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# ARDUINO BASED SMART SENSING PLATFORM FOR MONITORING WEATHER PARAMETERS

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**Abstract**— The unreliability about weather conditions can be tragic in planning out human activities because monitoring the weather conditions manually is difficult. Constructing the wireless weather monitoring system need critical analysis of different climatic conditions, studying the patterns and processing data obtained to produce results. They need very active human interaction to examine weather conditions, and are not necessarily reliable since they are sometimes inaccurate. wireless Weather system station provides a solution to this problem; however, the cost of construction is to be considered. The wireless weather monitoring system based on GSM was constructed and tested practically. The system is able to sense the weather parameters; temperature, humidity, and light which is sent as an SMS of the current weather conditions to mobile users at a given period of time. This prototype was designed to accommodate multiple sensors and detect different weather conditions. It was also designed to be cost effective by choosing the GSM technology as the cheapest form of wireless technology to support remote access to the system. The system can be further improved to predict more weather conditions such as rain sensor.

**Keywords**— Arduino, wireless, GSM, weather conditions, weather station.

## I. INTRODUCTION

In our contemporary world of information and technology (IT), monitoring and observing weather conditions is vital in our day to day activities; In Agriculture to predict where and when to plant and wait for harvest, in our general lives to predict where and when to hold events, in transportation to predict how safe it is to travel by road, by air, or by water because, all of these have weather as an important factor.[1]. Weather has always been the force of nature that influenced mankind in a very commanding manner. Trying to understand the weather and trying to forecast it correctly has been going on over the centuries and a lot of knowledge and data has been gathered which helped the researchers extrapolating methods of

measuring weather phenomena and even forecasting the hazardous incidents of weather.[2].“Meteorology” is a part of science which is solely devoted to this field. In this modern era many new technologies and methods have been developed for accurate monitoring of weather.

A weather monitoring station which gives digital data usually consists of several weather phenomena sensing sensors and a processor unit which integrates all of the monitoring systems altogether.

Digital weather stations can be categorized into personal stations and professional stations. The personal weather stations are characterized to have relatively low cost with limited capabilities. The equipped sensors are less sensitive and usually they don't have the capabilities of logging data or transmitting them. On the other hand, professional stations are more costly. They usually are wireless and stand-alone stations with capability of logging data autonomously and transmit them by wireless means to a nearby situated base station/computer. Personal weather stations lack self-sustainability, precision and reliability. On the other hand, professional weather stations are too expensive for public use. The aim of this research (Wireless weather Station systems) is to develop a professional weather stations which is user friendly and portable weather measuring device.[3]

the aim of this project is to construct a Wireless weather station system that is able to sense multiple weather conditions; temperature, humidity and light, simultaneously, at particular time intervals for a given coverage and eliminate human interaction Using Arduino.

## II. METHOD

The objectives of this project stipulate that a portable prototype of the proposed system has to be built. The system will interface with sensors to measure and transmit and receive data through the GSM. To attain these objectives different design approaches have been verified. The proposed system has been designed to consist of a microcontroller reading data from temperature, humidity, light intensity and pressure. The system is interfaced to a GSM900 shield for transmitting and receiving data through wireless communication.

