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RASPBERRY PI AND IOT BASED INDUSTRIAL AUTOMATION

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ABSTRACT— Industrial automation has become very much popular these days because of its various advantages. This is achieved by using local networking standards and remotely controlling and monitoring industrial device parameters by using Raspberry Pi and Embedded web server Technology. Raspberry Pi module consists of ARM11 processor and Real Time Operating system whereas embedded web server technology is the combination of embedded device and Internet technology. Using embedded web server along with raspberry pi it is possible to monitor and control industrial devices remotely by using local internet browser. Use of these both technology reduce complexibiliy of devices and also reduces overall cost of the system.

KEYWORDS— Embedded Web Server, Raspberry Pi, Raspbian OS, TCP-IP.

I. INTRODUCTION

As the world is getting more technologically forwardlooking, we find new technology coming deeper into to our personal and professional lives. Current home automation and industrial process monitoring systems make use of PC-based servers. Appliances in case of process monitoring system are connected to these servers and therefore it becomes necessary to keep the server on all the time which ultimately increases the cost of the system. The remedy to this problem is to use embedded web server instead of pc based server. Embedded web server is basically a only chip implementation of Ethernet networking standards which we can achieve by using Raspberry Pi board. By embedding Ethernet onto the device it has the competence to interconnect via Ethernet without using a PC. The server allows web access to the automation and monitoring system and provides a mountable networking solution that is enhanced for instrumentation, and industrial as well as home automation. The user can surf the home page of the system using local web browser and can control the industrial appliances and enquire about their operational status from remote place. This project develops such a low cost electronic prototype which is designed for monitoring and controlling industrial appliances via web browser from remote place. At the same time user can monitor security situation at industry in real time through different sensors installed at industry.

II. SYSTEM ARCHITECTURE

The proposed system is divided into two parts.

A. Industrial Nodes

B. Embedded Web server

A. Industrial Node:-

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This Node contains various sensors which can be used in Industrial plant for sensing various parameters like temperature, humidity, pressure, gas etc. along with Raspberry Pi module.

B. Embedded Web Server:-

Embedded web server consists of Linux ARM11 Based Raspberry Pi module to Monitor and Control above mentioned Industrial parameters using sensors from remote location. Raspberry pi is based on ARM11 processor which has HDMI port, Memory Card slot, Ram, Audio port, Ethernet port, Bluetooth and Wi-Fi to build Small Low Cost Computer with open source Linux based Operating System which is freely available.

Block Diagram:-

Here the sensors transmits the digital values to the Raspberry Pi. In Raspberry Pi Board we will be setting some threshold values by coding using Python Language/Linux. If the sensors value goes up above the threshold value then it will controlled through Relay circuit.Relay will be connected with the Raspberry Pi which will do the work of controlling. As the sensors value goes up the Raspberry Pi sees which sensors value has gone high and accordingly it will give the instruction to the Relay circuit which will perform ON/OFF action depending upon requirement so as to control the industrial parameters which are under measurement. This data will also be monitored by the user through the PC by using local browser raspberry pi's particular IP address.Camera interfaced with Raspberry Pi will detect any suscpecious moments near plant and send those pictures on concerned persons mobile phone automatically.

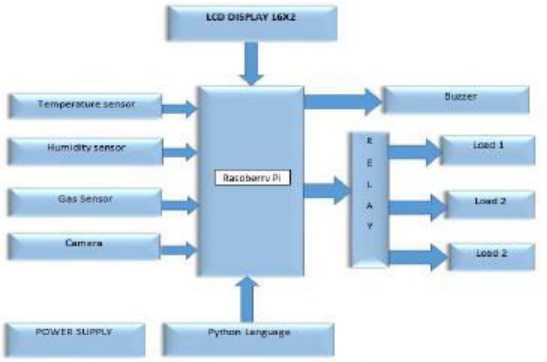

Fig 1. System Block Diagram

Here Raspberry Pi will be connected to the Wifi which will send these images over the Internet by which the user will be able to see the images and can keep a watch on proper opearation of his system.

III. SYSTEM DESIGN

The designing part includes basically two sections as follow.

1. Hardware Section
2. Software Section

1) Hardware Design

It includes Raspberry Pi, Temperature sensor, Humidity Sensor, IR module, Camera, Liquid Crystal Display, Relay, Switch etc.

a) Raspberry Pi :- Raspberry Pi 3

The Raspberry Pi is a small computer about the size of a credit card. A complex board that integrates the major functional essentials in to a only chip in Raspberry Pi are its Quad-core 64-bit ARM Cortex A53 clocked at 1.2 GHz CPU, 400MHz VideoCore IV multimedia GPU, 1GB LPDDR2-900 SDRAM (i.e. 900MHz) Memory along with 4USB ports, HDMI,

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composite video (PAL and NTSC) via 3.5 mm jack video output, 10/100Mbps Ethernet and 802.11n Wireless LAN, 17 GPIO plus specific functions, and HAT ID bus, Bluetooth 4.1. It forms a embedded web server. All the sensors are connected to this which senses industrial parameter under control and send them to user by using either inbuilt Bluetooth or Wi-Fi. User can monitor this data from its local web browser by using dynamic IP address of Pi Module.

