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Real-Time Monitoring Security System Integrated with Raspberry Pi and e-mail Communication Link

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Abstract: ***The alarming rate of increase in crimes has led to the invention of many security devices. In many cases the thieves escape due to the delay in passage of info to the concerned authorities such as control room. The system proposed here is for a security module with Raspberry pi using IOT by integrating webcam and motion sensor with e-mail. Whenever any motion is detected, the webcam streams a live video and the Raspberry pi device alerts the owner through an e-mail on his registered mail-id. A second level of security is included with the help of RFID tags verification. If a wrong pin is entered or if the tag isn't verified then, in either of these cases the webcam captures the intruder's image and sends it via an e-mail for real-time action to be taken by owner to prevent unauthorized access.***

Keywords: Internet of things, Raspberry Pi, Motion Detection, E-mail, Video Streaming, RFID tag verification.

I. INTRODUCTION

A system which is able to finish its task and send its service on time is said to be a real time operating system. RTOS controls the application software and affords a device to allow the processor run. It is responsible for managing the different hardware resources of a personal computer and also host applications which run on the PC.

The different types of security systems used are Monitored Alarm System, Smoke Alarm System, Burglar Alarm System, Medical Alarm System, Critical Alarm System. From the types of security systems, the project proposed here is for home security using IoT and Raspberry Pi. In the world of Internet of Things (IoT) when we have all the technologies to revolutionize our life, it is a great idea to develop a system which can be controlled and monitored from any place in the world. There are many types of good security systems and cameras out there for home security but they are much expensive so a low cost, simple Raspberry Pi based intruder alert system which not only alerts us through an e-mail but also sends a picture of the intruder when it detects any is to be designed. The Raspberry pi 3 Model B is integrated with a Webcam, PIR sensor. Raspberry Pi controls the whole system. This system can be installed at the main door of an office or home. The primary system used here is an embedded system.

An embedded system is one kind of a computer system mainly designed to perform several tasks like to access, process, store and also control the data in various electronics-based systems. Embedded systems are a combination of hardware and software where software is usually known as firmware that is embedded into the hardware. One of its most important characteristics of these systems is, it gives the output within the time limits. An embedded system uses a hardware platform to perform the operation.

Hardware of the embedded system is assembled with a microprocessor/microcontroller. It has the elements such as input/output interfaces, memory, user interface and the display unit. The software of an embedded system is written to execute a particular function. It is normally written in a high-level setup and then compiled down to offer code that can be stuck within a non-volatile memory in the hardware. An embedded system software is intended to keep in view of the three limits such as convenience of system memory, convenience of processor's speed and When the embedded system runs constantly, there is a necessity to limit power dissipation for actions like run, stop and wake up.

II. RELATED WORKS

Ari Juels' survey examines approaches proposed by scientists for privacy protection and integrity assurance in RFID systems, and treats the social and technical context of their work.[1] Jongpil Jeong, et al. proposed an authentication protocol designed to accept the existing home networks based on the one-time password protocol.[2]Anil K. Jain, et al. proposed a paper using biometrics where it is possible to confirm or establish an individual's identity based on "who she is", rather than by "what she possesses" (e.g., an ID card) or "what she remembers" (e.g., a password).[3] Y. Zhao and Z.Ye .In this paper, the design and implementation of a low cost, low power consumption, and GSM/GPRS (Global System for Mobile Communication General Packet Radio Service) based wireless home security system is present.[4]Josh Potts and Somsak Sukittanon In this paper, they have developed a security system that interfaces with an Android mobile device.[5] M. N. Chowdhary, et al.

