Indoor Air Quality Measurement and Uploading the Data over Web

Mr. V.V.L. PAVANKUMAR, Mrs. R. BHAKKIYALAKSHMI

***Abstract*— This paper presents a system which is used to acquire the information related to particular area such as an indoor air quality measurement with the help of a sensor network, a processing unit and the provision of internet using a router. Primary aim is to provide a system of lower cost and reliable sensors providing information in order to perform continuous monitoring of air quality of air so as to indicate the factors that might cause asthma attack. System consists of a sensors which has the ability to measure the various environmental parameters such as humidity, carbon monoxide, temperature and will send the measured data to a processing unit and thereby over to the web with the help of a router. A software implication includes a client side application which is used to upload the measured information to the server with the help of internet. Raspberry pi is used as a processing unit which primarily processes the data coming from various sensors thereby it can be used to define the various alarm points. So this system acts as a HMI (human machine interface).**

***Index Terms*— Air quality measurement, raspberry pi, sensor network, web based information.**

I. INTRODUCTION

In the near future, ambient intelligence (AMI) will be in most houses in different ways. Wireless sensor networks (WSNs) are commonly recognized as one of the technological cornerstones of AMI. Sensor Networks are agile, low-cost, low power and can collect a huge amount of information from the environment in order to actuate and control different facilities. Using a biological analogy, a sensor network can be seen as the sensory system of the intelligent environment "organism". Sensor networks are irregular aggregations of communicating sensor-nodes, which collect and process information coming from on-board sensors, and they exchange part of this information with neighboring nodes or with nearby collection stations.

Sensor networks promise to revolutionize sensing in a wide range of application domains because of their reliability, accuracy, flexibility, cost effectiveness and ease of deployment. Several applications have been described for WSNs using gas sensors, despite of the youth of these devices, mainly outdoor applications, i.e. Fire detection, chemical processes and environment, indoor applications like room environment monitoring or air quality monitoring. Recently, with increasing living standards and expectations for comfortableness, the use of residential air conditioning is becoming widespread. The control and monitoring of indoor atmosphere conditions represents an important task with the aim of ensuring suitable working and living spaces to people. However, the comprehensive air quality monitoring which include monitoring of temperature, humidity, air quality, etc., is not so easy to be monitored and controlled. This work shows a simple approach of a sensor network to monitor several parameters interesting for the indoor environment control, like temperature, humidity, light and air quality. Nowadays people spend a lot of time in their indoor environment such as work from home, leisure, so the air quality has a direct affect on the respiratory condition of the person. So thereby poor quality of air might bring the pollutants deeply in lungs which may create a serious problem to the respiratory organs.

In this system network used for air quality measurement is dependent upon wireless fidelity or Bluetooth are of low cost solutions but have higher power consumption so nowadays Zigbee protocols had became a familiar solution for monitoring applications because of lower power consumption, more flexibility and the range. This article is presented in terms of sections, which describes about sensor networks, hardware, sensors for sensing the environmental conditions, software's used and various elements of design used for the purpose of management of data and the formations of a graphical user interface.

II. SENSOR NETWORK

Basically, WSNs are formed by a great number of small devices the so called sensor nodes or motes that are able to obtain information from their surroundings by means of transducers and transmit it towards a sink node using wireless communications. This information, after the suitable data handling, is stored by the sink node on a database, where (usually through the Internet) it is available for use, be it in real time or for statistical analysis [5]. WSNs comprise three different subsystems, namely: sensor nodes; sink node; and, information management system. Fig.1 is a network architecture showing how the sensors and processing unit would be placed in a room. All the information obtained by the different sensors are stored in a database which is handled using software that enters the data from the processing unit and offers them to users (normally through the internet).

