IoT Based Meteorological Station Using Raspberry Pi

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Abstract: This paper describes a real time meteorological station which is built to monitor the weather parameters. Temperature, humidity, rain fall, wind direction, wind speed are ecological parameters which are estimated by utilizing particular sensors for climate checking and applying it in various field such as agriculture, disaster management by weather forecasting and other industry advancements. The meteorological station measures the weather parameters mentioned above which will be IoT based and implemented using Raspberry pi. In this paper, different climate observing systems have been checked on. Framework stores the information on cloud and according to the solicitation information will be given to client using webpage. Real time data is displayed on the webpage and user can also be notified using message and email.

IndexTerms **- Raspberry Pi, IoT, Weather Station, Sensors, Webpage, Cloud**

I. INTRODUCTION

A meteorological station is a facility, with instruments estimating air conditions to give climatic figures. The estimations taken incorporate temperature, air pressure, moistness in air also known as humidity, wind speed, wind direction, and precipitation sums. Various meteorological instruments to measure the climatic parameters are as follows: thermometer is used for measuring air and sea surface temperature whereas barometer for measuring atmospheric pressure. Hygrometer is used for measuring humidity and anemometer for measuring wind speed. The anemometer, with cups revolving around a mobile axis, records wind speed and transforms it into a measurable speed. The weather vane indicates wind direction.

The Internet of things, or IoT, has turned into the cutting edge innovation where the web empowered smart gadgets take the necessary steps without human intercession. An IoT framework utilizes embedded processors, sensors and correspondence equipment to gather, send and follow up on information they get from their surroundings. IoT devices share the sensor data they collect by connecting to an IoT gateway or other edge device where data is either sent to the cloud to be analysed. Sometimes, these devices communicate with other related devices and act on the information they get from one another. The devices do most of the work without human intervention, although people can interact with the devices, for instance, to set them up, give them instructions or access the data. IoT has numerous applications in every single fields. As expressed above, I have utilized IoT as the base to build up a framework to screen the climate parameters which can additionally be utilized for different applications, such as smart farming, disaster management, industrial development, travel guide etc. The model is convenient, portable and economic in nature making it advantageous over conventional stations.

II. SYSTEM DEVELOPMENT

2.1 Block Diagram

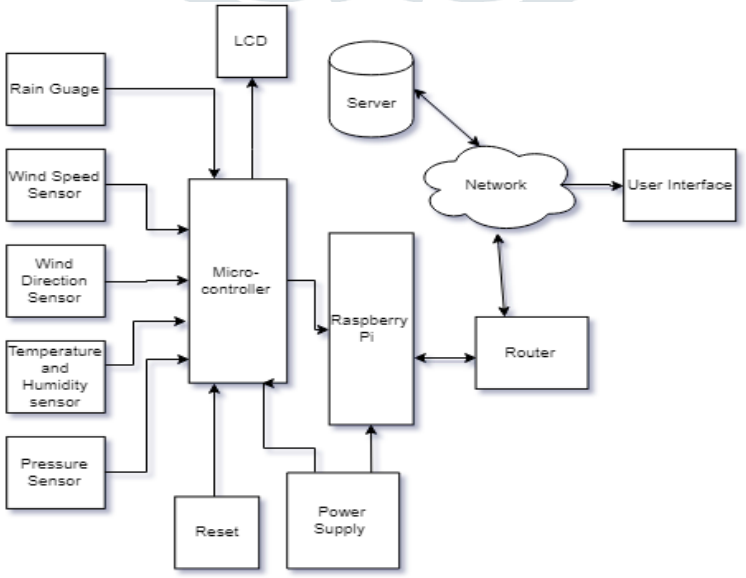


Fig 1. Block Diagram of Meteorological Station

2.2 Hardware

Raspberry Pi

Raspberry Pi is a computer based on Linux OS and is used for IoT applications. Raspberry Pi is considered among the best suited for IoT device is because of the fact that it runs a complete Linux Kernel and has direct interfaces such as Ethernet for wired internet as well as USB ports to connect to Wi-Fi. The operating system of raspberry Pi supports languages like python which makes the development of IoT application easier. Moreover, raspberry pi also has GPIOs so it can directly connect with devices, sensors and real world devices. The credit-card sized laptop is capable of doing many things like using the spreadsheets, word-processing and playing games. It can run many versions of Linux operating system and the heart of the system that makes this computer so powerful and compact is that the Broadcom BCM2835, a System-On-Chip provided by Broadcomm which has ARMl1 series processor with floating unit, it runs at 700MHz, and a Video core GPU. The system uses micro SD cards for saving data, so it is easier to organize and on equivalent hardware it can run many totally different operating systems. No Serial / USB connection with the board are required to install the operating system. Most Linux distributions for the Pi will live on a 4 GB micro SD card but larger cards are supported.