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In this system the access to the door is controlled by the user from any place in the world. It uses IoT for its working. A tweet is sent if any visitor comes ,the user can see the person through the camera and access is granted only if the owner wishes. [6]Y.W Bai, L. S. Shen .This system is based on MVM(Majority Voting Mechanism).If over half of the sensors are on then only the webcam starts to stream.[7]Jayashri Bangali and Arvind Shaligram .This paper suggests two methods for home security system. The first system uses web camera. Whenever there is a motion in front of the camera, it gives security alert in terms of sound and a mail is delivered to the owner. The second method sends SMS which uses GSM-GPS Module (sim548c) and Atmega644p microcontroller, sensors, relays and buzzers.[8]S.Nazeem Basha, et al.The proposed system provides a break through by utilizing the sensor activity on various applications as it is represented using Amazon Web Services IoT which is an emerging area of research.[9]R.Chuimurkar and V.Bagdi This paper deals with the implementation and results of Smart surveillance monitoring system using Raspberry pi and PIR sensor for mobile devices.[10]
Raja Shashipal Reddy, et al. In this paper, an OTP i.e, a one-time password generated by a microcontroller is used as a security key that has to be entered to enter their home. The OTP is sent to the android mobile number.[11]Md Monzur Morshed, et al. In this system RFID tags are used for security purposes.[12] N. Sravanthi and J. Krishna Chaitanya A palm sized surveillance robot along with docking station and Zigbee modules are used for securing houses that are locked for a long period of time.90 percent success rate has been achieved using the robot. As people can't rely totally on guards all the time such systems can be implemented. Though it is costly certain functions such as communication through Zigbee module, automatic recharging can be inculcated in the present project. [13]

III. SYSTEM ARCHITECTURE

The System Architecture is shown below.

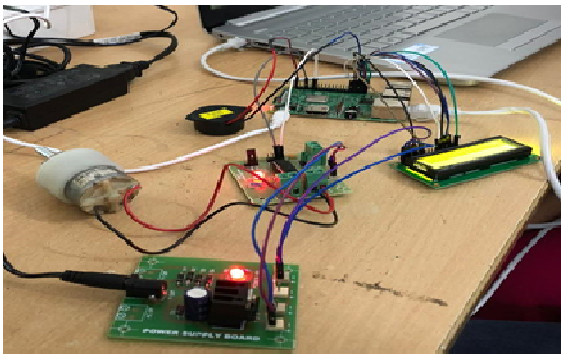


Fig.1: Assembly of Security System integrated with Raspberry Pi

In this system a PIR sensor is placed such that it detects motion in its area of working and alerts the Raspberry Pi, a Keypad is used to enter the security key. The webcam used here does the work of livestreaming and take snapshots of the person who is not able to get through the multilevel security system. Buzzer beeps whenever it finds any of the security levels is breached. An RFID reader is used to read the RFID tag. All the system components are controlled by the Raspberry Pi

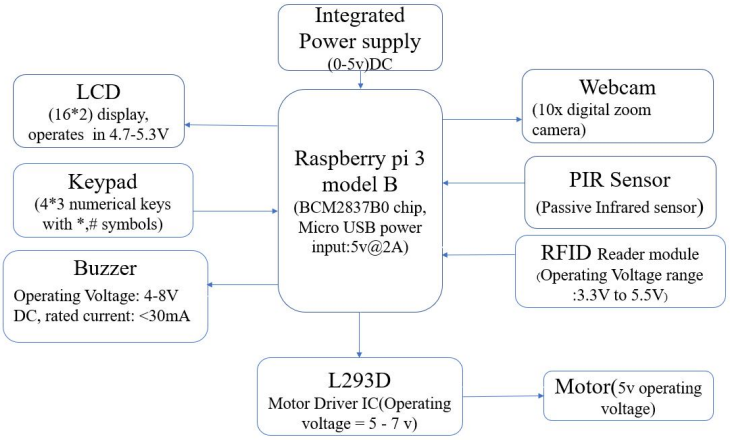


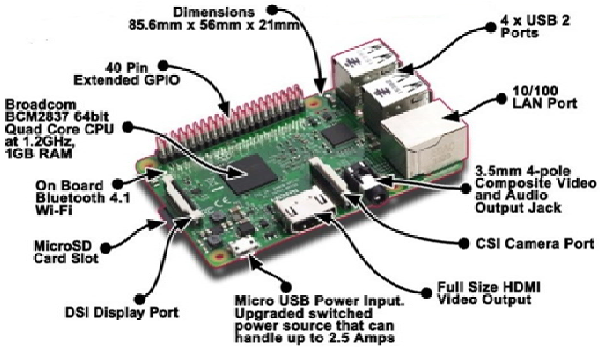
Fig.1: Block Diagram of Proposed System

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A. Raspberry Pi 3 Model B

The Raspberry Pi is a credit-card sized computer that plugs into your TV and a keyboard. It is a capable little computer which can be used in electronics projects, and for many of the things that your desktop PC does, like spreadsheets, word-processing and games. It also plays high-definition video. We want to see it being used by kids all over the world to learn how computers work, how to manipulate the electronic world around them, and how to program.

