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Radiosonde Payload for Weather Monitoring Systems

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Abstract:- The system aims to design a reliable embedded system that will be used in measuring various atmospheric parameters for up-to-date weather monitoring. Weather is monitored with the help of payload equipment which acts as a transmitter in which temperature, pressure, humidity, altitude, air quality, and light detection is measured with the combined action of all the sensors. These measured values are then transmitted to the ground receiver to view the information from the various sensors. NRF frequency signals are used for the communication between transmitter and receiver respectively. All the sensors and the transmitter/receiver module would be connected to the main Arduino/Microcontroller. The data received would be continuous and can be viewed from time to time on the receiver module, smartphones, and cloud storage simultaneously. The project is developed to produce a weather monitoring device capable to measure with more accuracy, reliability, and cost-efficiency.

Keywords:- *Arduino; sensors; cloud; transmitter; receiver; wireless communication.*

I. INTRODUCTION

Weather monitoring has always been a crucial part of detecting and recording various atmospheric parameters from various locations, and places, and comparing the various known values. Temperature, barometric pressure, altitude, light detection, air quality index, and humidity can be easily known from the present weather monitoring sensors and various types of equipment. Using IoT to effectively collect the various information from different kinds of weather monitoring sensors and store them either in SD cards or cloud storage. The collective work of all the sensors is the result of the values that we can see today. Arduino nano, the microcontroller is responsible for connecting multiple devices and exchanging real-time data using a simple interface. The Arduino is coded to collect information from these multiple devices to either display the information or store it in the cloud. Apart from using the sensors and Arduino, an SD/memory card is used to collect the information from the devices to secure it in times when there is any communication failure. The model runs in two parts one is the transmitter and the other is the receiver. The wireless communication between the two parts takes place with the help of NRF24 signals in the probable range from 50mts to 1km. Using the Bluetooth module, the information can be transmitted to our smartphone and can be viewed on the application. Cloud storage is an effective way to store the information on the internet and for easy access and retrieval of the data. This helps us to use this data for a long time and can also be used for trend analysis of the climatic conditions, graphical representations, and monitoring the weather conditions and thereby sending alerts, and notifications regarding the various parameters of the weather.

II. LITERATURE SURVEY

The usage of IoT devices has played a major role in the weather monitoring system. A wide range of applications to the existing weather monitoring system has been developed using IoT sensors and devices. Devices like Arduino, Raspberry Pi, Node MCU, etc are being used as the main components in the development of weather monitoring systems. Using Raspberry Pi to implement the weather monitoring system is exclusively discussed in [3] where Raspberry Pi is interfaced with the sensors in determining the atmospheric weather parameters. Using of cloud storage or a local web server [3] has become a medium to store the information for long-term usage. How an Arduino in the weather monitoring system is operated and enabled with a Wi-Fi module [1] is shown which explains how conveniently the usage of the sensors to obtain information and using the Wi-Fi module to establish the connection between the microcontrollers. Communication between the microcontrollers and sensors can be possible with either Bluetooth, Wi-Fi, NFC, etc [4]. In [4] the various modes of communication and the comparison between different modes have been discussed and from that Bluetooth has been selected as the preferred mode of communication in our project. Various sensors like DHT11 [1-5], BMP280 [1], etc are some of the most used sensors that are used to measure the temperature, barometric pressure, and humidity, and a majority of weather monitoring systems applications use these sensors as the main parts in their development. How a transmitter and receiver which are the two main parts of any weather monitoring system works is clearly explained in [2] which describes the actions performed by the transmitter as well as the receiver. Another model which shows the monitoring of weather uses the Nodemcu [6] to implement the weather monitoring system. The soil is measured at various locations and the sensors are placed at various locations and the collective information from all the sensors is collected to a local web browser using Thing speak [6]. By this way of using the sensors at various places, the information from various locations can be known simultaneously

III. PROPOSED METHODOLOGY

We propose a system that is used to measure, monitor, record, and control various atmospheric weather parameters like temperature, pressure, humidity, air quality, sunlight, and altitude. This can be implemented by using several sensors like DHT11, BMP280, LDR Module, IR sensor, HC-05, MQ2 Gas sensor, and RTC Module. The model is implemented in two parts i.e., the transmitter and receiver. The transmitter or the payload has the combination of all these sensors that are connected to the main microcontroller which is the Arduino. The transmitter also has the SD/memory card that is connected to another Arduino for storing the information. The transmitter module is also connected to the primary Arduino. In the receiver end, we have the receiver module and the Bluetooth sensors that are connected to another Arduino nano. The information from the transmitter is received on to the receiver which is displayed on the LCD screen. The model operates with two 3.6volts batteries which produce the main power. As the power is switched on it gives 5 beeps to indicate that the model is on and the sensing of the values will start soon. All the values are displayed on the LCD screen on the receiver with a gap of 3 seconds. We can place the transmitter wherever we wish to in a radius of 10mts to 1km and keep the receiver module with us to monitor and view the weather parameters. Simultaneously the information is stored on the SD card as well and the information can be viewed on the computer screen as well (shown in Fig.1)

