INTERNET OF THINGS APPROACH FOR MOTION DETECTION AND MOTION TRACKING USING RASPBERRY PI, PIR SENSOR AND DROPBOX

A Dissertation-2 report submitted in partial fulfillment of the requirements for the award of the degree of

Masters of Electronics and Communication

by

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2017

DECLARATION

I hereby certify that the work, which is being presented in the Thesis report entitled **"INTERNET OF THINGS APPROACH FOR MOTION DETECTION AND MOTION TRACKING USING RASPBERRY PI, PIR SENSOR AND DROPBOX"**, in partial fulfillment of the requirement for the award of the Degree of Master of Electronics and communication submitted to the institution is an authentic record of my own work Carried out during the period January to May under the supervision of **MR. SWAPNIL BAGWARI**. I also cited the reference about the text/figure/table from where they have been taken.

Date: Signature of the Candidate

This is to certify that the above statement made by the candidate is correct to the best of my knowledge. ‘

Date: Signature Supervisor

ACKNOWLEDGEMENT

First, I would like to express my best regards to my thesis guide **MR. SWAPNIL BAGWARI**, whose valuable guidance, encouragement and provision of necessary facilities made this work possible.

I would also like to express my gratitude towards the "**LOVELY PROFESSIONAL UNIVERSITY**" for providing me with the best facilities and proper environment to work on my project

Finally, I offer my great thanks to my family for their support which helped me through the difficulty and hardships of life to earn this achievement.

ABSTRACT

This report is on the INTERNET OF THINGS APPROACH FOR MOTION DETECTION AND MOTION TRACKING USING RASPBERRY PI, PIR SENSOR AND DROPBOX. This report explains that what effort is putted in making this system. This surveillance system is an approach to a world where our surveillance can detect the motion and can communicate by itself to the other smart devices without human interference.

The traditional or we can say general surveillance systems consume more space for storing the captured data. To save the storage cost the new surveillance systems have been evolved that uses motion detection algorithms. This surveillance system saves a lot of storage space. In this system the camera don't have to capture the images continuously like in general surveillance systems instead of that, the motion detection algorithms detects occurring of any motion in front of camera. Only after any motion is detected the camera will start recording and this detected motion images is then sent on an online server, where user can login anytime and see the images anytime he/she wants. This system consists of picmara module and PIR sensor for motion detection. The role of all of the components is explained in this report.

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TOPIC APPROVAL PERFORMA

School of Electronics and Electrical Engineering

Program : P175::M.Tech. (Electronics and Communication Engineering) [Full Time]

COURSE CODE : ECE521 **REGULAR/BACKLOG :** Regular **GROUP NUMBER :** EEERGD0217

Supervisor Name : Swapnil Bagwari **UID :** 15936 **Designation :** Assistant Professor

Qualification : _____ **Research Experience :** _____

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SPECIALIZATION AREA : Embedded Systems **Supervisor Signature:** _____

PROPOSED TOPIC : IOT based real time motion and tracking detection using Python and Open CV

Qualitative Assessment of Proposed Topic by PAC		
Sr.No.	**Parameter**	**Rating (out of 10)**
1	Project Novelty: Potential of the project to create new knowledge	8.00
2	Project Feasibility: Project can be timely carried out in-house with low-cost and available resources in the University by the students.	7.67
3	Project Academic Inputs: Project topic is relevant and makes extensive use of academic inputs in UG program and serves as a culminating effort for core study area of the degree program.	8.00
4	Project Supervision: Project supervisor's is technically competent to guide students, resolve any issues, and impart necessary skills.	8.00
5	Social Applicability: Project work intends to solve a practical problem.	8.00
6	Future Scope: Project has potential to become basis of future research work, publication or patent.	8.00

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PAC Member 4 Name: Anshul Mahajan	UID: 11495	Recommended (Y/N): Yes
DAA Nominee Name: Manie Kansal	UID: 15692	Recommended (Y/N): NA

Final Topic Approved by PAC: **IOT based real time motion and tracking detection using Python and Open CV**

Overall Remarks: Approved

PAC CHAIRPERSON Name: 11211::Prof. Bhupinder Verma **Approval Date:** 15 Oct 2016

CHAPTER 1

INTRODUCTION

The traditional or we can say general surveillance systems consume more space for storing the captured data. To save the storage cost the new surveillance systems have been evolved that uses motion detection algorithms. This surveillance system saves a lot of storage space. In this system the camera don't have to capture the images continuously like in general surveillance systems instead of that, the motion detection algorithms detects occurring of any motion in front of camera. Only after any motion is detected the camera will start recording. By this we save a lot of unwanted memory usage and these systems are also very much reliable. This surveillance system using Raspberry pi 3 board as the tiny computer. The Raspberry Pi board enables this surveillance system for motion detection and also enables this surveillance system to machine to machine interaction i.e. the internetworking of different smart devices. That is interchanging of information or data between different devices via internet without any human interference (IoT). This report portrays a surveillance system for security utilizing low power chips and Internet of things approach which helps in observing and gets the pictures and recordings of any object when in movement. This caught pictures and recordings are then sent specifically to a cloud server, the information can likewise be stored locally on the Raspberry pi when the cloud is not accessible and sent immediately to the cloud when association get built up. Motion tracking is the process of tracking the detected object as the object can be in motion. It is very necessary that the tracking of object should be fast and precise to get the accurate results from our system. In traditional surveillance systems or we can say general surveillance systems the data that is captured by the cameras are stored in continuation. This needs a lot of memory to store this much data which is most of the time is wasting of storage and wastage of money on storage devices. This system which I have discussed here concentrates on saving the storage cost by only saving those images and which show some motion in front of the camera. Now this captured and locally saved images and videos are sent to the online server in here it is Dropbox. Where the user can login and check the captured images and videos and take action according to that data The techniques I have used for motion detection is one of the difference motion detection techniques that is *frame difference (delta frame)* technique. After the motion detection takes place the detected motion is captured by the camera and send it on an online server here in this system that online server is the Dropbox. The advantage of sending the captured image to the online server is that

the captured data is safe and in any case the data is wiped out from the local memory of the Raspberry Pi board, we can retrieve our surveillance data from the online server anytime. For more accuracy I also added the PIR sensor in the surveillance system. The PIR sensor will detect the human motion and then send a notification message on the user's mobile phone that a intruder is detected.

1.1 Internet of Things (IoT):

internet of things is the internetworking between various smart gadgets. These gadgets embedded with electronics, programming, sensors, actuators and system network that empower the object to gather and trade information. The Global measures activity on Internet of Things (IoT-GSI) characterized the Iot as "infrastructure of information society". It is evaluated that by the year 2020 there will be around 50 billion web –enabled gadgets. The main organizations like HCL, Panasonic, Windows, IBM and so on are elevating and acquainting IoT with the world. The vast network of devices connected to the Internet, including advanced cells and tablets and nearly anything with a sensor on it – autos, machines underway plants, jet engines, oil drills, wearable gadgets, and many more. Presently IoT is being used in various fields like building management, home automation, health-care services, surveillance etc. IoT uses low-cost computing devices and also energy management.

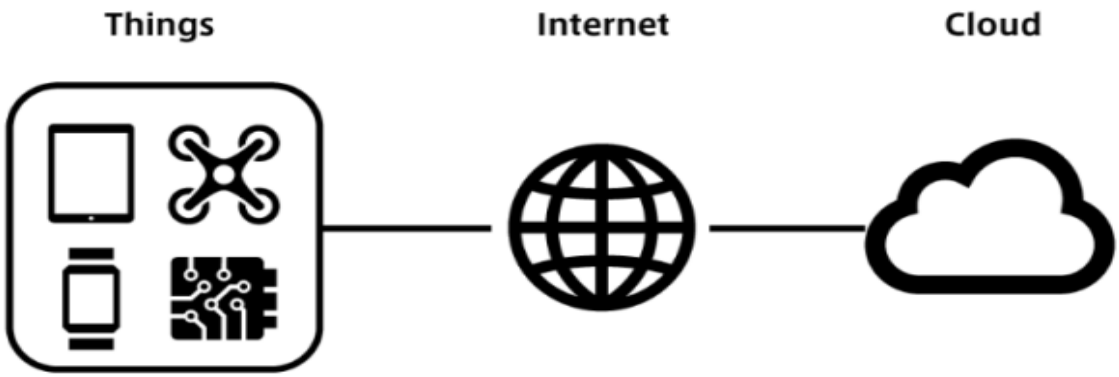


Fig.1.1 Internet of Things

Fig.1. shows how device can communicate each other with the help of internet. IoT has evolved from the convergence of wireless technologies, micro-electromechanical system (MEMS), micro-services and the internet. The convergence has helped tear down the silo walls between operational technology (OT) and information technology (IT), allowing unstructured machine-generated data\ to be analyzed

for insights that will improvements. Where there are so many advantages of IoT, there are disadvantages also. There are some limitations of IoT such as compatibility-currently, there is no international standard of compatibility for the tagging and monitoring equipment to overcome this problem manufactures made their equipments to follow standards such as Bluetooth, USB etc, complexity of IoT circuits are high that the failure rate is very high of IoT devices. Now a day's technology pioneers and big giants are also working on internet of things to connect our world more with internet and technology. Some of the names are Bosch- The Bosch Connected World Blog is hosted by Bosch Software Innovations the Bosch Group's spearhead for providing software for the Internet of Everything, Linklabs-Based in Annapolis, Maryland, Link Labs is a leading innovator in low power, wide area network technologies that power the Internet of Everything, Hackter.io-Hackster.io launched in 2013 to help people learn how to program, connect and create Internet-connected hardware, IoT Council- Council is a bottom IoT ecology accelerator with a large number of early innovators, startup and SME as members. It aims to offer the latest on technical building blocks but also tries to put this digital transition into a social context. In this system both the motion detection and internet of things are working to make this surveillance more intelligent.

1.2 Motion Detection

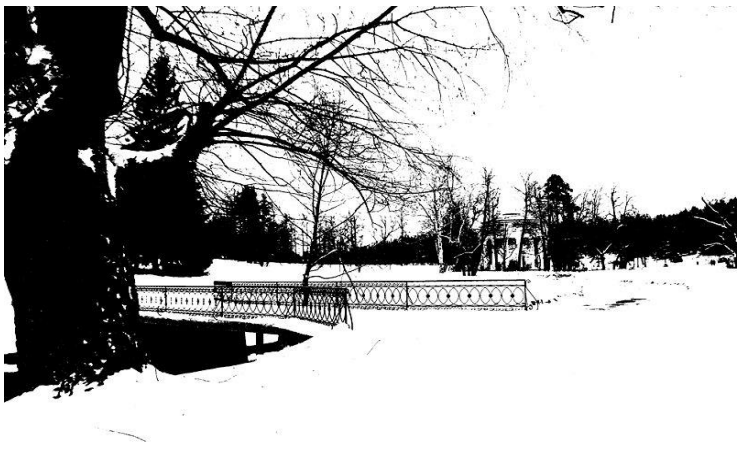
Motion Detection is the technique of detection of occurrence of any movement in front of the camera. Motion detection is the most important stage in video surveillance systems, good results of this stage are not justified only by the choice of the method but also by the good segmentation and the adaptation to changes in luminance. Here the process of motion detection is done through the tiny computer that is Raspberry Pi 3. In Raspberry Pi board there is a python script that would analyze the captures video and look for any difference in the frame from the last one. The running script basically compares the difference between the last captured frame and the current captured frame, if there is a difference occurred it would be flagged and the video recording and snapshots generation starts.