The Raspberry Pi is a low cost, credit-card sized computer that plugs into a computer monitor or TV, and uses a standard keyboard and mouse. It is a capable little device that enables people of all ages to explore computing, and to learn how to program in languages like Scratch and Python. It's capable of doing everything you'd expect a desktop computer to do, from browsing the internet and playing high -definition video, to making spreadsheets, word-processing, and playing games.What's more, the Raspberry Pi has the ability to interact with the outside world, and has been used in a wide array of digital maker projects, from music machines and parent detectors to weather stations and tweeting birdhouses with infra-red cameras. We want to see the Raspberry Pi being used by kids all over the world to learn to program and understand how computers work. There are currently four Raspberry Pi models. They are the Model A, the Model B, the Model B+ and the Compute Module. All models use the same CPU, the BCM2835, but other hardware features differ.



(a)

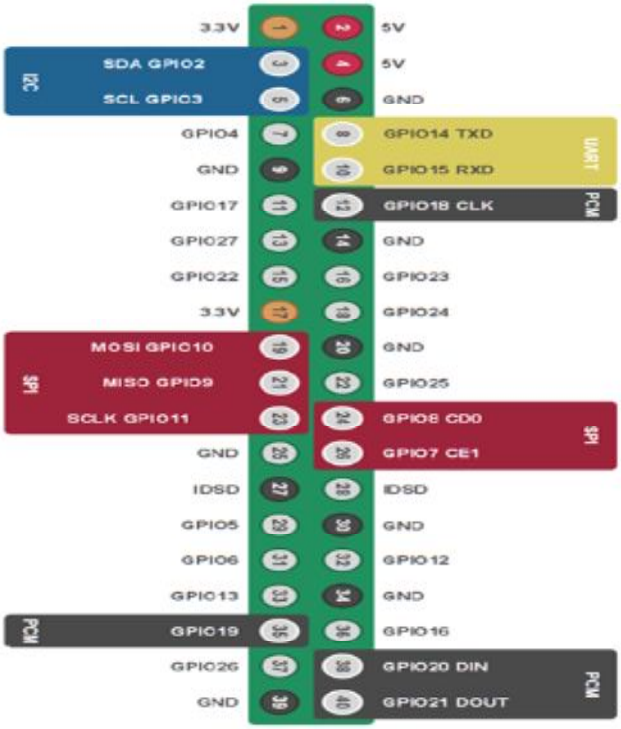


Fig.2: (a) Raspberry Pi 3 Model B (b) Pin Description of Raspberry Pi 3
[Source: Google]

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B. Webcam

A webcam is a video camera that feeds or streams an image or video in real time to or through a computer to a computer network, such as the Internet. Webcams are typically small cameras that sit on a desk, attach to a user's monitor, or are built into the hardware. The webcam used has features such as built-in mic with noise reduction, interpolated to 25 Mega Pixels, 10 Level Zoom on live Motion Picture, Special Visual Effects, True Motion Picture .Night Vision 6 Bright light switch ON through switch and potentiometer, inbuilt Sensitive Microphone, background changeable of Live Motion Picture, UP TO 30% better exposure to give better picture even in dark, Auto Exposure, Special Face Effects, USB 2.0 cable.



Fig.3: Quantum Digital zoom 10x webcam

C. PIR Sensor

PIR sensors allow you to sense motion, almost always used to detect whether a human has moved in or out of the sensors range. They are small, inexpensive, low-power, easy to use and don't wear out. For that reason they are commonly found in appliances and gadgets used in homes or businesses. They are often referred to as PIR, "Passive Infrared", "Pyroelectric", or "IR motion" sensors. Every living being with a temperature greater than 0K emits IR rays which are detected by the PIR sensor.



Fig 4:PIR sensor

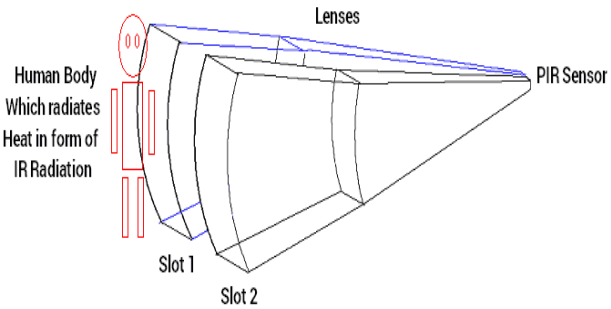


Fig.5: Working of PIR Sensor

The PIR sensor is split into two slots. The two slots are connected to a differential amplifier. Whenever a stationary object is in front of the sensor, the two slots receive the same amount of radiation and the output is zero. Whenever a moving object is in front of the sensor, one of the slots receives more radiation than the other slot. This makes the output swing high or low. This change in output voltage is a result of detection of motion.

