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Low-Power IoT-based Weather Monitoring System

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Abstract
This paper proposes to monitor weather of specific places on Websites and Android devices using internet of things. The communication between the devices is wireless. The protocol between the units in the design is enhanced to be suitable for most of the appliances. Weather variables such as wind speed and direction, temperature, humidity, solar radiation, soil moisture and rainfall may all be important factors in determining the course of a wide range of events. For example, agriculture has always been heavily dependent on the weather and weather forecasts, both for its control on the quality and quantity of a harvest and its effect on the farmer's ability to work the land or to graze his stock. Water resources generally depend critically not just upon rainfall, but also other weather phenomena that together drive plant growth, photosynthesis, and evaporation. Weather monitoring is also important not just in defining the present climate, but also for detecting changes in climate and providing the data to input into models which enable us to predict future changes in our environment.

1. INTRODUCTION

Weather forecasting is the application of science and technology to predict the state of the atmosphere for a given location. Human beings have attempted to predict the weather informally for millennium and formally since the nineteenth century. Weather forecasts are made by collecting quantitative data about the current state of the atmosphere on a given place and using scientific understanding of atmospheric processes to project how the atmosphere will evolve on that place. Personal weather stations have the ability to display an astonishingly large array of weather conditions, whether it is temperature, humidity, wind direction and speed, rain fall, or even solar and ultraviolet radiation.

And all of this information can be gathered without even leaving the house. The weather station provides you with the possibility to share the measured values either by easily integrating it into your own already existing webpage, or you can take advantage of the possibility to use many tools for analyzing the actual and historical data.

IoT- Based weather monitoring systems are classified based on the technology used. 1) WSN, 2) Satellite, 3) Arduino, 4) GSM, 5) Radar, 6) Zigbee, 7) Camera- Based System. Wireless Sensor Networks (WSNs) [1] include various sensors distributed spatially with the capacity of communication, processing and computing. Here, in real-time manner, data is processed and managed. One proposed framework [2]

conquers the above restriction by organization of WSN base for different climate advance utilizing virtual sensor and overlay idea.

Fig1. Weather station

Satellite information is progressively being utilized as a part of conjunction with routine meteorological perceptions in the concise investigation and traditional climate gauge to concentrate data [4]. CanSat [5] is a scale reproduction of the outline, creation and dispatch of a genuine satellite. It is described by minimal effort of usage. Climate observing is the utilization of science and innovation to foresee the condition of the climatefor a given area. Through a specific framework [7] [8], it can naturally gather data about stickiness and temperature. The points of interest are put away in a database and as per present and past information authors can deliver the outcomes in a graphical way in the framework. In GSM- based systems[9][10], a gadget for ongoing climate observing is displayed to screen the constant temperature, environmental weight, relative dampness, and air's dew point temperature through such system which is utilizing simple and advanced parts. In Radar-based systems like [11] [12], the creators introduced a technique that coordinates both of the information sources to give strategic and arranged climate radar. To create sensor networking and weather station monitoring system without human mediation, utilizing Wireless ZigBee Technology [13][14]. Zigbee is the most recent remote climate checking method. The previous checking frameworks of Weather Monitoring System are manual at that time.With a unique sort of camera and computerized multi-image photogrammetric framework, it's currently conceivable to takeout Digital Elevation Models (DEM) with capturing an image by the camera [15].Using such a strategy; the plane may not be limited to flight way straightly. And it may go straightforwardly along the objective region.

2. SYSTEM ARCHITECTURE

Our wireless weather monitoring system is an automated version of measuring weather parameters and sending the information to a distant database thingspeak wirelessly via ESP8266. Our system hasgot almost all things automated so that we get an advantage of this concept, i.e. the real time direct measurement of the parameters through ESP8266. Maintaining backup of sent data is easy and can be done within a few seconds. This model uses Sensors, ESP8266 module, and a ATMEGA-328 Microcontroller.

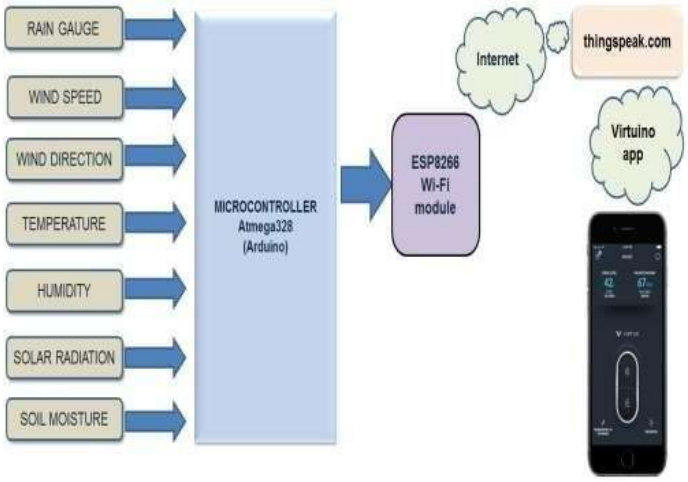

Fig2. System model

2.1 ATmega328 based Arduino Board

AVR RISC-based microcontroller Arduino is both an open-source software library and an open-source breakout board for the popular AVR micro-controllers. The Arduino IDE (Integrated Development Environment) is the program used to write code, and comes in the form of a downloadable file on the Arduino website. The Arduino board is the physical board that stores and performs the code uploaded to it. Both the software package and the board are referred to as "Arduino.

