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Real Time Weather Monitoring from Remote Location Using Raspberry pi

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ABSTRACT: In today's world, everyone is worried about their safety in hazardous environments. This has led to increase in importance of weather monitoring. Weather or climatic changes play important role in human life. Weather monitoring is vital in applications ranging from household to industrial environments. Monitoring is achieved through measuring various weather parameters using sensors. Measured parameters are not useful if they are not transferred in a fast and accurate manner to the primary users. Processing and transfer of data is very important aspect of modern measurements. The main aim of this paper is to develop an effective weather monitoring system using Raspberry pi and wireless technologies.

KEYWORDS: Weather monitoring, Sensors, Raspberry pi, Qt creator, Web Server.

I. INTRODUCTION

This project is a model to develop simple, low cost real time remote weather monitoring system with fast and accurate data transfer using the advantages of Raspberry pi and wireless technologies [4]. This System fetches weather conditions continuously using various sensors interfaced with Raspberry pi to measure various weather parameters like temperature, humidity, pressure, gas concentration, light intensity etc. System displays it on LCD for local monitoring, transfers to web page created for remote monitoring and stores in data base for further analysis. The web page also has an option to display location of the system on Google maps with the use of GPS values transferred by raspberry pi (GPS is interfaced with raspberry pi) and display of sensors data on graph to keep track of historical information on daily basis. For the purpose of analysis, authorized users can access whole weather parameters information from database table by logging into database. Among various techniques of weather monitoring systems Raspberry pi is the latest and efficient remote weather monitoring technology [8]. Real time weather monitoring system function is developed using C++ & Python languages in Qt creator IDE on raspberry pi, webpage is developed using HTML and PHP coding on Web server, accessing of database using SQL queries in side of PHP script. This project is useful for any users who wish to monitor the weather conditions of a location without being physically present.

II. MOTIVATION

The Primary motivation behind taking up this project is the large utility of remote weather monitoring in various areas ranging from house hold applications to industrial applications. The weather conditions at a particular location can be monitored from a distant place by remote user and eliminates the physical presence in order to know the climatic conditions at the location by using wireless technology. Person's physical presence may be dangerous in certain conditions like leakage of poisonous gases.

III. OBJECTIVES

The objective of this project is to design a real time weather monitoring system to measure weather parameters from remote location in which Raspberry Pi is main part of the system.

- Raspberry pi is interfaced with various sensors for weather parameter measuring, GPS is interfaced for gathering location information

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- Developing a web page for display of weather parameters, display of location on Google maps according to GPS values transferred by raspberry pi for remote user access
- Enabling the internet connection to the raspberry pi by connecting through Wi-Fi interface
- LCD is interfaced with Raspberry pi for local monitoring
- Weather parameters and location values are uploaded to the web page for remote monitoring
- Creating data base table and storing the weather parameters data continuously in the data base for future analysis
- Creating data bases and embedding graphs to track historical data and for further analysis

IV. PROPOSED SYSTEM

In this paper we proposed a system for Real time weather monitoring using Raspberry pi, it will measure various weather parameters like humidity, temperature, light intensity, atmospheric pressure, Gas/smoke level using appropriate sensors interfaced with Raspberry Pi, it uses wireless technology to provide real time data transfer. Transferred data is monitored locally and remotely using LCD display and webpage respectively.
Raspberry pi is the main block of the system it collects the weather parameter data from sensors, processes the data and transfers the parameters information to LCD for local monitoring and uploads to the web page created for remote monitoring which is developed on web server. Whole sensor data is stored into the database on the server for further analysis. Authorized users can access the database by logging into it. Historical data is analyzed by embedding graphs into the system.

