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Wireless Web Server for Industrial Data Acquisition and Control Using Raspberry Pi

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Abstract: In today's world wireless technologies are more used in industrial automation. Wireless technology offers a good opportunity in the area of communication. When the embedded devices are provided with internet access the demand will rise due to the remote accessing capability of these devices. Users can monitor and control remote systems by using embedded web server. This system is designed to develop a Data Acquisition System for industrial use which will also act as live web server. All data which is monitored can be seen live on webpage along with the live video coming from Raspberry Pi Camera. Data Backend is also provide in this system. If Temperature Sensor value exceeds beyond threshold value then client will receive mail. This increases the productivity of the conventional Data Acquisition and Control System largely, making it smart Data Acquisition System.

Keywords: Raspberry Pi, Embedded Web Server, Real Time Processing, Raspberry Pi Camera, Sensors.

I. INTRODUCTION

Wireless Technologies plays an important role in various industries of automation field. Day by Day the application of wireless communication in industrial automation is increasing rapidly. The method of communication which was used previously is not so beneficial and efficient for the fulfillment of today's industrial needs. Data Acquisition Systems with remote accessibility are in great demand in industry and consumer applications.

The Wireless Network for Industrial Applications is standardized nowadays. Intelligent and low-cost automation of industrial processes are developed rapidly in order to improve process accuracy of the system. Industrial automation systems consist of various field devices and technologies working in synchronization. These devices are responsible for a variety of functions related to instrumentation, control, supervision and operational management [1].

II. BLOCK DIAGRAM OF SYSTEM

Figure 1 shows the block diagram of the proposed system. The system consists of an embedded web server, ARM11 Raspberry Pi. This ARM11 acts as main processor. A wireless sensor network containing various sensors such as PIR (Passive Infrared), Light intensity sensor, Gas Sensor, Humidity Sensor and Temperature Sensor used. The ARM hardware is built on single chip module [2].

There are various slots to the ARM11 processor for connecting the various external devices such as Raspberry Pi Camera, Keyboard and Mouse. A regulated power supply is provided to the overall system as shown in figure 1. To implement this system used different hardware, which are described in this section.

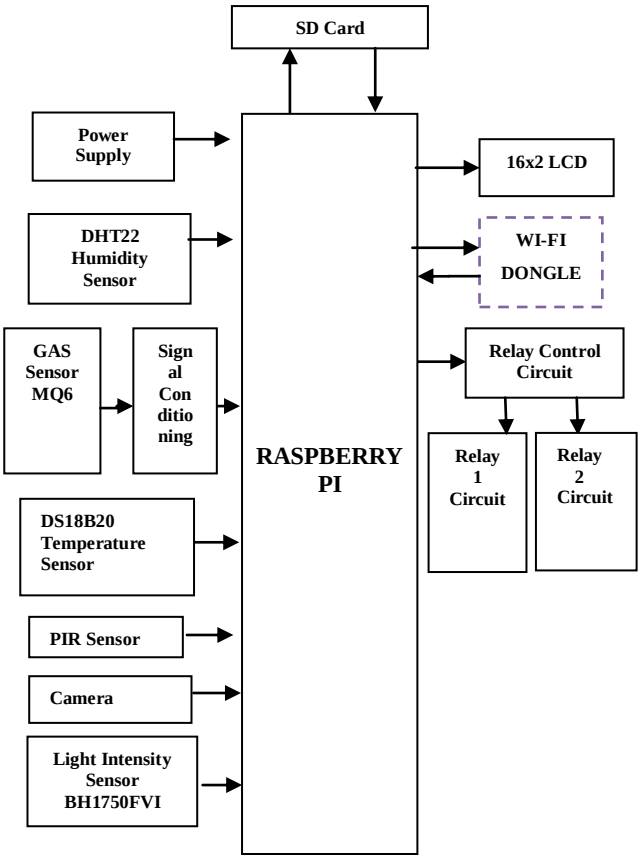

Figure 1: Block Diagram of System

All the sensors sense the respective data and send this data towards the controlling unit such as Raspberry Pi. Thus all the data is collected by the Raspberry Pi and is maintained at this location. An embedded web server is designed

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which will display all the sensor values in real time through web page. Thus a successful communication is achieved between a server and client side by using this type of system. Therefore the status of different sensors installed at working place is monitored at anywhere. Thus personal computer and a Raspberry Pi Camera will continuously monitor all the data from remote processing unit. In thus reporting of this real-time data corresponding to the process plants can therefore be of great use for future analysis.

