Design of Embedded System for Safety and Surveillance

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Abstract— This project deals with the Design & implementation of embedded system for the safety & surveillance monitoring using the raspberry Pi , PIR sensor, RFID reader , temperature sensor & gas sensor. It increases mobile technology to provide the safety & security for the control application. The proposed system allows the authorize person to access the control system if the unauthorized person tries to access the system then it captures the image through webcam & send it to the web server for evaluation to the user with alerts of possible intrusion also it detect the gas & temperature in the monitoring area & send the real time image to user with alerts. The system is tested in many different situations; firstly, RFID sensor scanned with valid card then system does not give any alerts to the user only displays valid entry message on web server. In second test the RFID sensor scanned with Invalid card then system gives alarm to user with real time image on web server with message of invalid entry. In third test we have tested system with temperature sensor as the temperature reaches to critical level then the system give the alarm signal with real time image on web server with temp alert message on the web server at the end we tested system for gas sensor as the gas level in the monitoring area reaches to the critical level then the system gives alerts to the user with real time image. Thus we have studied system warns the user by first sending an alerts on web server then real time view of the control place captured through webcam.

Key words: USB Camera, PIR sensor, RFID, Temperature Sensor, Gas Sensor, Raspberry Pi, and Relay

I. INTRODUCTION

With the rapid development of security awareness and embedded system society have a higher demand for security & surveillances. The majority of scientific research institute & manufacturers have attached more importance to the design of intelligent security & surveillance system for improving monitoring capabilities and securities of the office & remote places.

Closed-circuit television monitoring system has now become an indispensable device in today's society. Supermarkets, factories, hospitals, hotels, schools, and companies are having their own CCTV system for 24/7monitoring. It gives real-time monitoring, provides surveillance footage, and allows the authorities have evidences against illegal activities. It is believe that CCTV can deter crimes. Although surveillance camera records video and helps the authorities to identify the cause of an incident such as crime or accident, it is just a passive monitoring device.

Here we have designed an active surveillance camera that has the capability of identifying the context of the scene being monitored and able to give notification or alarm as the event happens rather than passive recording 24/7.

Also fire is an undesirable event that could bring a great loss of social wealth and human life. To prevent fire losses, various protection and alarm systems have been developed such as smoke detectors, temperature sensor based systems etc. As technologies evolved and instruments such as temperature sensors, camera etc becomes affordable, various automated fire alarm systems are now available. In conjunction with the cheaper instruments, there is a possibility that automated fire alarm system give false signal to the fire controlling authority. To avoid the false signaling here we have designed system that will give the alarm and real time scenario of the incident place to the user then by analyzing scenario user can take the necessary actions.

The availability of cheap , small size, single board computer such as the Raspberry Pi has enabled the creation of numerous automated, monitoring & surveillances system that has low power consumption, faster processing ability at a lower cost. The security & surveillance system proposed here will integrate the use of affordable instruments, connectivity and wireless communication.

II. SYSTEM ARCHITECTURE

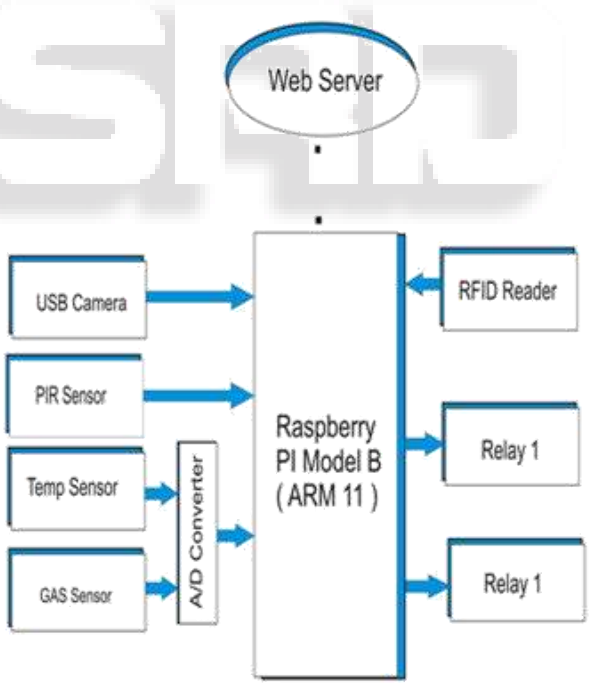


Fig. 2.1: Block Schematic of Proposed system

Figure 2.1 shows the system architecture. The structure of the security & surveillance system composed of six components, which are Raspberry Pi Model-B single-board computer, RFID Reader, gas sensor, PIR sensor, webcam and output relay. Raspberry Pi was selected due to its good technical specifications, high performance for data processing and is cheaper than other single board computers available in the market. The web cam is used to capture the image.

