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Pi Server Based Door Automation for Security and Monitoring

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ABSTRACT: *It is expected that the Internet of Things (IoT) applications for home automation services can be one of the most remarkable field for rapid growth. IoT consists of communications and sensors to accomplish purpose. Our research approach is to design and develop reliable, efficient, flexible, economical, real time monitoring system for smart homes. The internet of things technology is deployed into the home environment. By using this technology and video processing techniques, we develop a system, which monitors the video footage of the door, and whenever any person arrives, it automatically sends a tweet to the user if he is outside the door. If he is inside an alarm is raised and the person can unlock the door sitting inside itself. We initiate the research with the development of the smart home approach and implement it in different home conditions (different houses) to monitor the activity of visitors for door automation. Additionally, our research extends the smart home system to smart buildings and models the design issues related to the smart building environment; these design issues are linked with system performance and reliability.*

I. INTRODUCTION

Nowadays, technology plays an essential role in our life in which different domain of interests are taking advantage of technology. Recently, computers and smart phones have significantly contributed our daily life where numerous computations and adjustments are being accomplished by such technologies. Securing homes has become one of the concerning issues that facing many people. With the expanded duration of leaving the home due to work, study and other duties, homes are being more vulnerable for several threats especially being burgled.

Apart from the threats, there are different cases where securing or monitoring the house is very critical such as the existence of elderly individuals or kids with baby sitter. For this manner, home security system or so-called Home OS has been proposed in order to provide more secure arrangements. Such concept aims to turn the home into a smart in which different tasks especially monitoring can be performed remotely. Monitoring and controlling some tasks inside the house would have the ability to provide maximum safety [1]. Home automation system is a computer-based application that has the ability to connect different electronic devices for the sake of monitoring and controlling the home appliances.

Home automation system is an area that has caught several attentions by both the academic and business fields. The earliest effort of home security system was relied on wired home networks however, due to the appropriate planning and construction works required to offer a wired home, such effort tend to be insufficient. As a solution for this problem, wireless communication has been emerged to provide more flexible platform where the installation cost is significantly lower than the wired one. Therefore, it has been applied for different security home systems in order to provide an alarm for critical threats such as intrusions or other environmental risks such as gas leaking or fire [2].

Recently, electronic door lock systems are one of the most popular security systems that is being installed for many residents and business places. The key characteristic behind such systems lies on the reliability in which the authorized individuals can gain the permission to access the doors throughout a secure system that has an interactive interface.

A new system has been emerged which is called Near Field Communication (NFC) door lock system [3]. Such system is based on a pattern recognition technology where the individuals' faces are being analyzed in order to identify their personalities [4]. Such analysis takes different forms such as analyzing facial image or video stream. In addition, the size and position of the face's elements are being also considered in the analysis This paper aims to present a novel security home system based on Bluetooth network. The main goal is to develop a prototype that has the ability to simulate the wireless tasks including monitoring and controlling digital door lock. Such system would have the capability to provide secure and controlled home appliances.

II. LITERATURE REVIEW

Several remote systems have been proposed whether for the academic or business domain. Such systems were intended to provide a remote control and monitoring tasks. For instance, a system has been proposed by [5] which is based on Zigbee technology. This system is composed of multiple modules such as the human detection module (HDM) which aims to detect the user at

the door. This can be performed using the camera module in which the images or the video stream is being processed.

Consequentially, the results of the two-mentioned module will go through the Zigbee module that would identify verification International Keypad 4x4 Raspberry pi3 Camera LCD Email with Picture Wifi tag for each user. Once the user got failure in terms of the zigbee verification tag, a speaker phone will be provided with the owner of the property. Digital door lock in home automation system provides proper control and home environment monitoring to the user.

A system has proposed by [6] based on the RFID technology which provides a touch LCD monitor. Another system consists of a build in NFC capabilities of a smart phone which would eventually be the key to open the door by means of logical link control protocol, which then matches the user's own set of passwords to verify that user should be given permission or not [7]. Another system has been proposed by [7] which based on an NFC featuring smart phone abilities. Such system uses logic link control to identify the permission of the user's identities. In addition, a system proposed by [8] based on design of GSM digital door lock system using PIC platform.5-digit password is used to lock/unlock the door. If the user submits an incorrect password the system notifies the owner.