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Fig.1: Sensor and processing unit placement

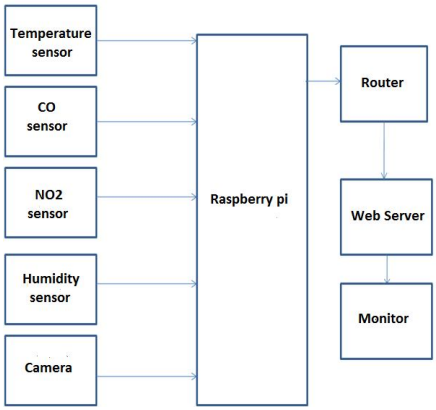


Fig. 2 : Block diagram

Here Fig. 2 shows the basic block diagram of the system consisting of various sensors such as temperature sensor, carbon monoxide sensor, nitrogen dioxide sensor and camera are connected to the processing unit that is raspberry pi either through wires or wirelessly with the help zigbee modules. Over here camera is placed for live monitoring of a particular indoor area. If the system is based upon wireless sensor network then the embedded pc (raspberry pi) is connected to the Ethernet port of the router, which receives IPv6 frames within zigbee protocol frames and forwards them to the server. If the sensor network is wired then all the sensors will be connected to the GPIO pins of the raspberry pi and the raspberry pi can be connected internet with help of a router either through Ethernet ports or through Wi-Fi. The communication between raspberry pi and wireless sensor node zigbee coordinator is based on a RS232 serial communication protocol [9].

A. Sensors

The sensor used for measuring the temperature is DS18B20 digital thermometer shown in Fig. 3**,** which provides 9-bit to 12-bit Celsius temperature measurements. It communicates over single wire bus that means it requires only data line for communicating with the processing unit. Sensor consists of three pins which are connected to raspberry pi in such a way that V_{dd} is connected to 3.3v pin, DQ is connected to one of the general purpose input output (GPIO) pin and GND pin is connected to one of ground pin in raspberry pi. Fig.4 shows the pin description of raspberry pi.

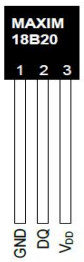


Fig. 3: Pins of sensor

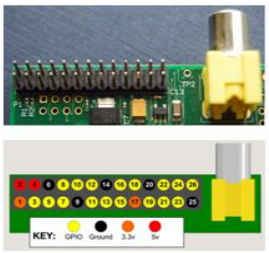


Fig. 4 : Pin description of pi

MQ-7 gas sensor is used for detecting carbon monoxide gas. Additionally a set of sensors NO_2, smoke, CO_2, are used to obtain the important information that is used for the calculation air quality index in relation to the equation [10]. Processing unit deals with the digital values so if any of the sensor provides analog output then the output must be converted to digital format with the help of analog to digital convertor.

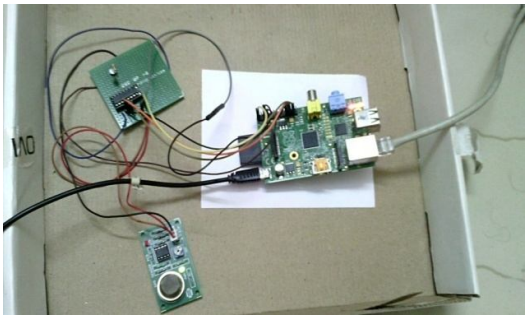


Fig. 5: Sensors connected to GPIO

Fig. 5 shows how sensors are connected to the raspberry pi's general purpose input output pins. Power supply to various sensors can be taken from the processing unit. Pi is connected to router which is enabled with internet through Ethernet cable.

B. Routing of information

The processing unit i.e. raspberry pi is connected to the router. So thereby router will assign an default IP address to raspberry pi. Therefore in order to access the pi we have to know what is the IP address of pi for that we can use software named as zenmap or IP address can be obtained by connecting the pi to a monitor with the help of a HDMI cable and some Linux commands. IF router is connected to internet then the pi can upload the data over server used for monitoring. In case, when wireless sensor network is implemented then there might be multiple nodes sending the data to the processing unit using zigbee must be handled.