III. DEVELOPMENT OF THE SYSTEM

The development of the system consists of following two sections.
1) Hardware Development
2) Software Development
The hardware design consists of various sensors, Raspberry Pi processor kit, Relays Signal Circuit, a remote PC and Raspberry Pi camera. All these hardware's are interfaced with each other as shown in figure 1. Developed a coding in python language. Also using Raspberry Pi Camera to motoring live video to monitoring data and it will provide a result in real time.

1) Hardware Development
To develop the overall system used different hardware's, which are described in this section.

1.1) Raspberry Pi
The Raspberry Pi is a credit-card-sized single-board computer developed in the UK by the Raspberry Pi Foundation. It has a Broadcom BCM2835 system on a chip (SoC), which includes an ARM1176JZF-S 700 MHz processor, Video Core IV GPU. It does not include a built-in hard disk or solid-state drive, but uses an SD card for booting and persistent storage. It can be connected to a network using an external user-supplied USB Ethernet or Wi-Fi adapter. Generic USB keyboards and mice are compatible with the Raspberry Pi [2]. The Raspberry Pi primarily uses Linux-kernel-based operating systems. Figure 2 shows the Raspberry Pi B+ Module.

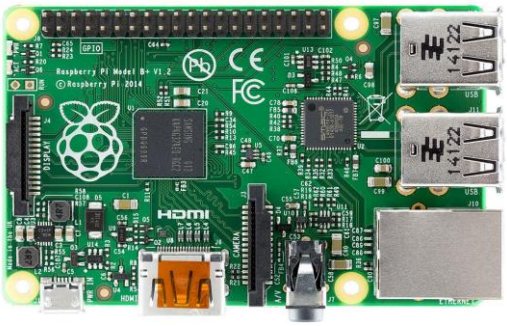

Figure 2: Raspberry Pi B+ model

1.2) PIR Sensor (Passive Infrared)
PIR sensor is as shown in figure 3 PIR sensors allow you to sense motion, almost always used to detect human motions [2]. They give the output when digital pulse is high (3V) when triggered (motion detected) and digital pulse is low when idle (no motion detected) [3]. They are having range of sensitivity up to 20 feet (6 meters). They are small, inexpensive, low-power, easy to use and are commonly found in appliances and gadgets used in homes, businesses and industries.

Figure 3: PIR Sensor

1.3) Temperature Sensor –DS18B20

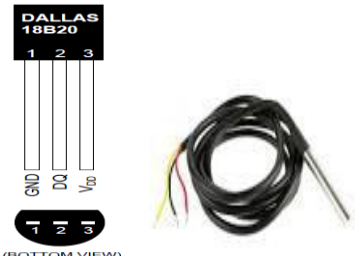

Figure 4: Temperature Sensor

Temperature Sensor as shown in figure 4.The DS18B20 digital thermometer provides 9-bit to 12-bit to measure Temperature in Celsius [4]. The DS18B20 communicates over a 1-Wire bus that by definition requires only one data line (and ground) for communication with central microprocessor. It has operating temperature range of -55°C to +125°C and is accurate to ±0.5°cover the range of -10°C to +85°C.

1.4) Humidity Sensor – DHT22
Relative humidity is a measure of the amount of water vapor contained within the air which is usually expressed as percentage humidity. Output of DHT22 is digital signal. It applies exclusive digital-signal-collecting-technique and humidity sensing technology, assuring its reliability and stability. Small size and low power consumption and long transmission distance (100m) enable DHT22 to be suited

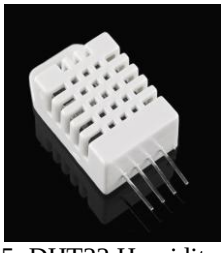

Figure 5: DHT22 Humidity Sensor

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in all kinds of applications. Single-row packaged with four pins, making the connection very convenient.