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*D. KeyPad 4*3*

A 4*3 matrix Keypad is used with a set of buttons or keys bearing digits, symbols and/or alphabetical letters placed in order on a pad, which can be used as an efficient input device.

Typically, one port pin is required to read a digital input into the controller. When there are a lot of digital inputs that have to be read, it is not feasible to allocate one pin for each of them. This is when a matrix keypad arrangement is used to reduce the pin count. Therefore, the number of pins that are required to interface a given number of inputs decreases with increase in the order of the matrix.

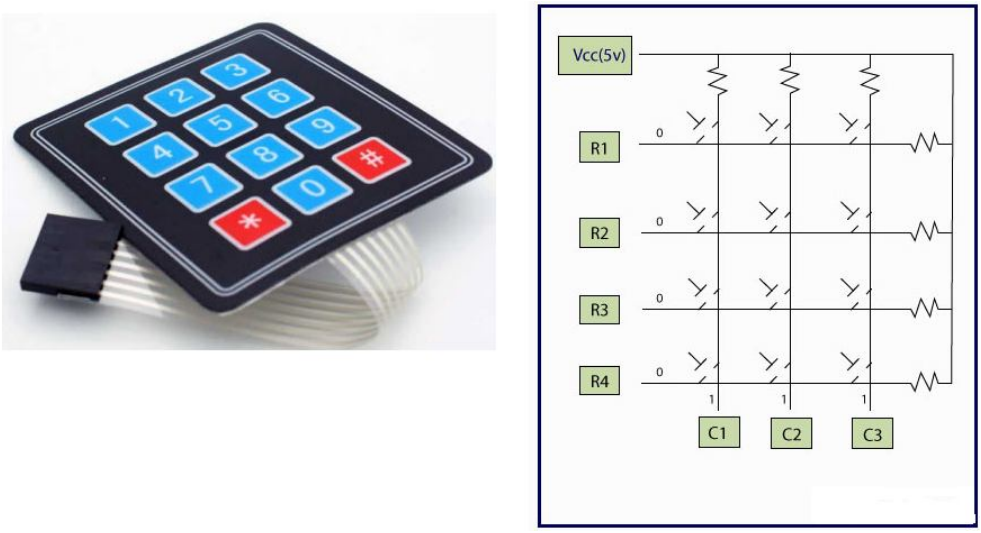


Fig 6: 4*3 Keypad

Digits 1 to 9 are present with #and* symbol. There are four rows and three columns. It is the choice of the user to allocate inputs and outputs to the rows and columns. Altogether twelve MOS switches are used.

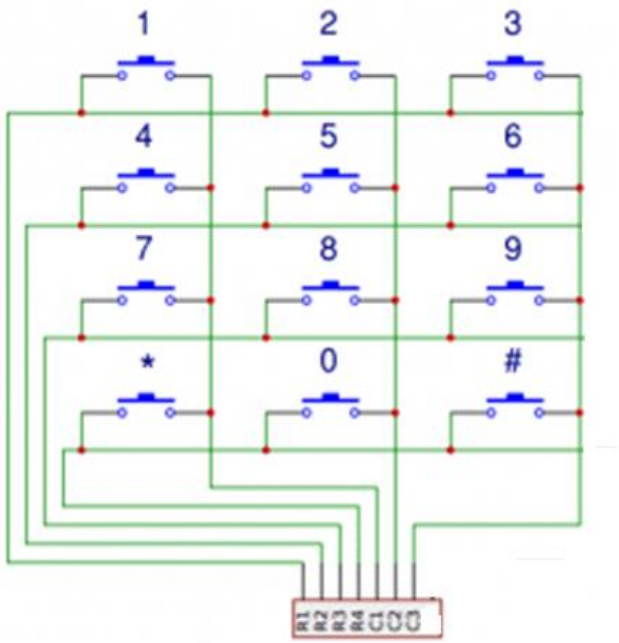


Fig.7: Keypad switches structure

Whenever a switch is pressed the particular column and row lines are closed. Hence, in this way we can reduce the number of GPIO pins used by Raspberry Pi device.