1.3 Threshold technique for motion detection

Threshold is the most important part of motion detection. In order to achieve good results for segmentation and detection the good choice of the automatic threshold is very important. The thresholding is the method of separating object from background. Thresholding is the simplest method of image segmentation. From a grayscale image, thresholding can be used to create binary images. According to the definition, the simplest thresholding methods replace each pixel in an image with a black pixel if the image intensity is less than some fixed constant T, or a white pixel if the

image intensity is greater than that constant. In the example image on the right, this results in the dark tree becoming completely black, and the white snow becoming completely white. In this system I have used the most accurate and best thresholding method for motion detection in both indoor and outdoor areas. I have chosen the best threshold method the iterative self-organizing selection (Iterative Self-Organizing Data Analysis Technique, ISODATA). I have tested this threshold technique and compared it with two different threshold techniques also they are Otsu's threshold method and Kapur's entropy method. After comparing these three methods I have found that the best threshold algorithm that gives best results in both indoor and outdoor conditions is the iterative self-organization selection technique. Fig 1.2 shows the effect of threshold on image.

(a)



(b)

Fig 1.2 (a) Image before threshold applied, (b) Image after threshold applied

CHAPTER 2

TERMINOLOGY

1. IoT – Internet of things
2. MEMS- Micro-Electromechanical System Micro-Services operational technology
3. OT- Operational Technology
4. IT- Information Technology
5. ISODATA- Iterative Self-Organizing Data Analysis Technique
6. PIR- Pyroelectric Infrared
7. CCTV - Closed-Circuit Television
8. USB- Universal Serial Bus
9. BLE- Bluetooth Low Energy
10. NAT- Network Address Translation
11. CV- Computer vision
12. API- Application Peripheral Interface
13. IR- Infrared
14. SoC- System on Chip
15. GPU- Graphics Processing Unit
16. PCC - Percentage of Correct Classification
17. JC- Jaccard coefficient
18. YC- Yule coefficient

CHAPTER 3

OBJECTIVE OF THESIS

3.1 Objective of the thesis

- Internet of Things Approach for Motion Detection and Motion Tracking using Raspberry Pi is an modern times monitoring system and objective of this thesis is to enhance and explore more about this technology.
- To connect our daily life devices to each other by using Internet of Thing technology.
- To give the user more flexibility in the surveillance system.
- To connect the user with the devices and establishing a communication channel between humans and machines.
- To avoid the interference and to reduce the power constraints.
- To reduce the storage wastage.
- To provide the user cloud server to save his/her data on the cloud this saves the system memory.
- To provide the system motion detection technique so that is can detect the motion start recording.

CHAPTER 4
LITERATURE REVIEW

Aamir Nizam Ansari, Mohamed Sedkyl, Neelam Sharma, Anurag Tyagil (2015)[1] In this base paper the creator portrayed a alarm system utilizing low handling power chips and utilizing Internet of things which helps to monitor and get alerts when motion is detected and sends photographs and recordings to a cloud server. Internet of things based application can be utilized remotely to see the movement and get warnings when movement is detected. The photographs and recordings are sent specifically to a cloud server, when the cloud is not accessible then the information is put away locally on the Raspberry Pi and sent when the association resumes. The creator has utilized the difference motion detection technique that is comparison between the past frame and the present frame. On the off chance that any distinction is recognized the motion got detected.

Huu-Quoc Nguyen, Ton Thi Kim Loan, Bui Dinh Mao and Eui-Nam Huh.(2015)[2]In this base paper the author depicts the design and implementation of a low-cost monitoring with the help of Raspberry Pi, a solitary board computer which takes after Motion Detection calculation written in environment. Furthermore, the system uses the motion detection technology to overcome utilization of large memory space to reduce the investment costs. The algorithm for motion detection is being implemented on Raspberry Pi, which empowers live streaming camera alongside motion detection. The live camera can be seen from any web browser, even from mobile phones.

Kamal Sehairi, Fatima Chouireb, Jean Meunier.[3] In this base paper the author compared five different threshold algorithm in order to find the best suited threshold algorithm for the motion detection in both indoor and outdoor. All these five threshold methods have been tested on different differential motion detection algorithms, using four scenes with different complex backgrounds. A pixel-based evaluation has been done to determine the best combination. Five different threshold methods: the Otsu's method, the iterative selection (ISODATA Iterative Self-Organizing Data Analysis Technique), Kapur's Entropy thresholding, Ramesh's threshold method

and Tsai's threshold. The author tested all this five threshold methods and find out that otsu's method and iterative selection method gives the best result in both the indoor and outdoor conditions.

Ravi D. Simaria, Prof. D. S. Pipalia (2015)[4] This paper presents an implementation of real time detection and tracking of an unknown object in video stream with 360° (azimuth) rotating camera. It also presents adaption of different object tracking algorithms and their effect on implementation. The system described in this paper contains a camera that is connected to an embedded system (standalone board) or PC/laptop. They (board/PC) are having an image processing algorithm which detects an object first and then tracks it as long as it is in the line of sight of the camera. As the object moves, the PC/laptop/embedded Board gives signal to motor to rotate the camera which is mounted on a stepper motor. To monitor Object in video user can have multiple options. If user is using laptop/PC to track object it is very simple for him because he already has a screen but in case of embedded board user can monitor the activity of the object of interest using HDMI output or streaming video on WEB server. The object can be defined directly by the end user by selecting a portion of the frame in video stream. The embedded board/PC also saves the video stream in a storage device for playback purpose.

Won Jin Kim and In-So Kweon (2011). [5] In this paper the author dealt with multi-moving object detection and tracking under moving camera. Moving objects are detected by homography-based motion detection technique. Tracking of the detected object is done by the online-boosting trackers to track moving objects. The authors integrate two systems into one system, since each tracker and detector measured independently. Therefore the algorithm suggested by the author do the detection and tracking of moving object without background modeling. The results from sequences are obtained from the experiments done in the natural outdoor scene. The experiment shows the high rate of success rate in outdoor conditions.

Cheah Wai Zhao; Jayanand Jegatheesan and Son Chee Loon (2015) . [6] This article explores the utilization of Raspberry Pi to work as a server in which a few laptops are associated with it to copy, store and erase the files over network. IT requires authentication for user login before granting access to the file to ensure data integrity and security. File server is generally utilized as a part of numerous regions, for instance in instruction for uploading study note into the serve and understudy quick downloading it into

their PC. In addition this work likewise explores the utilization of Raspberry Pi B+ display and XBee (ZigBee module) to demonstrate wireless communication data transmission, demonstrating the legitimacy of use as a portable low-control remote system correspondence. The primary objective of the exploration is to investigate the utilization of Raspberry Pi for client-server communication using various wireless communication scenarios, for example, Wi-Fi and ZigBee.

The creators utilized here the python language for programming, Windows 7 OS is utilized by the client model to gain remote access to file server. It can store, copy and erase record in server and Samba is an open source server fundamentally for document exchange. This venture is a venturing stone to present the different components and potential outcomes accessible in Raspberry Pi and opens up a road for analysts who wish to set out into this new implanted development. Raspberry Pi can likewise be utilized as an instructive apparatus as it accompanies Scratch as a movement device for youthful learners.

Kumar Mandula, Ramu Parupalli, CH.A.S.Murty, E.Magesh, Rutul Lunagariya (2015)[7] In this paper the author examined about the IoT and how the Iot can be used to make a smart home automation using a micro-controller and Android smart phone application. Here the smaller scale controller utilized by the creator is the Arduino board. In this paper, two models specifically horne automation using Bluetooth in an indoor domain and horne automation using Ethernet in an outdoor environment are presented. This exploration work will be conveyed forward by integrating relays to Arduino board for controlling home appliances from a remote location in a real scenario. As an expansion, creators propose a non specific loT system and utilize cloud computing infrastructure for interfacing and overseeing remote gadgets and furthermore store sensor information.

Yuan-Kai, Ching-Tang Fan and Jian-Fu Chen (2014) [8]. In this paper, we propose a camera irregularity detection technique for traffic scene that has particular attributes of dynamics because of traffic flow and traffic crowd, contrasted and typical observation scene. Picture quality utilized as low-level features is measured by no-referenced metrics. Picture dynamics utilized as mid-level features are figured by histogram circulation of optical flow. A state-arrange classifier for the recognition of irregularity is contrived by the demonstrating of picture quality and video dynamics with probabilistic state transition. The proposed approach is vigorous to many testing issues in urban observation situations and has low false alarm rate. Trials are led on real world recordings recorded traffic scene including the situations of high traffic flow and severe crowding. Our test outcomes show that the proposed technique is better than past strategies on both accuracy rate and false caution rate for the anomaly detection of traffic cameras.

Lihong Zheng, Xiangjian He (2010)[9]. This paper is demonstrates a productive technique for the removal of non-character region. This method depends on the license plate detecting utilizing AdaBoost algorithm. At that point it takes after the character tallness estimation, character width estimation, estimation, block identification and segmentation. The algorithm is proficient and can be applied in real-time applications. The investigations are performed utilizing OCR programming for character acknowledgment. It is demonstrated that substantially higher acknowledgment exactness is acquired by gradually removing the license plate boundaries.

Rinu Merin Baby, Rooha Razmid Ahamed (2014) [10]. This paper presents the use of Optical stream Motion Detection algorithm on Raspberry Pi. The LucasKanade algorithm was chosen for the use. The algorithm works by taking a gander at two progressive picture outlines. To find out a dislodged question, the algorithm tries to figure the course of uprooted protest as opposed to examining the second picture for the coordinating pixel. This ought to be conceivable by agreeing to the optical flow vector by expecting that the vector will resemble a little neighborhood encompassing the pixel. The algorithm was reproduced using Python OpenCV. The execution of LucasKanade algorithm was successfully done on Raspberry Pi.