A. Functional Description:

1) Raspberry Pi:

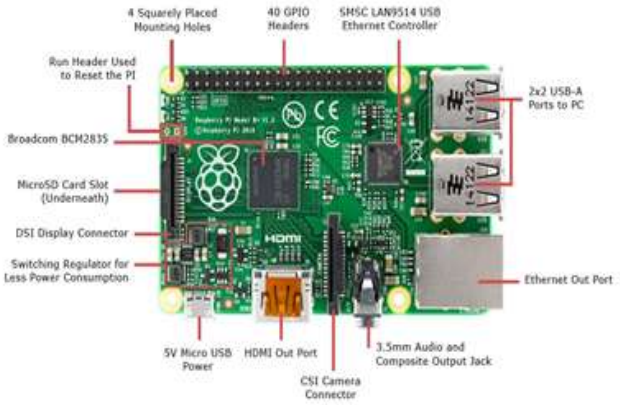


Fig. 2.2: Raspberry Pi Model B

Raspberry Pi board development started on 2006. It is an inexpensive computer that uses Linux-based operating system. The Various functionalities components are given below,

1) SoC: BROADCOM BCM 2835 is defined as System on chip.
2) CPU core: ARM1176JZF-S, ARM11 core clocked at 700MHz; ARM VFP. The ARM11 core implements the ARMv6 Architecture.
3) GPU core: a Broadcom Video Core IV GPU providing OpenGL ES 1.1, OpenGL ES 2.0, hardware-accelerated Open VG 1.1, Open EGL, Open MAX and 1080p30 H.264 high-profile decode. There are 24 GFLOPS of general purpose compute and a bunch of texture filtering and DMA infrastructure.
4) SD Card Slot is used to install OS/booting/long term storage .The total memory of the SD card is about 8GB.
5) Micro USB Power Port provides 700mA at 5A.
6) RCA Video Out is connected to display if HDMI output is not used. It is mainly used to carry audio and video signals. They are otherwise called as A/V jacks.
7) Audio out Digital audio is obtained if HDMI is used to obtain stereo audio. Here analogue RCA connection is used.
8) Ethernet Port is used to connect to the Internet. It also plays a role in updating, getting new software easier.
9) HDMI OUT (High Definition Multimedia Interface) is used with HDTVs and monitors with HDMI input.
10) GPIO allows us to control and interact with real world.

2) USB Camera:

USB Camera captures the image and sends it to the USB port of the Raspberry Pi board. The camera model used here is USB Camera model 2.0.

1) Specification:
   - Interface Plug Type: USB
   - FPS/Resolution: I use 320x240 @ 30fps
   - Setup Distance: Ideal at about 12-24”
   - Viewing Angle: 54 degrees

3) RFID

Radio frequency identification technology, known as RFID. In RFID systems, an item is tagged with a tiny silicon chip and an antenna; the chip plus antenna (together called a “tag”) can then be scanned by mobile or stationary readers, using radio waves (the “RF”). The chip can be encoded with a unique identifier; allowing tagged items to be individually identified by reader (the ID”) .RFID devices have three primary elements: a chip, an antenna, and a reader. A fourth important part of any RFID system is the database where information about tagged objects is stored.

4) MQ-4 GAS SENSOR

1) High sensitivity to CH4 , Natural gas
2) Normal sensitivity to alcohol, smoke
3) Fast response.
4) Stable and long life
5) Simple drive circuit

Fig. 2.3: MQ4 Sensors

Pin No.	Description	Material Used
1	Gas sensing layer	SnO2
2	Electrodes	Au
3	Electrode line	Pt.
4	Heater coil	Ni-Cr alloy
5	Tubular ceramic	Al2O3
6	Anti-explosion network	Stainless steel gauze
7	Clamp rings	Copper plating Ni
8	Resin base	Bakelite
9	Tube Pin	Copper plating Ni

MQ-4 gas sensor used in gas leakage detecting equipments in family and industry, are suitable for detecting of CH4, Natural gas.LNG, avoid the noise of alcohol and cooking fumes and cigarette smoke.