A. The system block diagram for the weather station is illustrated in figure below

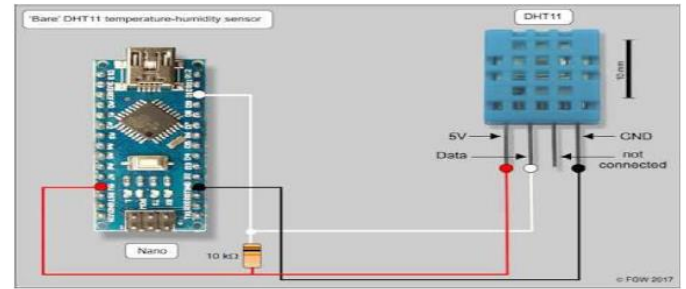
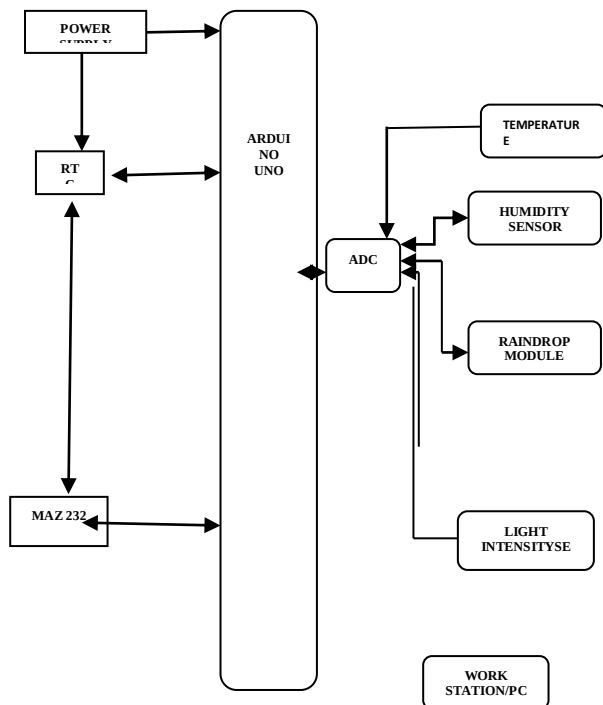


Fig. 1.DHT11 PIN CONFIGURATION [9]

### 3 ATMOSPHERIC PRESSURE SENSOR

The BMEP280 digital sensor uses the I2C interface. Since pressure varies with altitude it can be used to measure altitude too. It has 4 pins SDA, SCL, GND and Vin, the pins are connected to Arduino as follows.

- connect VCC to Arduino's 3.3V output
- connect the GND pin to Arduino's GND
- connect SDA (Serial Data Line) pin to Arduino's analog pin A4
- connect SCL (Serial Clock Line) pin to Arduino's analog pin A5

Figure 2 below shows BMEP280 connection with Arduino

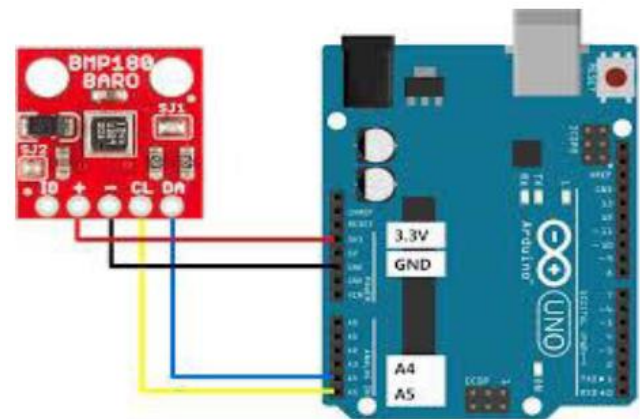


Fig. 2. BMEP280 connection with arduino [9]

## B. HARDWARE CONNECTIONS

### 1 ARDUINO UNO

Arduino uno microcontroller is the heart of the weather station system. Arduino provides enough processing power and memory to run the software required and it can read multiple sensors simultaneously. To add network connectivity to the project, a SIM900 GSM shield is plugged on top of the arduino board. SIM900 GSM shield enables the system to transmit SMS messages containing measured weather parameters to the user. The SIM900 GSM module also receives user's requests for desired weather parameters in form of text messages. The SMS received is passed to the arduino microcontroller for processing

### 2 TEMPERATURE AND HUMIDITY SENSOR

The combined humidity and temperature sensor measure the ambient temperature and humidity of the environment. The DHT11 is used for measuring air temperature and relative humidity. The DHT11 digital sensor is wired to Arduino uno board as follows:

- connect VCC pin to Arduino's 5V output
- connect GND pin to Arduino's GND and
- connected the DATA pin to Arduino's digital pin D7

The figure 1 below shows the pin configuration of DHT11 sensor and how it is connected to Arduino.

### 4 RAIN DETECTION SENSOR

The rain drop sensor module is used to detect whether there is any rain or presence of rain weather near the surroundings. It is a tool for rain detection. The module consists of a rain board on which droplets can be detected, and a potentiometer is attached to adjust its sensitivity and a LED to show the power indication. It gives only analog output. The raindrop detection module is connected to Arduino as follows.

