

Home Surveillance System using Raspberry Pi

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Abstract - Home surveillance systems are widely used now a day. An intelligent surveillance system can provide multiple functions to the users. The focus of the home surveillance systems is to monitor the home with the wireless systems along with the help of the camera. The surveillance system will continuously record the video using OpenCV for python and processing it using Raspberry Pi. It also feeds live data to the user. It sends notification to the homeowner in case of detection of movements with the frame in which movement is being captured. The surveillance system will also distinguish between the family members and the intruders.

Key Words: Camera, Computer vision, Notification, OpenCV, Python, Raspberry Pi

1. INTRODUCTION

Today many home owners have a home surveillance system. Traditionally these systems have been built in an ad hoc fashion with direct wired connections between the control center and the sensors. This is changing due to the use of local area network technology for the interconnections (be they wired or wireless) and the fact that the controlling system is increasingly connected to the Internet.

The connection to the Internet enables home owners (and potentially others) to access information collected by the home security and monitoring system from any place.

Some vacation houses are located in rural areas, and they might be used only during vacation time or the House is locked whole day due to their work and used only during Night. Home owners cannot easily check on the condition of their home every day. Therefore, surveillance is needed to inform the homeowner if the house has been broken into. The services that can be provided by such a system can also be very convenient for families with children. When the children play in different rooms, using this surveillance system the parent(s) can easily monitor the movement of the children within the house.

The home surveillance system also includes face detection and recognition process, face detection includes detecting the human face and recognition includes matching the

detected face with the face of the family members and comes to the conclusion whether they are family members or not.

The process of face detection helps the home owner in the following manner, the owner need not open the door every time to see who are all coming near the door. If the person coming near the door is a non-family member, intruder alert message is sent to the owner through the email along with the captured intruder face which was taken near the door.

1.1 Tool Set

Python[1]: It is an open source programming language with large developer community and is easy to learn. It is powerful, fast and plays well with others. It is also user friendly

Open CV[2]: This is an open source computer vision and machine learning software library. OpenCV is free for both academic and commercial use since it is released under a BSD license. It has C, C++, Java and Python interfaces. Windows, Linux, Mac OS, iOS and Android platforms are supported. OpenCV was designed for computational efficiency and with a strong focus on real-time applications. It is written in optimized C/C++. The library can take advantage of multi-core processing.

Raspberry Pi[3]: It is the main part of the home surveillance system. The Raspberry Pi 2 Model B is the second generation Raspberry Pi. Compared to the Raspberry Pi 1 it has:

- A 900MHz quad-core ARM Cortex-A7 CPU
- 1GB RAM

Like the (Pi 1) Model B+, it also has:

- 4 USB ports
- 40 GPIO pins
- Full HDMI port
- Ethernet port
- Combined 3.5mm audio jack and composite video
- Camera interface (CSI)
- Display interface (DSI)
- Micro SD card slot
- VideoCore IV 3D graphics core

Because it has an ARMv7 processor, it can run the full range of ARM GNU/Linux distributions, including Snappy Ubuntu Core, as well as Microsoft Windows 10.

The Raspberry Pi 2 has an identical form factor to the previous (Pi 1) Model B+ and has complete compatibility with Raspberry Pi 1.

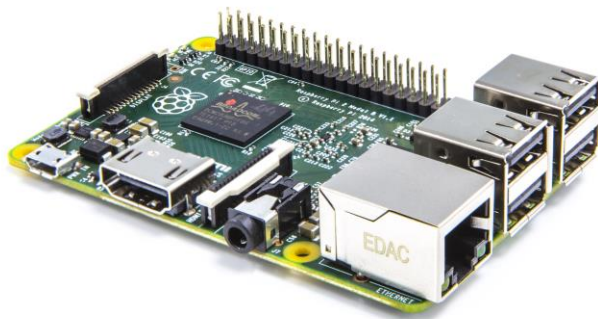


Fig -1: Raspberry Pi 2

1.2 Paper Organization

The following paper discuss about the motion detection in section 2, section 3 discuss about face detection and recognition methods. Section 4 discuss about sending notification. Result and the summary are given in section 5. Section 6 is a conclusion phase.

2. MOTION DETECTION

This phase includes detection of movements inside the home. The camera is placed inside the home in all the rooms where the motion has to be detected. The camera continuously captures the frame inside the home.

Some important terminologies used here are defined as follows

Base frame: Frame which is taken initially during the setup is known as Base frame.

Current frame: Frame which is taken at that instant of time is known as Current frame.