1) Specification
1) Operating Voltage: 5 V ±0.1
2) Heating voltage: 5 V ±0.1
3) Heating consumption: less than 750mw
4) Operating Temperature : -10℃ to 50℃
5) Storage Temperature: -20℃ to 70℃
6) Related humidity: less than 95%Rh
7) Sensing Resistance: 10KΩ- 60KΩ

5) PIR Sensor:

Fig. 2.4: PIR Sensor

PIR sensors used to sense the motion, almost always used to detect whether a human has moved in or out of the sensors range. These are small, low-power, easy to use, inexpensive,

and don't wear out. So that reason they are mostly found in the appliances and gadgets used in homes or businesses. PIRs are basically made of a pyroelectric sensor, which can detect levels of infrared radiation. Everything emits some low level radiation, and the hotter something is, the more radiation is emitted. The sensor in a motion detector is actually split in two halves. The reason for that is that we are looking to detect motion (change) not average IR levels. The two halves are wired up so that they cancel each other out. If one half sees more or less IR radiation than the other, the output will swing high or low.

The pyroelectric sensor is made of crystalline material that generates a surface electric charge when exposed to heat in the form of infrared radiation. When the amount of radiation striking the crystal changes the amount of charges also changes and can then measured with sensitive FET device built in to the sensor. The sensor elements are sensitive to radiation over the wide range so a filter window is added to the TO5 package to limit detectable radiation to the 8 to 14 mm range which is most sensitive to human body radiation.

6) A to D Converter MCP3004/08):

The Microchip Technology Inc. MCP3004/3008devices are successive approximation 10-bit Analog to-Digital (A/D) converters with on-board sample and hold circuitry. The MCP3004 is programmable to provide two pseudo-differential input pairs or four single-ended inputs. The MCP3008 is programmable to provide four pseudo-differential input pairs or eight single-ended inputs. Differential Nonlinearity (DNL) and Integral Nonlinearity (INL) are specified at ±1 LSB. Communication with the devices is accomplished using a simple serial interface compatible with the SPI protocol.

1) Characteristic:
1) 10-bit resolution
2) 2 ± 1 LSB max DNL
3) ± 1 LSB max INL
4) 4 (MCP3004) or 8 (MCP3008) input channels
5) Analog inputs programmable as single-ended or pseudo-differential pairs
6) On-chip sample and hold circuit.
7) SPI serial interface (modes 0,0 and 1,1)
8) Single supply operation: 2.7V - 5.5V
9) 200 kbps max. sampling rate at VDD = 5V
10) 75 kbps max. sampling rate at VDD = 2.7V
11) Low power CMOS technology

7) Relay:

Relay is an electromagnetic device which is used to isolate two circuits electrically and connect them magnetically. They are very useful devices and allow one circuit to switch another one while they are completely separate. They are often used to interface an electronic circuit (working at a low voltage) to an electrical circuit which works at very high voltage.

A relay can be divided into two parts: input and output. The input section has a coil which generates magnetic field when a small voltage from an electronic circuit is applied to it. This voltage is called the operating voltage. The output section consists of contactors which connect or disconnect mechanically. In a basic relay there are three contactors: normally open (NO), normally closed (NC) and common (COM).

B. Software Resources

Raspbian Wheezy The Raspberry Pi primarily uses Linux kernel-based operating systems it is not possible to run Windows on the Raspberry Pi. The install manager for Raspberry Pi is NOOBS. The OSs included with NOOBS are:

1) Arch Linux ARM
2) Open ELEC
3) Pidora (Fedora Remix)
4) Raspbmc and the XBMC open source digital media center
5) RISC OS – The operating system of the first ARM-based computer
6) Raspbian Wheezy

1) Raspbian Wheezy

Maintained independently of the Foundation based on the ARM hard-float (armhf) Debian 7 'Wheezy' architecture port originally designed for ARMv7 and later processors compiled for the more limited ARMv6 instruction set of the Raspberry Pi. A minimum size of 2 GB SD card is required, but a 4 GB SD card or above is recommended. There is Pi store for exchange the programs.

The Raspbian Server Edition is a stripped version with other software packages bundled as compared to the usual desktop computer oriented Raspbian. The Wayland display server protocol enable the efficient use of the GPU for hardware accelerated GUI drawing functions Raspbian for Robots - A fork of Raspbian for robotics projects with LEGO, Grove, and Arduino.