Temperature & Humidity Sensor:

DHT11 is basically a Temperature & Humidity Sensor which has got a calibrated digital signal output. It ensures high reliability and excellent long-term stability because of using the exclusive digital-signal-acquisition technique and temperature & humidity sensing technology. The sensor has a resistive-type humidity measurement component and an NTC temperature measurement component, and connects to a high performance 8-bit microcontroller which in turn offers an excellent quality, fast response, anti-interference ability and cost-effectiveness.

Atmospheric Pressure Sensor:

For measuring the air pressure we have BME180 as an absolute barometric pressure sensor It is specially designed for mobile or portable applications. The packaging of the sensor is extremely compact and therefore has small dimensions and its low power consumption. This is useful in the implementation in battery powered devices such as mobile phones, GPS modules or watches featuring high accuracy and linearity as well as long term stability and high EMC robustness. Numerous device operation options offer highest flexibility to optimize the device regarding power consumption, resolution and filter performance.

Anemometer:

Anemometer is an instrument which measures wind speed which make them vital for meteorologists to study weather patterns and trace the way air moves. It has three or four cups attached to horizontal arms. These arms are attached to a vertical rod. The cups rotate when the wind blows, making the rod spin. Rod spin is directly proportional to the speed at which the air blows, the stronger the wind blows, the faster the rod spins. Hence wind speed is measured by counting the number of rotations, or turns. Wind speed is usually averaged over a short period of time because wind speeds are not consistent. Wind speed is measured by the cup-type anemometer and it works by closing a contact as a magnet moves past a switch. A wind speed of 1.492 MPH (2.4 km/h) causes the switch to close once per second.

Rain Gauge:

Rain is measured using the rain gauge. It has a mechanism of self-exhausting tipping basin type. Its comprise of funnel which collects and sends the precipitation into a small size teeter-totter. When a pre-set amount of precipitation falls, the momentary contact will form, then collected water will release. One momentary contact closure caused 0.011" (0.2794mm) of rain. The recording can be done with a digital counter.

Microcontroller:

All the sensors are connected to microcontroller ATMEGA328P which also acts as the analog to digital converter for few sensors which have their output in analog form. The high-performance Microchip picoPower 8-bit AVR RISC-based microcontroller combines 32KB ISP flash memory with read-while-write capabilities, 1024B EEPROM, 2KB SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible timer/counters with compare modes, internal and external interrupts, serial programmable USART, a byte-oriented 2-wire serial interface, SPI serial port, a 6-channel 10-bit A/D converter (8-channels in TQFP and QFN/MLF packages), programmable watchdog timer with internal oscillator, and five software selectable power saving modes. The device operates between 1.8-5.5 volts. By executing powerful instructions in a single clock cycle, the device achieves throughputs approaching 1 MIPS per MHz, balancing power consumption and processing speed [9].

LCD

An LCD is an electronic display module which uses liquid crystal to produce a visible image. The 16×2 LCD display is a very basic module commonly used in circuits. The 16×2 can display 16 characters per line in 2 such lines. In this LCD each character is displayed in a 5×7pixel matrix. Here LCD is used to display the weather parameters such as temperature, humidity, wind direction, wind speed. These values are fetched from the microcontroller. LCD is interfaced to microcontroller to display the values.

Server

A cloud server is a logical server that is built, hosted and delivered through a cloud computing platform over the Internet. Cloud servers possess and exhibit similar capabilities and functionality to a typical server but are accessed remotely from a cloud service provider.

Router

A router is a networking device that forwards data packets between computer networks. Routers perform the traffic directing functions on the Internet. Data sent through the internet, such as a web page or email, is in the form of data packets.

