An Ethernet Based Real-Time Weather Monitoring System Using Raspberry Pi

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Abstract - *This paper presents the real-time monitoring of different environmental parameters using embedded web server technology at low-cost. For this purpose we have used ARM based Raspberry Pi board with RJ-45 Ethernet port. Raspbian operating system is used with Linux kernel for Raspberry Pi. Python is used as software platform for operating system. In this system DHT11, BMP180, LDR and marked scale with ULN2803 are used for environmental parameter measuring. Acquired data from these sensors can be displayed on embedded web server using internet protocol and Ethernet interface. Along with this all collected data can be seen in view log.*

Key Words: Raspberry Pi, Ethernet, ARM, Sensors, Raspbian, SPI, I2C.

1. INTRODUCTION

Weather station is the study of different environmental parameters using some instruments and equipments. Weather affects all living creatures very closely. Also from agricultural field to industrial field have effect of weather changes. So to meet the goal of weather monitoring we have designed the real-time, portable and low-cost weather station. At our weather station we are measuring some environmental parameters like temperature, humidity, pressure, altitude, light intensity and level. Some weather monitoring systems uses GSM module, ZigBee module, Ethernet module along with microcontroller and ADC for environmental parameters monitoring. Here in this system we have used ARM based Raspberry Pi board which is a complete system and it can handle many operations. There is no need of any external module, microcontroller and ADC in this system. The proposed system uses Ethernet network for weather parameters monitoring. Ethernet network is formed by giving LAN connection to RJ-45 Ethernet port which is inbuilt on Raspberry Pi board and HTTP internet protocol. IDLE is the text editor for Raspberry Pi where programs can be written in Python. Hyper Text Markup Language (HTML) is used to write Web Pages.

2. LITERATURE SURVEY

M. Rahaman Laskar et al. presented paper on weather forecasting using Arduino and Cube-Sat. This proposed system uses temperature and humidity sensor (DHT11), pressure and altitude sensor (BMP180) and accelerometer (ADXL-335). The data processing unit Arduino Uno is used. Cube satellite is used to provide information of weather from anywhere without using network. A gas balloon is used to hold and carry the Cube satellite. This system is simple to construct, portable, cost efficient, low power consuming and reliable. But there are some limitations such as device may not communicate at long distance without powerful transceiver section, at higher altitude record of data with the help of gas balloon may be a problem and components may be damaged by rain or long time use. [2]

Vinayak Aappasaheb Pujari et al. have proposed the system that uses the solar power panel. This system is used to monitor temperature, wind speed, wind direction, humidity and rain. The sensed data will be sent to GSM module and through gateway to the personal computer. A server is connected to the database. [3]

Prof. Satyashil Nagrale et al. have proposed the weather monitoring system using real time data transmission. The proposed system uses VAISALA weather transmitter sensor WXT520 to transmit the data to the control room. It sense the parameters like wind speed, wind direction, precipitation, atmospheric pressure, temperature, relative humidity. This real time data is transmitted wirelessly through GSM over long distance. This system provides flexibility as needs changes. [4]

Sheikh Ferdoush et al. have proposed their system for environmental monitoring applications. This system includes an in-situ base station and a number of distributed wireless sensor nodes. Base station is designed using Raspberry Pi Model B. networked sensor nodes are developed using Arduino and Zigbee modules. To access the sensor nodes and data from the outside world, a web application is developed on the base station using the Apache HTTP web server. This system is low-cost, compact, scalable, easy to customize, easy to deploy and easy to maintain. This system can be expanded by integrating additional sensing modalities to sensor nodes. Also web interface can be further developed. [5]