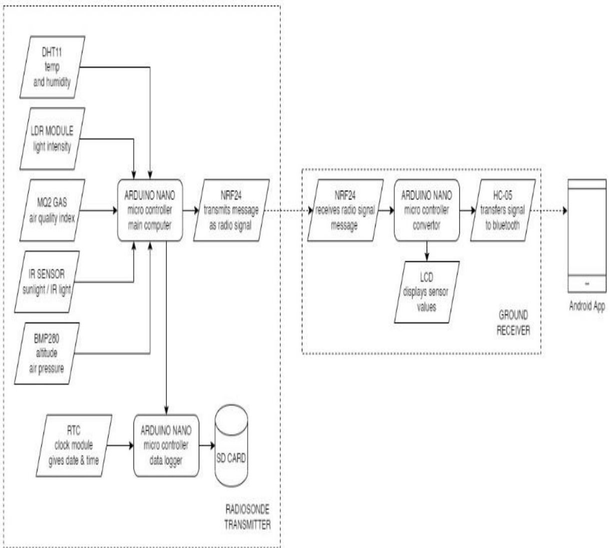

Fig. 1: Overview of the weather monitoring system

A. Required Components

a) ARDUINO NANO:

Arduino nano is also the microcontroller through which all the connections are made and sensors are connected. Arduino IDE is used to communicate with the sensor's actions and has 14 pins in total and operates at 5volts. In the developed model, three microcontrollers are used for transmitter and receiver connections.

Fig. 2: Arduino nano

b) BMP280:

The real-time temperature and air pressure can be known with a BMP280 sensor. It uses a very low amount of power to operate effectively.

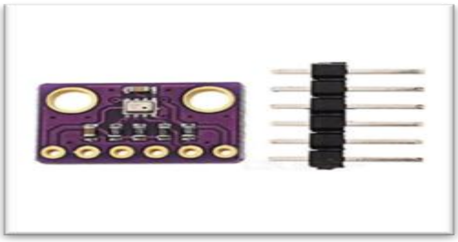

Fig. 3: BMP280

c) DHT11:

DHT11 is a temperature and humidity sensor. The sensor has a humidity measurement component and a temperature measurement component. High reliability, fast response, and cost-effectiveness can be seen with this sensor.

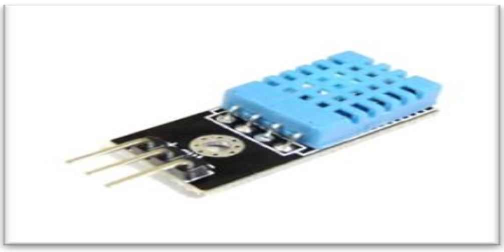

Fig. 4: DHT11

d) NRF24:

NRF24 signal is used for wireless communication between all the microcontrollers. Transmission of received data is provided by the RF transmitter, while the data is received by the RF receiver.

Fig. 5. NRF24

e) LDR MODULE:

To indicate the presence of daylight in particular surroundings LDR module is used. Depending upon the presence or absence of light the daylight is measured and displayed.

Fig. 6: LDR Module

f) SD CARD:

The memory card is used to store the information from the sensors that are present in the transmitter module. The SD card when connected to a personal computer the information can be viewed.

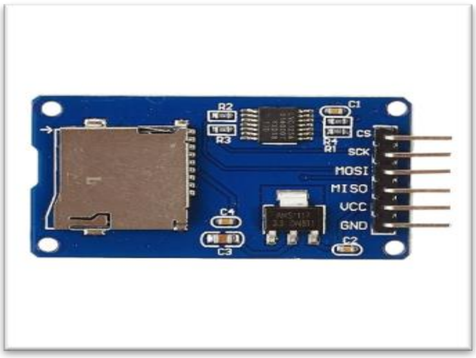

Fig. 7: SD Card

g) HC-05:

HC-05 is the Bluetooth module that is used to transmit the information from the model to our smartphones via Bluetooth. This sensor is present on the receiver module of the model.

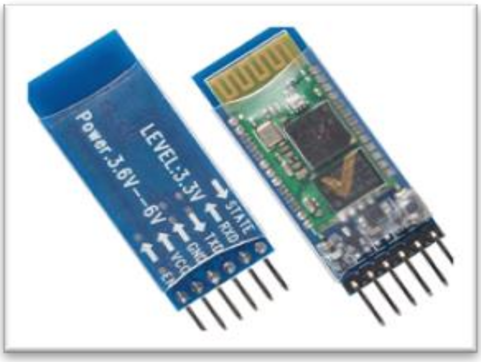

Fig. 8: HC-05

h) RTC clock module:

RTC is a real-time clock that is used to keep a track of the exact date & time of the day. RTC clock module is integrated with all the sensor values which will record at what time and date the values are measured.