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*E. LCD 16*2*

LCD or Liquid Crystal Display is an electronic display module which is used as an output device. A 16*2 LCD has 16 columns and 2 rows. It can display 16 characters on each of the two lines. It is an Alphanumeric Display and hence can display Alphabets, Numbers, and Symbols. Each character is framed by a 5*8pixel box. It operates in 4.7 V - 5.3 V voltage range with consumption of 1mA current without backlight. It has 16 pins for connection. The data lines, read, write and enable pins are connected accordingly to GPIO pins of Pi. Out of the two modes of LCD i.e., the command mode and data mode, the data mode is used where the commands to the user are displayed so that he/she can go to the next step of getting access to the place.



Fig.8: LCD Display

F. Buzzer



Fig.9: Buzzer

Buzzer is a electronic device that converts the electronic signal into buzzing noise, that is applied to it. It is used as an alarming circuit in the proposed system. It is a device in which due to an A.C voltage to an element, the element extends and shrinks diametrically. It is used to generate vibrations giving rise to sound waves. Whenever any of the authentication processes is breached the buzzer beeps.

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G. D.C Motor

The internal configuration of a DC motor is designed to harness the magnetic interaction between a current-carrying conductor and an external magnetic field to generate rotational motion. In the proposed system the D.C motor rotates in the clockwise direction to indicate “door opening” condition and in the anti-clockwise direction to indicate “door closing” condition.

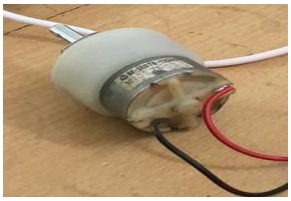


Fig 10: D.C Motor

H. L293D Motor driver circuit

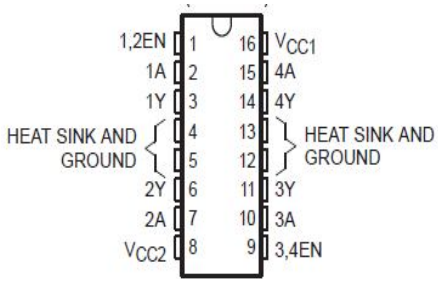


Fig 11:L293D Motor driver circuit

In this system, the driver circuit drives the motor by connecting the chip pins with appropriate GPIO pins of Pi. Drivers are enabled in pairs, with drivers 1 and 2 enabled by 1,2EN and drivers 3 and 4 enabled by 3,4EN. When an enable input is high, the associated drivers are enabled and their outputs are active and in phase with their inputs. When the enable input is low, those drivers are disabled and their outputs are off and in the high-impedance state. With the proper data inputs, each pair of drivers forms a full-H (or bridge) reversible drive suitable for solenoid or motor applications.

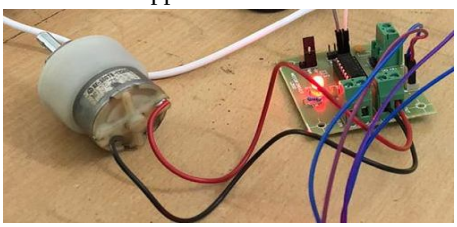


Fig 12: Interfacing L293D Chip with the D.C Motor

I. EM18 RFID Reader Module



Fig13:RFID reader module

They convert radio waves returned from the RFID tag into a form that can be passed on to Controllers, which can make use of it. RFID tags and readers have to be tuned to the same frequency in order to communicate. RFID systems use many different frequencies, but the most common and widely used & supported by our Reader is 125 KHz. An RFID system consists of two separate components: a tag and a reader. An RFID scanner uses electromagnetic waves. To transmit these waves, the scanner uses an antenna that transmits a signal communicating with the tags’ antenna. The tag’s antenna receives data from the scanner and transmits its particular chip information to the scanner.

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J. RFID Tag

RFID tag includes microchip with radio antenna mounted on substrate which carries 12 Byte unique Identification number. The data on the chip is usually stored in one of two types of memory. The most common is Read-Only Memory (ROM), as its name suggests, read-only memory cannot be altered once programmed onto the chip during the manufacturing process. The second type of memory is Read/Write Memory, though it is also programmed during the manufacturing process, it can later be altered by certain devices. We have used passive RFID tags in this system.