In [9] a system has designed that contains sensors to detect obstacle, touch, heat, smoke, sound. The whole system is controlled by a PIC microcontroller 16F76. It gathers the information from the sensors makes a decision and sends SMS to a corresponding number by using a GSM modem. If an interruption has been identified, then PIC will send a SMS to the owner and another SMS to the Police Station. Similarly, for environmental threats such as fire interruption a SMS will be sent to the fire brigade and another to the owner [9]. In this system require extra hardware components like Sensors, GSM Modem.

Alerts are sent through only SMS. In [10] an intelligent system for home security using illumination sensitive background model is presented. Such system enables tracking and detection of intruder and it is based on providing home security. For this purpose, a face recognition technique is utilized to identify the intruder and on finding him, an image of the intruder is sent on the owner mail id for further action. The implementation of this system also includes the comparison of different approaches for object tracking and then used an illumination-sensitive background modeling approach for the proposed security system. But this system doesn't use password for identification.

III. DESIGN OF HARDWARE

This chapter briefly explains about the hardware implementation of Pi Server Based Door Automation for Security and Monitoring. It discusses the circuit diagram of each module in detail.

3.1. ELECTROMAGNETIC RELAY

A **relay** is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a separate low-power signal, or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits as amplifiers: they repeated the signal coming in from one circuit and re-transmitted it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations.

A type of relay that can handle the high power required to directly control an electric motor or other loads is called a contactor. Solid-state relayscontrol power circuits with no moving parts, instead using a semiconductor device to perform switching. Relays with calibrated operating characteristics and sometimes multiple operating coils are used to protect electrical circuits from overload or faults; in modern electric power systems these functions are performed by digital instruments still called "protective relays".

Magnetic latching relays require one pulse of coil power to move their contacts in one direction, and another, redirected pulse to move them back. Repeated pulses from the same input have no effect. Magnetic latching relays are useful in applications where interrupted power should not be able to transition the contacts.

Magnetic latching relays can have either single or dual coils. On a single coil device, the relay will operate in one direction when power is applied with one polarity, and will reset when the polarity is reversed. On a dual coil device, when polarized voltage is applied to the reset coil the contacts will transition. AC controlled magnetic latch relays have single coils that employ steering diodes to differentiate between operate and reset commands.

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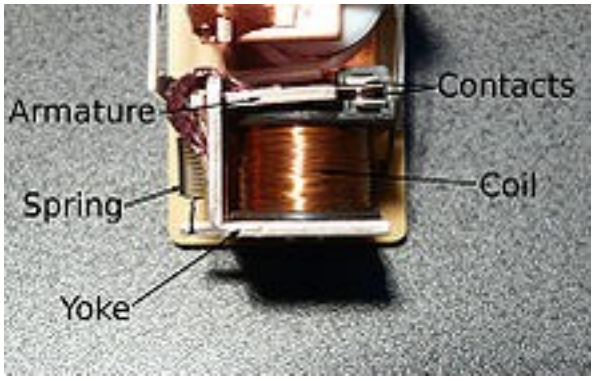

Fig .1 relay internal diagram

When the coil is energized with direct current, a diode is often placed across the coil to dissipate the energy from the collapsing magnetic field at deactivation, which would otherwise generate a voltage spike dangerous to semiconductor circuit components. Such diodes were not widely used before the application of transistors as relay drivers, but soon became ubiquitous as early germanium transistors were easily destroyed by this surge. Some automotive relays include a diode inside the relay case.

If the relay is driving a large, or especially a reactive load, there may be a similar problem of surge currents around the relay output contacts. In this case a snubber circuit (a capacitor and resistor in series) across the contacts may absorb the surge. Suitably rated capacitors and the associated resistor are sold as a single packaged component for this commonplace use.

3.2 SOLENOID Valve LOCK

A solenoid door lock is a remote door locking mechanism that latches or opens by means of an electromagnetic solenoid. In most cases, the actual locking mechanism of a solenoid door lock will be identical to a conventional key-operated example. The only difference between the two is the inclusion of a low-voltage solenoid in the mechanism, which pulls the latch back into the door when a push button or other controller is activated. The latch will then be retained in the door for as long as the button is pushed, or, in the case of a latching solenoid, indefinitely until the button or controller is activated again. These types of door locks are used extensively in remote security access and automotive doors.