Fig 2. Developed System

2.3 Software

Flowchart:

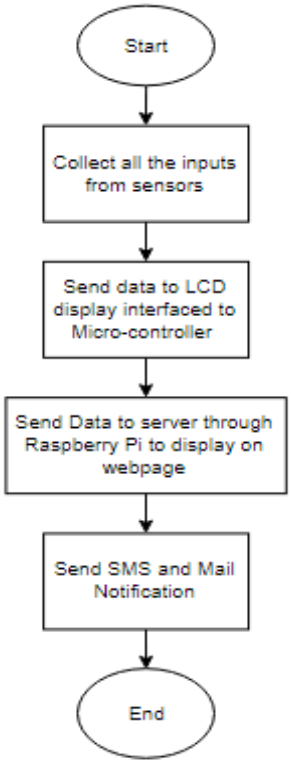


Fig 3. Flowchart

Webpage:
In weather monitoring station, access to weather data is so important and therefore we need a web application which consist of database server and webpage. The values are stored in text file at the server side. The .php page is created to display the value of the weather parameters that are measured and processed by the system. Raspberry Pi continuously uploads data to the to the server and real time data is accessible by web page. Therefore, weather data can be easily available to distant location also. As stated above, the system is design to get the real time data. Remote location weather monitoring directly helps in analysis and user shall easily save time and money

Embedded C:
Embedded C is perhaps the most popular languages among Embedded Programmers for programming Embedded Systems. There are many popular programming languages like Assembly, BASIC, C++ etc. that are often used for developing Embedded Systems but Embedded C remains popular due to its efficiency, less development time and portability. Embedded Software or Program allow Hardware to monitor external events (Inputs) and control external devices (Outputs) accordingly. During this process, the program for an Embedded System may have to directly manipulate the internal architecture of the Embedded Hardware (usually the processor) such as Timers, Serial Communications Interface, Interrupt Handling, and I/O Ports etc.

Python:
Python provides lots of features. Python is easy to learn and use. It is developer-friendly and high level programming language. Python language is more expressive means that it is more understandable and readable. It is an interpreted language i.e. interpreter executes the code line by line at a time. This makes debugging easy and thus suitable for beginners. It can run equally on different platforms such as Windows, Linux, Unix and Macintosh etc. So, we can say that Python is a portable language. Python language is freely available at official web address. The source-code is also available. Therefore, it is open source. It supports object oriented language and concepts of classes and objects come into existence [10].

III. RESULTS AND DISCUSSIONS

Meteorological station is deployed in an open space where wind direction and speed along with precipitation levels can be measured. Various climatic parameters are sensed with highly calibrated sensors with good accuracy.
Real time values are displayed on the LCD. Also the data is send to the cloud server where it is stored in a file from where the data can be retrieved on request. Real-time data or the previous data can be accessed as per the requirement. The url for result page is http://www.iotsystem.in/index18402.php.
Majority of the climatic conditions are taken into consideration so that the scope of device increases and it is used in number of applications. Using Raspberry Pi as the data logger system allows flexibility like reprogramming the system to achieve required results and further process as per the requirement. The result that we obtain is the real time climatic conditions which are displayed on the screen. User can also download the csv file which has all the parameter values. Also the email as well as SMS has been send to the concern authority. The results are more accurate than the systems that are build using various other sensors.