Priya B. Patel, Viraj M. Choksi, Swapna Jadhav, M.B. Potdar, PhD (2016)[11]: In this paper the auththor portrayed that, in surveillance, CCTV camera is exorbitant in view of the utilization of PC. It holds excessively space for keeps recording and furthermore obliges labor to distinguish the unapproved activity. In any case, contrasted with the current system Raspberry pi system is substantially less expensive with better determination and low power utilization include. Here pyroelectric infrared (PIR) sensors are utilized as a basic however capable individuals nearness triggers. This system is appropriate for small personal area surveillance. i.e. individual office cabin, bank locker room, stopping passageway. At whatever point the movement is distinguished through PIR sensor inside the room the picture is caught through camera and incidentally put away in the raspberry pi module. internet of things based application can be utilized remotely to see the action and get warnings when movement is identified. System works independent without the PC once modified. One android Application is utilized to get the warning on motion detection.

Kodinaria Brijesh, Vineeta Tiwari (2015)[12]: This paper is on a research project that is carried out to determine some of the basic human motion detection algorithm that had been founded or developed or even researched in past. As, the report is mainly aimed for the readers that the

architecture of a human motion detection system in applications. Combining raw measurements in order to understand what is happening in the monitored scenario.

CHAPTER 5

MATERIALS AND RESEARCH METHOLOGY

PHASE-I

The traditional surveillance systems that we are using from years need a lot of installation cost. Long cables are needed to connect the camera with the system. The storage space needed for these kind of general surveillance systems are also very high and hence this will increase the overall cost of the system. The components consist of the traditional surveillance system are as follows:

a) Camera or CCTV (closed-circuit television) Cameras
b) Device for storage and monitoring that is a computer system.

The architecture of traditional closed-circuit television video surveillance system is shown in fig 5.1.

Fig 5.1 architecture of CCTV television video surveillance system

These surveillances systems are now a day's replacing by the modern surveillance systems that are much smarter than the traditional systems. These surveillance systems have new technologies like motion detection, internet of things approach, connectivity to the internet and what not!

5.1. Base paper-I review

There are so many surveillance systems tested before also that have motion detection capabilities. One of which I have taken as my base is “An Internet of Things Approach for Motion Detection using Raspberry Pi”. The authors of this paper suggested a surveillance system that is connected with an online server via internet. After the motion is detected the image is then send to the online server. The architecture of this system is shown in fig. 5.2.

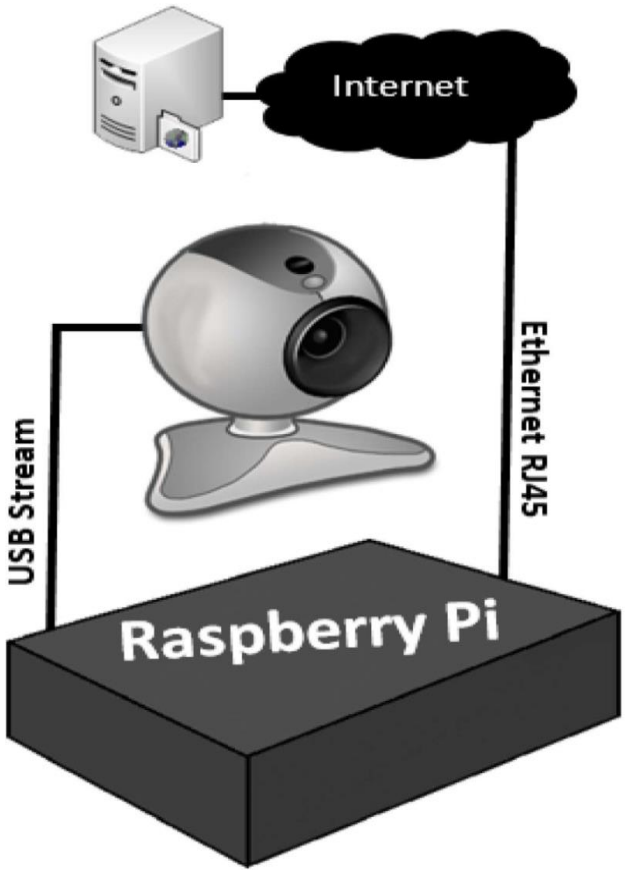
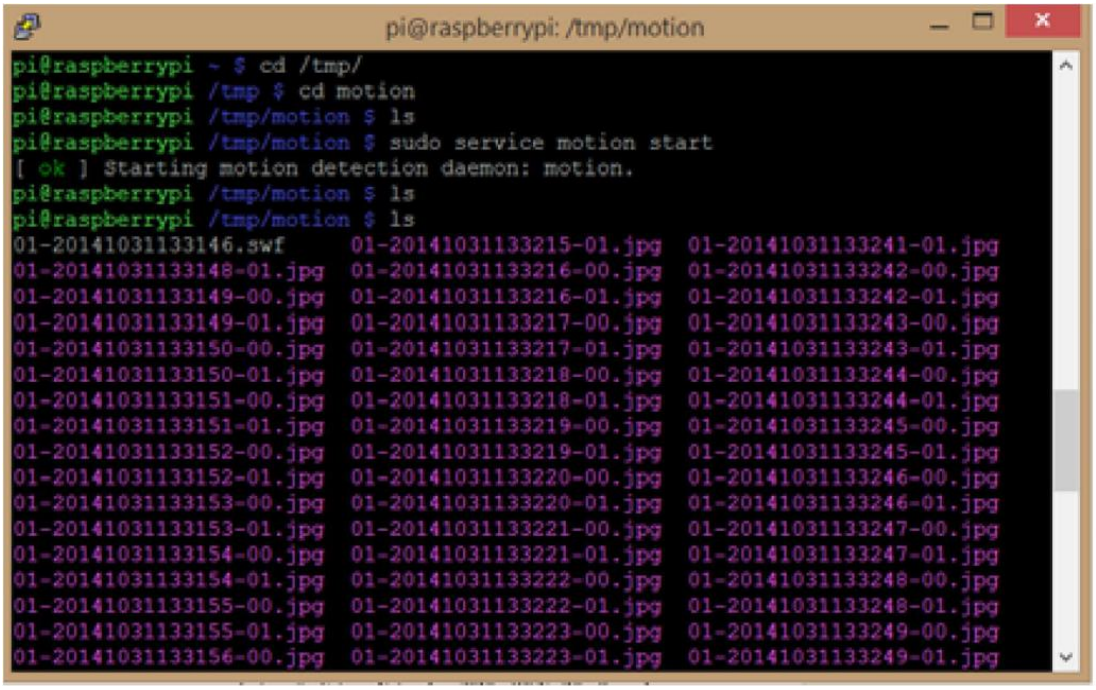
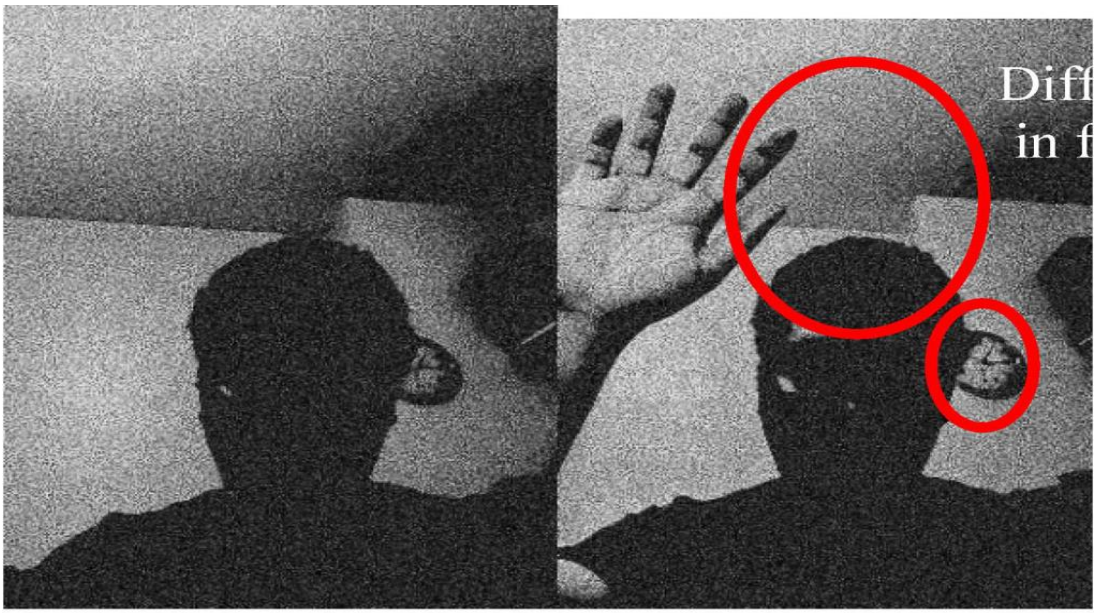


Fig 5.2 Architecture of system

The above system has a USB camera connect with the Raspberry Pi board with the help of an Ethernet cable. The Raspberry board is connected with internet cloud. The image that is captured is sending on the online cloud. The authors of this paper tested their system using frame difference technique for motion detection; this technique is discussed in detail in next sec. that is the Phase II of this chapter. The authors did not specify the threshold method that they are using. The result that they got is shown in fig 5.3.



(a)



(b)

Fig 5.3 (a) Images saved locally on the raspberry pi board before sending them on cloud (left), Motion is detected and an image is captured (right)

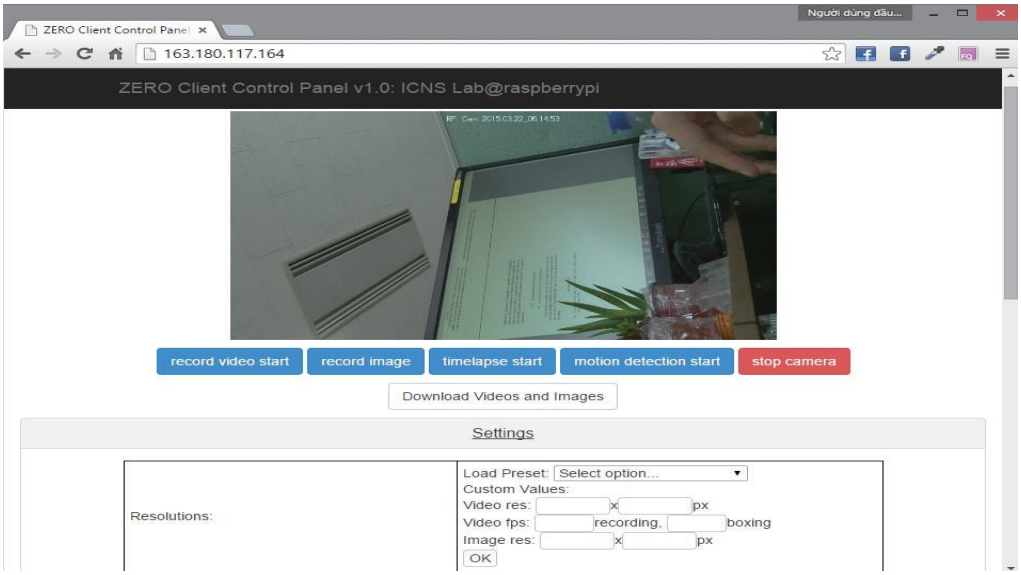
The accuracy of this system is fairly good, but the speed is questionable. The other authors with the same approach made a system like this some uses PIR sensor also to increase the accuracy of the

system. But the speed is still the problem all are facing. The speed at which the motion is detected is very important factor and the accuracy by which the motion is detected. Any unwanted motion detection can leaves a false alarm for the user. This accuracy in motion detection can be achieved by the use of proper threshold method.

