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Vision Based – Real Time Monitoring Security System for Smart Home

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ABSTRACT: With the development of modern technologies, now-a-days smart home concept in metro cities has become very popular. It includes various features for security, surveillance & appliance control. This paper is focused on the design and implementation of a low cost, smart and compact real time monitoring home security system using Raspberry Pi (RPI) and OpenCV. It has motion detection and face detection capability that can provide precaution to potential crimes. It also has remote monitoring facility to allow user to do live monitoring from any place in the world. The system uses Pi camera for capturing image or video.

KEYWORDS: Motion detection, face detection, remote monitoring, Raspberry pi, OpenCV

I. INTRODUCTION

We are living in a world where crime rate has been increasing dominantly. Houses have become a very easy target of crime. Many people have started using various types of security systems to prevent unauthorized trespasses in their property. Such systems help in giving people a safety feeling while they are travelling or going outside for work. Many of these systems still work within their certain boundaries. For example CCTV camera footage can only be seen while the user or the guard is present in control room. Crime prevention with remote monitoring is one of the goal of current research. The focus is to save valuable lives, money and time.

Basic idea of a smart home system is explained in literature [2]. It also provides comparison between different models of Raspberry pi and Comparison of Raspberry pi's performances with similar prototype platforms.

Open Source Computer Vision (OpenCV) software, a powerful library of image processing tools is a good choice. The library is written in C, C++, Python and runs under Linux, Windows & Mac OS X. OpenCV is a free software that can help optimize code for basic image processing infrastructure.

II. RELATED WORK

Smart security system has motion detection and face detection capability. In this system basic background subtraction is used for motion detection. The basic background subtraction has the lowest processing speed requirement but it can't be implemented in a complex background environment [1]. Comparison between different background subtraction techniques has been done with respect to Speed, Memory requirements and Accuracy. Running Gaussian average is the fastest in estimation but its accuracy is medium. Accuracy of Mixture of Gaussians and Kernel density estimation is very high but memory requirement of Kernel density estimation is also high [8].

GMM algorithm gives a compact representation which is suitable for further processing. In GMM algorithm, processing time is reduced and foreground segmentation is improved. It can detects and marks shadows too, but at the loss of processing speed[12] & [13].

In literature [14], algorithm was implemented under highly variable lighting conditions. It uses first few (120 by default) frames for background modeling. It employs probabilistic foreground segmentation algorithm that identifies possible foreground.

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III. SELECTION OF DIFFERENT PROTOTYPE BOARD

Name	RAM	Operating System	Prog. language	USB Ports	Cost per node US$	LAN (MBit)
Raspberry pi	512 MB – 1GB	Raspbian, Ubuntu, Android, ArchLinux, FreeBSD, Fedora	C, C++, Java, Python	1–4	25–35	10/ 100
Arduino	16 – 32 KB	-	Arduino	1	34	-
Beagle-Bone Black	512 MB	Linux Angstrom	Arduino	1	45	10/ 100