Most door locks work in one or two basic ways. In the case of access doors in buildings, a latch or pins in the lock mechanism located in the door leaf are pushed into a hollow compartment or socket in the frame, thereby preventing the door from being opened. A fairly simple cam arrangement allows the latch to be withdrawn and retained in the lock mechanism when the door is unlocked.

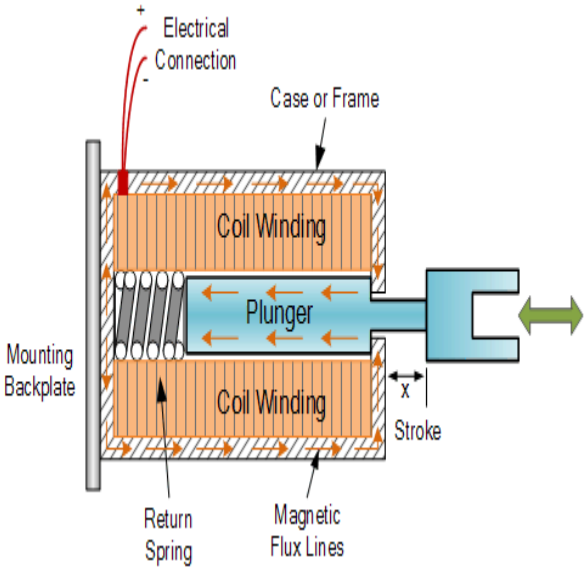

Fig .2 lock internal diagram

Car door locks usually function in a slightly different manner and feature a slotted cam which locks over a latching bar on the car body. An arrangement of levers and linkages is used to lift the cam and open or lock the mechanism. The solenoid door lock, on the other hand, makes use of a static wire wound coil and a moving armature or plunger to perform the work of the key and linkages in conventional locks. The coil is wired into a circuit, which will include a low-voltage, direct-current (DC) power source, and at least one control input such as a push button. When the control is activated, electric current flows to the coil, energizing and creating a strong magnetic field around it. This magnetic field attracts the armature or plunger, causing it to move rapidly towards the coil. The locking mechanism latch or cam is attached to the armature or plunger via an actuator arm and is consequently pulled out of the locking position.

In the case of some security access doors, the solenoid door lock will remain active for a couple of seconds courtesy of a built-in delay circuit allowing time for the door to be opened. It may also be kept active by an operator holding down the control button until the door is opened. When the power is cut to the solenoid, the latch resets and the door locks again when closed. Where the lock is meant to stay open for protracted periods, a latching solenoid may be used. These solenoids include a set of permanent magnets at the rear of the coil which hold the plunger in place, allowing power to be cut to the solenoid door lock coil, preventing overheating and unnecessary power drain.

3.3. Raspberry Pi

It is a powerful, low cost, and a small card sized device which is a perfect platform for interfacing with

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many devices. The board contains a processor, graphics chip, RAM memory, interfaces to other devices and connectors for external devices, of which some are necessary and some are optional. There are much versions of Raspberry Pi but the CPU (BCM2835) of all the models of Raspberry Pi remains same. The CPU is somewhat cheap, powerful and efficient and it does not consume a lot of power. It works in the same way as a standard PC requiring a keyboard for giving commands, a display unit and power supply.

Here, in Raspberry Pi, SD card is used in the same way as the hard disc in the computer. The connectivity of raspberry pi to the internet may be via a LAN (Local Area Network) cable / Ethernet or via a USB modem. The main advantage of Raspberry Pi is that it has a large number of applications. It also has 4 pole stereo output and composite video port. Video processing applications are also possible using raspberry pi like video compression.

Compressed video can successfully decrease the bandwidth required to transmit the video through terrestrial broadcast, cable TV, or satellite TV services [19]. The Raspberry-Pi runs on Linux based OS, an open source operating system. In this system we used Raspbian OS which is Linux based OS. The programming language for the Raspberry-Pi for the system implementation is Python.

3.3.1 Hardware

The Raspberry Pi hardware has evolved through several versions that feature variations in memory capacity and peripheral-device support.

