

Night Vision Motion Estimation and Notification using Wireless Communication

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Abstract— Video Surveillance during night is important as far as security is concerned these days. The current technologies require RFIDs which are costly and hence the security domains in all become expensive. This paper describes the aims at establishing an easy way of detecting motion at night using Raspberry Pi. The Raspberry Pi can be connected with the web camera to capture the footage. The Raspberry Pi will transmit captured information through internet. The algorithm for motion detection is being implemented on Raspberry Pi which enables live video streaming. This Raspberry Pi connected with web camera which will continuously monitor and as the motion is detected it will start taking snapshots and sent directly to the end user using SMTP protocol. Also, alarm system will alarm when the motion is detected so that action is taken at that moment. The basic idea of the project is to upgrade the presently working system to Raspberry Pi which is a low cost, credit card sized computer has capability of working as a normal computer and also there is no need to have machines at both the ends to get desired output.

Key words: Video Surveillance, Raspberry Pi, Image thresholding, Motion detection, Block matching, Motion vector

I. INTRODUCTION

Video Surveillance [12] refers to observation of real time video of a region from a remote area. IP and PTZ cameras are used for deliverance of real time video remotely. However their usage is restricted when cost matter is concerned. Raspberry Pi is the least expensive technology whose usage is being proposed in this paper as an alternative for video surveillance [6]. It is the cheapest and commercially available option when comparing with other alternatives. Paper presents a new dimension in the security domain by utilising this mini board. Here paper proposed a Block matching algorithm [14] which is used to estimate the motion.

In motion estimation process[14], firstly, a frame is partitioned into many non-overlapping blocks with different block sizes according to the motion contents, secondly, the target block in the current frame is compared with the candidate blocks in the reference frame; under the constraint of cost function, we can obtain the best matched block by minimizing the cost function, and finally, the motion vector(MV), which represents the displacement between the current block and the best matched block, together with the residual signal, which is the pixel difference between the current block and the best matched block, are transported to the next process to be coded[7][8][10]. In this system various image processing techniques such as image filtering, image thresholding, image segmentation, contour fitting are used for making image better. The underlying supposition behind motion estimation is that the patterns corresponding to

objects and background in a frame to form corresponding objects on the subsequent frame.

The paper presented here is organized as follows. Section 2 briefs about mini board Raspberry Pi, Web Cam. In Section 3 Related Research which contains Noise Filtering Methods, Image Segmentation, Image Thresholding Techniques, Morphological Operators, Motion Estimation, Block Matching Algorithm. Section 4 contains software development tools such as putty, vnc server and SMTP (Simple Mail Transfer Protocol).

II. HARDWARE DESCRIPTION

A. Raspberry Pi-An Introduction

Raspberry Pi: It is credit card sized computer, which can plug into any HDMI input device or RCA video input device and a keyboard is required for operation. Once it is initialized the HDMI and keyboard can then operate it by other means such as ssh for command line interface and VNC if graphical user interface is desired. The main technical specifications of the latest model of Raspberry Pi also known as Model B have the following key features:

- 1 GB RAM
- 4 USB ports A 900 MHz quad-core ARM Cortex-A7 CPU
- Full HDMI port
- Ethernet port
- Combined 3.5 audio jack and composite video
- Camera interface(CSI)
- Display Interface(DSI)
- Micro SD card slot
- Video core IV 3D graphics core

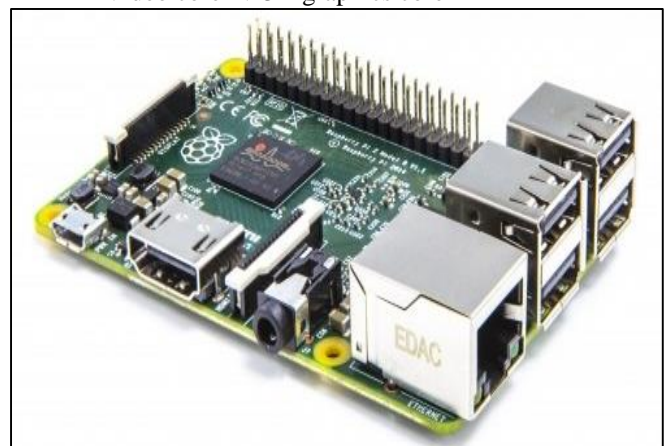


Fig. 1: Raspberry Pi 2 model B [1]

The Raspberry Pi runs Linux based operating systems and pycharm is an Integrated Development Environment (IDE) used for programming in python as it cross-platform working on Windows, Mac OS X and Linux which can run almost all programs. It provides code analysis,

a graphical debugger, an integrated unit tester, integration with version control systems (VCSes), and supports web development [1] [2].