Prof. C. H. Chavan et al. have proposed their system to develop wireless sensor network for an agricultural environment. This system uses the Wireless Sensor Networks which consisted of radio frequency transceiver, sensors, microcontrollers and power sources. Hardware of this system includes 8 bit AVR, ZigBee, Blue tooth module, temperature, humidity, soil moisture sensors, LCD. This system is reliable and efficient for agricultural parameters monitoring. [6]
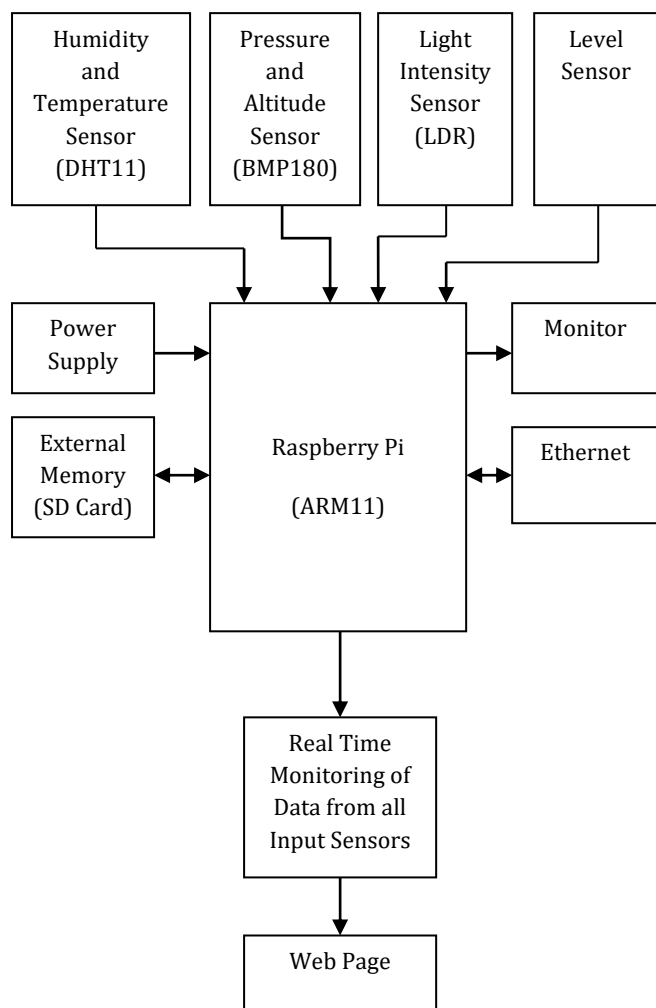
3. SYSTEM DEVELOPMENT

Fig -1: Block Diagram of Complete System

This Ethernet based weather monitoring system is developed using powerful development platform Raspberry Pi board. By using Raspberry Pi board system hardware can be minimized. There is no need of any external microcontroller, ADC and communication module. Proposed system uses Temperature and Humidity Sensor (DHT11), Pressure and Altitude Sensor (BMP180), Light Intensity Sensor (LDR), Water Level Measuring Sensor developed using marked scale with ULN2803. All these sensors are interfaced with Raspberry

Pi board. To get real time monitoring of data from sensors Ethernet network is used. Block diagram of complete system is as shown in Fig -1. Interfacing diagram of sensors with Raspberry Pi board is as shown in Fig -2. Flow chart for proposed system is as shown in Fig -3.
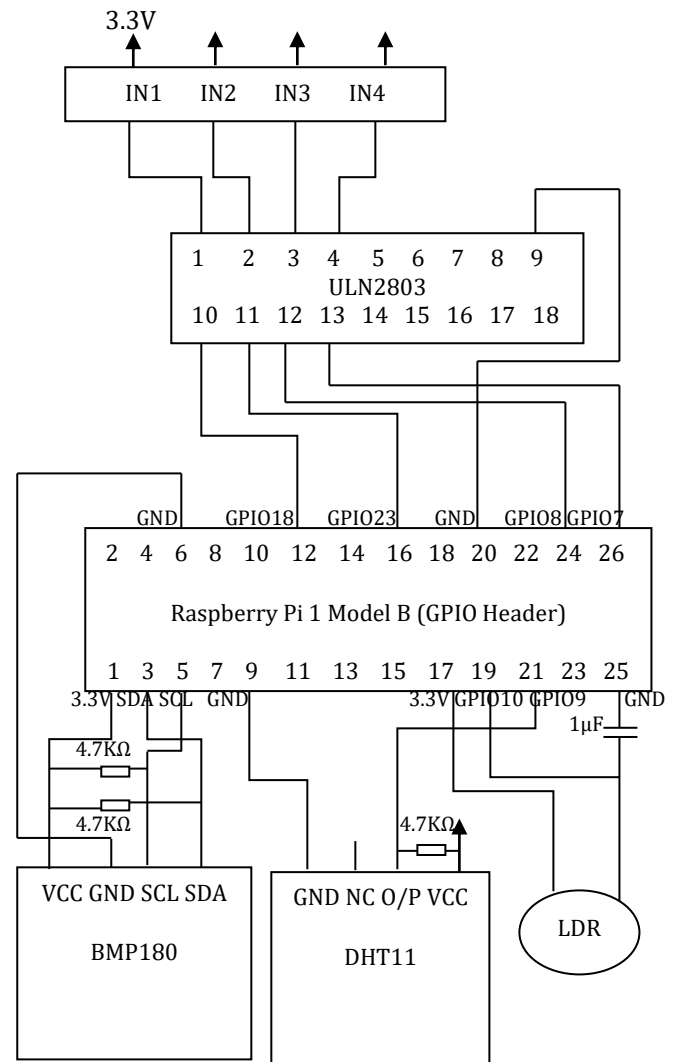