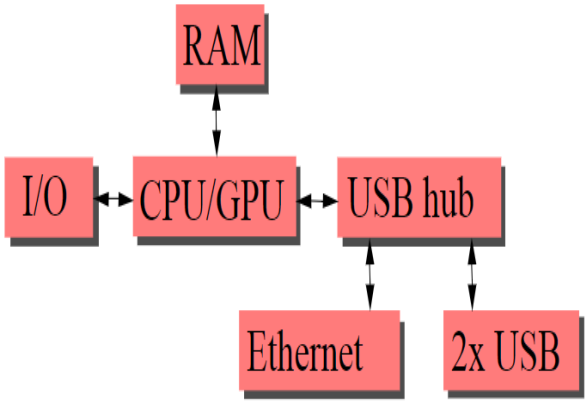

Fig 3 Raspberrypi block function

This block diagram depicts Models A, B, A+, and B+. Model A, A+, and the Pi Zero lack the Ethernet and USB hub components. The Ethernet adapter is internally connected to an additional USB port. In Model A, A+, and the Pi Zero, the USB port is connected directly to the system on a chip (SoC). On the Pi 1 Model B+ and later models the USB/Ethernet chip contains a five-point USB hub, of which four ports are available, while the Pi 1 Model B only provides two. On the Pi Zero, the USB port is also connected directly to the SoC, but it uses a micro USB (OTG) port.

3.3.1.1 Processor

The Raspberry Pi 2 uses a 32-bit 900 MHz quad-core ARM Cortex-A7 processor. The Broadcom BCM2835 SoC used in the first generation Raspberry Pi is somewhat equivalent to the chip used in first modern generation smartphones

(its CPU is an older ARMv6 architecture),[22] which includes a 700 MHz ARM1176JZF-S processor, VideoCore IV graphics processing unit (GPU),[23] and RAM. It has a level 1 (L1) cache of 16 KB and a level 2 (L2) cache of 128 KB. The level 2 cache is used primarily by the GPU. The SoC is stacked underneath the RAM chip, so only its edge is visible.

The earlier models of Raspberry Pi 2 use a Broadcom BCM2836 SoC with a 900 MHz 32-bit quad-core ARM Cortex-A7 processor, with 256 KB shared L2 cache.[24] The Raspberry Pi 2 V1.2 was upgraded to a Broadcom BCM2837 SoC with a 1.2 GHz 64-bit quad-core ARM Cortex-A53 processor,[25] the same SoC which is used on the Raspberry Pi 3. The Raspberry Pi 3 uses a Broadcom BCM2837 SoC with a 1.2 GHz 64-bit quad-core ARM Cortex-A53 processor, with 512 KB shared L2 cache.[26]

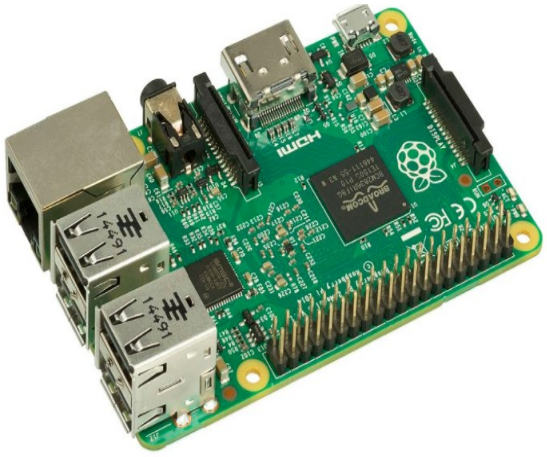

Fig 4 The Model B boards incorporate four USB ports for connecting peripherals.

3.4. POWER SUPPLY:

The power supplies are designed to convert high voltage AC mains electricity to a suitable low voltage supply for electronic circuits and other devices. A power supply can by broken down into a series of blocks, each of which performs a particular function. A d.c power supply which maintains the output voltage constant irrespective of a.c mains fluctuations or load variations is known as “Regulated D.C Power Supply”.