V. IMPLEMENTATION OF REAL TIME WEATHER MONITORING SYSTEM

Real time weather monitoring system is developed using Qt creator IDE on Raspberry pi, Weather parameter data gathering, processing, transferring parameters data to LCD for local monitoring and uploading onto web page is done by writing the code in C++ and python languages in Qt creator IDE. Qt creator is a crass platform for C++, python, java script, QML integrated development environment [8]. Raspberry pi is ported with linux based raspbian operating system. By using Linux command wget, sensors data is transferred to the webpage over internet [21]. Raspberry pi continuously sends the weather parameters data to the web page using wget method.
On the server side, php web page is developed for reading sensor data transferred by Raspberry pi, displaying it on webpage for remote monitoring, and sending sensor data to database for storing values.
Sensor data sent by raspberry pi is sent to MySQL database using php coding with mysql queries, we used Google maps java script API [18] for displaying location on Google maps application on webpage, php coding is used to display environmental parameters information on webpage, java script API is used for displaying graphs on webpage. By entering the URL of webpage of Remote weather monitoring in the browser we can monitor the weather parameters of a system placed at the location where we required monitoring from any part of the world.

VI. DIFFERENT HARDWARE COMPONENTS USED IN THIS PROJECT

- Raspberry pi2 model B
- Usb Wi-Fi dongle
- Micro USB power adapter
- 16X2 LCD For Local monitoring display
- GPS receiver for gathering location information of a system by longitude and latitude values.
- ADC mcp3208 to connect analog sensors with Raspberry pi
- Weather Sensors
  - To measure Humidity and Temperature: DHT-11.
  - To measure Air Pressure: BMP180.
  - To measure Co/ Alcohol/smoke/ methane/LPG gas level: MQ3 sensor.
  - To measure Light intensity: LDR