Fig -2: Interfacing Diagram of Sensors with Raspberry Pi

3.1 Raspberry Pi

Raspberry Pi is nothing but small computer. For the proposed system we have used Raspberry Pi generation 1 model B board. It has 700MHz single core ARM1176JZF-S processor having 512MB RAM. An SD card of 8GB is inserted in SD card slot which is external memory where we can store all files and data. It has two USB 2.0 port. Also analog audio and analog video out jack are there on board. It has 15 pin Camera Serial Interface (CSI) connector video input from Raspberry Pi camera or Raspberry Pi NoIR camera and 15 pin Display Serial Interface (DSI) video output to communicate with LCD or OLED display screen. In this project we have used HDMI port for video out, which is connected to monitor using HDMI to VGA cable.

RJ-45 Ethernet port is used for internet connection from LAN using Ethernet cable. A good quality 5V, 1A micro USB power adapter is used for giving power supply to Raspberry Pi board. For interfacing with sensors, Raspberry Pi is having onboard 26 pin General Purpose Input and Output (GPIO) header. [1]

3.2 Humidity and Temperature Sensor (DHT11)

DHT11 is interfaced with Raspberry Pi board at GPIO9 for humidity (in %) and temperature (in ^oC) measurement using single wire serial interface (SPI). DHT11 has resistive type humidity measurement component and negative temperature coefficient (NTC) temperature measurement component. It gives calibrated digital output which Raspberry Pi can directly understand so no need to have analog to digital converter. This sensor needs 3-5.5V voltage supply and 0.5-2.5mA current supply, which can be given from Raspberry Pi board.

3.3 Pressure and Altitude Sensor (BMP180)

BMP180 is interfaced with Raspberry Pi board at SDA and SCL pin for atmospheric pressure (in Pa) and altitude (in m) from sea level measurement using I2C interface. It can also measure temperature. BMP180 works on the principle of piezo-resistive technology. BMP180 gives fully calibrated digital output so no need to have ADC. This sensor needs 1.8-3.6V supply voltage and 5μA supply current in standard mode, which can be given from Raspberry Pi board.

3.4 Light Intensity Sensor (LDR)

Light Dependent Resistor (LDR) is interfaced with Raspberry Pi board at GPIO10 pin for light intensity measurement. LDR gives analog output which Raspberry Pi does not understand and to avoid the use of ADC, circuit is developed using capacitor. Here we measure capacitor charging time depending on resistance of LDR. Resistance of LDR changes with intensity of light, if more light intensity resistance will be less and if low light intensity resistance will be high. So at high light intensity capacitor charging time will be less and at low light intensity capacitor charging time will be more. By taking some readings of capacitor charging time light intensity is decided to measure in three values that are High, Medium and Low. In graphical representation that is shown in terms of percentage.

3.5 Level Sensor

Level sensor is designed to measure rain water level in terms of percentage. Here we are measuring five levels of container. Level measuring scale is interfaced with ULN2803 IC. ULN2803 is then interfaced with Raspberry

Pi board at GPIO7, GPIO8, GPIO18, GPIO23 for IN1, IN2, IN3, IN4 inputs respectively.

3.6 Raspbian

Raspbian is the free operating system. Here Linux kernel is used for operating system. Raspbian operating system is used to run our Raspberry Pi. An SD card is used to store all packages from Raspbian that we need for our project.

