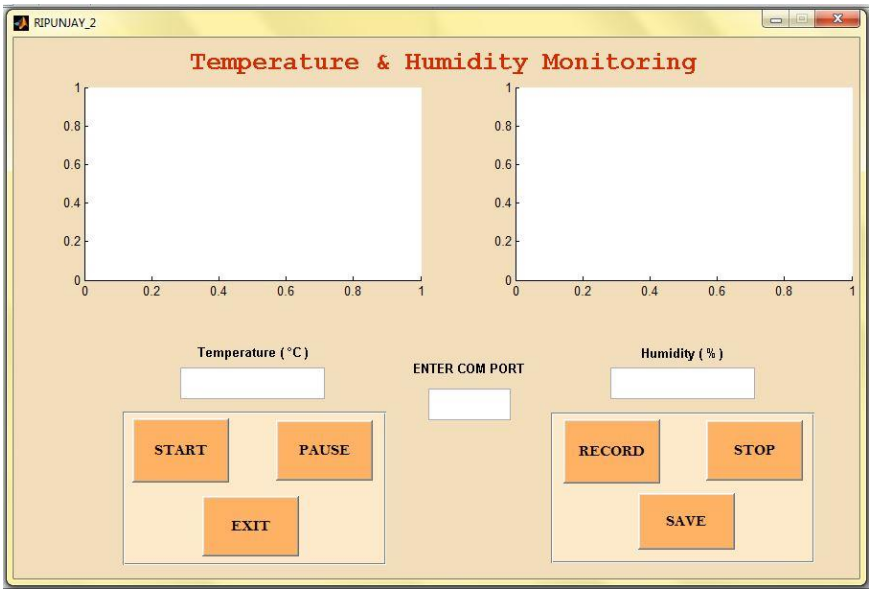


Figure 8: GUI interface

This GUI provide us with an additional advantage for analyzing the temperature and humidity values at a later time. It can provide us with the information for the long term information about the sensor neighboring information.

The flow diagram of the device has been shown in the figure. The pictograph of the prototype has been shown in figure.