B. Web Cam



Fig. 2: Web Cam [17]

1) Features:

- 720p High –Definition Webcam with exceptional image quality.
- 6 LEDs for night vision, with brightness controller.
- Multi-utility camera base (can be used on Desktop,Laptop & LCD)
- High-speed USB 2.0 interface.

2) Specifications:

- Sensor Resolution: 1 MP CMOS
- USB Interface: USB 2.0.
- Max. Image Resolution: 5500x3640 pixels
- Max.Video Resolution:1920x1080 pixels.
- Frame Rate: 30 frames per second max.

III. RELATED RESEARCH

A. Noise Filtering Methods

Noise is the unwanted variation and fluctuation in image which is captured by the camera. Noises in the images are arising during the image acquisition and transmission of data. There are various types of noise are present in image such as salt and pepper noise, Gaussian noise, gamma noise, Rayleigh noise and uniform noise. Due to the noise information in the image are lost so, it is necessary to filter the image.

In this step, on captured image noise is present. Various noise filtering methods such as median filtering, mean filtering, Gaussian filtering, Min-Max filtering are used to remove the noise. Among all filtering methods median filtering provide better results but for real time, also Gaussian filter gives better result [3].

B. Image Segmentation

Segmentation is used to differentiate the object and the background in an image.

- Intensity based Segmentation: Segments an image based on the intensity levels and is called as threshold based approach.

- Threshold based approach classifies an image into two classes: 1) Pixels belonging to certain range of intensity values.2) Rest of the pixels in the image.

C. Image Thresholding Techniques

Image Thresholding is the technique of image segmentation. In the Thresholding technique colour image or gray scale image is converted into the binary image. Image Thresholding separate the object from the background.

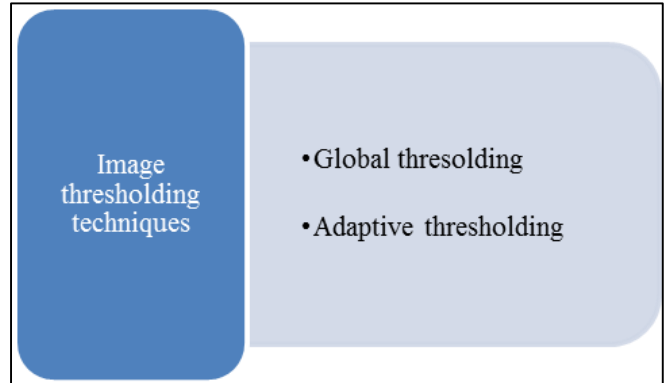


Fig. 3: Reviewed methods for image thresholding [4]

1) Global Thresholding

In global thresholding technique single threshold value is used for whole image.

$$g(x,y) = \begin{cases} 1 & i(x,y) \geq t \\ 0 & i(x,y) \leq t \end{cases}$$

Where $g(x,y)$ =output image

$i(x,y)$ = input image

t = threshold value

Global thresholding works better when the histogram of image is uniformly distributed. The disadvantage of the global thresholding technique is that it gives bad segmentation under varying light condition.

2) Adaptive Thresholding

Adaptive thresholding technique image is divided into the sub images. The thresholding value is depend on the neighborhood pixel properties. Separate thresholding value is used for all sub images. This algorithms works fine under the varying light condition and it provide better segmentation compare to the global thresholding technique.

D. Morphological Operators

Morphological operations are affecting the form, structure or shape of an object. Applied on binary images (black & white images – Images with only 2 colours: black and white).