- Connect the VCC pin to Arduino's 5V output
- Connect the GND pin to Arduino's GND
- connected Analog Data to Arduino's analog pin A0

Figure 3 below shows raindrop sensor connection with Arduino



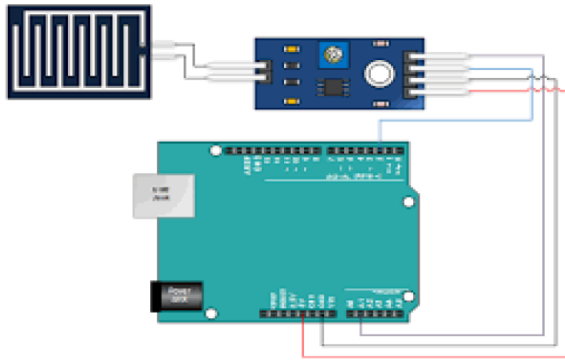


Figure 3. rain sensor module to arduino connection[8]

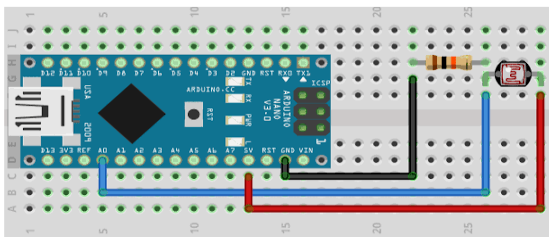
### 5 LIGHT INTENSITY SENSOR

The light sensor acquires analog values that determine the current concentration of light or sunlight in its environment. Light dependent resistor measures the exponential values of light concentration making it more variable than that of temperature and humidity measurements. Data is passed to the microcontroller for further processing and conversion to digital data. It connects to the microcontroller as follows:

The LDR is connected to the VCC 5 volts output and analog pin 0 on the microcontroller.

It is also connected to the resistor and grounded

Fig 4. BH1750 connection with Arduino [10]



### 6 LIQUID CRYSTAL DISPLAY (LCD)

The liquid crystal display provides a human interface to take weather parameter readings on the weather station locally. The LCD is connected in 4-bit mode as shown in figure 5 below

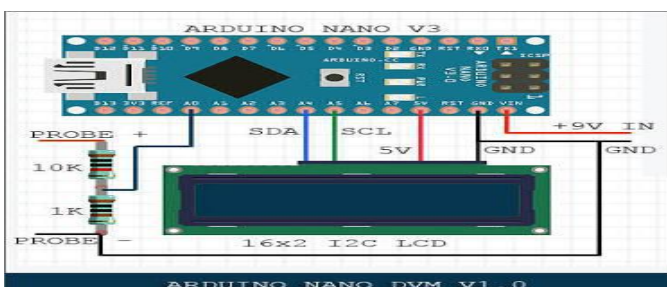


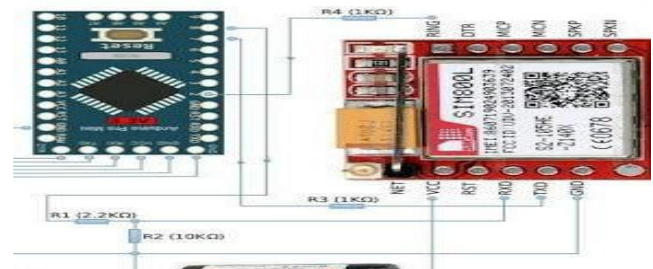
Fig 5. LCD Pin Configuration.

### 7 GSM MODULE

The GSM module transmits SMS to the mobile user. SIM 800 module is implemented and connected to the microcontroller with the transmit and receive pins wired to 2 digital pins on the Arduino processor. It is connected as follows:

- SIM 800 5 volts is connected to the 5 volts pin on Arduino
- GND pin connects to the GND pin on Arduino
- Transmit pin is connected to digital pin 9
- Receive pin is connected to digital pin 10
- VCC pin connected to 5 volts output

Fig 6: SIM 800 PIN CONFIGURATION (Electronic Projects,2018)



### 8 SOFTWARE

In Arduino programming there are two main functions. Main functions are setup() and loop(). Setup() function is only operated once when device is booted up, it is mostly used to setup initiation settings. Loop() function will run repeatedly until power off or reset button is pushed. Arduino programming is supported by wide amount of libraries. The system software was written, compiled and uploaded to arduino board using arduino's IDE. Figure 3.8 below shows a flowchart of the system's software.