IV. SYSTEM FRAME WORK & DESIGN

A. *System Design:*

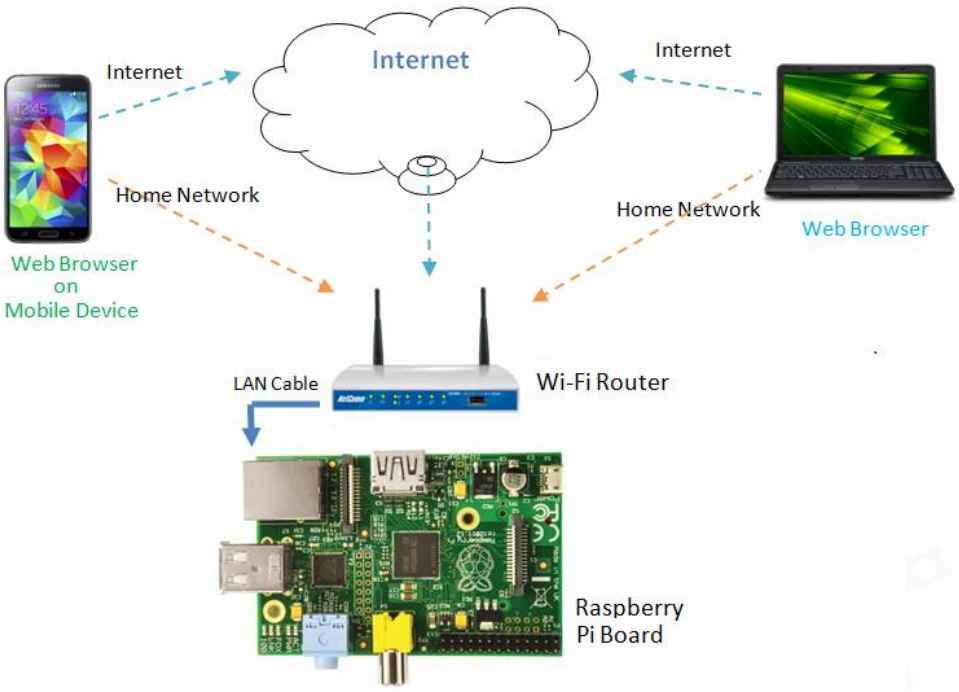

Fig. 1. System block diagram

Raspberry Pi is the central platform for image processing and signal alerting. Pi camera captures the images or video. The system has the capability of detecting motion of an object by the background subtraction algorithm. When the moving object is detected, the system can further check whether face is detected or not. If face is detected it will save the images on local drive. System also has remote monitoring facility. Configuration of Wi-Fi router for port forwarding is required for this purpose.

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B. *System Flow Diagram:*

To optimize the algorithm, the researcher separates the algorithm into two parts which are motion detection & face detection. If there is no motion detected, the program will not go to face detection. Current frame of detected motion will be processed by face detection algorithm.

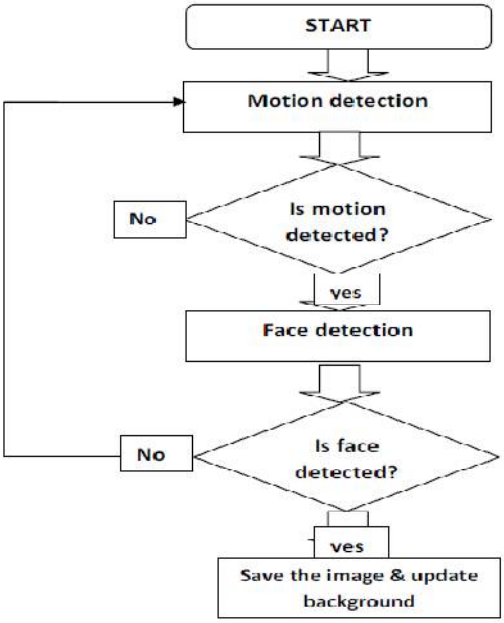

Fig. 2. System flow diagram

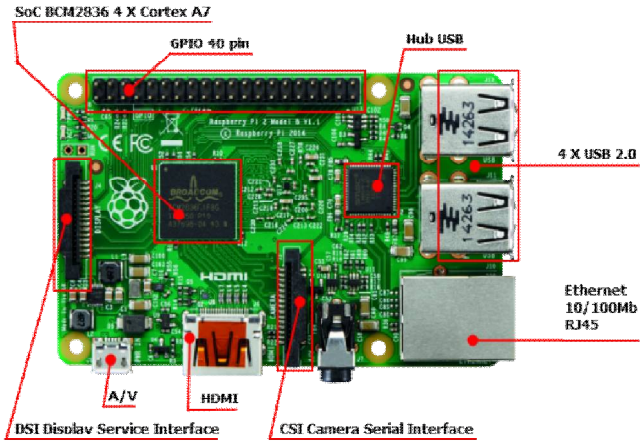

Fig. 3. Raspberry pi 2 board

C. *Raspberry Pi 2 module:*

Raspberry Pi is a new hardware platform which provides all the functionalities similar to personal computer or laptops.The Raspberry Pi 2 delivers 6 times the processing capacity compare to previous models. This second generation Raspberry Pi has an upgraded Broadcom BCM2836 processor, which is a powerful ARM Cortex-A7 based quad-core processor that runs at 900MHz. The board also features an increase in memory capacity to 1Gbyte. Raspbian is a free operating system based on Debian optimized for the Raspberry Pi hardware. Raspbian provides more than a pure OS: it comes with over 35,000 packages, pre-compiled software bundled in a nice format for easy installation on Raspberry Pi board.

D. *Background Substraction for Motion Detection:*

Background subtraction (BS) is a common and widely used technique for generating a foreground mask (namely, a binary image containing the pixels belonging to moving objects in the scene) by using static cameras. As the name suggests, BS calculates the foreground mask performing a subtraction between the current frame and a background model, containing the static part of the scene or, more in general, everything that can be considered as background given the characteristics of the observed scene.