2) WINDISK 32 Utility

This is a Windows program for saving and restoring images from removable drives (USB drives, SD Memory cards, etc). It can be used to write boot images to a SD Flash device or USB flash device, making it bootable.

3) PuTTY suite 0.63:

PuTTY s a free and open-source terminal emulator, serial console and network file transfer application. It supports several network protocols, including SCP, SSH, Telnet, rlogin, and raw socket connection. It can also connect to a serial port(since version 0.59). The name "PuTTY" has no definitive meaning. PuTTY was originally written for Microsoft Windows, but it has been ported to various other operating systems. Official ports are available for some Unix-like platforms, with work-in-progress ports to Classic Mac OS and Mac OS X, and unofficial ports have been contributed to platforms such as Symbian and Windows Mobile. PuTTY was written and is maintained primarily by Simon Tatham. PuTTY supports many variations on the secure remote terminal, and provides user control over the SSH encryption key and protocol version, alternate ciphers such as 3DES, Arcfour, Blowfish, and DES, and Public-key authentication. It also can emulate control sequences from xterm, VT102 or ECMA-48 terminal emulation, and allows local, remote, or dynamic port forwarding with SSH (including X11 forwarding). The network communication layer supports IPv6, and the SSH protocol supports the delayed compression scheme. It can also be used with local serial port connections.

4) PHP:

The PHP hypertext preprocessor (PHP) is a server- side scripting language designed for web development. PHP code is integrated by a web server with a PHP processor

module which generates the resulting web page. PHP is basically used for developing web based software applications and also to manage database, dynamic content, session tracking etc. PHP 5 was used in this project.

5) Python:

Python is a widely used general-purpose, high-level programming 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. Python supports multiple programming paradigms, including object-oriented, imperative and functional programming or procedural styles. It features a dynamic type system and automatic memory management and has a large and comprehensive standard library.

Python interpreters are available for installation on many operating systems, allowing Python code execution on a wide variety of systems. Using third-party tools, such as Py2exe or Py installer, Python code can be packaged into stand-alone executable programs for some of the most popular operating systems, allowing for the distribution of Python-based software for use on those environments without requiring the installation of a Python interpreter.

CPython, the reference implementation of Python, is free and open-source software and has a community-based development model, as do nearly all of its alternative implementations. CPython is managed by the non-profit Python Software Foundation.

III. Design and Implementation

The Proposed System is divided into two parts: Hardware i.e. sensor interfacing and Software programming .This chapter contains design of the application in the system. It covers the Hardware implementation i.e. Interfacing of different sensor and Software implementation i.e. Raspbian board programming.

A. System Implementation

System implementation includes hardware implementation of proposed system, interfacing of different sensor and software implementation of proposed system

1) Interfacing of RFID & USB Camera

Fig. 3.1: USB Camera & RFID Interfacing

Above figure represent the hardware implementation of system which contains the interfacing of the RFID reader, USB 2.0 camera.

2) Interfacing Of Temperature Sensor & Gas Senor:

The temperature sensor LM35 & gas sensor MQ4 are connected to the channel no 1 & channel no 2 of MCP 3208 respectively. MCP 3208 convert the analog input of the sensor to the digital using inbuilt A to D converter & provides the serial data to the GPIO of Raspberry PI.

Following diagram gives the detail interfacing of the MCP 3208 to the GPIO of the Raspberry Pi.

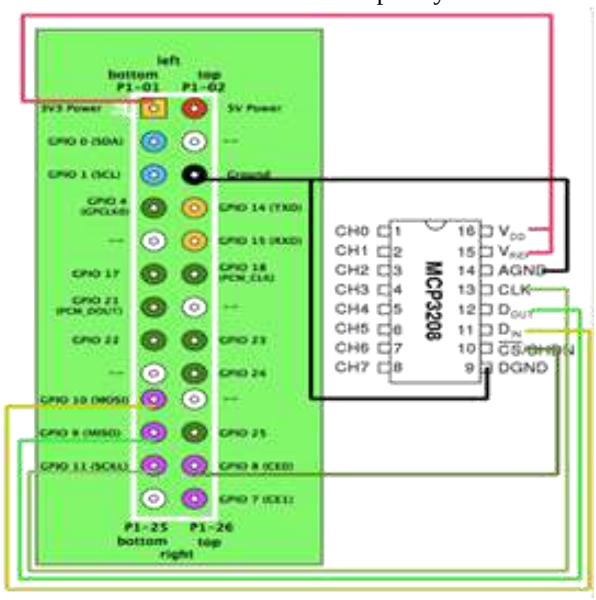


Fig. 3.2: Interfacing of A/D IC to Raspberry Pi Board

B. Software Implementation:

1) Steps To Install Raspbian OS

In order to install Raspbian OS, first next out of box software (NOOBS) has to be installed. We have selected Raspbian Wheezy.