The processing unit will gather the information, process the data and send the data through Ethernet to the client of the network. The system is implemented in such a way that client can access the information about the environmental condition of a room from anywhere with the help of internet so for that purpose the local client of the network is a raspberry pi which runs a java application. Fig. 6 is just a snapshot describing how we can access the various files that were previously saved in operating system of pi using some Linux commands. Apache server can be installed in pi and in order to work over it we need to switch the user to root user.

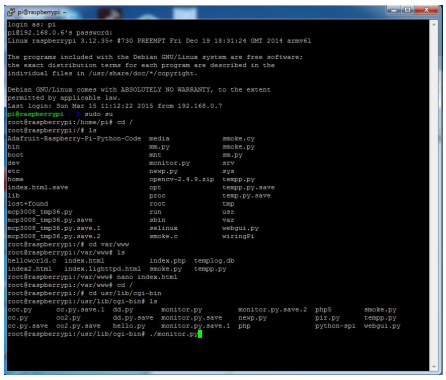


Fig. 6: Snapshot showing access to pi using Linux Commands.

III. SOFTWARE IMPLICATIONS

When a laptop is connected to the network in which raspberry pi is present in order to access the operating system of raspberry pi requires software's such as putty and Xming. Putty is a network file transfer application; it supports several network protocols including SCP, SSH, Telnet, rlogin and raw socket connection. Xming provides the X window system display server, it may be used with implementations of secure shell (SSH) to securely forward X11 sessions from other computers.

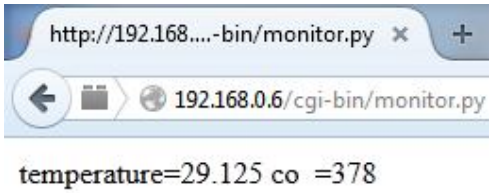
This paper presents a system where we have a service of information over web which is based on a client – server architecture. A web server based in PHP provides a minimal set of services, maintaining the security of a system. A java client application requires the services. The java based application was designed in such a way to send the data to a database and thereby reception of data from the database. Application has a robust response even if client does not have internet connection at the moment it will save the data obtained from various sensors in a file and send the data to the server database when connected to internet. This client application was deployed in raspberry pi which receives sensors data such as values of physical quantities such as temperature and relative humidity. In order to deal with various threshold levels established for air quality conditions, a set of alarms may be generated in accordance by comparing the value obtained from the sensor and the threshold values.

Server will provide a site which will act as an user interface that can be accessed from anywhere. So the server acts as a bridge between the indoor environment and the user which can be developed using free library PHP. Database of the system is based upon SQL. Thereby web service plays a vital role in sending the data of sensors to the database of the system. Nano is an easy to use text editor that proves itself versatile and simple. It is installed by default in Ubuntu and many other Linux packages and works well in conjunction with sudo.

IV. RESULTS

A system is developed which is used gather the data from sensors and process the data in a processing unit thereby with the help of a java based application the processed data is sent to the database through internet. This data can we viewed over the site developed through the internet. Fig.7(a) shows a snapshot of the site showing the submit type buttons and live streaming coming from the USB camera for monitoring purpose. Fig.7 (b) shows what happens when buttons are clicked i.e. shows the value of sensors.

(a)



(b)

Fig. 7: Snapshot of website (a) showing submit type button and live streaming, (b) sensor values

V. CONCLUSION AND FUTURE WORK

Thus a system with sensor network to monitor the indoor air quality was developed in accordance with the factors that might trigger asthma attacks. Information of air quality obtained from various sensors is presented and the status of various alarms can be viewed on a developed website. Java application acts as a bridge between sensor network and database with the help of internet connectivity. This presented solution for indoor environment is helpful to prevent an asthma attack.

As future work inclusion of a GPS along with each sensor and some additional sensors capable of measuring other gas sensors that might affect air quality can be done. With help of GPS we can control our camera to rotate towards that particular sensor whose behavior requires attention. Further we can add various features so that system can automate itself to control the air quality such as turning on cooler or heater when the temperature raises or drops respectively in accordance with the prescribed threshold temperature.

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