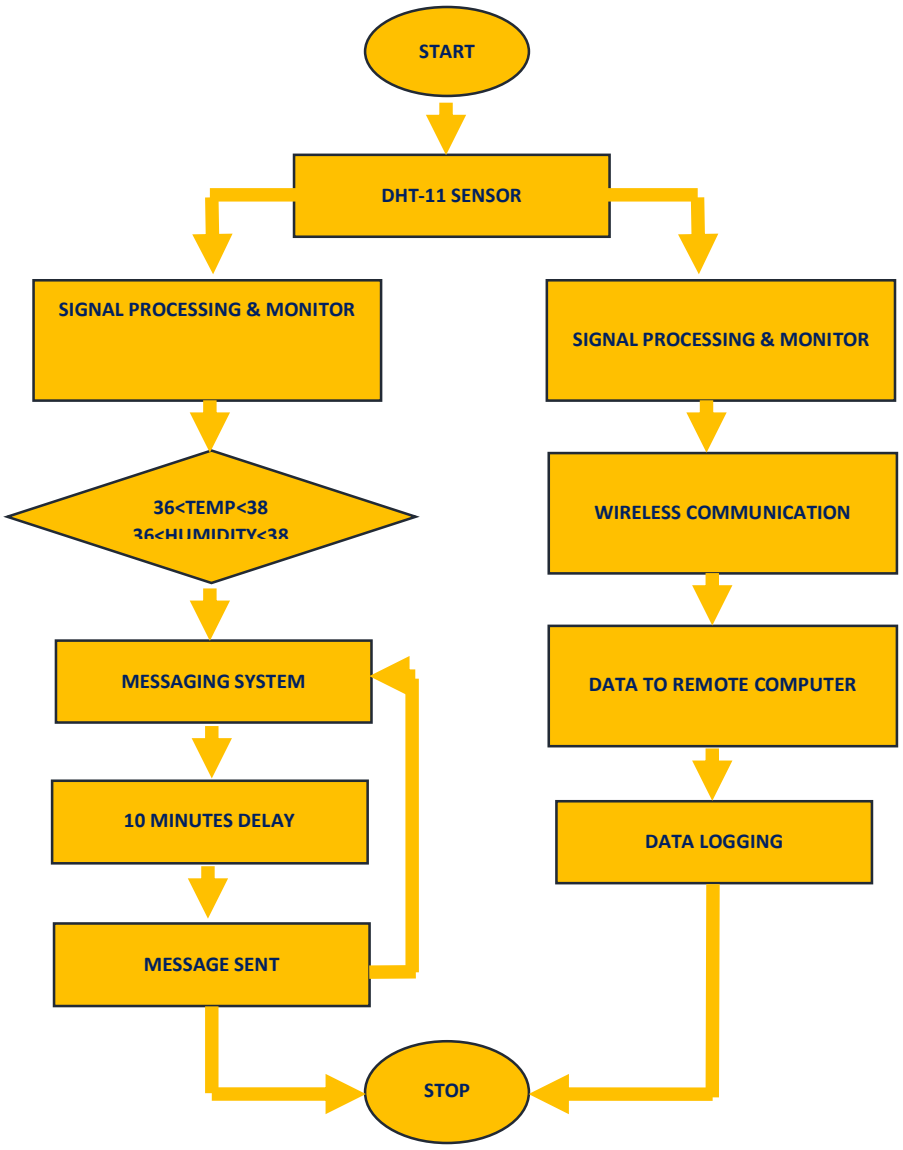


Figure 9: Flow of functionality of the device

Testing of the device:

Case1:

In this case the normal or the temperature range was kept as 36 °C and 38 °C i.e. when this particular temperature is reached the GSM service will work and the message will not be send to the predefined mobile number. Initially the temperature inside the orbital shaker chamber was kept at 37 °C. To demonstrate the malfunctioning of the device, the chamber temperature was increased using the interface provided in the orbital shaker. Due to this increase in temperature the humidity

decrease as they are related. The datas provided by the DHT11 sensor i.e. increase in the temperature and the decrease in humidity, the GSM module is activated. Using the communication protocol followed by the ZigBee continuous transmission of data is possible.

The schematic representation of the functionality of the device has been shown in the figure.

Figure 10: Schematic of case 1(a)

The next experiment done to prove the ability of the sensor to work in Colling environment. The initial temperature is kept at 37 °C. The temperature was finally brought down to 35 °C using the interface provided in the orbital shaker incubator. This decrease in temperature is found to activate the messaging service because of the triggering of the GSM shield[21].

The schematic representation of the functionality of the device is shown in the figure.

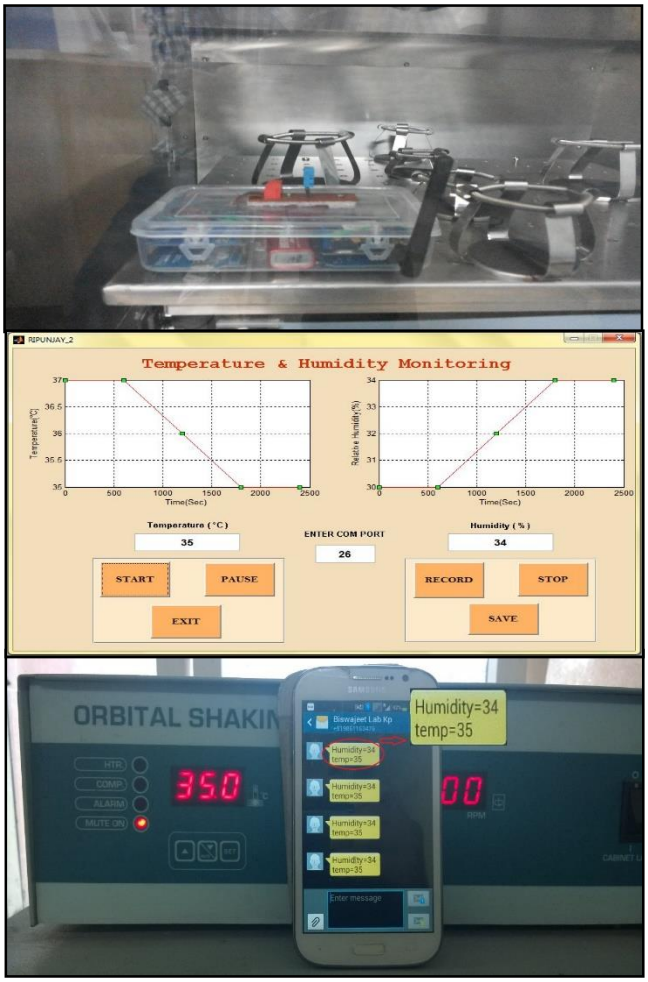


Figure 11: Schematic of case 1(b)