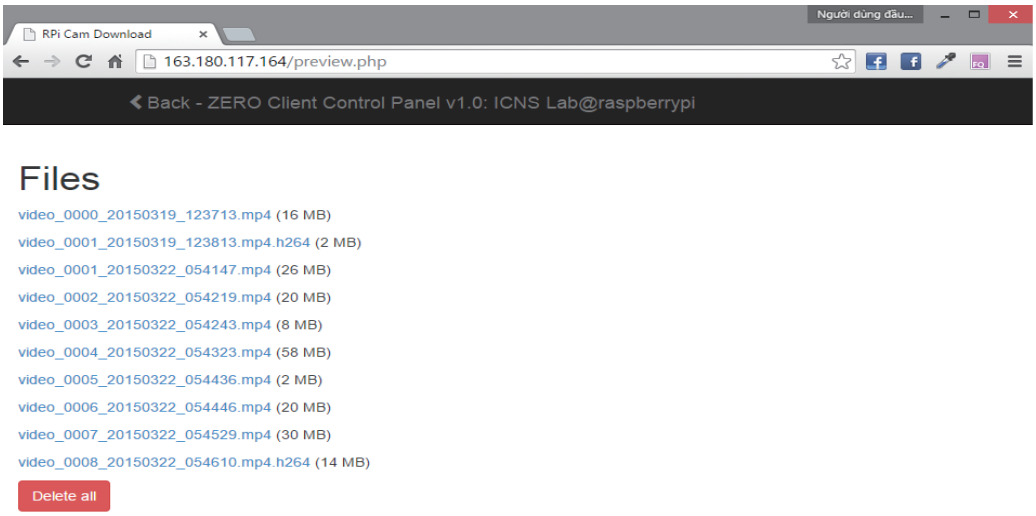
5.2. Base paper-II review

Some other papers also gave reference for the motion detection surveillance system they are “Low Cost Real-Time System Monitoring Using Raspberry Pi “. The authors of this paper have made a low cost real time monitoring system. They used the Picamera instead of the regular USB camera. Although the Picamera is very dedicated and need care for use, but still it gives user more flexibility to choose the pixel resolution, frame size, frame rate and the speed of pi camera is also greater than the normal USB camera. The architecture of this system is same as the previously discussed system the only difference is the camera module.

The drawback of this system is that the author is using Apache Server that needs port forwarding method. Port forwarding can be clarify as In computer networking, port sending or port mapping is an utilization of network address translation (NAT) that diverts a correspondence ask for from one address and port number mix to another while the bundles are traversing a network gateway, such as a router. The utilization of router will include more consumption in the system cost. The results that the author got after testing his system are shown in fig. 5.4.



(a)



(b)

Fig 5.4 (a) Monitoring web interface; (b) videos list after recorded

As shown in fig 5.4 the author uses the apache server to make a webpage of his own were videos can be saved as shown in fig 5.4 (b) a list of videos is shown that can be accessed any time by the user.

PHASE-II

In this phase I am going to show what improvements I have done in my motion detection surveillance system. However, first I will explain the hardware components, software and the algorithms using in my system.

Starting with the hardware material used to build this system:

- Raspberry Pi 3 board.
- PIR Sensor
- Pi camera Module

Software that used to build this system is listed as follows:

- Python (Programming Language)
- OpenCV

- Dropbox API and Online server
- Twilio API and online server

5.3 Raspberry Pi 3 Board

The Raspberry Pi is a series of credit card measured single-board PCs created in the United Kingdom by the Raspberry Pi Foundation to promote the teaching of basic computer science in schools and in developing countries. The first model ended up plainly significantly more mainstream than foreseen, offering outside of its objective market for utilizations, for example, uses such as robotics. Accessories including consoles, mice and cases are excluded with the Raspberry Pi. A few frill however have been incorporated into a few official and informal packs. Raspberry Pi 3 Model B is the most up to date mainline Raspberry Pi. The Raspberry Pi 3 Model B includes a quad-center 64-bit ARM cortex A53 timed at 1.2 GHz this puts the Pi 3 approximately half quicker than the pi 2. Contrasted with the Pi 2, the RAM continues as before 1GB of LPDDR2-900 SDRM, and the illustrations capacities, given by the Videocode IV GPU, are the same as they ever were.11n Wi-Fi and Bluetooth 4.0. Wi-Fi, remote consoles, and remote mice now work out of the container. Additionally point by point dialog on the Raspberry Pi will be done in research methodology.

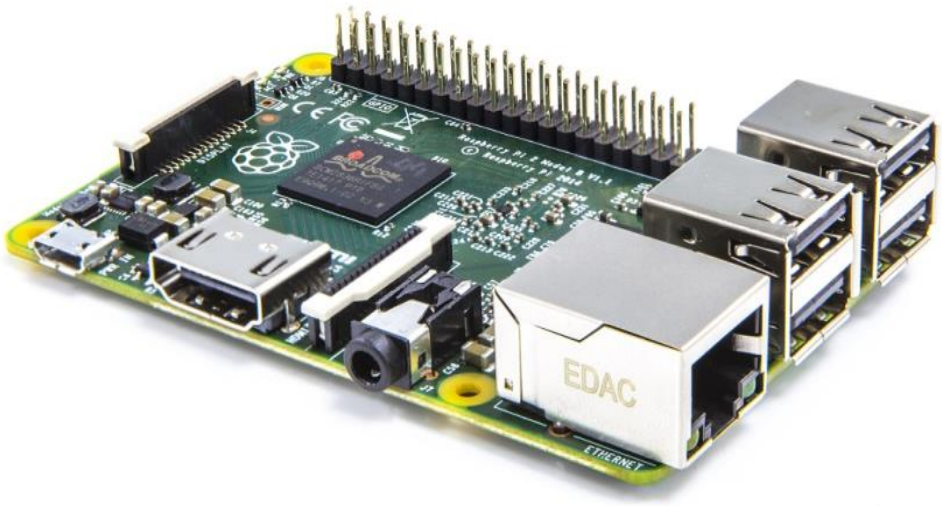


Fig 5.5 Raspberry Pi 3 board

- Broadcom BCM2837 64bit ARM Cortex-A53 Quad Core Processor system on chip (SoC) running at 1.2GHz
- 1 GB RAM
- 4 x USB2.0 Ports with up to 1.2A output
- Expanded 40-pin GPIO Header
- Video/Audio Out via 4-pole 3.5mm connector, HDMI, CSI camera, or Raw LCD (DSI)
- Storage: microSD
- 10/100 Ethernet (RJ45)
- BCM43143 Wi-Fi on board
- Bluetooth Low Energy (BLE) on board
- Low-Level Peripherals:
    - 27 x GPIO
    - UART
    - I^2C bus
    - SPI bus with two chip selects
    - +3.3V
    - +5V
    - Ground
- Power Requirements: 5V @ 2.4 A via microUSB power source
- Supports Raspbian, Windows 10 IoT Core, OpenELEC, OSMC, Pidora, Arch Linux, RISC OS and more.

The Raspberry Pi 3's four built-in USB ports provide enough connectivity for a mouse, keyboard, or anything else that you feel the RPi needs, but if you want to add even more you can still use a USB hub. The Raspberry Pi 3 has improved power management then its previous versions of Pi boards, with an upgraded switched power source up to 2.5 Amps, to support more powerful external USB devices.

5.4 PIR Sensor

PIR sensors enable you to detect motion, quite often used to detect whether a human has moved in or out of the sensors range. They are small, cheap, low-control, simple to utilize and don't destroy easily. Hence they are generally found in appliances and devices utilized as a part of homes or organizations. They are often referred to as PIR, "Inactive Infrared", "Pyroelectric", or "IR motion" sensors. The utilization of PIR sensor in this venture is that, the PIR sensor identify the human motion and sends a warning message on the client's cell phone that an intruder is detected utilizing an online server TWILIO. TWILIO will send a message on the user mobile phone that is defined in a script. Fig 5.3 demonstrates the PIR sensor with its pin description.

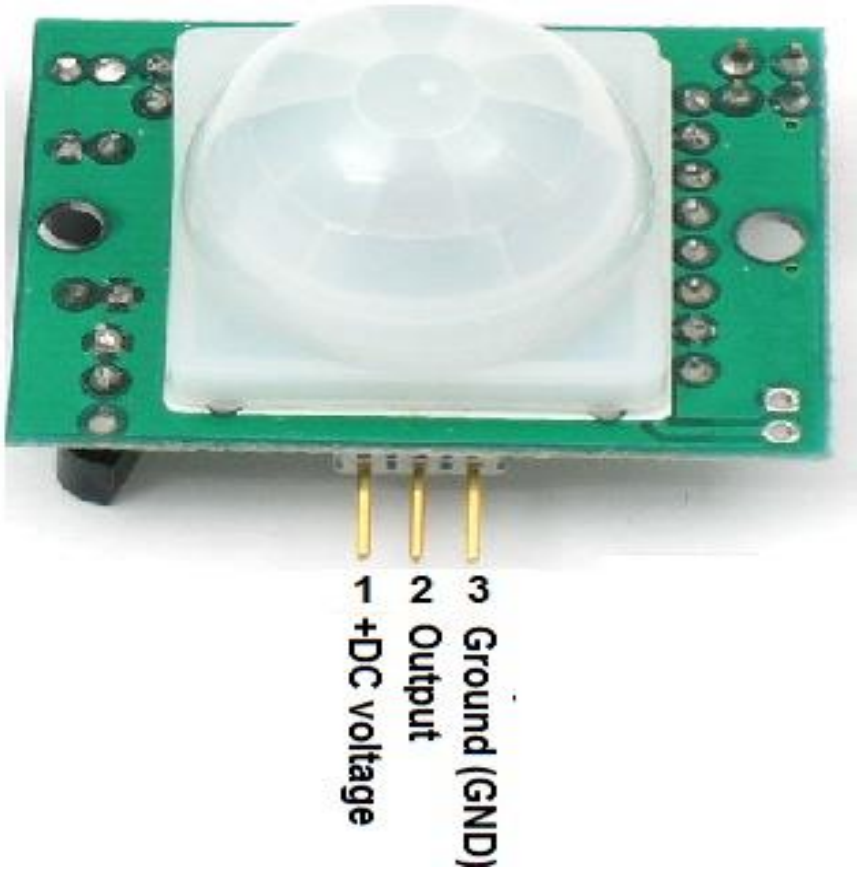


Fig 3.6 PIR sensor

5.5 Picamera Module

Raspberry Pi camera module can be used to take high-definition video, as well as stills photographs. It’s easy to use for beginners, but has plenty to offer advanced users if you’re looking to expand your

knowledge. There are lots of examples online of people using it for time-lapse, slow-motion and other video cleverness. You can also use the libraries we bundle with the camera to create effects.