Camera placed inside the home, say camera 1 continuously monitors the room. As soon as the Raspberry pi is turned ON, camera 1 captures the base frame or the first frame which contains only the image of the room provided nobody should be in the room. Later the frame captured by the camera 1 is stored in the current frame. Both base frame and current frame are converted to grayscale for better comparison. The absolute difference between the current frame and base frame is computed. If there is any difference between the base frame and the current frame then the

current frame is temporarily stored so that the image can be used to send notification to the home owner else the current frame is ignored and goes to the next frame.

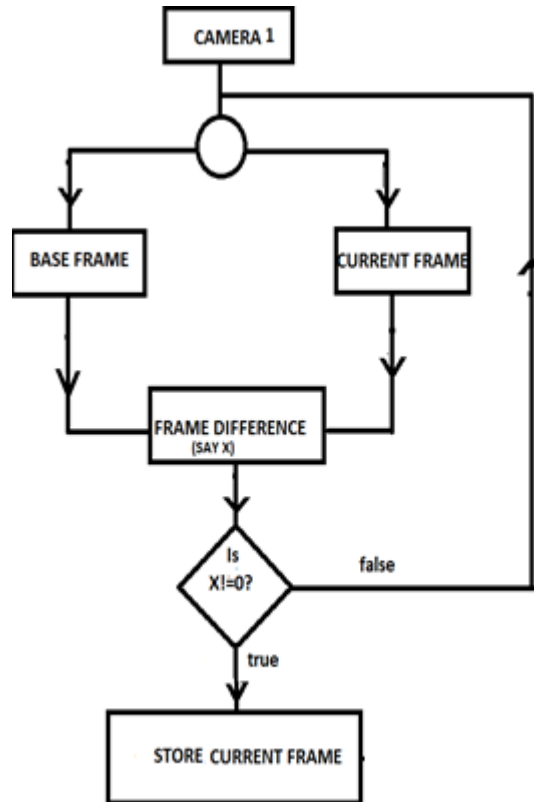


Fig -2: Flow chart of motion detection

All the computations are done in Raspberry Pi and the codes are written in Python language and making use of some functions of OpenCV. When the movement is detected the notification has to be sent through the email to the owner. The notification sending part is explained in section 4.

3. FACE DETECTION AND RECOGNITION

The camera 2 placed near the door is used for face detection and recognition process. As shown in the flowchart face detection camera runs continuously in a loop and it comes out of the loop only when the face is not recognized, the non-recognized face is considered as a intruder and the face of the intruder is captured and stored.

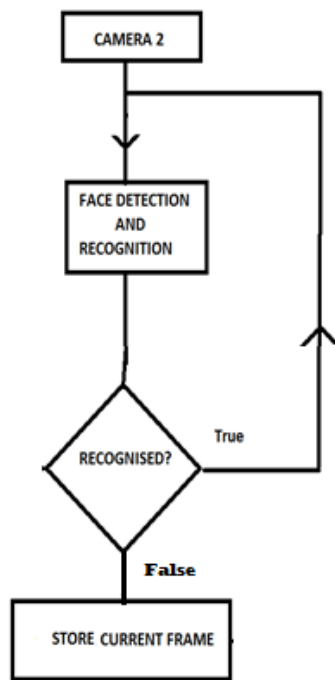


Fig -3: Flow chart of face recognition

The whole face recognition phase can be divided into 3 steps.

- i. Building an image database of the members of the house.
- ii. Detecting the faces in the database and use it to train the face recognizer.
- iii. Detect faces in the captured frame and compare it with the trained database.

Database of the images should be taken with different lightings and different expressions of the members else even the members of the house may be identified as intruders. All the images are stored in a folder.

OpenCV contains many pre-trained classifiers for face detection which is based on Haar-Cascade based classifier. All the faces in image database is detected, converted to grayscale and saved.

The camera will be looking for a face continuously. If a face is detected, that frame is compared with the trained database and if a matching frame is not found in the database, the current frame is captured and it is sent as a notification through the email to the owner. The notification sending part is explained in the next section.

4. SENDING NOTIFICATION

The notification sending part is the final part of this paper. Whenever either the motion is detected or the face is not recognized the notification has to be sent. The notification is sent through email. The email address of the owner is entered in the program. An email with an alert message and the captured image is sent to the owner. The mail can be sent to multiple users if we enter multiple email addresses.