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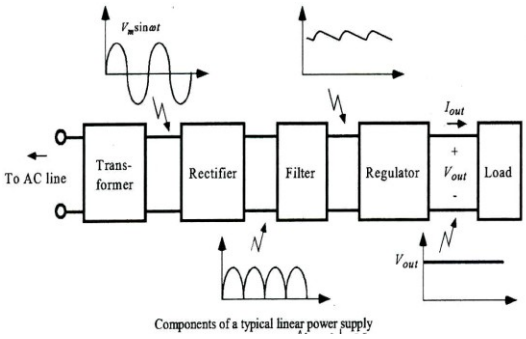

Fig:5. Block Diagram of Power Supply

3.5. COMMUNICATION NETWORK

In health monitoring system, wireless network is used to forward measurement through a gateway towards cloud. The main network used here is IoT. The meaning of IoT is Internet of Things, simply called as Internet of everything. Different wireless communication technologies can be used for

(i) connecting the IoT device as local networks, and

(ii) connecting these local networks (or individual IoT devices) to the Internet. The connectivity technologies are NFC, Bluetooth, zigbee, cellular network etc. In this project, we use cellular network connectivity because of it has widespread mobile networks like 3G and LTE provide reliable high-speed connectivity to the Internet. However, they have a high power consumption profile and they are not suitable for M2M or local network communication [10].

IV. DESIGN OF SOFTWARE

4.1. INTRODUCTION TO MATLAB:

This is free software (evaluation version) which solves many of the pain points for an embedded system developer. This software is an Integrated Development Environment(IDE), which integrated text editor to write program, a compiler and it will convert your source code into HEX file. Raspberry Pi™ programming usually involves working with images, videos, audio, and other sensor data. MATLAB® and Simulink® help users quickly analyze and visualize this data and program their Raspberry Pi to respond accordingly. The products support two primary workflows:

- Reading, writing, and analyzing data from Raspberry Pi sensors and cameras
- Developing algorithms that run standalone on the Raspberry Pi

4.2 Read, Write, and Analyze Data from Raspberry Pi Sensors and Cameras

MATLAB support package for Raspberry Pi lets you write MATLAB programs that communicate with your Raspberry Pi and acquire data from the board's GPIO pins, cameras, and other connected devices. Because MATLAB is a high-level interpreted language, it is easy to prototype and refine algorithms for your Raspberry Pi projects. MATLAB includes thousands of built-in math and plotting functions that you can use for Raspberry Pi programming, covering domains such as image and video processing, optimization, statistics, and signal processing.

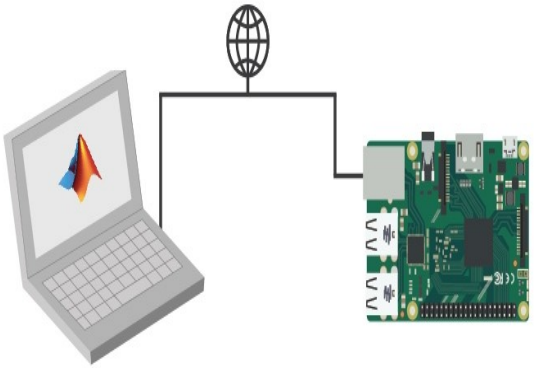

Fig 6: interfacing with web

With MATLAB support package for Raspberry Pi, the Raspberry Pi is connected to a computer running MATLAB. Processing is done on the computer with MATLAB.

4.3 Using MATLAB for Raspberry Pi programming lets you:

- Analyze Raspberry Pi sensor data using thousands of prebuilt functions for image processing, signal processing, mathematical modeling, and more
- Quickly visualize your data using the vast array of MATLAB plot types
- Use the same software to program other hardware devices, such as Arduino® and BeagleBone Black

Simulink Support Package for Raspberry Pi lets you develop algorithms in Simulink, a block diagram environment for modeling dynamic systems and developing algorithms, and run them standalone on your Raspberry Pi. The support package extends Simulink with blocks for configuring your Raspberry Pi, sending and receiving UDP packets, and reading and writing data from sensors. This includes writing data to the free ThingSpeak data aggregation service for Internet of Things applications.

After creating your Simulink model, you can simulate it, tune algorithm parameters until you get it just right, and download the completed algorithm for

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standalone execution on the device. With the MATLAB Function block, you can incorporate MATLAB code into your Simulink model.

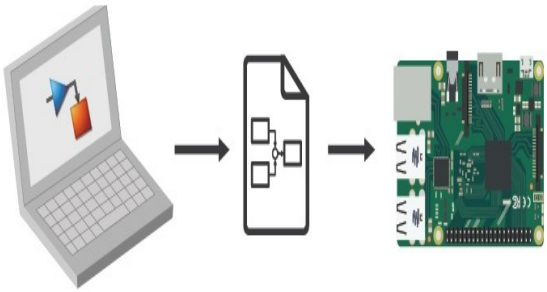

Fig 7 interfacing matlab with raspberry pi

With Simulink support package for Raspberry Pi, you develop the algorithm in Simulink and deploy to the Raspberry Pi using automatic code generation. Processing is then done on the Raspberry Pi.