1) First step is to allocate the drive for installing OS
2) SD adaptor can also be used for this purpose
3) Download WINDISK 32 utility from source forge Project which is a zip file
4) Extract and run the zip file
5) Select the file and click run as administrator
6) Select the image file which was extracted above
7) Select the drive letter of the SD card in the device box.
8) Click write and wait for write process to complete.
9) Exit the image and eject the SD card.

Fig. 3.3: Installed Raspbian OS.

2) Steps for PuTTY Configuration:

1) Obtain a copy of PuTTY pre-configured for use at Columbia from the PuTTY download page.

2) Save the installer file to your download directory or desktop.
3) Double-click on the file PuTTY-install.exe to begin the installation.
4) At the Choose Destination screen, Click Next to accept the recommended default destination location for installing PuTTY.
5) Click Next on the Select Program Folder screen to select PuTTY as the recommended Program Folder name (PuTTY should already be displayed in the Program Folders text box. Click Finish on the final screen to complete the installation.

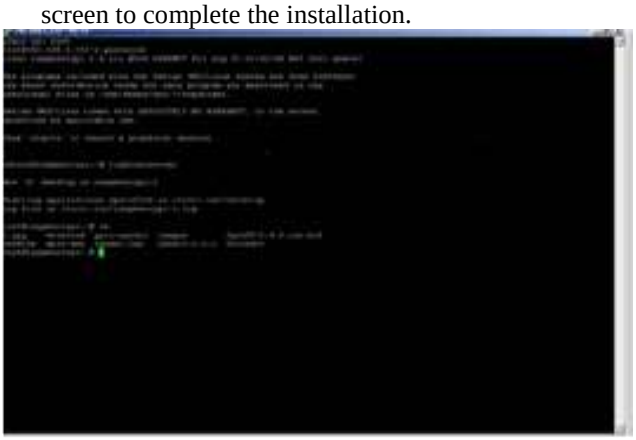
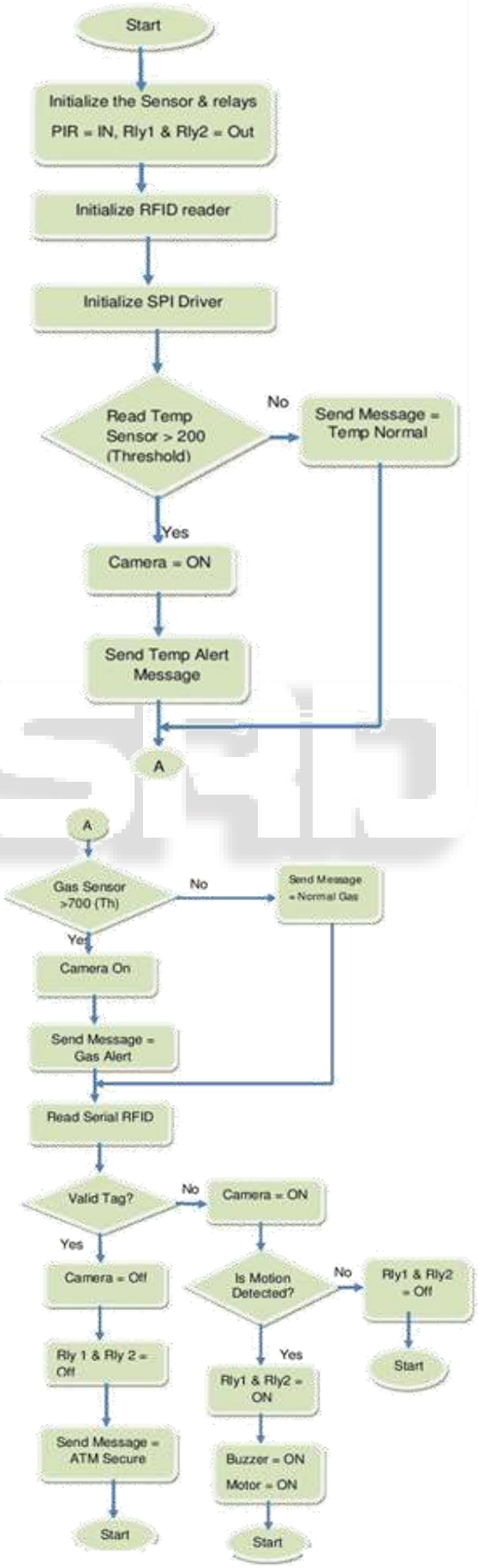