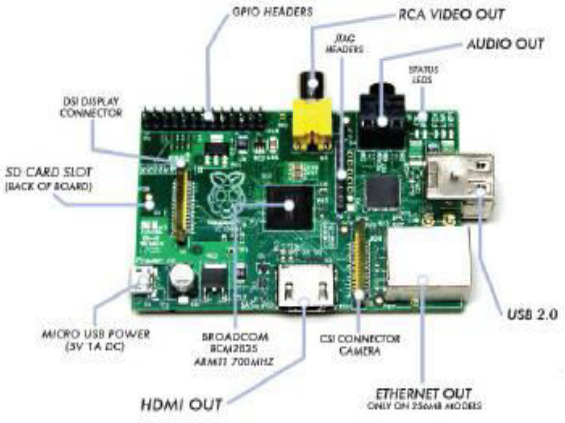

Fig 2. Raspberry Pi 3

b) Temperature Sensor :- LM35

The LM35 series are precision temperature sensors. Its output voltage is directly proportional to the Celsius temperature. Therefore LM35 has an advantage over linear temperature sensors calibrated in ° Kelvin, as the user does not need to subtract a large constant voltage from its output to obtain suitable centigrade scaling. It can be used with single power supply or with plus and minus power supplies. It sinks only 60 µA from its supply, it has less selfheating, less than 0.1 °C in still air. The LM35 is rated to operate over a -55 to +150 °C temperature range.

Fig 3. Temperature Sensor LM35

c) Humidity Sensor:- HIH4000/HSY220

The humidity sensor HIH4000 is developed by Honeywell. It is used for detecting the humidity. It delivers high quality RH (Relative Humidity) sensing performance at a cheap price. It is solder able SIP (Single In-line Package). Its Relative humidity is a measured, in percentage. It is the ratio of vapour present in the air at given instant to the total amount of vapour which could be present in the air at that given temperature. This sensors output voltage simply follows its supply voltage. Output voltage increases when the supply voltage increases, and vice a versa. It generally operates in the range of 4-5.8 supply voltage.For example the output voltage varies from 0.8 to3.9V at room temperature with 5V supply voltage, and room temperature, as the humidity varies from 0% to 100%.The resolution of humidity sensor is up to 0.5% of relative humidity (RH). As its current draw capacity is only 200 µA, this sensor series is suited for low drain, battery operated systems. Output voltage of these sensors changes in proportion with the changes in the surrounding RH. The output voltage of these sensors is proportional to the supply voltage. Therefore to convert this into RH form we need to consider both supply voltage and

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sensor's output voltage. This conversion can be done by using following formula RH = ((Vout / Vsupply) – 0.16) /0.0062, typical at 25°C ADC is used to convert this voltage into digital form by the and then it is sent as input to the RPI which reads the data.

Fig 4. Humidity Semsor HIH4000

D) Light Sensor:-IR

IR sensor detects IR radiation falling on it. Depending on the application there are many types of IR sensors which can be built. IR Sensors uses a specific light sensor to detect a particular light wavelength in the Infra-Red (IR) spectrum. Here we can install a LED which produces light of same wavelength as per sensor's specifications to observe the intensity of the received light. The light from the LED reflects back from the object and into the Light sensor when that object is close to the sensor. Because of this the intensity of the received light suddenly increases and this can be detected by using threshold.

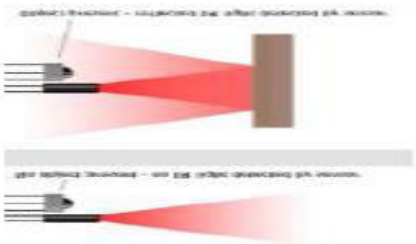

Fig.5 Light Sensor

e) Camera Module:- RPI camera module

User can take high-definition video, as well as stills photographs by using camera module. This camera module has a five megapixel fixed-focus camera which supports VGA90, 720p60 and 1080p30 video modes and stills capture as well. It can be connected to RPI by using a 15cm ribbon cable to the CSI port of the Raspberry Pi. This camera module can work with all models of Raspberry Pi 1 and 2. This module can be accessed by the MMAL and V4L APIs, as well as there are multiple third-party libraries built for it.

Fig. 6 Camera Module

f) Relay: -SPDT

A relay is basically an electrically operated switch. Many relay works on the principle of electromagnet to operate a switching mechanism. Where it is essential to control a circuit by a low-power signal, relays are used. It provides complete electrical isolation between controlled and controlling circuit. A magnetic field has been created by the current flowing through the coil. This magnetic field attracts a lever of the relay which changes the switch contacts. Most of the relays have double throw switch contacts. As shown in the diagram.