1.5) MQ-6 Gas Sensor

The MQ-6 Gas Sensor is a semiconductor type gas sensor which detects gas leakage by comparing the concentration of ethanol which is present as a mixture in the LPG with air. It then gives analog voltage as output. MQ-6 is a SnO2. It is with low cost and suitable for different applications.

Figure 6: MQ-6 Gas Sensor

1.6) Signal Conditioning Circuit

The signal extracted from the MQ-6 gas sensor is not suitable for feeding it to the data acquisition [5] system directly. Therefore, the signal conditioning circuit is developed using Op Amp LM358. The Op Amp has pairs of input channels and respective output channels operate on low power supply range typically 1.8v to 3.6 volt. The promising features of this operational amplifier suggest its suitability for dedicated application. The output of signal conditioner is fed to input of the Raspberry Pi.

1.7) Light Intensity Sensor

BH1750FVI is a Digital Light Sensor, which is an digital Ambient Light Sensor IC for I2C bus interface. This IC is the most suitable to obtain the ambient light data for adjusting LCD and Keypad backlight power of Mobile phone, it is also used in industrial applications. BH1750FVI light intensity as shown in Figure 7.

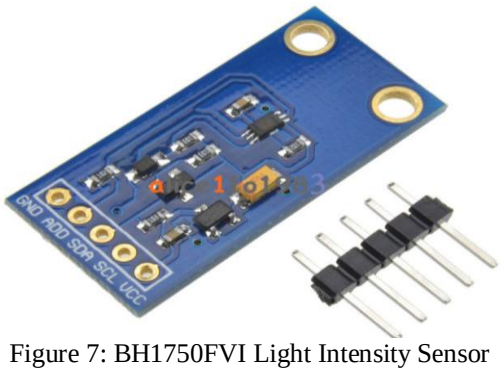

Figure 7: BH1750FVI Light Intensity Sensor

This module with a built-in 16 bit Analog to Digital converter generates a digital signal output. The data from this module is light intensity in lx (lux) with a resolution of 1 lx and a range of 1~ 65535 lx.

1.8) Raspberry Pi Camera

The Raspberry Pi Camera board plugs directly into the CSI connector on the Raspberry Pi.

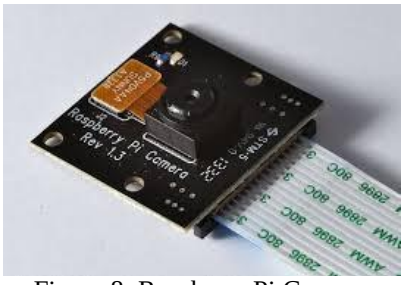

Figure 8: Raspberry Pi Camera

The Raspberry Pi camera module attaches to Raspberry Pi by way of a 15 pin Ribbon cable to the dedicated 15-pin MIPI Camera Serial Interface (CSI) which was designed especially for interfacing to cameras. It's able to deliver a clear 5 mega pixel resolution image or 1080p HD video recording at 30 frames/sec.

1.9) LCD Display Module

To ensure digital real time out the Liquid Crystal Display (LCD) module of Hitachi Corporation [Figure 9] is employed. It is composed of 2x16 lines Liquid Crystal Display. In present system, LCD is configured in 4 bit mode. The circuit configuration is depicted in figure 9.

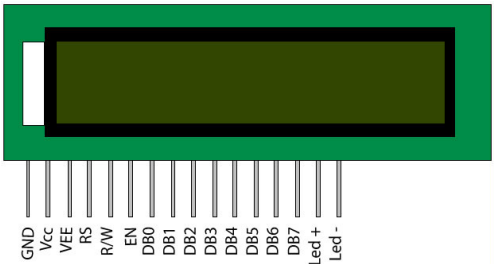

Figure 9: LCD Pin Diagram

2) SOFTWARE DEVELOPMENT

Python is a widely used general-purpose, language. Its design philosophy emphasizes code readability and its syntax allows programmers to express concepts in fewer lines of code than would be possible in languages such as C++ or Java. The language provides constructs intended to enable clear programs on both a small and large scale [6]. Python supports multiple programming paradigms including object-oriented imperative and functional programming and procedural styles [7]. It features a dynamic type system and automatic memory management and has large and comprehensive standard library.