### 9 INTERFACING BLUETOOTH MODULE (HC-05) WITH ARDUINO UNO

Bluetooth is a one of the great example for wireless connectivity. It is used in many fields. Bluetooth consumes very small amount of energy. Do you know about Smartphone controlled robot or car. Commonly one of these two wireless technologies is used in Smartphone controlled robot. One is WIFI and other is Bluetooth. And another commonly used wireless technology for controlling Robot car is RF. Which is the same remote and receiver used in drones. Here we are going to interface a Bluetooth Module (HC-05) with Arduino Uno. And describe each line of code. Then we control the built-in LED of Arduino Uno from smartphone via Bluetooth. HC-05 is a Bluetooth module which can communicate in two way. Which means, It is full-duplex. We can use it with most micro controllers. Because it operates Serial Port Protocol (SSP).The module communicate with the help of USART (Universal Synchronous/Asynchronous Receiver/Transmitter) at the baud rate of 9600. And it also supports other baud rate. So we can interface this module with any microcontroller which supports USART. The HC-05 can operate in two modes. One is Data mode and other is AT command mode. When the enable pin is "LOW" the HC-05 is in Data Mode. If that pin set as "HIGH" the module is in AT command mode. Here we operate this module in Data Mode.

## Technical Specifications

- Operating Voltage: 4V to 6V (Typically +5V)
- Operating Current: 30mA
- Range: <100m
- Works with Serial communication (USART) and TTL compatible
- Can be easily interfaced with Laptop or Mobile phones with Bluetooth

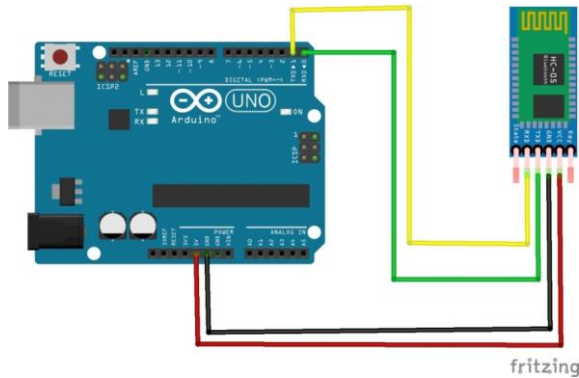


Figure 7. Bluetooth Module [6]

## C. INTEGRATED SYSTEM

Proteus 8 professional software was used to design the circuit diagram for the whole system.

All the sensors and the GSM shield were connected to arduino as illustrated in the system schematic diagram in figure 9 below

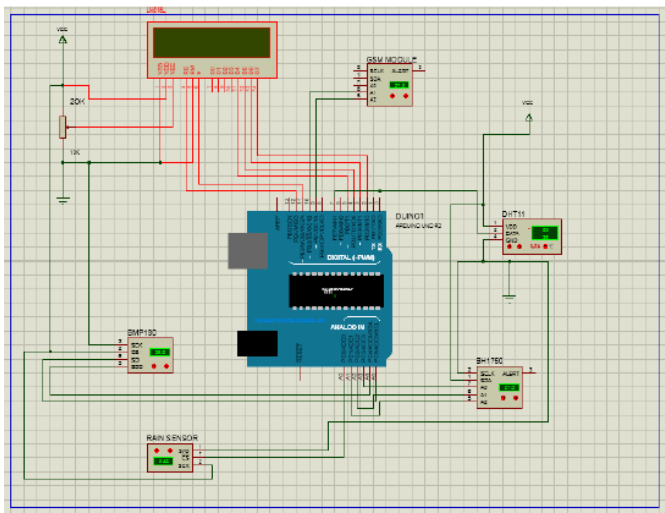


FIGURE 9.