Fig. 3.3: PuTTY Configurations

C. Algorithm Of Proposed System

1) Step 1: Start.
2) Step 2: Initialize the sensor & relays PIR= IN & Relay1 = Relay 2 = Out.
3) Step 3: Initialize the RFID reader set communication port & baud rate @ 9600.
4) Step 4: Initialize the SPI driver.
5) Step 5: Read the temperature from temperature sensor.
6) Step 6: If the temperature is greater than critical level then start camera & send the temperature alert message.
7) Step 7: Else send temperature normal message.
8) Step 8: Read the gas sensor
9) Step 9: If the gas level is above the critical level then start the camera & send gas alert message.
10) Step 10: Else send gas normal message.
11) Step 11: read RFID reader.
12) Step 12: If the valid card present then stop the camera, relays (realy1 & relay 2) & send the valid user message.
13) Step 13: Else start the camera, scan the PIR sensor.
14) Step 14: If the PIR sensor detect the motion then make buzzer on & send ATM unsecure message.
15) Step 15: Else stop the relays (realy1 & relay 2)
16) Step 16 : Go to step No. 1.

D. Flowchart Of The Python Programming In Raspberry Pi For Proposed System



IV. RESULT & DISCUSSION

A. Introduction

This chapter describes results obtained during the implementation of module. Hardware results are explained

B. Authorize User

as authorize user access the system then it display the message on web serve as Valid User & system is secure also temperature & Gas Sensor is normal then it gives Message GAS & temperature Normal which is shown in below image.

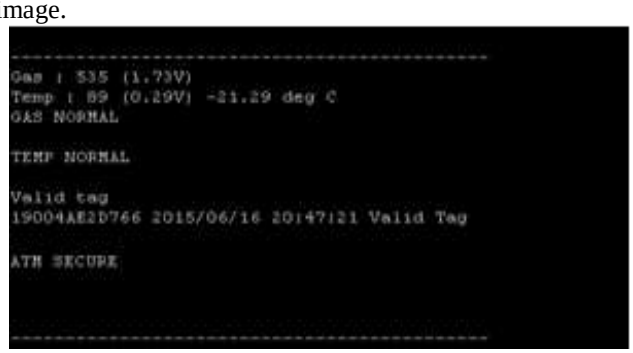


Fig. 4.1: Authorize entry Display Message

C. Unauthorized user:

As Unauthorized user tries to access the system then system activates the motion sensor . if motion detected then system gives the alerts to the user by sending message on web server along with real time image of the place on the web server. Then user can take the appropriate action by analyzing the real time image.

Fig. 4.2: Web server Message for Unauthorized entry

Fig. 4.3: Web server display Image of Camera

D. Temperature Alert:

As the temperature above the 60 degree centigrade then the system gives the Alert message on the web server with the alarm.

Fig. 4.4: Web server Message for temperature alert

E. Gas Alert:

As the Gas Sensor MQ4 detects the gas above the critical level then it gives the alarm with alert message on the web server.

Fig. 4.5: Web servers Message for gas alert

V. CONCLUSION

Thus we have designed & presented a smart surveillance system capable of recording/capturing video/image and transmitting to web server after the unauthorized entry occurs .so that user can analyze the image & take the necessary action. Future work is to locate the number of persons present exactly in that area and their position so that accurate information can be obtained on the receiver side. Also we have designed & presented fire alarm system using the Raspberry Pi. The designed system offers a feature that enabled verification that a fire actually occurred. The fire alarm system warns the user by first sending an alert and asks for confirmation before submitting a report/alert to the "Firefighter". Thus system designed here having the low cost, with low power consumption and reliable instruments.

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