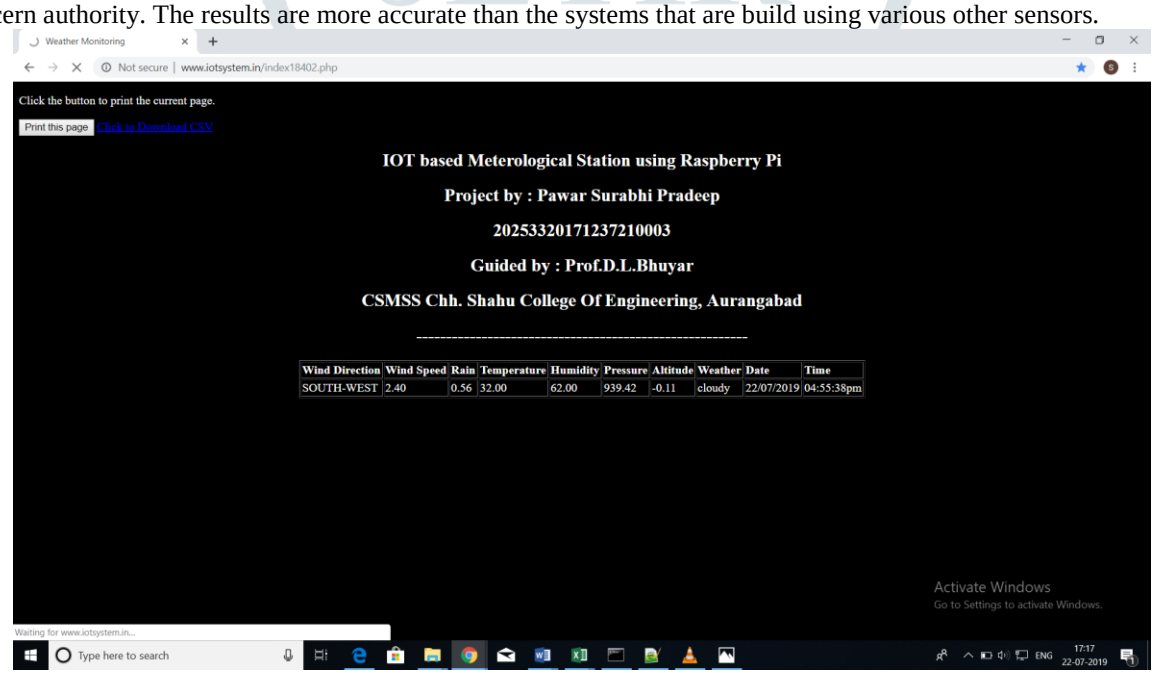
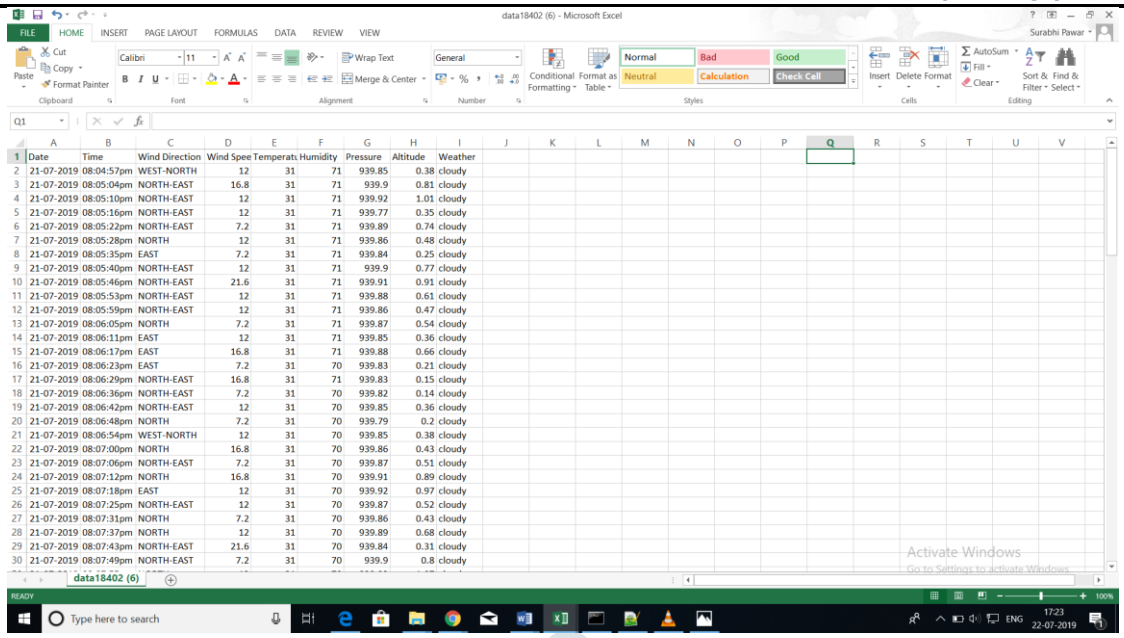