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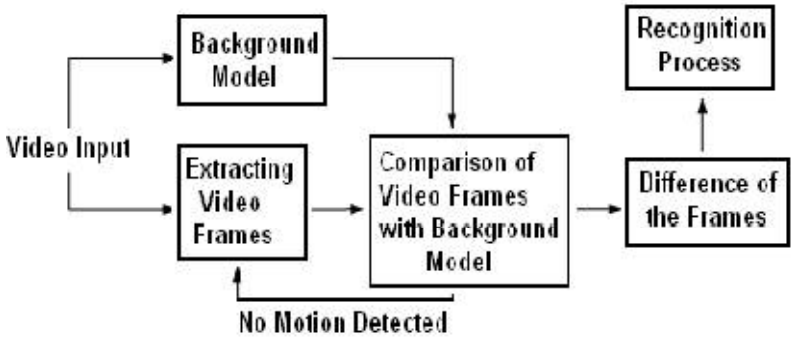

Fig. 4. Block diagram of background subtraction.[1]

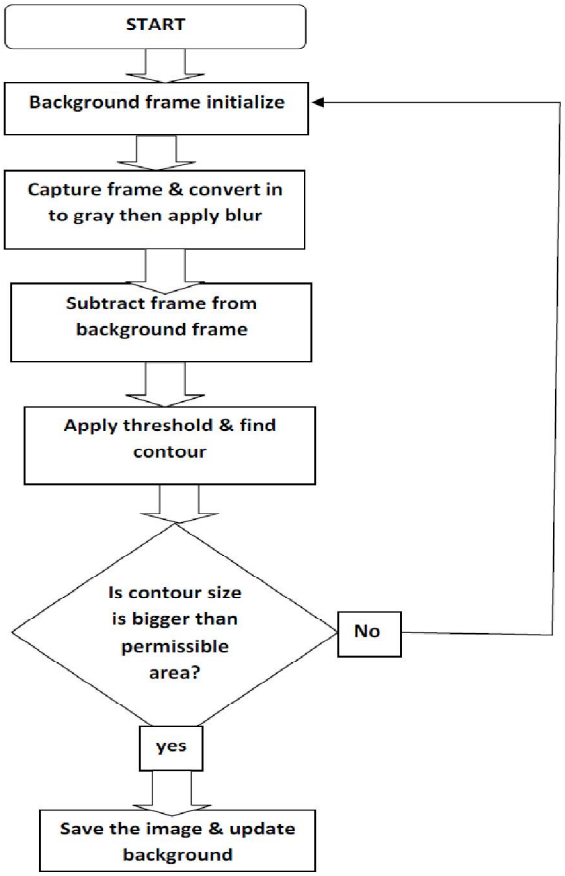

Fig. 5. Flowchart of background subtraction algorithm

In background subtraction first colour image is converted in gray image. For binary image conversion, blur is apply on gray image. Current image is subtracted from background image & apply threshold on it & finally find contour. If contour area is more than predefine area motion is detected.

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E. *Face Detection:*

Face detection part fully depends on the program of background subtraction. If motion detected, that particular frame will be the input frame to the face detection. The program will immediately convert the captured image to gray scale, improve the contrast of the image. The converted image will be process through Haar Classifier Stages. Haar like features is one of the common ways used for object detection [1]. OpenCV has available haar cascade file "haarcascade_frontalface_default.xml" covering face features which is used in this study.

F. *Worldwide Remote Monitoring:*

For live streaming from remote place, installation of motion software is required. Enable pi camera for capturing images. Modification in configuration file of motion software is required. In places where the Internet access is provided via an ADSL line, the configuration of the port forwarding applies to the router with an external IP address, connected with the device (Raspberry Pi). The Raspberry Pi used in the example requires forwarding of two ports (80 - web browser, 8081 - other data). It cooperates with TP-LINK router.

