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Cloud Based Weather Monitoring System

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Abstract:-Weather monitoring plays an important part in human life, so the collection of information about the temporal dynamics of weather changes is very significant. In any industry during certain hazards it is very important to monitor weather. The basic aim of this paper is to develop an embedded system to design a weather monitoring system which enables the monitoring of weather parameters. Such a system contains pair of sensors like Humidity, temperature, wind speed, wind direction data can be logged into cloud so that any one (authenticated person) from any place can observe the specific data. In case of any disasters like fire, heavy rain, heavy wind, temperature or humidity may be uncontrollable, in these cases the instant information can be conveyed throughout the world using cloud to the authenticated persons, even if his hardware is destroyed in emergency. The system uses a compact circuitry built around Raspberry Pie (ARM11) microcontroller Programs are developed in Embedded C.

Key words: *Humidity Sensor, Temperature Sensor, Wind Speed Sensor, Wind direction Sensor, Raspberry Pie Board.*

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I. INTRODUCTION

Cloud data can be secured and easy/fast for accessing. Any continuous varying data can be logged into cloud [1]. Software and hardware support logging into cloud are the two different processes [2]. Software based logging indicates logging with Personal computer. Hardware based support indicates logging with hardware systems with specific processor [3]. Hardware based support system may be dedicated to particular application and can be designed with RTOS with Embedded Processor [4]. In hardware support logging process, choosing processor is the main task. Fast and error less sensor network handling and processing having internet accessing service is the main requirement in hardware based logging system[5]. It is also required to enter real time varying data with specific intervals. We designed the hardware system so that it will direct the real time temperature, humidity, wind speed and wind direction's details to Google cloud. We can monitor the logged data to cloud from Internet. We used ARM 11 Raspberry pi board for designing committed Embedded system. Internet access and sensing system interface can be efficiently achieved with ARM 11 board so specifically used [6]. Python coding can be used for programming with Raspberry pi. Three Python modules can be designed 1) humidity and temperature sensing, 2) wind speed and wind direction sensing and 2) logging system for sending data to cloud [8]. First and second modules sense all the parameters and can exhibit on its monitor and second module sends the given information by logging into Google cloud [9]. Google cloud's service is taken for logging into their cloud. Excel sheet like content can be monitored from mass through Internet. Humidity, temperature, wind speed and wind direction for any application can be logged into mass so that any one (authenticated person) from any location can observe the specific data. In case of any calamity like fire, heavy rain, heavy wind, temperature or humidity inner side and or outside may be uncontrollable and different due to heavy rain or heavy wind. In these cases the immediate information can be conveyed throughout the world using mass to the authenticated persons so that action can be taken as early as possible with emergency help. This will be very much helpful in calamity management .System requires hardware like ARM 11 processor, humidity, temperature, wind direction and wind speed sensor circuitries, Internet connection through LAN or wifi. Far terminal requires the Internet connection (for demo we can use Internet through LAN access). Raspberry Pi Arm 11 panel is essential to be loaded with boot loader for proper operation. Raspberry pi desktop monitoring is essential to grow the Python coding. Raspberry p (Rpi) board's desktop can be accessed on Laptop/PC using LAN connection with Rpi board. Once Rpi board is set after Initial Loading, it can be pinged from our Laptop/PC. Putty and Xming software are used to entry the desktop of Rpi on Laptop. One can develop the Python using desktop of Rpi easily. Tools for Python editing, behead, debugging are already available in desktop of Rpi. So, Python dummy can be easily developed using those tools. We can use open origin Python coding for Rpi obtainable on Internet for developing the codes for hardware. Rpi system desktop is like a Windows desktop through which we can entry the Internet, LAN, wifi devices Bluetooth devices through ARM 11 processor. We can use the keyboard and mouse on desktop of Rpi like PC. It work on Linux operating system. Rpi panel can be act as real time dedicated system by loading our code on root. Features like easy to interface, easy to operate and easy to get information on Internet lead us to use this ARM 11 board for our purpose.DHT11 Sensor can be used for sensing the humidity and temperature. Rather than using dissimilar sensors for humidity and temperature, we decided to use the combined sensor for our work. The DHT11 is chosen because it is lab calibrated, accurate and stable and its signal output is digital. Most important of all, it is relatively inexpensive for the given performance. For wind speed and wind direction sensing, infrared speed sensing can be used and for wind direction sensing, compass sensor can be used. In this work, we are going to build weather measurement station that will automatically multiplex station all the data and send it to

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the cloud using the temboo Google service for monitoring, we like to connect our sensing devices wirelessly and to the web, especially using wifi ,one solution is to use wifi breakout boards or shields, for example using the cc3000 wifi chip ,connect it to an rpi board our own code for the wifi communication & remote interface.