Using Simulink for Raspberry Pi programming lets you:

- Develop and simulate your algorithms in Simulink and use automatic code generation to run them on the device
- Incorporate signal processing, control design, state logic, and other advanced math and engineering routines in your Raspberry Pi programming projects
- Interactively tune and optimize parameters as your algorithm runs on your Raspberry Pi

Programming Raspberry Pi with Simulink for robot motor control 6:56

In addition to using Simulink Support Package for Raspberry Pi, you can generate readable and portable C code from MATLAB algorithms and deploy it on a Raspberry Pi using Raspberry Pi support from MATLAB Coder.

4.4 CAPABILITIES AND FEATURES

Use MATLAB Coder® to generate readable and portable C code from your MATLAB® algorithm, and then deploy using Raspberry Pi support from MATLAB Coder. With MATLAB, you can design signal processing, computer vision, and image processing algorithms and applications for Raspberry Pi. You can use MATLAB Support Package for Raspberry Pi Hardware to log data from supported sensors on your Raspberry Pi computer, and analyze the data in MATLAB to help fine-tune your algorithm.

You can then generate C code from your MATLAB algorithm, and deploy it to run standalone on the Raspberry Pi using MATLAB Coder. Explore an example that guides you through the workflow.

V. PROJECT DESCRIPTION

This chapter deals with working and circuits of "**Pi Server Based Door Automation for Security and Monitoring**". It can be simply understood by its block diagram &circuit diagram.

5.1. BLOCK DIAGRAM:

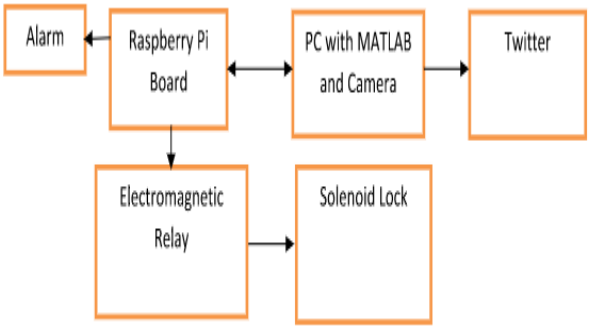

Fig 8 block diagram

5.2. SOFTWARE REQUIREMENTS:

- MATLAB
- Flash Magic
- Mat lab coding

5.3. HARDWARE REQUIREMENTS:

- Power supply
- LPC2148
- IR sensor
- Alcohol sensor
- LCD
- APR9600
- Speaker

5.4. WORKING:

The System architecture of Smart Home Security System is shown in the figure 1. Raspberry Pi, PiCamera and Power supply forms the entire security system to be installed at the required place. PIR motion sensor is connected to GPIO pins of Raspberry Pi. We can use LCD monitor for setting up Raspberry web server. Loudspeaker mounted at Audio Jack of Raspberry Pi. Relay Driver circuit with IC ULN2003 [16] is interfaced to Raspberry Pi to control Electromagnetic Door Lock.

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The image captured can save with time and date on SD card or USB Pen drive connected on Raspberry Pi. Figure 1: Block diagram IV. SYSTEM DESCRIPTION The remote monitoring and controlling of ECU over the Internet can be mechanized by setting up certain network architectural design strategies such as SSH and applying Internet protocol (IPV6) communication standards [3].

If any visitors arrive, ECU capture image of visitor, save it and sends it to an appropriate email including the details of time and date of captured image. The owner can directly login and interact with the ECU. The images captured and the video recorded will be directly streamed on user pre-decided android app on Smart Phone. User can access the video directly using the Static IP address or can also stream on local domain with the help of websites.