If you're interested in the nitty-gritty, you'll want to know that the module has a five megapixel fixed-focus camera that supports 1080p30, 720p60 and VGA90 video modes, as well as stills capture. It attaches via a 15cm ribbon cable to the CSI port on the Raspberry Pi. It can be accessed through the MMAL and V4L APIs, and there are numerous third-party libraries built for it, including the Picamera Python library. The camera module is very popular in home security applications, and in wildlife camera traps.

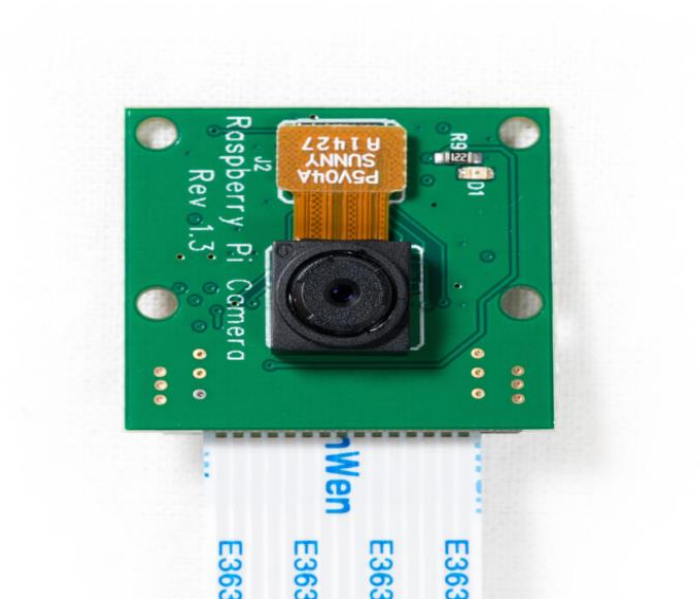


Fig 3.7 Pi camera

5.6 Python

In spite of the fact that there are numerous languages that can be utilized to program the Raspberry Pi, Python is the most popular programming languages. Actually, the Pi in Raspberry Pi is motivated by the word Python. Python is broadly utilized high- level, general-purpose, interpreted, dynamic programming language. Its design philosophy emphasizes code readability, and its syntax allows programmers to express concepts in fewer lines of code than possible in language provides constructs intended to enable writing clear programs on small and large scale.

5.7OpenCV

Computer vision (CV) enables your Raspberry Pi to see things. In literal terms, this implies your Raspberry Pi can analyze a picture, searching for things of interest and even recognizing faces and text. The library has more than 2500 optimized algorithms, which incorporates a complete comprehensive set of both classic and state-of-the-art computer vision and machine learning algorithms. These algorithms can be utilized to detect and recognize faces, distinguish objects, classify human activities in recordings, track camera movements, track moving items, extract 3D models of object, create 3D clouds from stereo cameras, join pictures together to deliver a high resolution picture of a whole scene, find comparable pictures from a picture database, expel red eyes from pictures taken using flash, take after follow eye movements, recognize scenery and establish markers to overlay it with augmented reality, etc. in my project I am using OpenCV library in my system for image processing purpose. The motion detection is an image processing processes that needs a special library and OpenCV is that library that runs in python programming language.

5.8 Dropbox

Dropbox is a file hosting service operated by American organization Dropbox, Inc., headquartered in San Francisco, California that offers cloud storag, file synchronization, personal cloud, and client software. Dropbox makes an uncommon envelope on the client's computer, the substance of which are then synchronized to Dropbox's servers and to different PCs and gadgets that the client has introduced Dropbox on, keeping the same files up-to-date on all devices. An Application program interface (API) of Dropbox is should have been installed in raspberry pi board so that the board can convey to the cloud server Dropbox and send the pictures on client's Dropbox account.

Fig5.8 Dropbox logo

5.9 Twilio

Twilio is a developer platform for communications. Software teams use Twilio APIs to add capabilities like voice, video, and messaging to their applications. This enables businesses to provide the right communications experience for their customers. Behind Twilio APIs is a Super Network, a software layer that connects and optimizes communications networks around the world. This is what allows your users to reliably call and message anyone anywhere. I am using Twilio for sending the notification on the user's phone that the intruder is present or the motion is detected. Twilio will respond as the PIR sensor senses any motion in the room. A script is running in parallel with the motion detection script that enables the Raspberry pi board to communicate with the Twilio, to send a message on user's phone when the motion is detected by the PIR sensor.

5.10 Architecture of system

The architecture is shown in fig 5.9 the Raspberry Pi board is connected with the system with the help of an Ethernet cable. Picamera is mounted on Raspberry Pi board connected with the picamera slot. The PIR sensor is connected with the 7th pin of Pi board as shown in figure below:

Fig 5.9 Architecture of system

5.11 Detect Motion

Now comes the most important part of this system "motion detection". In this a python script would analyze the video, if there is a difference from the last frame it would be flagged and video recording and snapshots generation will begin. This technique is implemented on the programming language called python. In python there is a package for image processing called as OpenCV. OpenCV is used for all the processing related to image and video. There are three algorithms of motion detection they are explained as follows:

5.12 DIFFERENCE MOTION DETECTION ALGORITHMS

The development in the video is a data source which has created a critical logical movement in a several fields for example, video surveillance. Video surveillance has been a key part in guaranteeing security at airports, banks, gambling clubs, and remedial organizations. All the more as of late, government organizations, and even schools are moving in the direction of video surveillance as a way to build open security [27]. In this area, an audit of movement identification calculations which are utilized as a part of this examination study is exhibited.

1. Frame Difference (Delta frame)

The frame difference calculation is a straightforward technique to extract moving objects; it comprises of exact difference between the past picture It-1 and the present picture I_t, (1).

$$\zeta(x,y) = \left|\frac{dI(x,y)}{dt}\right| = \left|\Delta I_{t,t-1}(x,y)\right| = \left|I_t(x,y) - I_{t-1}(x,y)\right| \quad (1)$$

2. Running Average Filter

Running Average filter or recursive foundation subtraction technique is a technique in which the foundation is developed by figuring the mean estimation of the past N frames, so as to refresh the first background image to assess new static object in the scene. An image is obtained as follows:

$$B(x,y) = \frac{1}{t}\sum_{t=1}^{t} I(x,y,\tau) \quad (2)$$

From equation no. (13) We can also compute recursively:

$$B(x,y,t) = \frac{t-1}{t}B(x,y,t-1) + \frac{1}{t}I\,(x,y,t-1) \quad (3)$$

This approach is not that reliable and may fail when change in lighting conditions significantly over time. The more recent image gives better results and contributes more to the background than the previous image. This can be accomplished by supplanting l/t in (3) by a steady α so that each image contributes to the background diminishes exponentially as it retreats into the past [17]. The background got by an exponential overlooking method is given by:

$$B(x, y, t) = (1 - \alpha)B(x, y, t - 1) + \alpha I(x, y, t - 1) \quad (4)$$

Where $\propto \in [0,1]$, is a time constant that presents hoe fast new information supplants old observations; in all experiments here we have taken $\propto = 0.75$. The difference is been perform using this background images as in (13):

$$\zeta_2(x, y) = |B(x, y) - I_t(x, y)| \quad (5)$$

3. Hybrid Motion Detection Method

The hybrid motion detection method comprises of consolidating the recursive background subtraction strategy with the three frame difference techniques.

The three frame difference method gives a vigorous detection for adequate extensive movements (substantial articles, questions close camera), and erases irrelevant movements, so all little movements like tree leaf movements out of sight (in the background) or banner movements in the wind will be expelled.

The adaptive luminance is easy adapted by this technique; the three frame difference is given by these three equations (6), (7) and (8):

$$\zeta(x, y) = \left|\Delta I_{t,t-1}(x, y)\right| = \left|I_{t,}(x, y) - I_{t-1}(x, y)\right| \quad (6)$$

$$\zeta(x, y) = \left|\Delta I_{t,t+1}(x, y)\right| = \left|I_{t,}(x, y) - I_{t+1}(x, y)\right| \quad (7)$$

$$\zeta_1(x, y) = \text{Min}(\zeta'(x, y), \zeta''(x, y)) \quad (8)$$

Where ζ' (x,y) is the frame difference between the frames t and t-1, ζ" (x,y) is the frame difference between the frames t and t+1, 1 ζ (x,y) is the three frame difference.

The drawback of this algorithm is that it leaves incomplete segmentation and the holes left in the object which is detection. That is why the hybrid method takes the maximum number of three frame difference and recursive background subtraction; this is assumed that this will fill the holes left by the first algorithm.

$$\zeta (x , y) = \text{Max } (\zeta 1(x , y),\zeta 2(x , y)) \quad (9)$$

All these motion detection methods are followed by a thresholding step as described in (9) to detect the region of changes.

Here in this project I am using Delta Frame technique. Another factor which is very important for the motion detection is the threshold technique used for the motion detection.

5.12Threshold Techniques for Motion Detection

Thresholding is a fast and simple method for the segmentation of the image and is successfully used in a wide spectrum of computer vision systems practical applications [14]. After the threshold operation a black and white image is obtained. The input image ζ is transform into binary image Ψ and then sent as the input for thresholding. If $\zeta(x,y)$ If $\zeta(x,y)$ is the result of motion segmentation in gray-level of the pixel $\zeta(x,y)$ in, then the corresponding values in Ψ are:

$$\Psi(x,y) = \begin{cases} 0, & if\, \zeta(x,y) < Th \quad for\ static\ backgoud \\ 1, & otherwise \qquad\quad for\ moving\ object \end{cases} \tag{10}$$

There are many threshold methods for motion detection such as the Otsu's method [5], the iterative selection (ISODATA Iterative Self-Organizing Data Analysis Technique) [6], Kapur's Entropy thresholding [7], Ramesh's threshold method [8] and Tsai's threshold [9]. All these methods have some advantages as well as some drawbacks. I have selected the best threshold algorithm form all this methods that perform well in both outdoor as well indoor conditions. The threshold method that I have used here in this system is the Iterative selection (ISODATA Iterative Self-Organization Data Analysis Technique).