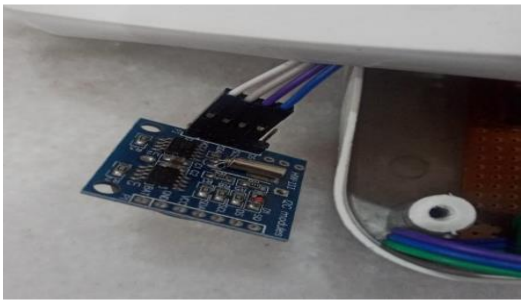

Fig. 9: RTC Clock Module

B. Connections

The model consists of a receiver and a transmitter which is discussed below. The transmitter or the payload (shown in Fig.11) contains the sensors and transmitter module connected to one Arduino, and the SD card connected to another Arduino. The RTC clock module is present to produce real-time data and time continuously. The receiver (shown in Fig.10), has the Bluetooth module and a receiver module that is connected to the Arduino. The battery present in the transmitter module is of 3.6volts and two batteries of 7.2volts are present. As Arduino can operate at a voltage of 5volts the voltage division from 7.2v to 5v takes place and power is provided. The mode of communication between the microcontrollers of both the parts takes place with the NRF24 signals and the values are displayed on the LCD screen which is discussed in the results. The Bluetooth module is the HC-5 sensor that is used for the transfer of data from the receiver to our smartphones.

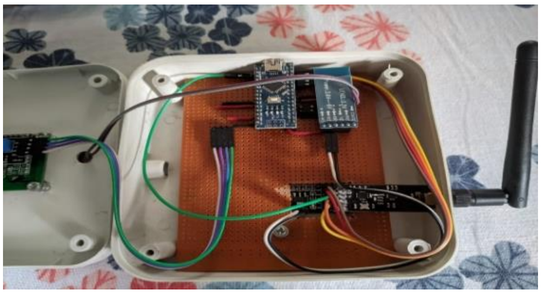

Fig. 10: Receiver module

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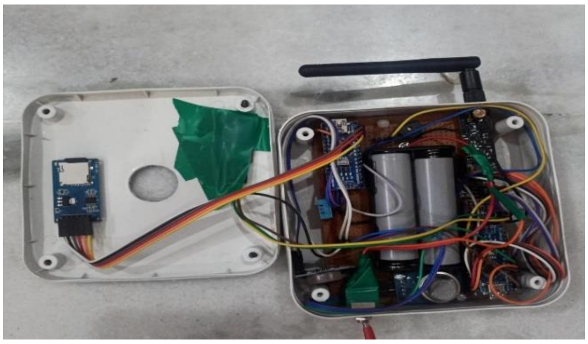