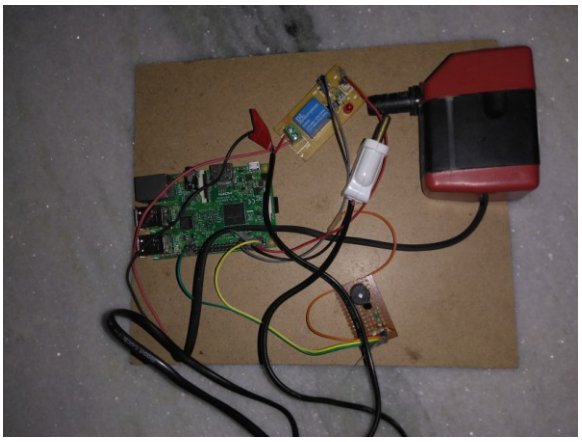
A. Raspberry Pi Raspberry Pi board [13] is a miniature marvel, packing considerable computing power into a footprint no larger than a credit card. The processor at the heart of the Raspberry Pi system is a Broadcom BCM2835 system-on-chip (SoC) multimedia processor. This means that the vast majority of the system's components, including its central and graphics processing units along with the audio and communications hardware, are built onto that single component hidden beneath the 512 MB memory chip at the centre of the board.

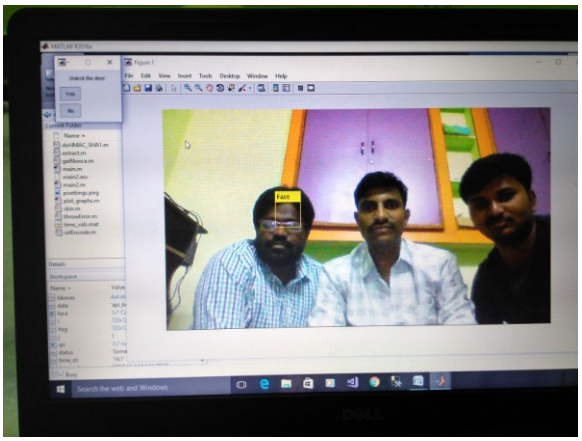
It's not just this SoC design that makes the BCM2835 different to the processor found in your desktop or laptop, however. It also uses a different instruction set architecture (ISA), known as ARM. The Raspberry Pi, by contrast, is designed to run an operating system called GNU/Linux Raspbian. Hereafter referred to simply as Linux. Unlike Windows or OS X, Linux is open source: it's possible to download the source code for the entire operating system and make whatever changes you desire.

Features of the Raspberry Pi [13] ♣ Model B+ Raspberry Pi with Mounting Points and ♣ 512MB RAM. ♣ Broadcom BCM2835 ARM11 700 MHz ♣ Integrated Video core 4 Graphics GPU capable of playing ♣ Full 1080p HD Video. ♣ 4 x USB Ports (Max Output 1.2A). ♣ Board Power Draw: 600mA. ♣ HDMI Video Output. ♣ 10/100Mb Ethernet Port for Internet Access. ♣ Micro SD Flash Memory Card Slot. ♣ 40-pin 2.54mm Header Expansion Slot (Which allow for peripherals and expansion boards) ♣ Dimensions 85 x 56 x 17mm. ♣ The Raspberry Pi is boot by external memory card.

Raspberry PiCamera Module The Raspberry Pi Camera Module is a custom designed addon for Raspberry Pi. It attaches to Raspberry Pi by way of one of the two small sockets on the board upper surface interface uses the dedicated CSI interface, which was designed especially for interfacing to cameras. The CSI bus is capable of extremely high data rates, and it exclusively carries pixel data.. PIR motion Sensor The PIR (Passive Infra-Red) Sensor is a Pyroelectric device that detects human body motion by measuring changes in the infrared levels emitted by surrounding objects. This motion can be detected by checking for a high signal on a single I/O pin. Incorporating a Fresnel lens and motion detection circuit. High sensitivity and low noise. Output is a standard 5V active low output signal. Module provides an optimized circuit that will detect motion up to 6 meters away Inexpensive and easy to use, The Output can be connected to GPIO pins of Raspberry Pi directly to monitor signal.

VI.HARDWARE RESULTS:





VII. CONCLUSION

This project presents the design and the implementation of an interactive Smart home security system with twitter alert, Web enabled video streaming and remote control of Voice alert and Door accessing system using Smart Phone or laptop. The Smart mobile Phone

based monitor and automatic control of equipment is forming a trend in automation field. Replacing PC with low-cost single chip processor which can make administrators to get parameters of different remote devices and send control information to field equipments at any time through Internet.

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