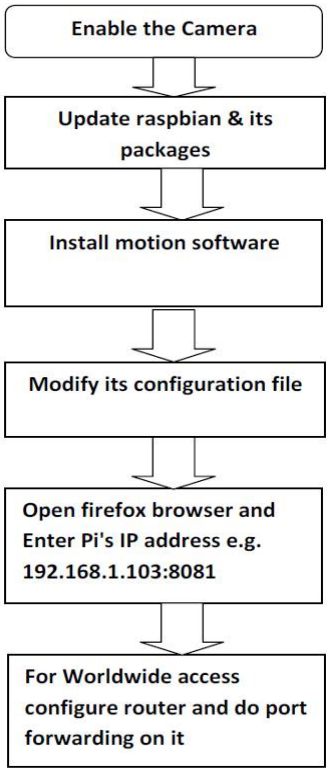

Fig. 6. Flowchart of background subtraction algorithm

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V. RESULTS & DISCUSSION

Figure 7 shows the live streaming in HTC phone with the firefox browser of the images being captured by the pi2 camera located at remote place. Figure 8 shows the output of the background subtraction. The moving object was successfully being identified and isolated by the algorithm as shown in thresh frame. Figure 9 show the face detection. The system was able to successfully identify the faces in the captured images.

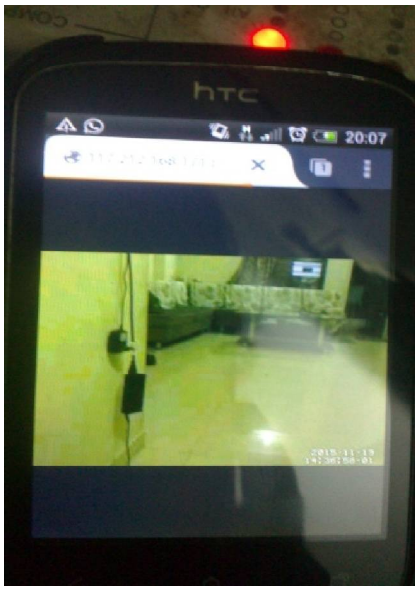

Fig. 7. Live streaming in mobile phone

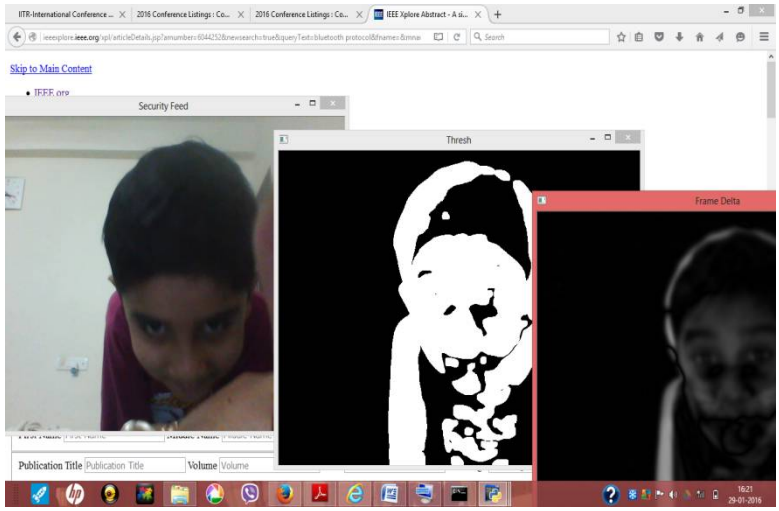

Fig. 8. Background subtraction

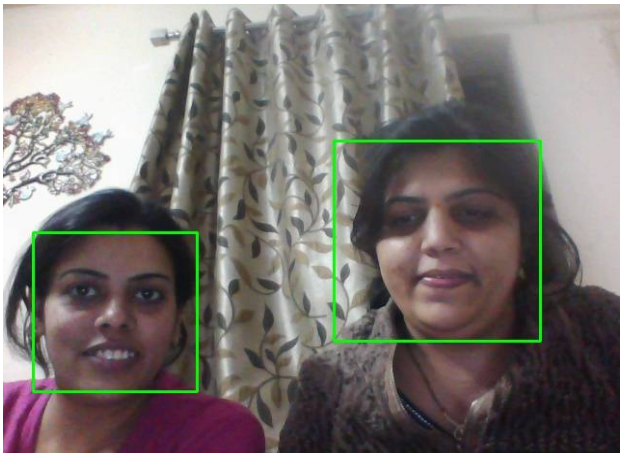

Fig. 9. Face detection

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VI. CONCLUSION AND FUTURE WORK

The developed system successfully implements complete basic background subtraction algorithm for motion detection. This basic background subtraction has the lowest processing speed requirement. OpenCV is the best library for image or video processing applications. Raspberry pi 2 is low cost embedded hardware platform which is having very good features.

For future development when motion is detected email as well as SMS intimation will be sent to the user. In future scope, automation of home appliances from remote place can be implemented to increase features in smart home.

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