Fig14: RFID Tag

IV. WORKING OF PROPOSED SYTEM

The person authorization is done in a very secured way. Initially the system will be checking for PIR sensor. If any motion is detected, PIR sensor output will be triggered and access to the keypad will be granted. The user has to enter the password using the keypad. If the password matches with any of the saved passwords, then the user has to provide the RFID tag near the reader. The reader reads the unique number from the tag. If the tag number matches with the saved tag numbers, then the person is recognized as authorized and finally the door opens and closes after a predefined delay. The camera captures the live video continuously.

If the password entered is wrong and does not match with any of the saved passwords, then the captured image will be sent to the predefined mail account. Else, if the RFID tag data does not match, even then the captured image will be sent to the predefined email account. Buzzer will be activated when the person is proved as unauthorized.

If the person is detected to be unauthorized, then the buzzer will be switched on and a message will be sent immediately to the predefined e-mail id through IoT.

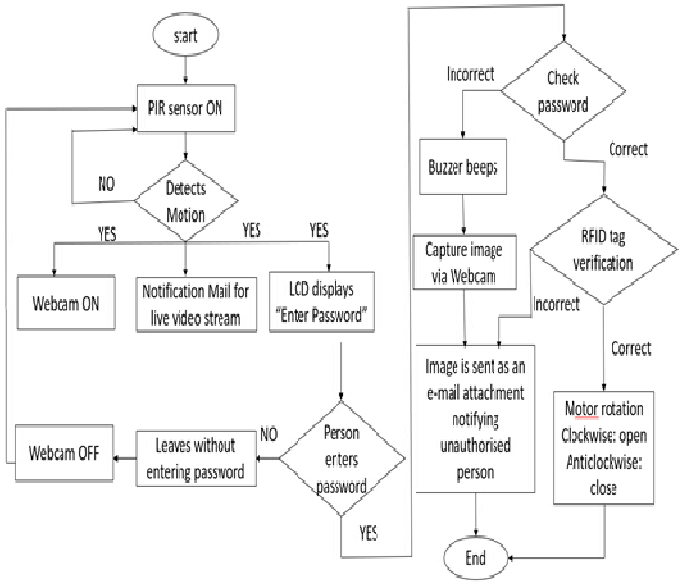


Fig.15: Flow-Chart of working of the system

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V. RESULTS AND DISCUSSION

The system proposed detects any person who tries to access a place with unauthorized access. The particular person's photo is captured and sent to the registered e-mail id. The video streaming used here is live and the user can access it using the proper IP address. This is a multi-level security system where the person goes through the first level of security i.e., the numeric password and also the RFID tags authentication which serves as the second level of security. After passing through these two levels of security access to the place is granted to the person. The buzzer beeps when any one of the authentication methods fail. The live video feed is available in the form of a link to the registered user in his/her mail. If any unauthorized entry is detected then also an e-mail with the image of the person is sent to the user. The proposed system provides info in the mail in real-time. It is a power efficient system as the webcam is switched on when motion is detected by the PIR sensor unlike CCTVs that record continuously. It increases the lifespan of the components. Raspberry Pi provides flexibility in embedding more number of sensors and other hardware equipment. The system uses IoT to implement its objective.

VI. CONCLUSION

The existing system is a one-step authentication process i.e. there is a PIN lock present but it can be modified into multiple level or multi-step process by adding Biometrics or RFID. This can make the system more secure. Hence, it leaves a lot much potential to improvise the system more. So, we have implemented another level of security using RFID tags. After the pin lock mechanism is verified even the RFID tag of the person has to be verified before giving him/her the access to the place. The info provided in the mail is very useful as it happens in real-time. It's also power efficient as the webcam is switched on when there is motion detection by PIR sensor unlike CCTVs that record continuously. It increases the life span of the components. Raspberry Pi provides flexibility in embedding more number of sensors and other hardware equipment. Therefore, the multilevel security system used here helps to prevent the entry of unauthorized access to the place in real-time.

VII. FUTURE WORK

The proposed system is a multilevel security system. More number of security levels that consume less power can be added to make it a system to be implemented in areas where high levels of security is needed. The security levels can be Face identification or Biometrics.