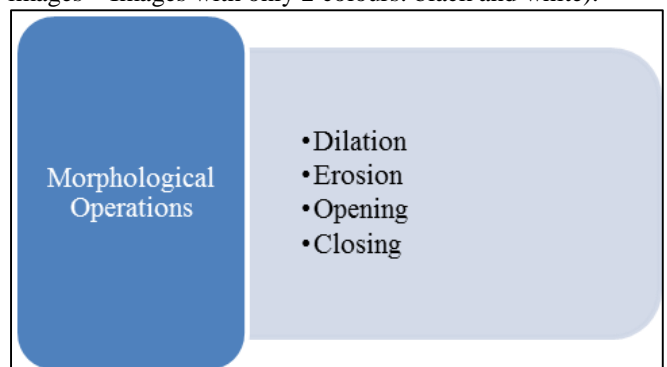


Fig. 4: Morphological Operators [5]

- The two principal morphological operations are dilation and erosion.

- Dilation allows objects to expand, thus potentially filling in small holes and connecting disjoint objects.
 - Erosion shrinks' objects by etching away (eroding) their boundaries.
 - These operations can be customized for an application by the proper selection of the structuring element, which determines exactly how the objects will be dilated or eroded.
- 1) Notation: black pixel: in gray scale values for a 8 bits/pixel indexed image its value will be 0
 - 2) white pixel: in gray scale values for a 8 bits/pixel indexed image its value will be 255
- These two basic operations, dilation and erosion, can be combined into more complex sequences. The most useful of these for morphological filtering are called opening and closing.
 - Opening consists of an erosion followed by a dilation and can be used to eliminate all pixels in regions that are too small to contain the structuring element. In this case the structuring element is often called a probe, because it is probing the image looking for small objects to filter out of the image [5].

E. Motion Estimation

Motion estimation is a process of determining motion vectors that describe the transformation from 2D image to another; usually from adjacent frames in a video sequence. The motion vectors may relate to the whole image (global motion estimation) or specific parts, such as rectangular blocks, arbitrary shaped patches or even per pixel[8].

In video compression, a motion vector is the key element in the motion estimation process. It is used to represent a macro block in a picture based on the position of this macro block (or a similar one) in another picture, called the reference picture.

Motion vector is a two-dimensional vector used for inter prediction that provides an offset from the coordinates in a reference picture.

1) Block Matching Algorithm

In block matching [14] motion estimation process, there is a high correlation between each pixel and its surrounding in a frame. Therefore, it is not necessary to assign motion vector to each pixel. It is enough to identify one motion vector per a block of pixels.

In a typical frame work to block matching motion estimation, a frame is divided into blocks of $n \times n$ then, for the maximum motion displacement of P pixels per frame, the current block of pixels is matched against a corresponding block at the same coordinates but in the previous frame. The best match on the basis of a matching criterion yields the displacement.

The bigger value for n means that the number of total blocks which need to process in each frame are decreased and for this reason, it is clear that the computational complexity will reduce.

2) Matching Criteria

Block matching is a subset of image matching and can be consider from a view perspective. In many image processing tasks, sometimes it is essential to examine two images or two portions of images on a pixel by pixel basis. These two images or two image regions can be choose from a spatial image sequence.

The aim of the examination is to determine the similarity between the two images and two portions of images. The similarity measure or correlation measure, is a key element in the matching process. On the other hand, instead of finding the maximum similarity, or correlation, an equivalent yet more computationally efficient way of block matching is to find the minimum dissimilarity, or matching error.

There are several types of matching criteria, such as the mean square error (MSE), and mean absolute difference (MAD) are illustrated below, which are used most of the time.

$$MAD = \frac{1}{n^2} \sum_{i=0}^{n-1} \sum_{j=0}^{n-1} |C_{ij} - R_{ij}|$$

Where n is the size of the macro block C_{ij} and R_{ij} are the pixels being compared in current macro block and reference macro block, respectively

IV. SOFTWARE DEVELOPMENT

A. Development Tool

1) Putty

On Windows you will need to download an SSH client. The most commonly used one is called Putty [19]. It doesn't have an installer package. When we run it you'll see the configuration screen below:

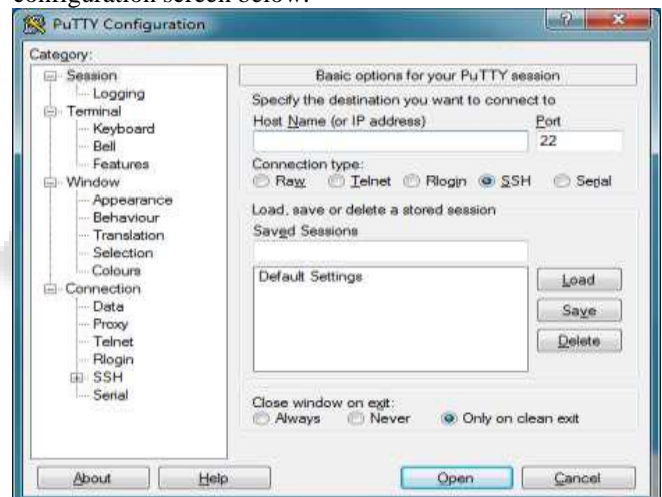


Fig. 5: Putty Configuration

Type the IP address of the Pi into the Host Name field and click the Open button.

You'll now have the usual login prompt, login with the same username and password which will be use on Pi. After login you can show the below putty window.

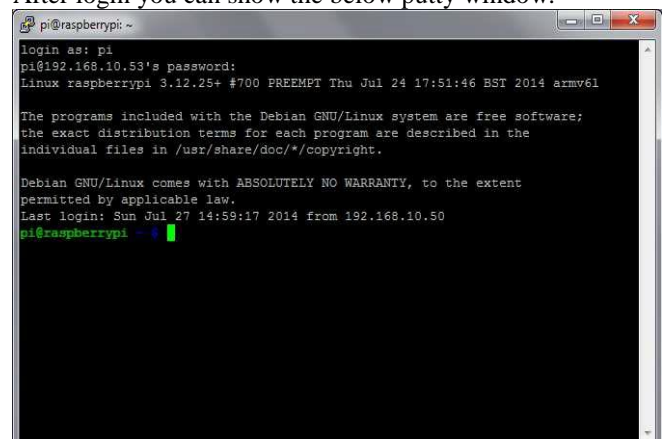


Fig. 6: Putty Window

If we want to see our programme file type nano filename.py in putty window and if you want to run our programme type sudo python filename.py in putty window.

You can type exit to close the Putty window.

2) *VNC server to connect Raspberry Pi with Laptop display*
Install Putty as per windows configuration and via ssh we can connect with our raspberry pi. As you get access to pi terminal, install[18].

– Starting VNC server on Pi:

Enter below command on SSH terminal:

```
$ vncserver :1
```

You will have to enter and confirm a password. This password you will need to use, to connect to the Raspberry Pi remotely.

The VNC server is now running on Pi and so we can connect to it. But first shift to the laptop from which we want to control the pi. Then setup a VNC client to connect to the pi.

– Setting up the Client side (Laptop)

Download VNC client and install it. When you first run VNC viewer, you will see following:

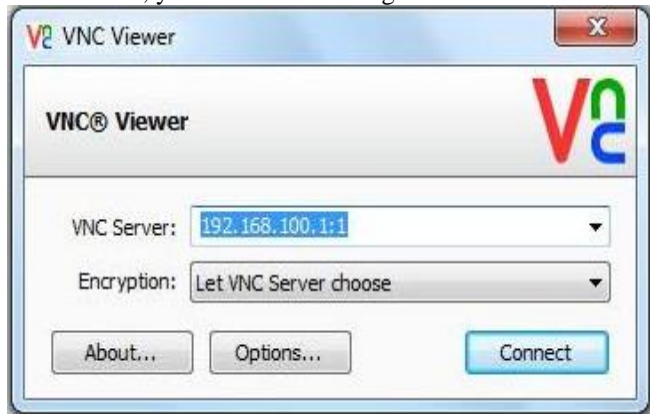


Fig. 7: VNC Viewer

Enter IP address of your raspberry pi given dynamically by your laptop (you got the address from the earlier step). And append with :1 (denoting port number) and press connect. You will get a warning message, press 'Continue':



Fig. 8: Unencrypted Connection

Enter the 8 digit password which was entered in VNC server installation on raspberry pi:

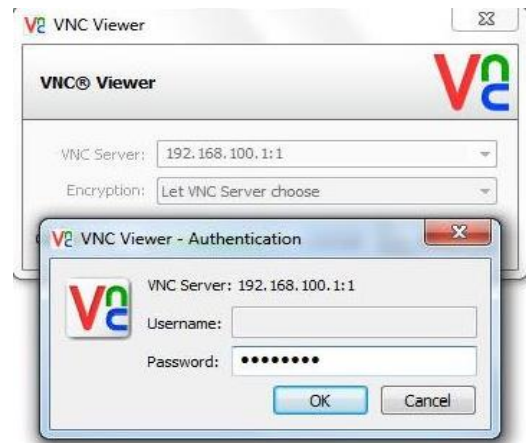


Fig. 9:

Finally, the raspberry pi desktop itself should appear as a VNC window.

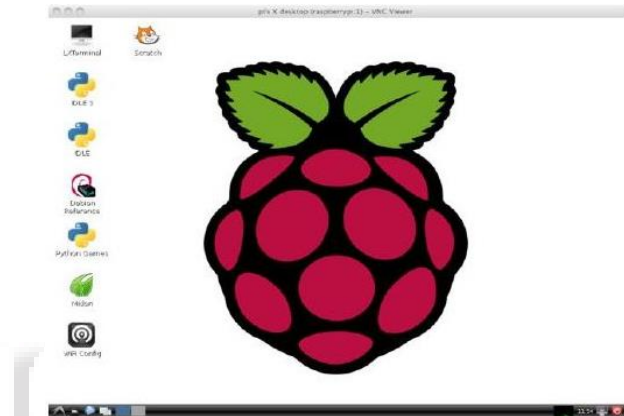


Fig. 10:

B. SMTP (Simple Mail Transfer Protocol)

Simple Mail Transfer Protocol (SMTP) is a standard protocol for email services for TCP/IP network. Using a process called "store and forward". SMTP provides the ability to send and receive mail messages.

SMTP is an Application layer protocol that enables the transmission and delivery of email over the internet [20].

V. RESULTS

A. Raspberry Pi Connections



Fig. 11: Raspberry Pi Connections

B. When The Room Is Empty

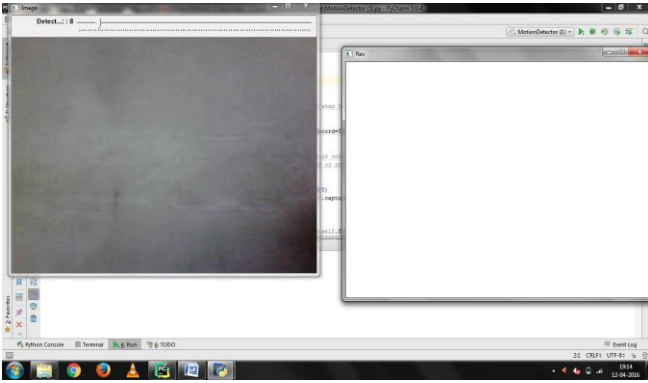


Fig. 12: When The Room Is Empty

C. Motion Is Detected When Light Is Present.

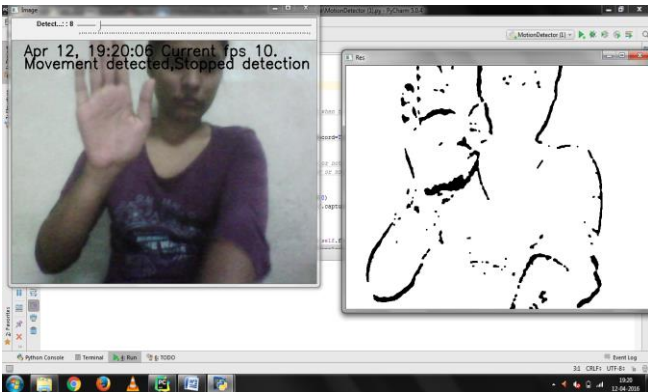


Fig. 13: Motion is detected when light is present



Fig. 14:

D. Motion Is Detected at Night.

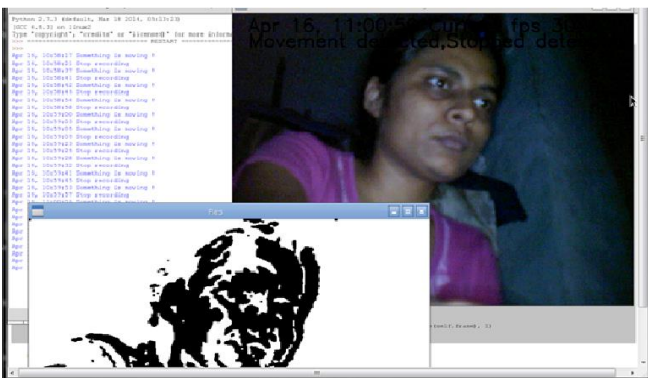


Fig. 15: Motion Is Detected at Night

E. Motion Detected When Two Cameras are Used.

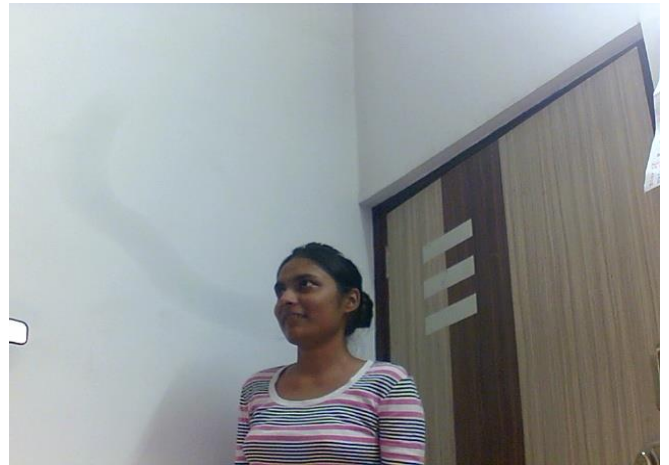


Fig. 16: Cam1



Fig. 17: Cam2

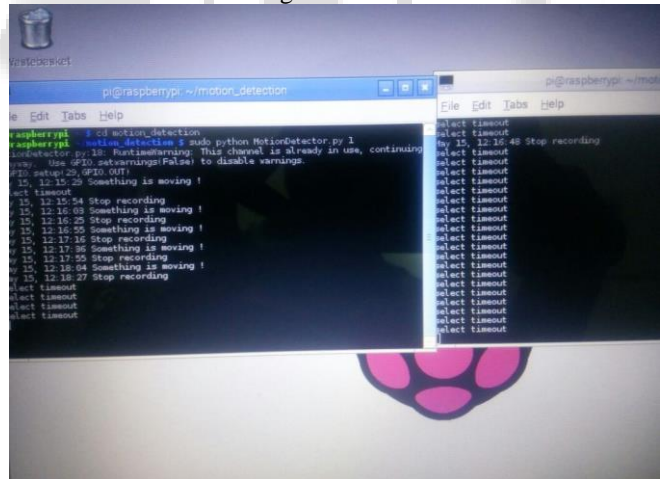


Fig. 18:

F. Mails transferred when motion is detected

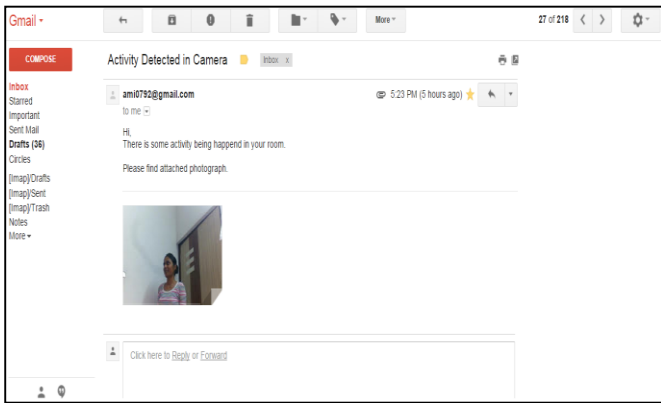


Fig. 19: From Cam1

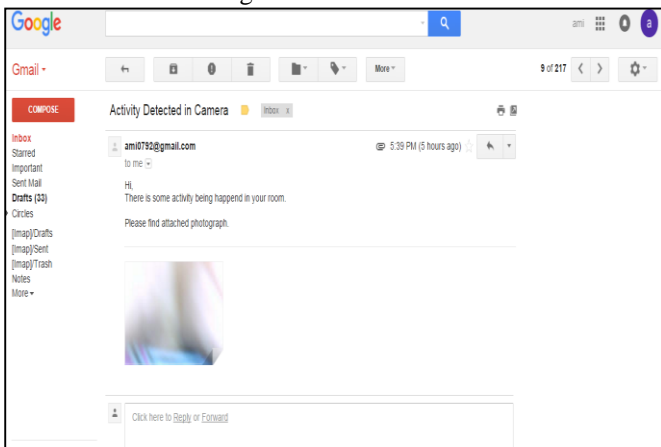


Fig. 20: From Cam2

VI. CONCLUSION

It is concluded that night vision motion estimation is performed using Block Matching Algorithm which is computationally less complex and performed motion detection upto good extent. Also, raspberry pi is used which is low cost and work as minicomputer due to which installation problem is solved. Motion detected frame is send to the owner using SMPT protocol so that one could be able to take action. So, due to this, system is used for security for the application such as bank, jewellery shops where security is of major concern.

REFERENCES

- [1] www.raspberrypi.org.
- [2] Aamir Nizam Ansari, Mohamed Sedky, Neelam Sharma, Anurag Tyagil, "An Internet of Things Approach for Motion Detection using Raspberry Pi", 2015 International Conference on Intelligent Computing and Internet of Things (ICIT).
- [3] Ruchika Chandel, Gaurav Gupta, "Image Filtering Algorithms and Techniques: A Review", International Journal of Advanced Research in Computer Science and Software Engineering, vol. 3, no. 10, pp. 198-202, 2013.
- [4] Slim ABDELHEDI, Khaled TAOUIL, Bassem HADJKACEM, "Design of Automatic vision-based Inspection System for Monitoring in an Olive Oil Bottling Line "International Journal of Computer Applications (0975– 8887), Volume 51– No.21, August 2012.

- [5] S. Bag and P. Bhowmick, "Adaptive-interpolative binarization with stroke preservation for restoration of faint characters in degraded documents", Journal of Visual Communication and Image Representation, vol. 31, pp. 266-281, 2015.
- [6] Changee, P. Shangyun and L. Sang-Joon, "An Efficient Moving Detection Methodology in Mobile Cloud Environment", *IEEE*, 2014.
- [7] Kiran, S. Kamal and C. Sharad, "A Modified Full Search Block Matching Algorithm with Reduced Number of Search Positions per Block per Frame", *ISSN*, vol. 1, no. 2, pp. 149-153, 2014.
- [8] S. Hussain and H. Mohd, "A Comparative Approach for Block Matching Algorithms used for Motion Estimation", *International Journal of Computer Science Issues*, vol. 11, no. 3, 2014.
- [9] Slomo Video: Slow-motion for video with Optical Flow. Simon A. Eugster, 2011, pp. 3-20
- [10] B. Hasanul, "Two Minimum Three Step Search Algorithm for Motion Estimation of Images from Moving IR Camera", *IEEE*, 2011.
- [11] S. Thomas and R. Jacob, "Ego-Motion and Indirect Road Geometry Estimation Using Night Vision", *IEEE*, 2009.
- [12] "Motion Detection Based Multimedia Supported Intelligent Video Surveillance System", *USA 48th International Symposium*, 2006.
- [13] X. Liu and K. Fujimura, "Pedestrian Detection Using Stereo Night Vision", *IEEE Trans. Veh. Technol.*, vol. 53, no. 6, pp. 1657-1665, 2004.
- [14] B. Aroh, "Block Matching Algorithms For Motion Estimation", *IEEE*, 2004.
- [15] F. Xu, X. Liu and K. Fujimura, "Pedestrian Detection and Tracking With Night Vision", *IEEE Trans. Intell. Transport. Syst.*, vol. 6, no. 1, pp. 63-71, 2005.
- [16] www.opencv-python-tutroals.readthedocs.org.
- [17] www.iball.co.in
- [18] www.realvnc.com
- [19] www.putty.org
- [20] www.emailaddressmanager.com.