Fig 3. Webpage showing the result



Date	Time	Wind Direction	Wind Speed	Temperature	Humidity	Pressure	Altitude	Weather
21-07-2019	08:04:57pm	WEST-NORTH	12	31	71	939.85	0.38	cloudy
21-07-2019	08:05:04pm	NORTH-EAST	16.8	31	71	939.9	0.81	cloudy
21-07-2019	08:05:10pm	NORTH-EAST	12	31	71	939.92	1.01	cloudy
21-07-2019	08:05:16pm	NORTH-EAST	12	31	71	939.77	0.35	cloudy
21-07-2019	08:05:22pm	NORTH-EAST	7.2	31	71	939.89	0.74	cloudy
21-07-2019	08:05:28pm	NORTH	12	31	71	939.86	0.48	cloudy
21-07-2019	08:05:35pm	EAST	7.2	31	71	939.84	0.25	cloudy
21-07-2019	08:05:40pm	NORTH-EAST	12	31	71	939.9	0.77	cloudy
21-07-2019	08:05:46pm	NORTH-EAST	21.6	31	71	939.91	0.91	cloudy
21-07-2019	08:05:53pm	NORTH-EAST	12	31	71	939.88	0.61	cloudy
21-07-2019	08:05:59pm	NORTH-EAST	12	31	71	939.86	0.47	cloudy
21-07-2019	08:06:05pm	NORTH	7.2	31	71	939.87	0.54	cloudy
21-07-2019	08:06:11pm	EAST	12	31	71	939.85	0.36	cloudy
21-07-2019	08:06:17pm	EAST	16.8	31	71	939.88	0.66	cloudy
21-07-2019	08:06:23pm	EAST	7.2	31	70	939.83	0.21	cloudy
21-07-2019	08:06:29pm	NORTH-EAST	16.8	31	71	939.83	0.15	cloudy
21-07-2019	08:06:36pm	NORTH-EAST	7.2	31	70	939.82	0.14	cloudy
21-07-2019	08:06:42pm	NORTH-EAST	12	31	70	939.85	0.36	cloudy
21-07-2019	08:06:48pm	NORTH	7.2	31	70	939.79	0.2	cloudy
21-07-2019	08:06:54pm	WEST-NORTH	12	31	70	939.85	0.38	cloudy
21-07-2019	08:07:00pm	NORTH	16.8	31	70	939.86	0.43	cloudy
21-07-2019	08:07:06pm	NORTH-EAST	7.2	31	70	939.87	0.51	cloudy
21-07-2019	08:07:12pm	NORTH	16.8	31	70	939.91	0.89	cloudy
21-07-2019	08:07:18pm	EAST	12	31	70	939.92	0.97	cloudy
21-07-2019	08:07:25pm	NORTH-EAST	12	31	70	939.87	0.52	cloudy
21-07-2019	08:07:31pm	NORTH	7.2	31	70	939.86	0.43	cloudy
21-07-2019	08:07:37pm	NORTH	12	31	70	939.89	0.68	cloudy
21-07-2019	08:07:43pm	NORTH-EAST	21.6	31	70	939.84	0.31	cloudy
21-07-2019	08:07:49pm	NORTH-EAST	7.2	31	70	939.9	0.8	cloudy

Fig 4. CSV file having multiple records

Conclusion:

The proposed system which is based on Internet of things can be used to measure weather parameters accurately over a wide area and log the data without human intervention. This system provides a portable, cheap, easy and real time solution to observe the weather parameters. The system helps in reducing the human error. Since all the parameters are displayed online, it can be made available to general public for smart cities. This concludes that the present work would be competent method for recording real time weather readings and can be implemented for the benefit of the society in various aspects such as weather forecasting, smart farming, and disaster management.

Future Scope:

System can incorporate solar cells for self-sustained power supply. Same system can be applicable to the variety of applications like controlling of data at remote location. IOT based meteorological station can act as the input to the systems which can be applied in smart farming, industrial developments, educational purpose, energy sectors, food industries, marines etc . The .csv file generated has multiple records of the all the parameter sensed. It can serve as the historical data for supervised machine learning.

IV. ACKNOWLEDGMENT

I express my sense of gratitude and sincere regards to my guide Prof.D.L.Bhuyar and co-guide Prof.A.S.Paymode sir. They have inspired and guided me at all stages of this project work.

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BIOGRAPHIES

Pawar Surabhi Pradeep is pursuing M.Tech. in the stream of Electronics Engineering from CSMSS Chh. Shahu College of Engineering, Aurangabad, Maharashtra, India. She has completed her B.E. in the stream of Electronics and Telecommunication Engineering in 2014.Her areas of interest are, Embedded system, Communication systems and IOT

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Prof.A.S.Paymode working as Assistant Professor in CSMSS Chh.Shahu College Engineering, Aurangabad. He have completed Bachelor of Engineering from Pune University in 2011 Electronics and Telecommunication Engineering. He also completed Master in Technology specialization in VLSI System Design in 2014 from JNTU Hyderabad. His research interests in VLSI, Machine Learning,Deep Learning, Artificial intelligence ,Data Science.