3.7 Preparing an SD Card

Raspbian operating system is installed in an SD card by using following steps:
-Insert an SD card of 8GB into computer using suitable card reader.
-Download the SDFormatter from www.sdcard.org
-Install and run the formatting tool on computer.
-Set "FORMAT SIZE ADJUSTMENT" option "ON" in the "Options" menu.
-Check that SD card inserted matches the one selected by the tool.
-Click the "Format" button.
-Download the latest version of NOOBS (New Out of Box Software) from www.raspberry.org
-From NOOBS zip file extract all the files.
-Then copy all the extracted files from NOOBS zip files onto the SD card.
-Insert SD card into Raspberry Pi and connect power supply.
-Before starting the installation procedure, select the language "English (US)" and also select keyboard layout as "US".
-Raspberry Pi will now boot into NOOBS and will display a list of operating systems that can be choose to install.
-Select Raspbian Operating System to install.

3.7 Python

Python is high level, free to use programming language for general purpose programming. It is interpreted, interactive, object-oriented, beginner's language. Here in this project Python runs on Linux kernel. IDLE (Integrated Development and Learning Environment) is the special text editor software it understand Python language that our Raspberry Pi will be able to understand and interpret.

3.8 HTML

On client side for Graphical User Interface (GUI) we need the web pages. Hyper Text Markup Language (HTML) is used to write web pages. Here in this project we are using HTML5 version of HTML. These web pages are displayed on World Wide Web using Hyper Text Transfer Protocol (HTTP).
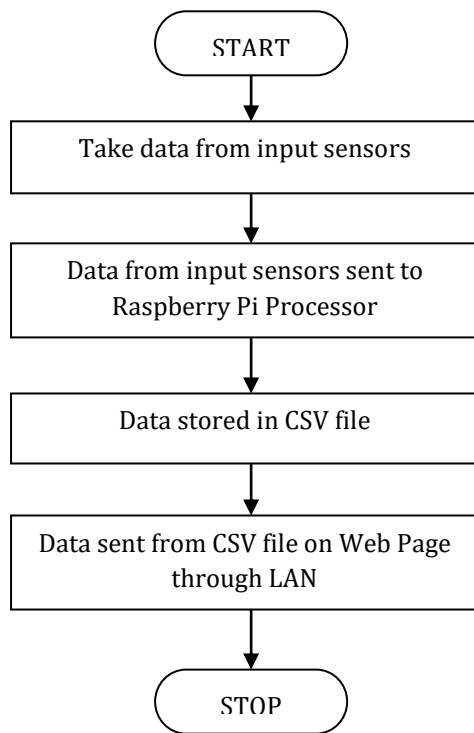
Fig -3: System Flow Chart

4. EXPERIMENTAL RESULTS

Experimental results give real-time monitoring of data from all the input sensors that are interfaced with Raspberry Pi board. All the sensors are connected at GPIO header of Raspberry Pi. When we will give internet connection to our system from LAN via Ethernet port then static IP address will be generated. By giving this IP address we can see real-time monitoring of data from our system on web page shows that in Fig -4.
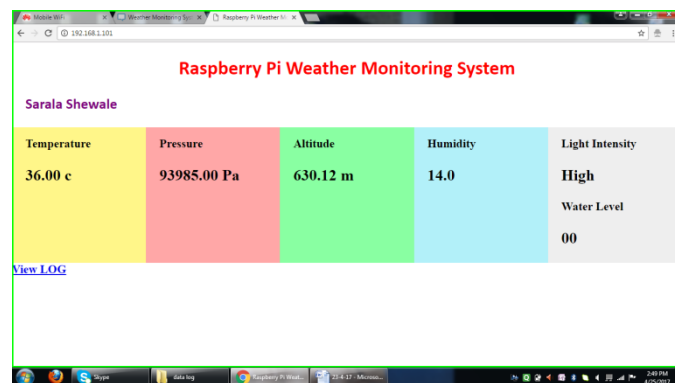

Fig -4: Web Page

5. CONCLUSION

By using this system we get real-time monitoring of Weather Station. Different environmental parameters are monitored by using different sensors. Here our parameters are temperature, humidity, pressure, altitude,

light intensity and rain water level. We can get access to real-time data from embedded web server which we have implemented using Raspberry Pi. This system gives fast data transfer. It has good performance ability and low power consumption. It is low-cost and portable system. This system has some limitations, it do not have built-in real time clock and built-in Wi-Fi. Direct internet connection is needed for networking. Sensors are needed to connect directly to the GPIO header. By using improved version of Raspberry Pi board system can be improved. Also system can be expand by adding more sensors.

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