II PREVIOUS PROBLEM

In the previous research, a single master-multi slave microcontroller communication method has been developed. The microcontroller is able to communicate using unicast communication, i.e. the master gave orders to one slave address via the master-slave network that has star topology. Then the slave who has the same address which is requested will respond or take action in accordance with the master command. Modbus Protocol is the rules of data communication with the master-slave technique. We designed the hardware system so that it will direct the real time temperature, humidity, wind speed and wind direction's data to Google cloud. We can monitor the logged data to cloud from Internet. We used ARM 11 Raspberry pi board for designing dedicated embedded system.

III NEW PROPOSED SYSTEM

System consists of sensing Circuit ARM 11 rpi Processor, Wireless/Internet Interface, Cloud System the connectivity between the various above components of system is shown in following diagram.

Sensing circuit consist of DHT11 sensor having temperature and humidity sensing capability. It is constructed by analog conditioning and analog to digital serial converter. Serially data can be connected to microprocessor MCU as shown in following diagram. DHT11 is the combined sensing device which can send the humidity as well as temperature data serially.

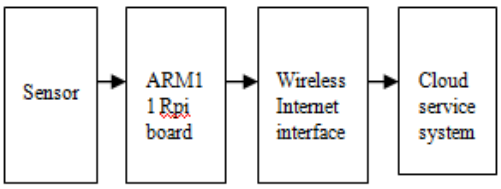

Fig 1- Block diagram of the system

Pin out of the sensor :-

Fig 2-Pin description

Pin Description:-

Pin	Name	Description
1	Vd	Power supply 3.3-5.5v dc
2	Data	Serial data output
3	Nc	Not connected
4	Ground	Ground

Connect the sensor to the Rpi board is as shown below-

DHT11	Rpi Board
Pin1	Vcc
Pin2	Pin10
Pin4	Gnd

This system includes measurement of wind speed, wind direction, humidity and temperature. The real time measured parameters will be stored in database and also to cloud. Cloud interface is requires internet access. We access internet using wifi module.

1) Wind speed measurement (anemometer):

An anemometer is a device used for measuring wind speed, and is a common weather station instrument. The term is derived from the Greek word *anemos*, which means wind, and is used to describe any wind speed measurement instrument used in meteorology.

Vane anemometers

One of the other forms of mechanical velocity anemometer is the *vane anemometer*. It may be described as a windmill or a propeller anemometer. Contrary to the Robinson anemometer, where the axis of rotation is vertical, the axis on the vane anemometer must be parallel to the direction of the wind and therefore horizontal. Furthermore, since the wind varies in direction and the axis has to follow its changes, a wind vane or some other contrivance to fulfil the same purpose must be employed. An *vane anemometer* thus combines a propeller and a tail on the same axis to obtain accurate and precise wind speed and direction measurements from the same instrument. The speed of the fan is measured by a rev counter and converted to a winds peed by an electronic chip. Hence, volumetric flow rate may be calculated if the cross-sectional area is known.

Fig 3-Pin wind measurement

Wind vane:-

We designed wind vane using computer fan blades and magnet assembly, when it rotates, its magnet also rotates, which is made up of 4 south and 4 north poles
alternately. So to measure the speed, the Hall Effect sensor is inserted in it which identifies the north and south pole motion and provides the square wave. The frequency of generated square wave corresponds to the speed of the rotation of fan blades.

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2) Wind direction measurement:
With the use of wind vane, the direction can be measured. We designed the wind direction measurement using an assembly of wind vane, potentiometer and adc which provides the digital signals corresponding to the rotation of potentiometer.

3) Humidity and temperature measurement:
DHT11 humidity and temperature sensor is used to measure these parameters. Proposed sensing circuit consist of DHT11 sensor having temperature and humidity sensing capability. It is constructed by analog conditioning and analog to digital serial converter serially data can be connected to microprocessor MCU as shown in following diagram. DHT11 is the combined sensing device which can send the humidity as well as temperature data serially.