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VII. BLOCK DIAGRAM

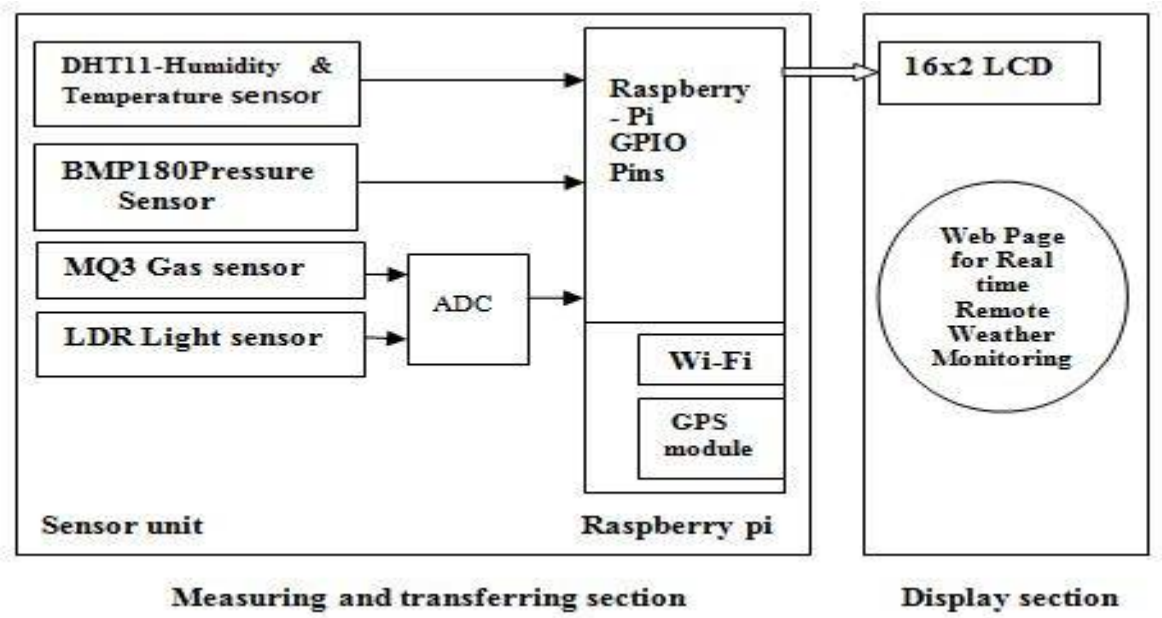

Fig 1. Block Diagram of Real time Remote Weather Monitoring system

Fig 1.Shows the block diagram of Real time remote weather monitoring system. The system can be divided into two sections one is Measuring & Data transferring section and the second is Display section.
At Measuring & Data transferring section, various sensors are interfaced with raspberry pi which collects the parameters information from the sensors & GPS, processes the data and transfers for display. The sensors are DHT-11 is a digital 1-wire Humidity and temperature sensor which is directly connected to GPIO pin of Raspberry pi, BMP 180 high precision digital pressure sensor is connected to the I2C pins of raspberry pi, Gas/Smoke sensor MQ3 & light sensor LDR are analog sensors these are connected to SPI bus of Raspberry pi through ADC. Raspberry pi doesn't have in built ADC (analog to digital converter); in order to connect analog sensors it needs external ADC interface [1].
In the display section it has two sub stages, display at Local monitoring stage and display at remote monitoring. Local monitoring is by display of Raspberry pi transferred sensor data on 16x2 LCD which is interfaced with Raspberry pi, remote monitoring is by entering URL of webpage created for real time remote weather monitoring on any browser, for remote monitoring raspberry pi uploads data to the created Web page.

VIII. STAGES INVOLVED IN THE SYSTEM

i. Sensing:
Various parameters are measured with the help of appropriate sensors; GPS is interfaced with Raspberry pi for gathering location information whose values are transferred to raspberry pi.
ii. Data processing and transferring (Raspberry Pi Functions):

- Raspberry pi is Connected to internet trough **Wi-Fi** module
- Reading sensor values, uploading / transferring sensor values to web page for storing in database and for Real time Remote monitoring
- Transferring sensor data to LCD for local monitoring
- Reading GPS (longitude and latitude) values and uploading onto web page to store in database for location monitoring

iii. Data Display (Options available on Web Server):

- Transferring Raspberry pi transferred data to database

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- continuous display of weather parameters on web page includes below
  - Humidity
  - Temperature
  - Pressure
  - Gas Level
  - Light Level

- Display of location details on web page
  - Longitude value
  - Latitude value
  - Display of Address of the system located
  - Map of Location of the system on Google Maps

- Display of readings using graphs for prediction analysis

IX. SYSTEM ARCHITECTURE

System architecture comprises of both software and hardware components to build remote weather monitoring system using raspberry pi, this system is to collect environmental parameters viz, temperature, humidity, light intensity, air pressure, and gas level continuously within the location from various appropriate sensors interfaced with raspberry pi and uploads to the web page created for remote monitoring application and data transferred to LCD for local monitoring. Different modules of the system are as follows.

i. Raspberry pi

Raspberry pi Model B is a credit card sized computer which can be plugged into any HDMI input device or RCA video input device. It can also operate it by means of an Ssh (putty) for command line interface and Xming if a graphical user interface is desired. By installing **xrdp** remote assistance command we can access raspberry pi as a remote computer through pc's by remote desktop connection with in the home network by entering the IP address of raspberry Pi [8]. Raspberry pi runs with a Raspbian operating system which is extracted from Noobs which is an open source operating system from raspberry pi organization [19]. Raspberry pi Model B offers following key features:

- Broadcom BCM2835 SoC processor with 700 MHz ARM1176JZF-S core, 512MB RAM
- Video core 4 GPU supports up to 1920x1200 resolution
- Camera module capable of full HD video @30fps
- Micro SD card slot
- 10/100Mbps Ethernet port
- 4 USB 2.0 ports
- HDMI, audio/video jack
- GPIO header-40 pin
- Micro USB power port
- Power supply for 3.3v and 5v

ii. DHT-11

DHT-11 is a low cost digital single wire integrated Humidity and temperature sensor, it uses restive humidity sensor and thermistor to measure surrounding air, and sends output value on data pin DHT -11 Sensor directly connects with GPIO pins of Raspberry pi, the measurement range of relative humidity and temperature are 20-90% of RH and 0-50^{0}C respectively [1].

iii. BMP180

High precision Digital pressure sensor, measurement range of pressure 300... 1100hpa (+9000m .500m relating to sea level), because of its ultra low power, low voltage it is used in consumer electronics, PDAs, mobile phones, GPS navigation devices. BMP 180 is designed to be connected directly to the Raspberry pi via the I2C bus. BMP 180 has