Fig. 11: Transmitter module

Fig. 12: The overall view of the model

IV.RESULTS

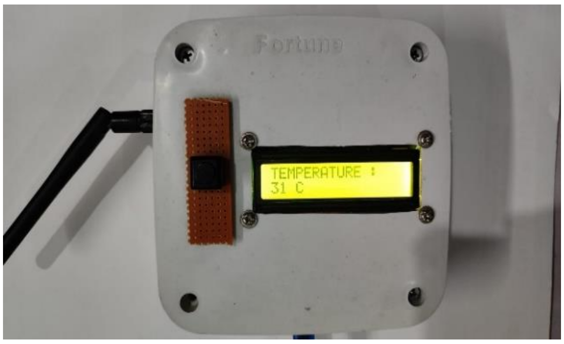

Fig. 13: Temperature displayed on LCD

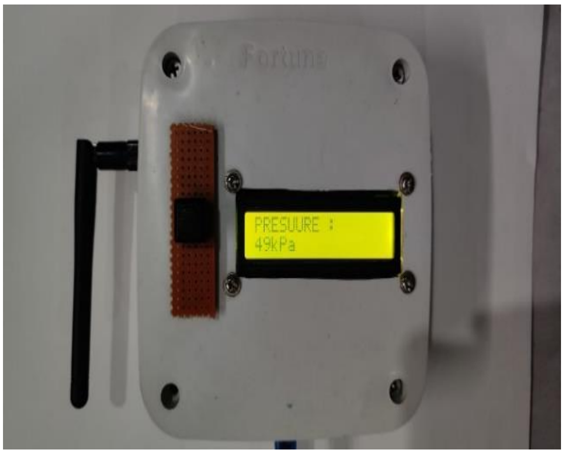

Fig. 14: Pressure displayed on LCD

Fig. 15: Humidity displayed on LCD

Fig. 16: Altitude displayed on LCD

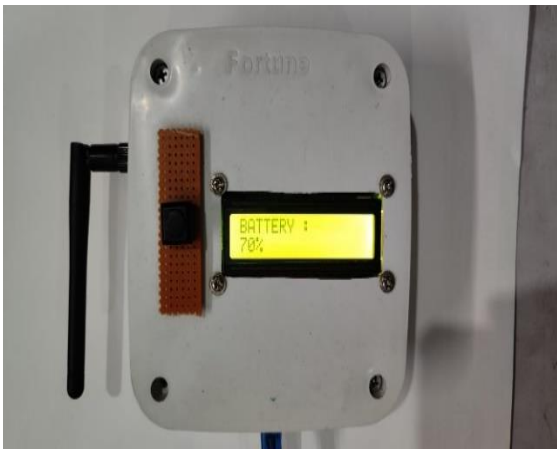

Fig. 17: Battery percentage displayed on LCD

Fig. 18: Air quality index result displayed on LCD

Fig. 19: The results on the serial monitor displayed on the smartphone

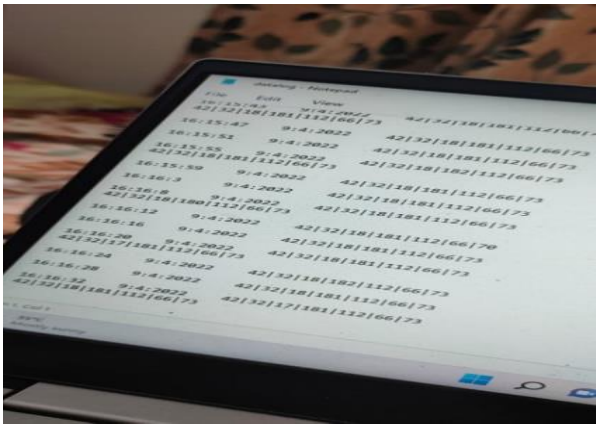

Fig. 20. The results stored on the SD card

Fig. 21: The value of daylight displayed on the LCD

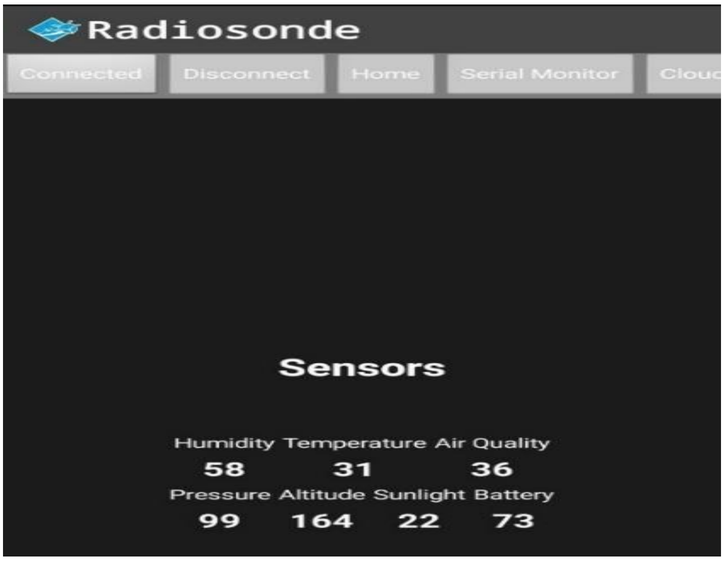

Fig. 22: The results of sensor values on the smartphone

V. TABLES

SNO	WEATHER PARAMETERS	SENSORS
1	Temperature	DHT11, BMP280
2	Humidity	DHT11
3	Pressure	BMP280
4	Air quality	MQ2 gas
5	Altitude	BMP280
6	Daylight	LDR

Table 1: The sensors used for the weather parameters

SNO	Weather parameters	Values are taken indoors	Values are taken outdoors	Recorded values from high altitude	Recorded values from low altitude (Ground level)
1	Temperature	30 (C)	31 (C)	34 (C)	32 (C)
2	Humidity	69%	68 %	64 %	56 %
3	pressure	102 (kPa)	96 (kPa)	39 kPa	124 kPa
4	Altitude	141 m	142 m	147 m	139 m
5	Daylight	30 %	95 %	97%	91 %
6	Air quality	16ppm)	17 ppm	Good	good

Table 2: Results in the analysis of the information from various sensors

VI. CONCLUSION

The model is an ongoing prototype embedded system that is developed with the notion to have a cost-effective, reliable, and simple model which is having the ability to produce accurate atmospheric weather parameters. Further enhancements in the model can be possible with much stronger batteries and sensors and can be upgraded with wi-fi-enabled cloud communication. With much farther communication enhancement between the payload and ground station implementation on a wider radius of the area is possible which is a potential future enhancement.

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