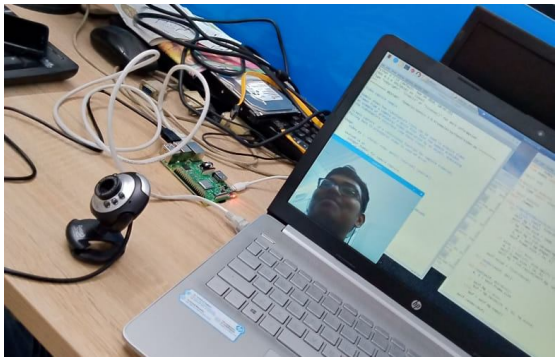


Fig16: Live video feed



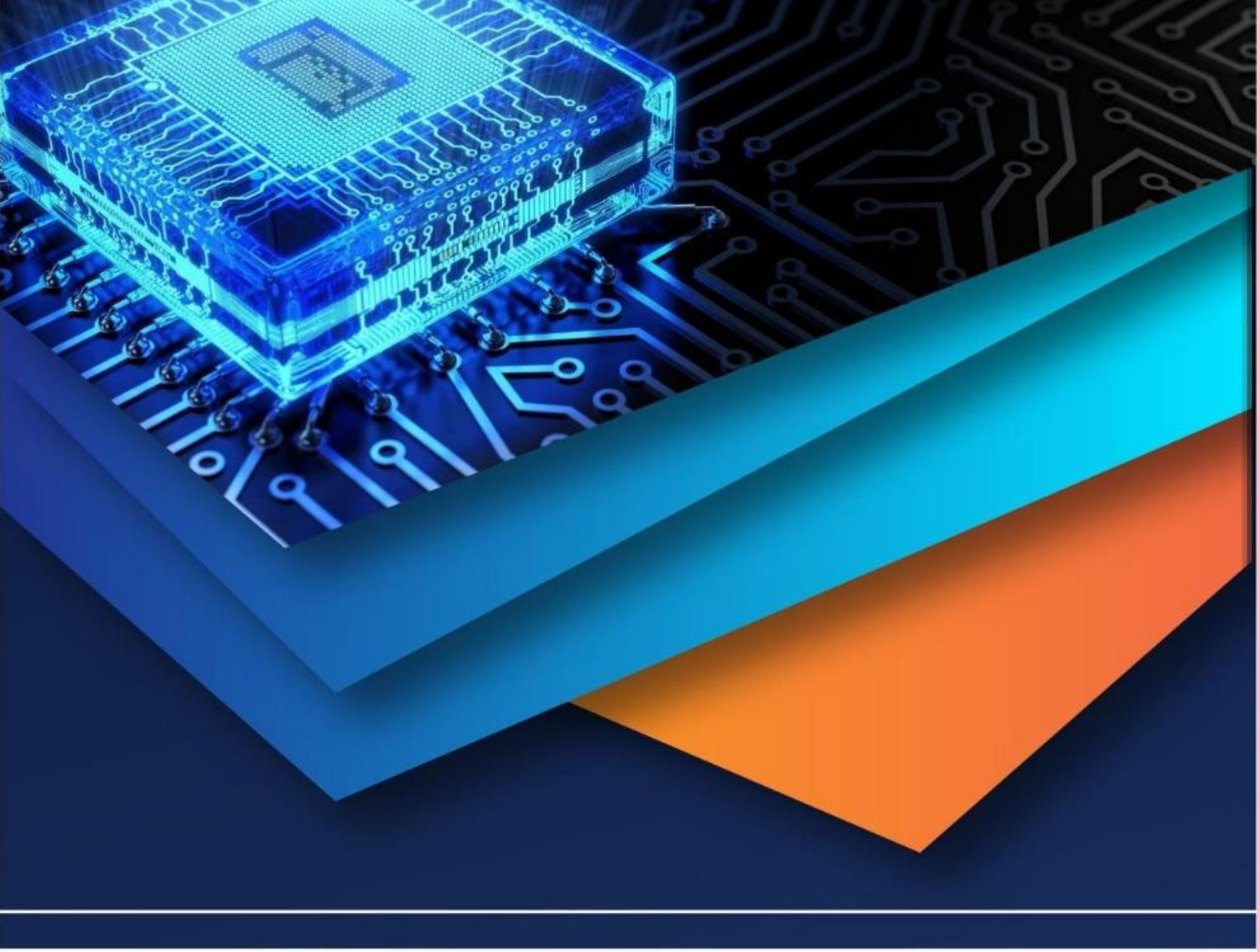
Fig 17: Integration of all the components

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