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176 bit E^2PROM. It is partitioned into 11 words of 16 bit each. These 11 words contain calibration coefficients, before first calculation of temperature and pressure the master reads out E^2PROM data. Master (pi) sends start sequence to start pressure or temperature measurement, after conversion time master reads out uncompensated pressure UP, uncompensated temperature UT via I2C bus, calibration data is used for calculating pressure in hpa and temperature in degree centigrade [1].

iv. MQ3

Sensitivity material of MQ3 gas sensor is SnO2, which with lower conductivity in clean air. This sensor has good sensitivity to alcohol and has good resistance to disturb of gasoline, smoke, vapor, LPG, Propane, Hydrogen, also could be used to methane and other combustible gas steam [6]. Output of MQ3 sensor is analog output; Raspberry Pi does not have built in analog inputs, MQ3 (analog) sensor output connected to raspberry pi through Analog to digital converter MCP3208.

v. LDR (Light dependent Resistor)

To measure intensity of light we have used LDR. LDR (Light Dependent Resistor) is variable resistor, the resistance of the LDR is inversely proportional to the light intensity, and it exhibits maximum resistance in the absence of light and minimum resistance in the presence of light. Resistive voltage divider circuit is used to measure the change of output voltage in terms of change in LDR resistance in accordance with the Light intensity [9]. Output of this sensor is analog, Raspberry pi does not have built in analog inputs, in order to connect this input to the raspberry pi, we have connected LDR output to the ADC- MCP3208.

vi. GPS interface with raspberry pi

In order to know the location information of the system we have interfaced GPS module with the serial port of Raspberry pi. GPRMC sentence of GPS data contains Longitude and latitude information by reading it and transmitting the longitude and latitude values to the webpage for providing location information on Google maps.GPS module is connected to the serial port of Raspberry pi [14], TX pin of GPS is connected to RXD pin of Raspberry pi.

vii. WIFI dongle interface with Raspberry pi

In order to provide internet connection to the raspberry pi Wi-Fi dongle is plugged into USB ports on the Raspberry pi and Pi is booted. After logging in, the Raspberry pi detects a new wireless adapter. Wi-Fi network is configured by programming the Wi-Fi network adapter using python scripting language using nano editor. The inet address i.e., the IP address and the Ssh id and password are addressed in the program. The command ifconfig is used to check the IP address of the Wi-Fi adapter [12].

viii. Power supply

The Raspberry pi is powered through the micro USB port on the side of the unit. Recommended input voltage given to Raspberry pi is 5V and input current is 2A.The Raspberry pi can function with the lower current power supplies 5V, 1A [19].

X. ALGORITHM

Process on Raspberry pi

Step 1: Start Raspberry pi
Step 2: Raspberry pi Loads OS
Step 3: Application program will be executed
Step 4: Parameter data reading section will be executed
Step 5: Fetch weather parameter values from sensors
Step 6: Read the Location values (Longitude and Latitude values) from GPRMC sentence of GPS data
Step 7: Transferring weather parameters data to LCD for local monitoring
Step 8: Post the Weather parameter values and GPS Values to the server
Step 9: Process from Step3 repeats continuously
Step10: Process on remote server: On the server side retrieving the data transferred by Pi and

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- Sending Weather parameter values to data base for storing
- Posting Weather parameter values to Webpage for remote monitoring display
- Sending Location values to web page for displaying
  - Location on Google Maps
  - Longitude & latitude values
  - Address location of the System
- Display of Sensor data on Graphs over a period of time by reading the data from the data base.