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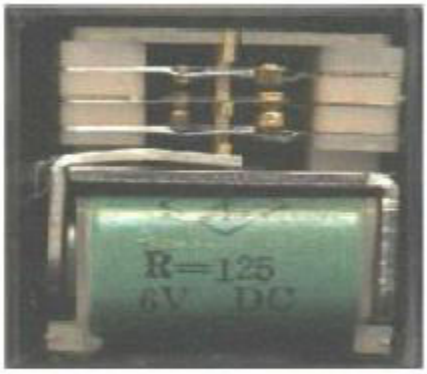

Fig 7. Relay

g) Buzzer:-

A buzzer is an audio signaling device which may be piezoelectric, mechanical or electromechanical. Buzzers are typically used in timers, alarming devices, and for confirmation of user input such as a keystroke or mouse click. It most generally comprises of various switches or sensors associated with a control unit that figures out whether and which switch was pushed or a preset time has slipped by, and for the most part enlightens a light on the fitting catch or control board, and sounds a notice as a nonstop or irregular humming or beeping sound. At first this device depended on an electromechanical framework which was indistinguishable to an electric bell without the metal gong which makes the ringing commotion.

2. Software design

a) Raspbian OS

Raspbian is a free working framework in based on Debian. It is based on the Raspberry Pi module. A working framework is the arrangement of fundamental programs and utilities that make your Raspberry Pi run. It gives essentially speedier execution to applications that make substantial utilization for floating point arithmetic operations. Every single other application will likewise increase some execution speed because of advanced instruction of the ARM11 CPU in Raspberry Pi.

B) Apache HTTP Server

The Apache HTTP Server which is called as Apache is the world's most famous web server software. It is based on the NCSA HTTP server. Apache has a big role in the initial growth of the World Wide Web. An open community of developers under the auspices of the Apache Software Foundation have developed and maintained Apache. This is most commonly used on a Linux; this software is available for a wide variety of operating systems, including UNIX, FreeBSD, Linux and Solaris.

C) TCP IP Protocol

The same layered structure as used in the TCP/IP protocol suite is used by the software running on the embedded web server. The TCP/IP protocol suite permits PCs of all sizes, running distinctive operating systems to communicate with each other. The TCP/IP protocol suite is a blend of various conventions at different layers as appeared in Figure. Figure demonstrates Layers of TCP/IP protocol suit. Each layer is independent from each other. The Link Layer generally incorporates the device driver in the operating system and corresponding network interface (card) in the PC. An Ethernet controller driver controls the Ethernet interface and the network layer controls the communication.

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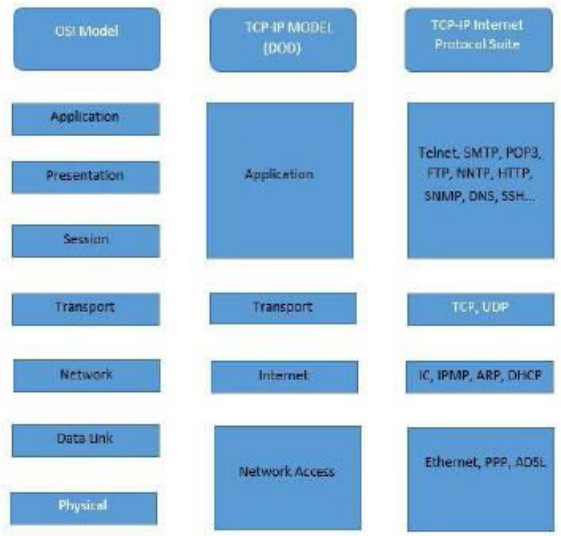
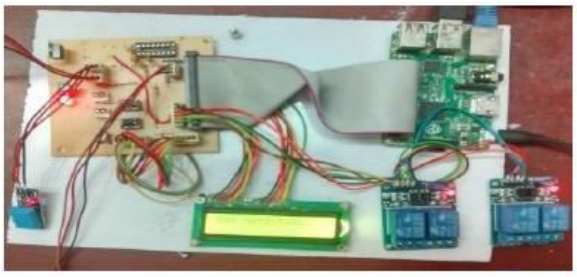


Fig. 8 TCP-IP Model

IV. RESULT



Following parameters have been tested.
1. Temperature
2. Humidity
3. IR

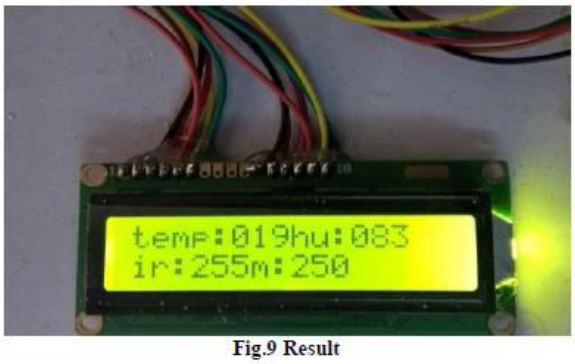


Fig.9 Result

CONCLUSION

Implementation of web server using Raspberry Pi for intelligent monitoring is a new method to monitor an industrial environment which designed here for the real time implementation. This system can have communication Port. It supports online supervision and control Private Network (LAN) as well as Public Network (Internet). The whole system has good portability, good openness and low cost and it is also easy for maintenance and upgradation. It is possible to interface various kinds of Sensors with these modules and make different applications. This system can monitor embedded system operation straight through Internet and achieve network monitoring. This work can further be extended by using high end embedded servers with wireless sensor networks with increase in sensor nodes and parameters.

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