5.13 Iterative selection algorithm

[6]The iterative selection algorithm or we can say ISODATA is an algorithm which is clustering-based and assumes that the distribution of grey-level values is based on a two-class Gaussian mixture model. The iterative threshold selection is a exceptional case of minimum error threshold technique with equal prior probability and equal variance.

1. Select an initial assessment of the threshold T. A decent initial value is the average intensity of the picture.

2. Calculate the mean grey values and of the partitions, R1, R2.

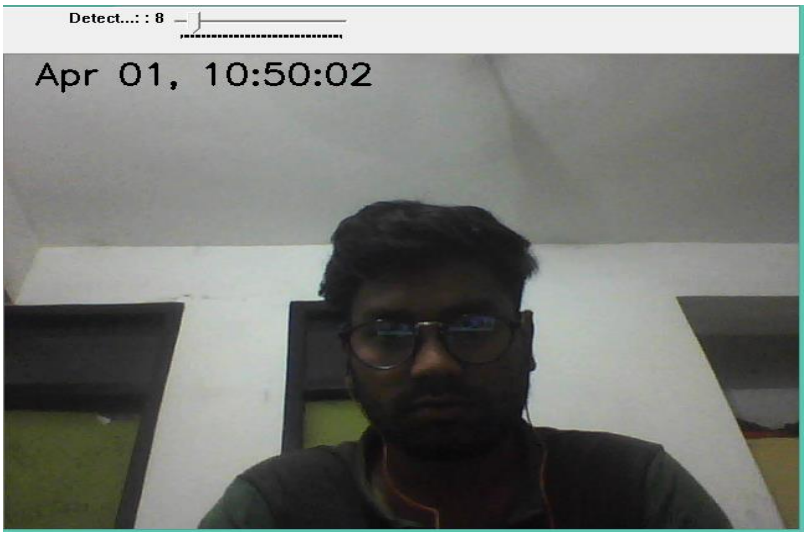
3. Partition the picture into two groups, R1, R2, utilizing the limit T.

4. Select another threshold.

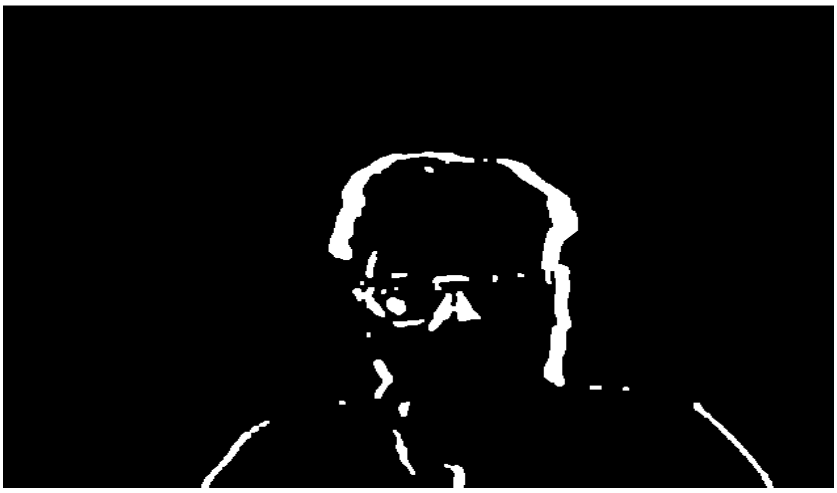
$$T = \frac{1}{2}(\mu_1 + \mu_2) \quad (11)$$

Above equation denoted the iterative self-organization threshold algorithm, where T is the new threshold which is established using the average of the foreground μ_1 and the background class means μ_2.

The results we got from the testing of iterative selection algorithm in both indoor as well as outdoor conditions are shown in fig. 5.1 and fig 5.2.

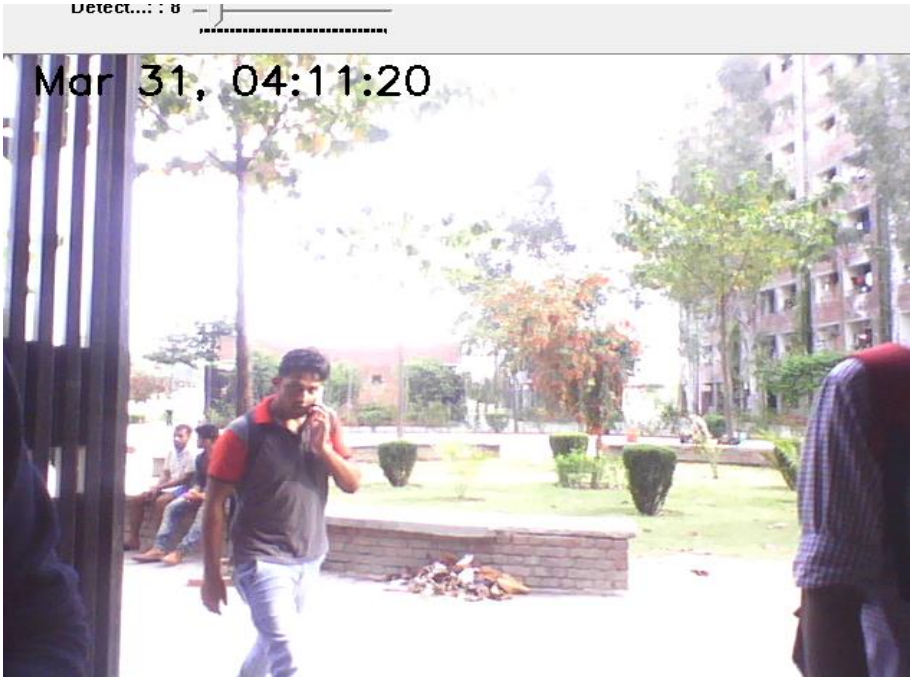


(a)



(b)

Fig.5.10. Indoor scene test for Iterative selection threshold algorithm



(c)

(d)

Fig.5.11 Outdoor test scenes of Iterative Selection algorithm

I have tested three threshold algorithms in indoor and outdoor conditions the algorithms are Otsu algorithm, Iterative self organization selection algorithm. Table 1.1 shows the result I have got after

comparison of these three algorithms . Table.1 presents the pixel-based evaluation of these methods applied on frame difference technique in indoor and open air territory; we take note of that we have high rating for PCC (percentage of correct classification), this is because of the little territory of moving object contrasted with the entire picture, however the Jaccard and the Yule coefficients beat this issue, the mean of this coefficient is surrendered to pick effortlessly the difference.

Tab.1.1 PIXEL-BASED EVALUATION OF DIFFERENT THRESHOLD METHODS APPLIED ON FRAME DIFFERENCE METHOD LARGER VALUES INDICATE BETTER PERFORMANCE.

		Scene1(indoor)	Scene2(outdoor)	Scene3(outdoor)	Average Coef. Scene1(indoor)	Average Coef. Scene2(outdoor)	Average Coef. Scene3(outdoor)
Otsu Algo.	PCC(%)	98.90	99.82	99.80	0.8004	0.9051	0.8346
	JC	0.5012	0.7648	0.5567			
	YC	0.9112	0.9523	0.9492			
IS Algo.	PCC(%)	98.70	99.82	99.80	0.7947	0.8857	0.8305
	JC	0.4997	0.7594	0.5419			
	YC	0.8976	0.8997	0.9516			
Kapur's Algo.	PCC(%)	98.70	99.82	99.80	0.6954	0.7611	0.7610
	JC	0.3864	0.6345	0.5213			
	YC	0.7129	0.7413	0.7638			

From the readings I got as shown in table 1.1, the best algorithm that realized is the iterative self-organization selection threshold algorithm. It gives the best results in both the indoor and outdoor condition as shown in table 1.1 IS algorithm is giving the highest values of the taken parameters for the calculation.

5.14 Working of PIR Sensor and Twilio

The working of PIR sensor in my system is to sense the motion in the room as set as active one. The script running background check if the PIR sensor is active one or not if it is one it will send a signal to the Twilio api to send a message on the user's phone that "motion is detected please check your dropbox".

The working of my system can be explained in some steps they are as follows:

1. A python script that runs on Raspberry Pi board to detect motion which is captured by the camera connected to the board.
2. Python compiler to handle the request.

3. PIR sensor senses the motion and turns to active high.
4. Script for the message on mobile phone to give notification to the user that the motion is detected.
5. Servers or cloud managed systems to store the file externally here the cloud server used by me is the Dropbox.

5.15 Advantages of this system

1. This system saves a lot of memory cost by saving the captured data on online server and start recording only when the motion is detected.
2. All the previous systems are a bit slower and have some flaws. Nothing is perfect so as my system is, but I tried to overcome some flaws like the speed of my system to detect motion is faster than the previous projects done in the same direction because I am using here the best threshold algorithm for motion detection that is “iterative self-organization selection algorithm”.
3. I am using third party server for saving the data that is free to use. This will reduce the cost of setting up our own server and website. Both the servers used Dropbox and Twilio are free.
4. This system has dual safety functions one is camera off course and other is the PIR sensor. This gives my system more accuracy and more sensibility then the previous systems.