IV. EMBEDDED WEB SERVER

Embedded Web Server technology is the combination of embedded device and internet technology, which provides a flexible remote device monitoring and controlling function based on internet browser [8]. Raspberry Pi collecting data form sensors and send to the centralized server .The server collects the data and stores it in database. The web pages create using HTML. Using IP address open the web page simple log in page all the data available on page. IP address is two type static IP address

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and Dynamic IP address. From distance location controlling simply using smart phone internet connection is available in phone using IP address log in page controlling all device from that location all the data available on page to monitoring and controlling.

V. SYSTEM RESULTS

The individual testing of different modules are done and the final setup is made by arranging all the devices in proper order. The whole tested system is as shown in figure 10. After requesting the web pages by the client, the online processing web page for client is opened. Client can interact with the system through its own browser via these embedded web pages. The web page representing the sensor values are maintained by the embedded web server and if Temperature value is exceeds than threshold value, then client will receive mail. System Monitoring Page is shown in figure 11. The client access data through this web page sent by the server. If client wants to access the pervious data, he can access it from the server .Data logger is provided in this system. All data which is monitored can be seen live on webpage along with the live video coming from Raspberry Pi camera. Following figures and tables show the developed system results.

Table 1: Temperature Readings

Temperature	DS18B20 Sensor	Mercury Thermometer
Normal	27.2^0C	27^0C
Hot Water	40.3^0C	41^0C
Cold Water	26.4^0C	26^0C

Table 2: Humidity Readings

Date	Time (PM)	Sensor Reading	Atmospheric Reading
14-Aug-2016	2.30	69.5%	69%
	4.30	73.2%	73%
	5.00	72.9%	72%
	5.40	72.2%	72%
	6.30	77.1%	77%
	8.00	79%	79%

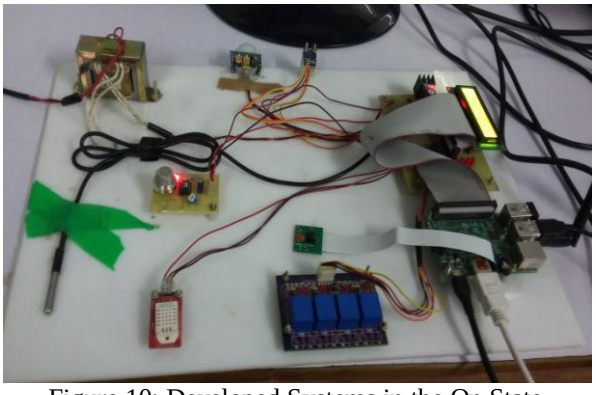

Figure 10: Developed Systems in the On State

The Temperature Sensor (DS18B20) is calibrated using Mercury Thermometer and Humidity Sensor (DHT22) has been calibrated with reference of web page of Aurangabad on internet.

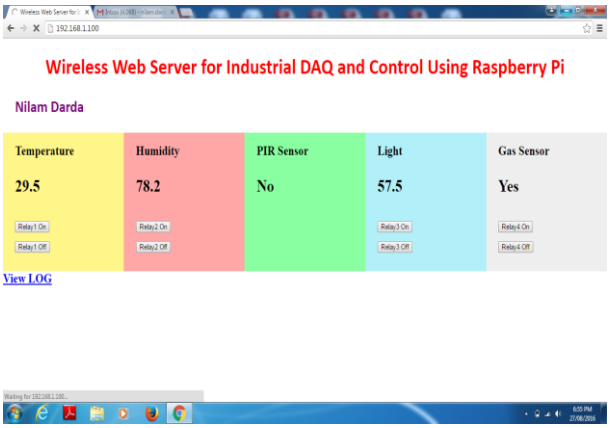

Figure 11: Systems Monitoring Page

VI. CONCLUSIONS

Raspberry Pi smart, economic and efficient platform for implementation of industrial data acquisition and controlling of different devices. The system of industrial module monitoring and controlling different parameter like Temperature, Humidity, Light Intensity, Motion detection, Gas detection from distant location using web server. Implementation of web server using Raspberry Pi for intelligent monitoring is new method to monitor parameter. The whole system has low-cost and easy to maintain and given up gradation facility. Using Raspberry Pi can reduce cost as well as the complexity of monitoring industrial devices. Real time data monitoring and controlling of devices from distant location is possible using Raspberry Pi and web server.

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