Case 2:

This case tests the capability of the developed device in responding to the change in the environmental conditions. A hot iron in on condition was put in the vicinity of the developed device. The range of the temperature and the humidity were kept same as in the previous case. The iron increases the temperature of the surrounding as the time passes. This increase in the temperature led to the decrease in the humidity as sensed by the DHT11 sensor[22]. As the temperature gets out of the pre mentioned range the GSM module was activated and starts sending messages to the user's mobile number. Simultaneously the device is capable of sending data to the monitoring station,

The schematic representation of the functionality of the device has been shown in the figure.

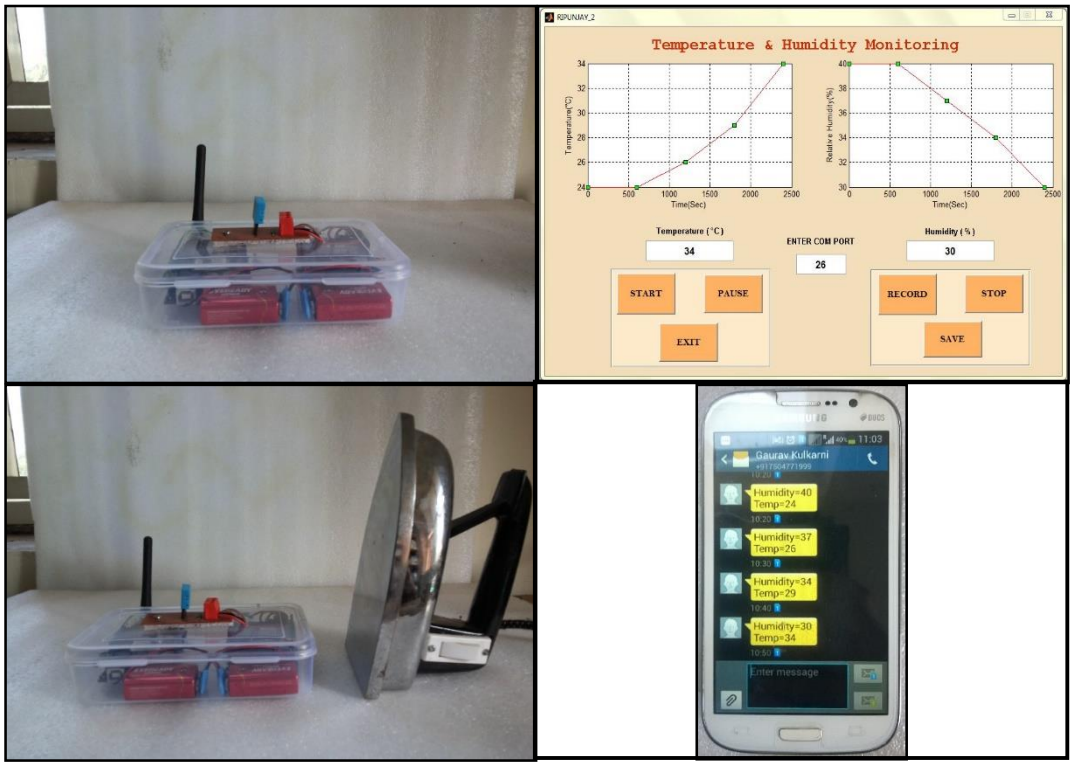


Figure 12: Schematic of case 2

CHAPTER 5
CONCLUSION

5. CONCLUSION

The designing of an intelligent temperature-cum-humidity monitoring system is depicted in this current project. The designing of the fully functional prototype is developed in-house. Once the humidity of the temperature gets out of the range mentioned by the user the device sends a SMS to the user's predefined number[8]. This SMS contains information of the current temperature and the humidity. The developed device is also able to send the data to the monitoring station for recording and graph plotting for analyzing purposes at the later stage. The developed device has been tested under various simulated conditions.

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