Step11: Process on Remote server repeats continuously
Step12: By entering the URL of the webpage developed remote user can access the weather data

XI. HARDWARE ASSEMBLY & OUTPUT AT DISPLAY SECTIONS

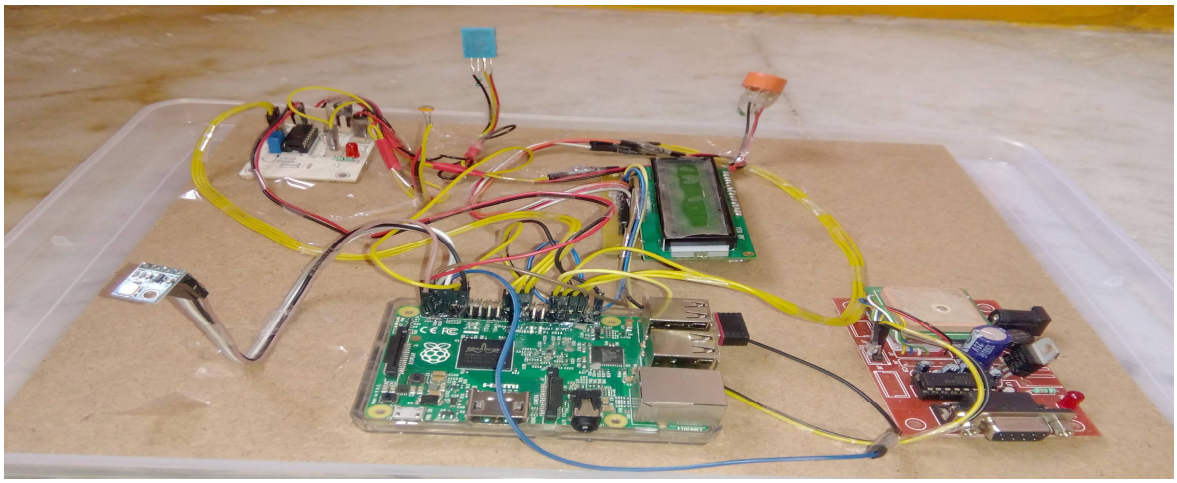

Fig. 2. Real time weather monitoring system Circuit

Fig 2, Shows the hardware assemble of the system, internet connection is connected to the system using Wi-Fi module, GPS and Sensors are interfaced with Raspberry pi, Raspberry pi gathers parameter values and transfers to LCD and uploads to Webpage, the application program is implemented on Qt creator IDE and programs written in python & C++ languages. By entering URL of a Web page created for the system we can monitor the weather parameters, following fig 3, 4, 5 shows the outputs at display units.

Display on LCD for local monitoring
Light level is represented with LDR label,
Temperature reading in ˚C is represented with Temp label,
Gas/ Smoke level is represented with GAS label,
%Humidity is represented with HUM label.

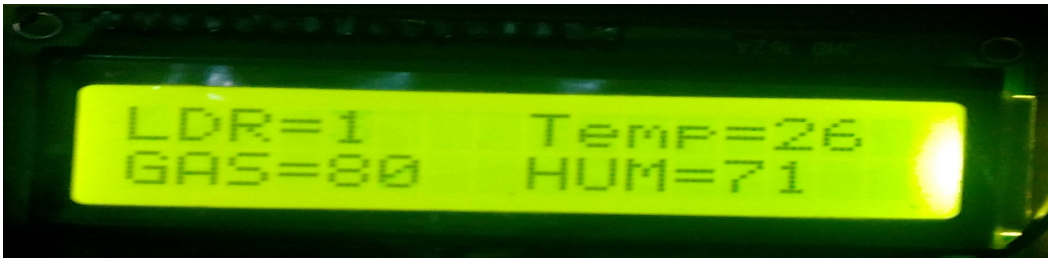

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Fig. 3. Sensor data display on LCD