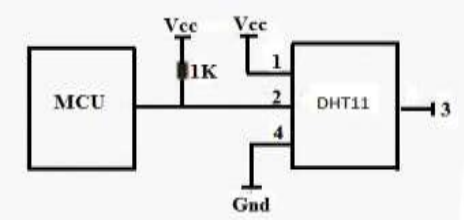

Fig 4-Temp and Humidity sensor

Arm 11 Rpi Processor:-
Over the 90% of the embedded market is based on ARM architecture. ARM Ltd. makes over $100 billion USD annually in royalties and licensing fees for this technology. Over two billion units are shipped each year. ARM stand for Advanced RISC Machine. ARM11 is a family of an ARM architecture 32 bit RISC microprocessor cores. The ARM11 is based on the ARMv6 instruction set architecture. These include SIMD media instructions, multiprocessor support and new cache architecture. The implementation included a significantly improved instruction processing pipeline, compared to previous ARM9 or ARM10 families, and is used in smart phones from Apple, Nokia and others. It supports Bi-endian, that can operate in either little endian or big-endian format. Most of the devices today uses little-endian format. Actually it uses two instructions set, the 32 bit ARM and 16 bit Thumb. Science many embedded devices have small amounts of memory, a smaller 16 bit instruction set can be used. This 16 bit Thumb instruction set makes use of implied operands and reduced functionality to reduce the code size. Thumb instructions are decoded into ARM instruction on fly at execution time, through consuming an additional cycle. CPU is either “ARM state” OR “Thumb state”. It consist of 16 general purpose resisters, 17 general purpose “mode specific” register and 7 status registers, one for each operating mode.

Raspberry Pi, Model B+:-
The Raspberry Pi is a small, powerful and lightweight ARM based computer which can do many of the things a desktop PC can do. The Raspberry Pi is built using ARM11 processor. The Raspberry Pi is based on a Broadcom BCM2835 chip. The Raspberry Pi is a credit card sized computer that runs the freely available Linux Operating System. It is powered by a typical mobile phone charger using a micro USB connector, but be careful to choose a charger that can supply at least 700 milli-amps. The Raspberry Pi can be connected to a TV using an HDMI cable although an analogue connection is also available. The powerful graphics capabilities and HDMI video output make it ideal for multimedia applications such as media centers and narrowcasting solutions. It does not feature a built-in hard disk or solid-state drive, instead relying on an SD card for booting and long-term storage. Raspbian is a Debian-based free operating system optimized for the Raspberry Pi hardware. The specifications are as follows:

1) The Raspberry Pi is based on Broadcom BCM2835 SoC processor chip.
2) It is having CPU of 700 MHz Low Power ARM1176JZFS Applications Processor.
3) It having general processing unit of Dual Core Video Core IV® Multimedia Co Processor.
4) It Provides Open GL ES 2.0, hardware-accelerated OpenVG, and1080p30 H.264 high-profile decode.
5)It Capable of 1Gpixel/s, 1.5Gtexel/s or 24GFLOPs With texture filtering and DMA infrastructure.
6) It have inbuilt 512MB SDRAM memory.
7) The operating System Boots from SD card and a version running on the Linux operating system.SD card is expandable up to 32 GB.
8) The size of Raspberry pi is 85.6mm (length) x 53.98mm (width) x 17mm (height).
9) It required 5V DC power supply.
10)Raspbian is a Debian-based free operating system optimized for the Raspberry Pi hardware.
11)It is having 4 USB connector, 3.5mm jack, and 10/100 Ethernet RJ 45 on board network.
12)It is having HDMI (rev 1.3 & 1.4) composite RCA (PAL and NTSC).
The Raspberry Pi is a computer, Easy to use but powerful, affordable and (as long as we are careful) difficult to break. Raspberry Pi processor is mainly used in this system because of the HDMI port which is required for displaying images on display in home chip.

IV HARDWARE DESCRIPTION

In this project, we have to acquire all environmental parameters like temperature, humidity, gas a accelerometer sensors and the measure these sensor values using ADC pins in LPC1768. Here in the above figure we use Multi sensor Board for placing the sensors Max Board is used for transmitting the data using serial communication.


Fig 5-Experimental setup1

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Fig 6-Experimental setup2

Output Display for Rpi ARM 11:-

The output of the proposed system should be seen on LCD which has HDMI connection facility. The HDMI connector is used to connect monitor of personal computer. Nowadays, HDMI connection facility is also available on LCD and LED Televisions.

HDMI (High-Definition Multimedia Interface) is a compact audio/video interface for transferring uncompressed video data and compressed or uncompressed digital audio data from a HDMIcompliant source device, such as a display controller, to a compatible computer monitor, video projector, digital television, or digital audio device. HDMI is a digital replacement for existing an alogue video standards. HDMI implements the EIA/CEA-861 standards, which define video formats and waveforms, transport of compressed, uncompressed, and LPCM audio, auxiliary data, and implementations of the VESA EDID.