The code that was written and uploaded to Arduino uno board is shown in the appendix

## III. RESULTS AND ANALYSIS

### 1) TEMPERATURE MEASUREMENTS

The results acquired with DS18B20 sensor measures in degree Celsius. Throughout the testing period, the values of the measurements taken both indoor and outdoor were almost

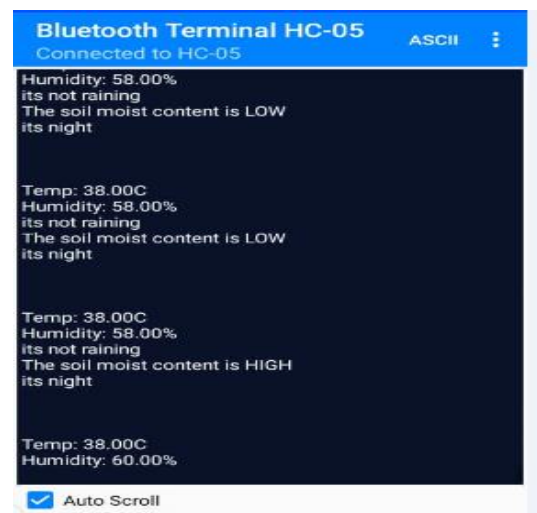
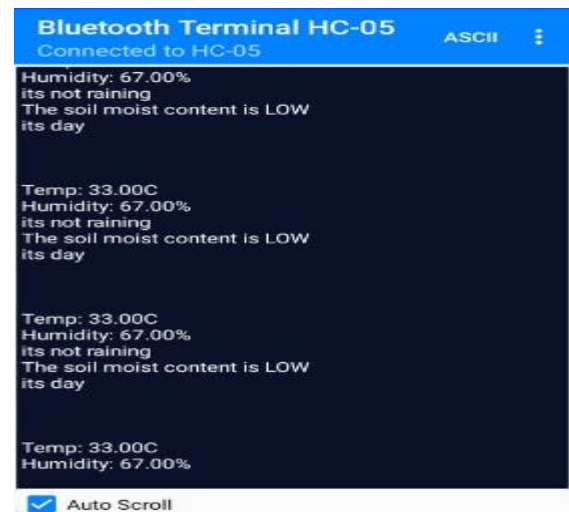
constant, varying between 28 to 29°C. The result displays on mobile's user via Bluetooth terminal HC-05 as TEMP: value.

### 2) HUMIDITY MEASUREMENTS

The DHT11 sensor is responsible for acquiring the data that displays the result for humidity in percentage. The values, similar to that of the temperature do not often vary in its indoor and outdoor environments. The result displays on mobile's user via Bluetooth terminal HC-05 as H(%) (Value), and are displayed as Humidity: value.

### 3) LIGHT INTENSITY MEASUREMENTS

Light constantly varies and is immediately sensed by our eyes. The values therefore, are not constant. They are exponential values that vary greatly in few seconds. The LDR measures the light depending on the focus of light on the sensor. The results are affected by any source of light and not just sunlight. A focus of light sourced from a flashlight or the sun. The result displays on mobile's user via Bluetooth terminal HC-05 as day or night.