CHAPTER 6

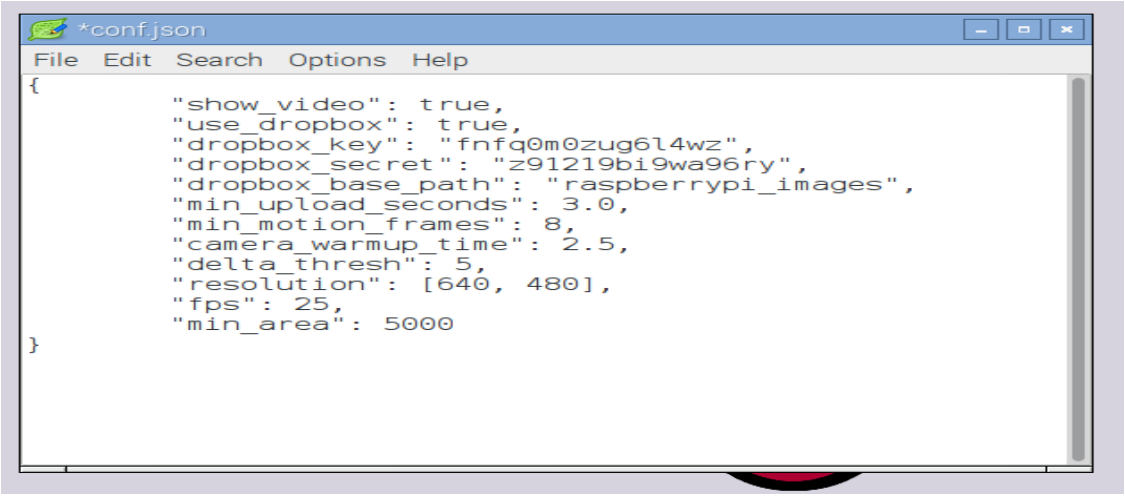
RESULTS AND DISCUSSION

6.1 Experiment Work

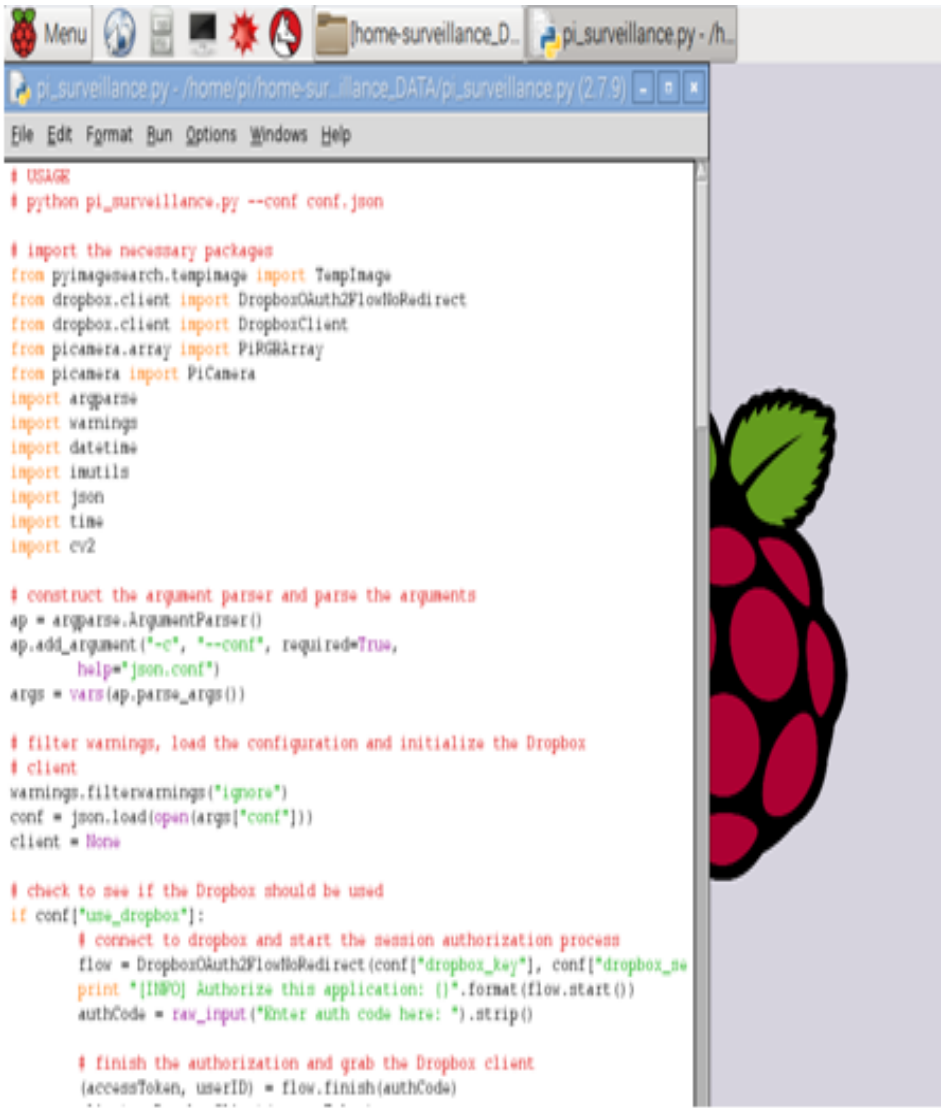
This motion detection surveillance is tested for several times, the system is tested for indoor conditions only but it will perform with exactly same accuracy and perfection as it works in indoor condition. The difference is that in outdoor condition the number of moving object is more than indoor condition, so the captured data will be more. Although, the threshold algorithm I am using (i.e iterative self organization selection method) is able to detect the necessary motion and not detect the unnecessary one, but to standardize the working of my system I have taken the indoor data only.

6.1.1 Python Script

A script coded in python language starts running. In this script only I have defined the resolution of the picamera that is 640x480 and the frame rate is also defined in the json script that is 25 fps (frame per second). Json script has all the authentication related information in it. This information in the json script is passes as the arguments in the main script. Fig 6.1 shows the "json.conf" script that has all the authentication information of the Dropbox account of the user.



(a) json.conf script



(b) The use of json.conf script in main program

Fig6.1

6.1.2 Home surveillance and motion detection with Raspberry Pi

The other script that works in my system is the main script that does the task of motion detection and sending the detected image to the online server. The speed and the accuracy at which the motion is detected is totally dependent on the threshold algorithm. Thresholding is a fast and simple method for the segmentation of the image and is successfully used in a wide spectrum of computer vision

systems practical applications [14]. After the threshold operation a black and white image is obtained. Threshold algorithm that I am using is the iterative self-organization selection algorithm. This algorithm is best in indoor and outdoor conditions as I have tested before, the results of testing this algorithm is shown in tab.1.1 in pervious sec. the motion detection part of the main script is shown in fig 6.2. (a) and (b).

Home surveillance and motion detection with the Raspberry — OpenCV/Python

```
# initialize the camera and grab a reference to the raw camera capture
camera = PiCamera()
camera.resolution = tuple(conf["resolution"])
camera.framerate = conf["fps"]
rawCapture = PiRGBArray(camera, size=tuple(conf["resolution"]))

# allow the camera to warmup, then initialize the average frame, last
# uploaded timestamp, and frame motion counter
print "[INFO] warming up..."
time.sleep(conf["camera_warmup_time"])
avg = None
lastUploaded = datetime.datetime.now()
motionCounter = 0
```

(a) Initializing the pi camera and grab a reference to the camera capture

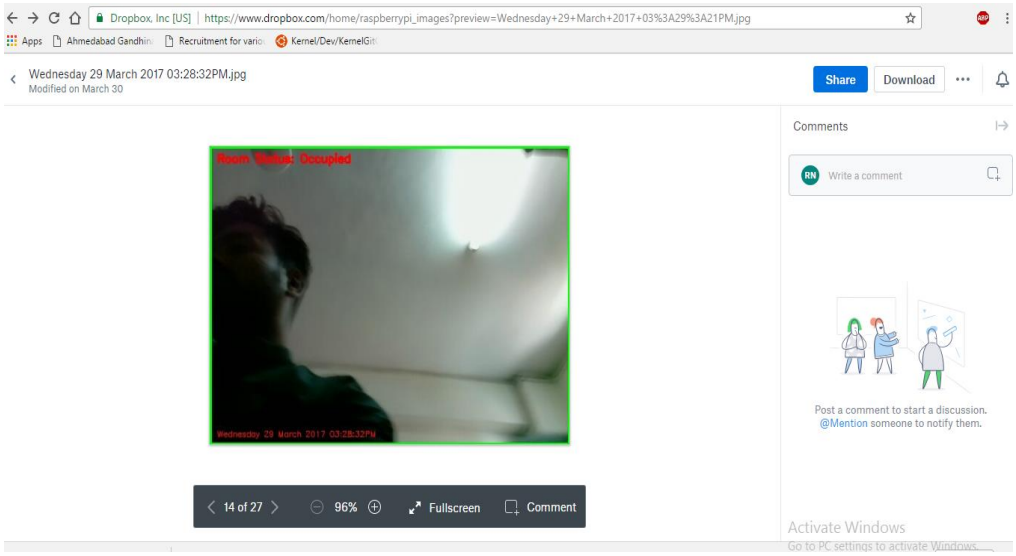
Home surveillance and motion detection with the Raspberry — OpenCV/Python

```
    # threshold the delta image, dilate the thresholded image to fill
    # in holes, then find contours on thresholded image
    thresh = cv2.threshold(frameDelta, conf["delta_thresh"], 255,
        cv2.THRESH_BINARY)[1]
    thresh = cv2.dilate(thresh, None, iterations=2)
    (cnts, _) = cv2.findContours(thresh.copy(), cv2.RETR_EXTERNAL,
        cv2.CHAIN_APPROX_SIMPLE)

    # loop over the contours
    for c in cnts:
        # if the contour is too small, ignore it
        if cv2.contourArea(c) < conf["min_area"]:
            continue

        # compute the bounding box for the contour, draw it on the frame,
        # and update the text
        (x, y, w, h) = cv2.boundingRect(c)
        cv2.rectangle(frame, (x, y), (x + w, y + h), (0, 255, 0), 2)
        text = "Occupied"

    # draw the text and timestamp on the frame
    ts = timestamp.strftime("%A %d %B %Y %I:%M:%S%p")
    cv2.putText(frame, "Room Status: {}".format(text), (10, 20),
        cv2.FONT_HERSHEY_SIMPLEX, 0.5, (0, 0, 255), 2)
    cv2.putText(frame, ts, (10, frame.shape[0] - 10), cv2.FONT_HERSHEY_SIMPLEX,
        0.35, (0, 0, 255), 1)
```

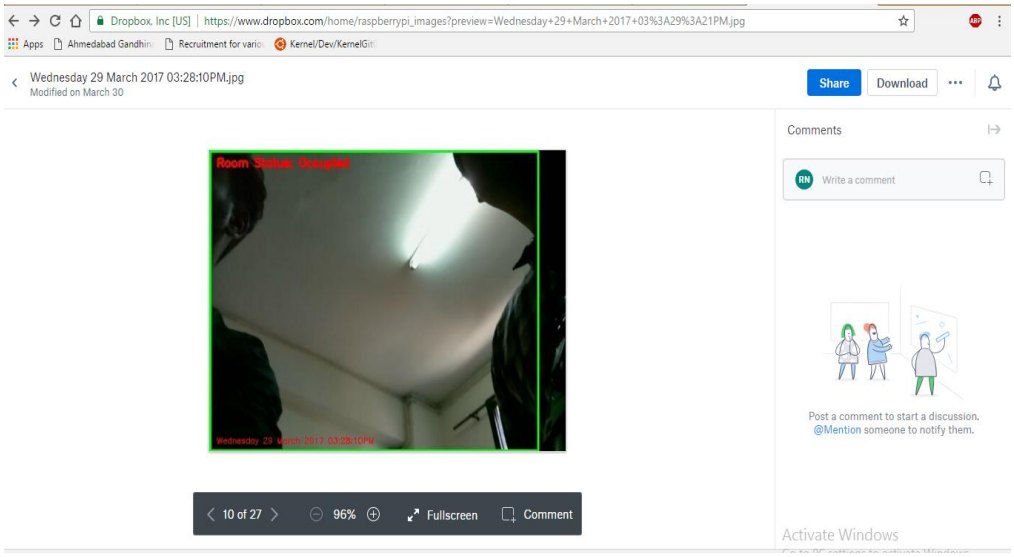
(b) Threshold the delta image and draw abounding box around the detected object in motion

Fig.6.2 Script of Home surveillance and motion detection with the Raspberry Pi

The obtained results are shown in fig6.4. As the script starts running it detects the motion and sends the images on the online if any motion is detected. There is one more feature in my system that it shows a status that a room is occupied when anyone is present in the room.