Fig3. Atmega- Arduino Pin mapping

2.2 ESP8266 Wi-Fi module

The ESP8266 is a Wi-Fi SOC (system on a chip) produced by Espressif Systems. The ESP8266 can be used as an external Wi-Fi module, using the standard AT Command set Firmware by connecting it to any microcontroller using the serial UART, or directly serve as a Wi-Fi enabled micro-controller, by programming a new firmware using the provided SDK. This board has been around for almost a year now, and has been used mostly in IoT contexts, where we want to add connectivity, for example to an Arduino project.

Fig4. ESP8266Wi-Fi Module

2.3 Sensors

2.3.1 Wind Speed (Anemometer)

An anemometer is a device used for measuring the speed of wind, and is also a common weather station instrument. The wind moves the cups on the anemometer, which in turn rotates an enclosed magnet. The magnet closes a reed switch on each rotation, which is reflected on the output. You can measure this on the two inner conductors of the RJ-11 connector (pins 2 and 3), using a digital counter or interrupt pin on your microcontroller.

Fig5. Wind Speed Sensor

2.3.2 Wind Direction

The wind vane indicates the direction that the wind is blowing. This is actually the most complex gauge of the three. Internally on the vane are eight switches, each with their own unique resistor. As the wind vane rotates, a magnet closes the reed switches, and may close two at a time due to their proximity to each other. With the use of an external resistor, a voltage divider can be created.

Fig5. Wind Direction Sensor

2.3.3 Rain Guage

The rain gauge measures rainfall. The sensor is a self-emptying tipping bucket collector. This means that for each 0.011" (0.2794 mm) of rain that falls on the sensor, the bucket will tilt, dumping the water out and closing a momentary contact. The closure of the momentary switch can be measured using interrupt pins or a digital counter. The center conductors of the RJ-11 connector are connected to the gauges switch.

Fig6. Rain Guage Sensor

2.3.4 Solar Radiation sensor

The sensor is designed for continuous measurement of solar radiation or light measurements in open field for long durations. The low power consumption makes it ideal for remote applications. The sensor provides a linear 0 to 5 volt output.

Fig7. Solar Radiation Sensor

2.3.5 Soil moisture sensor

Soil moisture sensors measure the volumetric water content in the soil. Since the direct gravimetric measurement of free soil moisture requires removing, drying, and weighting of a sample, soil moisture sensors measure the volumetric water content indirectly by using some other property of the soil, such as electrical resistance, dielectric constant, or interaction with neutrons, as a proxy for the moisture content.

Fig8. Soil Moisture Sensor

2.3.6 Temperature & Humidity sensor

A temperature sensor is a device that provides temperature measurement through an electrical signal.

A humidity sensor senses, measures and regularly reports the relative humidity in the air. It measures bothmoisture and air temperature.

Fig9. Temperature and Humidity Sensor

2.4 Printed circuit board

A Printed Circuit Boards (PCB) is a rugged, copper and non-conductive substrate-based structure used to connect electrical components. The PCB is the backbone of electrical devices, allowing you to connect passive (resistor, inductor, capacitors, etc.), active (operational amplifiers etc.) and embedded devices together, into specific form factors to fit the design need. Connections between the components are made through copper connections (routes) which become passageways for electrical signals.

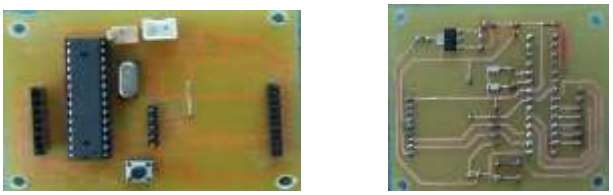

Fig9. Assembled Printed Circuit board

3. SIMULATIONS AND EXPERIMENTAL RESULTS

The simulation is done on Arduino IDE. The output voltage of sensors is obtained in millivolts and is converted to digital value. The Hardware system provides the weather information through the Thingspeak server. The ESP8266 module works in station mode so we provide a connectivity through any router, then thismodule sends all collective sensors values to thingspeak.

All sensors are connected to port of the ATMEGA328 microcontroller device. The overall power consumption by the system is very less.

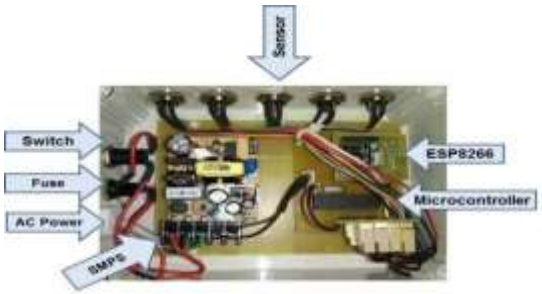

Fig10. Hardware Assembly

Table1. Power Consumption of components

Components	Power (approx.)
Microcontroller	80 mW
ESP8266	450mW
Rain Sensor	5 mW
Wind Speed Sensor	5 mW
Wind Direction Sensor	5 mW
Temperature and Humidity Sensor	10 mW
Soil Moisture Sensor	30mW
Solar Radiation Sensor	150 mW
Total Power	730 mW (at 5v and 140 mA)

All collected values can be monitored directly which is simultaneously displayed on the Virtuino app panel and a message is sent to the mobile by using Virtuino when some particular condition is occur at the same instance.

Fig11. Final result on thingspeak Server

4. CONCLUSION

The paper deals with designing a weather monitoring system using some sensors, ESP8266 module and ATmega328 microcontroller unit to monitor weather conditions of the desired location and transmit it to a webserver and android application. The designed product module is at the prelim stage and designed for monitoring some parameters like Temperature, humidity, rain level, wind speed, etc but can be enhanced for monitoring other different types of environmental and climatic behavior of a location, which also can consume less power. In this paper we use the ESP8266 Wi-Fi module for sending data to the server so it requires connectivity with any router when connectivity is lost, the information will not send by the station for avoiding this we can also use inbuilt connectivity by using GSM module.

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