Display on webpage

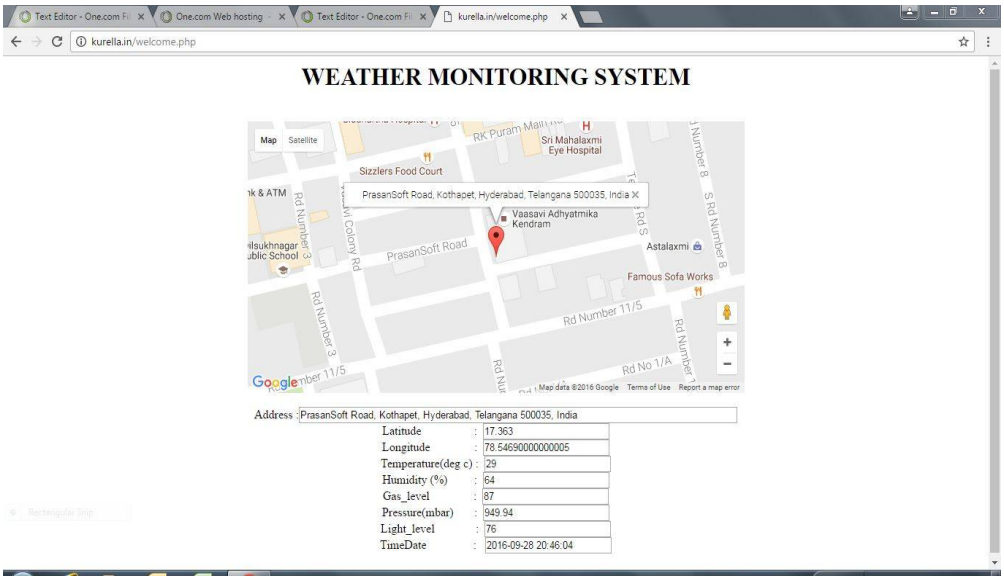

Fig. 4. Display of weather parameter data and Location of the system on Webpage

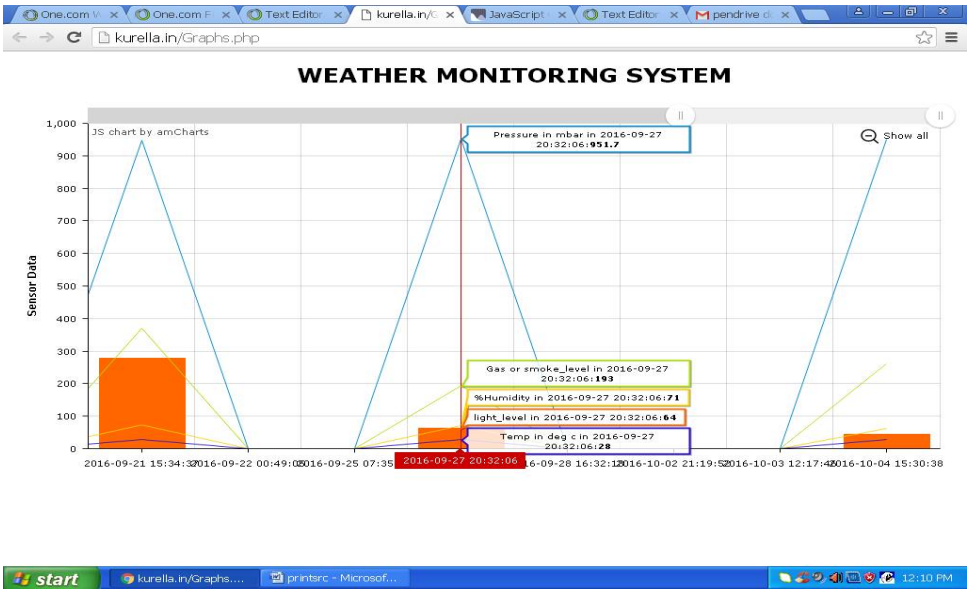

Fig.5. Graphs display.

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XII. CONCLUSION

The project deals with designing a simple, highly efficient, cost effective and easy to operate Real time weather monitoring system using Raspberry pi to monitor various weather parameters of the desired location and transmit it to webpage created for remote monitoring & to LCD for local monitoring. This project is a model of monitoring 5 parameters only but can be enhance for monitoring other different type of environmental and climatic behavior of location, which will also be cost effective.

FUTURE SCOPE

The System can be extended using many other sensors for monitoring exhaustive parameters of weather with the use of information gathered, an effective system can be developed for the prediction of future climatic conditions. This system can be integrated with various other systems developed for weather analysis. We can get the vision of the system at the location by interfacing camera and enabling live streaming on webpage.

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