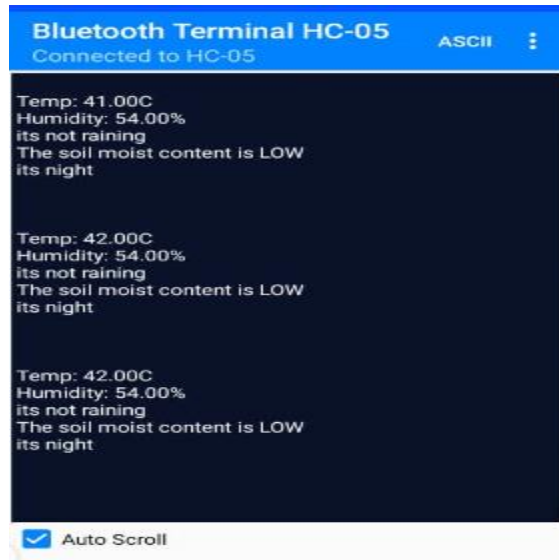


Figure 10: RESULTS OF WEATHER PARAMETERS DISPLAYED ON LCD SCREEN

Table 1: OVERALL WEATHER MEASUREMENT ON A 30 MINUTE BASIS

| WEATHER | RESULTS ON       | AFTER 30minut |             |               |       |
|---------|------------------|---------------|-------------|---------------|-------|
| TIME    | TEMPERATURE (°C) | HUMIDITY (%)  | RAIN        | SOIL MOISTURE | LIGHT |
| 0:00    | 24.3             | 82            | Not raining | low           | Night |
| 1:00    | 24.3             | 88            | Not raining | low           | Night |
| 1:30    | 24.3             | 88            | Not raining | low           | Night |
| 2:00    | 24.3             | 90            | Not raining | low           | Night |
| 2:30    | 24.3             | 94            | Not raining | high          | Night |
| 3:00    | 24.3             | 94            | Not raining | low           | Night |
| 3:30    | 24.3             | 94            | Not raining | low           | Night |
| 4:00    | 24.3             | 93            | Not raining | high          | Night |
| 4:30    | 25.1             | 89            | Not raining | low           | Night |
| 5:00    | 25.4             | 74            | Not raining | high          | Night |
| 5:30    | 26.6             | 69            | Raining     | low           | Night |
| 6:00    | 27.2             | 63            | Raining     | low           | Night |
| 6:30    | 29.6             | 58            | Raining     | low           | Day   |
| 7:00    | 29.6             | 58            | Raining     | high          | Day   |
| 7:30    | 29.6             | 58            | Raining     | high          | Day   |
| 8:00    | 29.6             | 65            | Raining     | low           | Day   |
| 8:30    | 28.5             | 75            | Raining     | low           | Day   |
| 9:00    | 27.8             | 78            | Raining     | high          | Day   |

|       |      |    |             |      |     |
|-------|------|----|-------------|------|-----|
| 9:30  | 29.6 | 75 | Raining     | low  | Day |
| 10:00 | 29.6 | 78 | Raining     | low  | Day |
| 10:30 | 27.8 | 80 | Raining     | low  | Day |
| 11:00 | 26.5 | 80 | Raining     | high | Day |
| 11:30 | 25.9 | 81 | Not raining | low  | Day |
| 12:00 | 24.2 | 81 | Not raining | low  | Day |

## B. ANALYSIS

The results obtained from this project were not compared with the results obtained from standard weather measuring equipment because of the scarcity and unavailability of the equipment with the exception of the thermometer used for measuring the temperature. Therefore, the experiments carried out are focused basically on theoretical rather than practical applications. This implies that the accuracy of the results obtained are not certain since they were not compared with other measuring equipment and that the system is not free from errors and imperfection because of electromagnetic interference or noise disrupting the acquirement of data. The wireless technology aspect is also not flawless, as messages may get delayed before being received.

The wireless weather monitoring system based on GSM was constructed and tested practically as shown in the fourth chapter. The system is able to sense the weather parameters; temperature, humidity, Rainfall, Soil moisture and light which is sent as an SMS of the current weather conditions to mobile users at a given period of time. It can be applied in science laboratories, industries and agriculture to monitor weather parameters by providing an accurate analysis of the weather in a cost effective manner. It also proves to be more useful in a smaller area for effective weather analysis and accurate results. The project is simply a prototype of the intended system. In the actual practical implementation of the weather monitoring system, an uninterrupted power supply from a solar panel is required.

## IV. CONCLUSIONS

It has been emphasized throughout this project that weather monitoring is necessary for organized and coordinated plans of activities to be carried in our regular routines in life. Furthermore, wireless weather monitoring has proven to be useful to provide mobile users with information concerning the weather of an environment even when they are not present. The prototype was designed to be flexible to accommodate multiple sensors to detect different weather conditions. It was also designed to be cost effective by choosing the GSM technology as the cheapest form of wireless technology to support remote access to the system. The prototype was built with three sensors for temperature, humidity and light intensity connected to the microcontroller and was able to produce results of the weather conditions. The objectives for the project were met and the results were found to be reliable.

## RECOMMENDATIONS

1. The system can be designed to include an alarm that goes off when weather parameters, e.g. temperature,



risers or falls to a certain threshold to alert the user, or, send a message as a triggered update without waiting for the default time period to elapse.

2. The system should have an uninterrupted power supply to prevent from having to change batteries frequently.
3. The system can be further improved to predict weather useful for disaster management.
4. Addition of more sensors e.g. rain sensors, to predict more weather conditions.
5. Designing the system to allow duplex communication between the user and the system. Mobile users can request for weather parameters without having to wait for a time period to elapse. This reduces the cost of SMS sent at short intervals.

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