(a)



(b)

Fig 6.3 Captured images saved on the online cloud

These are the images obtained on the cloud server and showing that a intruder is present in the room. Now to alert the user to check that the motion is detected, another device is added by me for more accuracy that is the PIR sensor. A python script is programmed such that as the motion is detected by the PIR sensor it will send a message on user's phone. The image of the script is shown in fig.6.4.

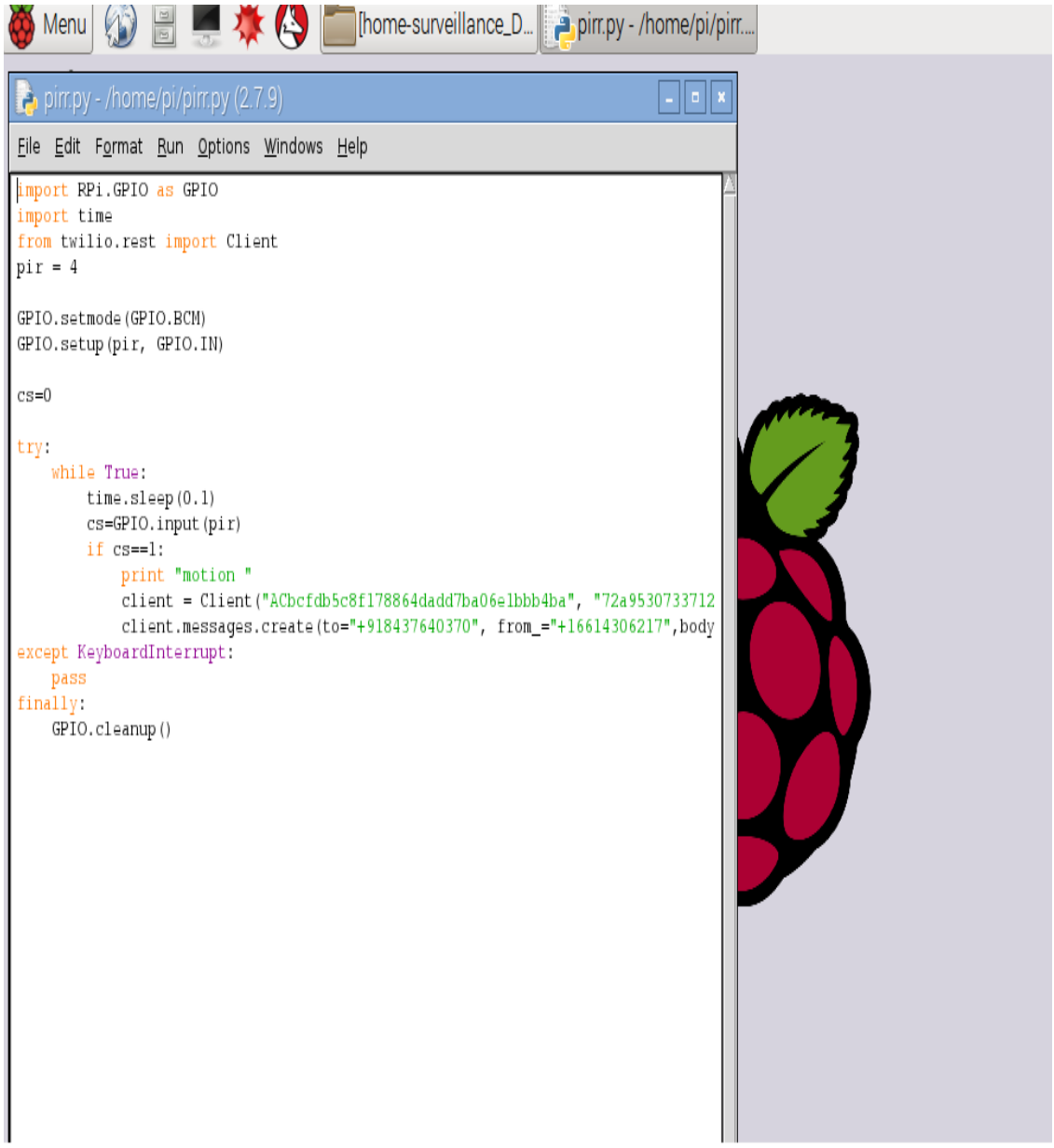


Fig6.4 Python script to send message on the user's phone when the motion is detected by the PIR sensor

Twilio is the 3rd party server that is used here in this system and the notification that is sent by Twilio looks like this shown in fig 6.6.

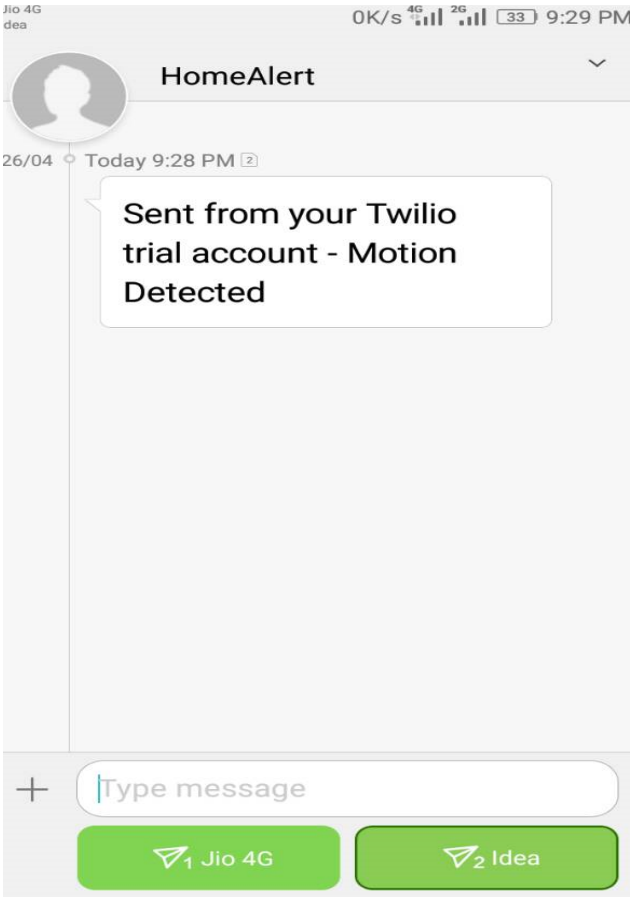


Fig 6.5 Alert message from Twilio to the user's phone

As I have saved the Twilio server Number as HomeAlert that's why in fig 6.6 and since the account in twilio I have opted for is trail account that's why it's showing trial account.

6.2 PERFIRMANCE EVALUATION

- In terms of speed this system is faster than the previously tested systems. The motion detection is way much faster and accurate after the use of iterative self-organization selection algorithm. I have evaluated three threshold methods and evaluated them as shown in tab 1.1.

Tab.1.1 PIXEL-BASED EVALUATION OF DIFFERENT THRESHOLD METHODS APPLIED ON FRAME DIFFERENCE METHOD LARGER VALUES INDICATE BETTER PERFORMANCE.

		Scene1(indoor)	Scene2(outdoor)	Scene3(outdoor)	Average Coef. Scene1(indoor)	Average Coef. Scene2(outdoor)	Average Coef. Scene3(outdoor)
Otsu Algo.	PCC(%)	98.90	99.82	99.80	0.8004	0.9051	0.8346
	JC	0.5012	0.7648	0.5567			
	YC	0.9112	0.9523	0.9492			
IS Algo.	PCC(%)	98.70	99.82	99.80	0.7947	0.8857	0.8305
	JC	0.4997	0.7594	0.5419			
	YC	0.8976	0.8997	0.9516			
Kapur's Algo.	PCC(%)	98.70	99.82	99.80	0.6954	0.7611	0.7610
	JC	0.3864	0.6345	0.5213			
	YC	0.7129	0.7413	0.7638			

- As shown in tab 1.1, the highest average values of all the parameter (Percentage of Correct Classification (PCC), The Jaccard coefficient (JC) and the Yule coefficient (YC)) is obtained form otsu and iterative algorithm. But iterative algorithm gives better performance in low light or indoor conditions that's why I have used the iterative threshold algorithm and set threshold value as 5.
- Detection of motion is needed to be fast and the uploading of captured data on the online server in fast speed is also equally necessary. The speed of uploading the data on the online server is 3 sec minimum which is quite fast then other system. And the cost for the third party server should also be low, here in this system I am using free online server Dropbox. Dropbox gives free services for storage of data, this save a lot of money wastage in storage devices.
- Similarly I am using Twilio another third party server used for sending a notification message on the user's phone as the PIR sensor detects the motion.
- The performance of pi camera is also better than the systems using USB camera. Its speed is faster than USB camera and the resolution of picamera can also be set according to our convenience. Here the resolution of pi camera is set at 640X480 pixels and the frame rate is set at 25 frames per sec.

CONCLUSION AND FUTURE SCOPE

In this project I have analyzed that with the use of Raspberry Pi and PIR sensor for motion detection and Internet of things enhances the capabilities of a normal surveillance system. The use of IoT gives the capability to the surveillance system that it can connect to the internet and communicate with other devices via internet without human continuous monitoring. This system can also be introduced as a better alternative for the expensive traditional security systems that takes much storage space and not affordable for everyone. This system is compact and doesn't required any special modifications in the system can be implement easily also. As I tested this system several times and found that the accuracy of this surveillance system is 98%. The cost of making and implementation of this system is also very low. It gives all results accurately and on given time limit.

The future expansion of this system can be addition of recognition of image that is detected I am working on this part also. For this I am using online service that have a pre recognized data. A large archive of data is saved in very big servers of this online service provider such as IBM Watson. Watson is considered as the smartest computer invented till the time. It has very large archive of data. Some services are allowed by the IBM (the creator of Watson) for the use of normal people. So we can use this service to recognize any detected object. Which means the image which is capture from the streaming video can recognized also. For example if the any motion is occurred in very low light condition, so that it is very hard to identify weather the intruder in the video in motion is an animal or a human. So this can be resolved by the recognition technique. The system will send the image on the online server that have large archive of data where the data will be compared and the result will then be send to the user. This will help a lot in border security where terrorists always try to enter in the country.

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Thesis

ORIGINALITY REPORT

%21	%16	%12	%13
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	ijarcce.com Internet Source	%5
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4	www.ijais.org Internet Source	%1
5	www.europment.org Internet Source	%1
6	Submitted to VIT University Student Paper	%1