Fig 7- HDMI connector

Fig 8- LCD display

CEA-861 signals carried by HDMI are electrically compatible with the CEA-861 signals used by the Digital Visual Interface (DVI). No signal conversion is necessary, nor is there a loss of video quality when a DVI-to-HDMI adapter is used. The CEC (Consumer Electronics Control) capability allows HDMI devices to control each other when necessary and allows the user to operate multiple devices with one remote control handset. Several versions of HDMI have been developed and deployed since initial release of the technology but all use the same cable and connector. Newer versions optionally support advanced features such as 3D, an Ethernet data connection and improved audio and video capacity, performance and resolution.

Wireless and Internet Interface:-

Wifi module can be interface to Rpi for Internet connectivity. The CC3000 WiFi chip from Texas Instrument is a quite versatile chip that can be used to connect the system to the web. However, connecting Rpi project to a web server can be tricky for which we need to know how to install & configure a web server, and know a bit about HTML & PHP.

Here how to connect a temperature & humidity sensor to an online platform for connected objects, Google cloud. The sensor will be connected to an Rpi board, which will also communicate with the Adafruit CC3000 breakout board for the WiFi connectivity. But instead of communicating with a local server, the CC3000 chip will communicate directly with the Google cloud server and send the data over there. At the end, you will be able to monitor the data sent by the server directly from your browser, wherever you are in the world, just by logging into the Google cloud website.

V SOFTWARE REQUIRMENT DETAIL

Introduction to Thing Speak and overview of its basic work flow. The Internet of Things provides access to a broad range of embedded devices and web services. ThingSpeak is an open data platform and API for the Internet of Things that enables you to collect, store, analyze, visualize, and act on data from sensors or actuators, such as Arduino®, Raspberry Pi™, Beagle Bone Black, and other hardware. For example, with Thing Speak you can create sensor logging applications, location-tracking applications, and a social network of things with status updates, so that you could have your home thermostat control itself based on your current location. The primary element of Thing Speak activity is the *channel*, which contains data fields, location fields, and a status field. After you create a Thing Speak channel, you can write data to the channel, process and view the data with MATLAB® code, and react to the data with tweets and other alerts. The typical ThingSpeak workflow lets you:

1) Create a Channel and collect data
2) Analyze and Visualize the data
3) Act on the data using any of several Apps

The Thing Speak API is available on Git Hub and includes the complete Thing Speak API for processing HTTP requests, storing numeric and alphanumeric data, numeric data processing, location tracking, and Status updates.

Software development:

Main Algorithm:

1. Initialize all the devices.

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2. Read all the sensors within specified duration say 1 sec each.
3. Collect the data and store in a file as a local database.
4. Send the data to cloud in different channels.

Algorithm to measure wind speed:

1) Read the serial data from Hall Effect sensor continuously.
2) Temporarily store it for calculation of speed. It provides pulse like signal.
3) Calibrate the data to find the duration between picks of the varying waveform.
4) Calculate the duration between two picks of the waveform.
5) Calibrate it in into the speed of the wind.
6) Algorithm to measure wind direction.
7) Read the data of potentiometer from adc.
8) Compare the data with the predefined values corresponding to the different directions.
9) It gives the direction in terms of N, S, E, W, NE, NW, SE and SW.

Algorithm to measure temperature and Humidity:

1) Read the serial data1 from DHT11 sensor.
2) Calibrate the serial data into exact value of temperature.
3) Read the serial data2 from DHT11 sensor.
4) Calibrate the serial data into exact value of temperature.
5) Algorithm to send the data to cloud using ThingSpeak.com:
6) Initialize the predefined channels of ThingSpeak.com
7) Get data from every sensors and send it to the N corresponding channels.
8) Repeat the above step every 1 sec.

Procedure to run on the system:-

1) Connect all the sensors as per the connection diagram.
2) Connect the Internet through wifi. Check whether it is connected or not.
3) Ping to the IP 184.106.153.149 to check the connectivity to the cloud server.
4) Run the code on the command window.
5) Check the website, www.thingspeak.com/ channel where channel _ is provided during the configuration of the cloud.
6. It will show real time updating of all the channels in terms of different graphs.

VIII CONCLUSION

We have developed the system in which the real time acquisition and cloud storage is demonstrated. We used the wind speed and direction measurements and temperature and humidity measurement for our work. We proved that with minimum efforts we can add the extra sensors and channels so that in future automatic enlargement of adding sensors and channels are possible. This storage can be used by researchers and academician for further analysis and prediction globally. With very few seconds data can be visualized in to the globe so can fulfil the today's need.

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