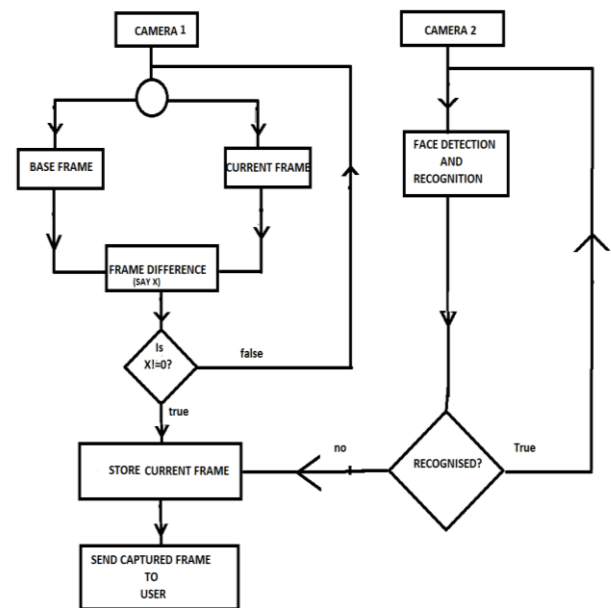


Fig -4: Overall flow chart of our work

Simple Mail Transfer protocol (SMTP) is used to send the mails. We make use of a native library in Python - "smtplib" to send emails. [4]The smtplib module defines an SMTP client session object that can be used to send mail to any Internet machine with an SMTP or ESMTP listener daemon. MIME protocols are used to send attachments. SMTP connection is put in TLS(Transport Layer Security) mode to ensure security.Port number 587(for smtp.gmail server) is used for sending emails.

4. RESULTS AND SUMMARY

On successful completion of this work, the home owner gets the notification with the motion detected frame along with the time stamp on the frame. The face of the person is detected and recognized. The comparison between the captured face and the faces stored in the database is performed. The notification is sent to owner using Gmail for both the motion detection and face recognition to owner separately.

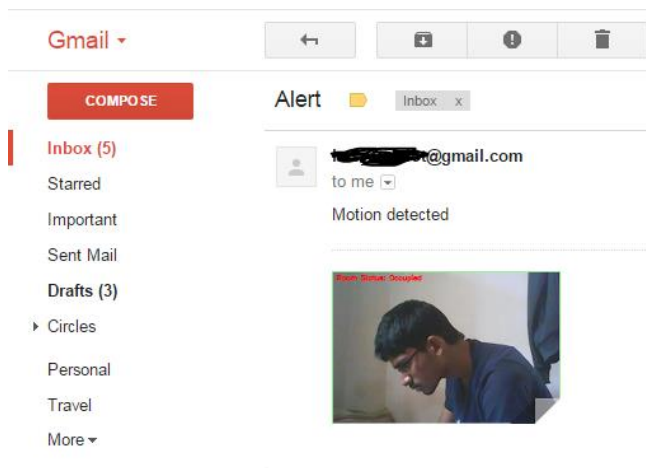


Fig -5: Image of email notification upon motion detection

In motion detection, suppose during the capture of the first frame if there was a person or an object and not during the second frame or the further frames then it will continuously show that the motion is detected because even though there was no person or that object in the second frame at that instant but the first frame has the person and it is continuously compared with the base frame and it will always show a person or an object difference. Because of this the home owner will continuously get notification from his mail saying motion is detected. Hence capture of Base frame should be done carefully.

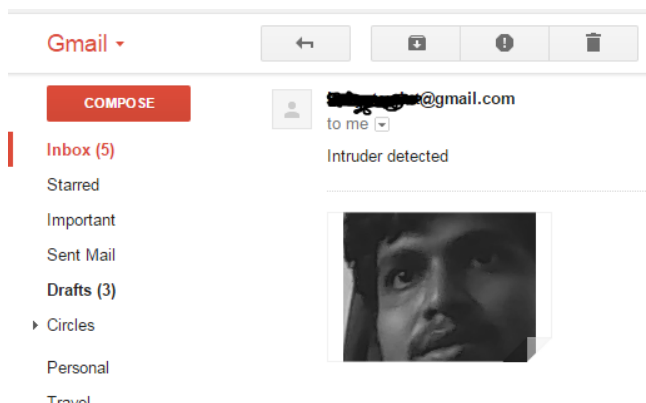


Fig -6: Image of email notification upon face recognition

In face detection and recognition, the database should consist of images of faces taken in different positions and in different day lights. Suppose images for the database are taken during bright day then the owner may be recognized as intruder during cloudy day.

5. CONCLUSIONS

In current work we have designed the system such that it is able to do both the motion detection and face recognition part without any glitches.

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REFERENCES

- [1] <https://www.python.org>
- [2] <http://docs.opencv.org>
- [3] <https://www.raspberrypi.org/products/raspberry-pi-2-model-b/>
- [4] Behrouz A. Forouzan, Data Communications & Networking, 4th Edition, McGraw-Hill,2007