Examination of Raspberry Pi as a Multifarious Smart Face Detecting and Alarm System

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Abstract

***Purpose*:** The unique purpose of this paper is to broaden the concept of security and deliver a multifarious security system to the people. The goal is to deliver a system which is not only apt to provide security under disparate circumstances but also capable of exhibiting intelligence as that of humans.

***Values*:** The primary values portrayed by this system are to deliver a safe and secure environment to the users. The system contributes to the social value by providing assured security, reliability and real-time notifications to the people.

***Design Methodology*:** The smart system is designed using the background subtraction method summed up with Haar and LBPH classifiers. All the methods are implemented using Python and different packages included within it.

***Findings*:** The research findings commit to deploying security with various applications. It not only works for providing security but also helps in surveying the security measures. The system can be used to develop or refine different reactive and proactive security strategies.

***Keywords*:** *Background Subtraction, Breadboard, Haar, LBPH, Multifarious, Raspberry Pi.*

1.Introduction

Security is known to be one of the salient parameters which is used to keep the data away from the intruders. Security is implemented using many ways in many fields. Network security is used to keep the data secure and ensures the integrity of it, a security camera is one of the many technological assets used domestically and commercially by people across the world. Traditional security cameras are only capable of recording the footage of a particular scenario and do not provide real-time notifications. Our security system uses an algorithm capable of differentiating between different type of motions and triggering the specific module accordingly. Moreover, our system exhibits human intelligence which is implemented using the computer visions. This system proposes a method which captures faces or objects and is able to transmit the information over the network. (Prasad et al., 2014).

The approach used in this paper is cost effective and it combines the functionality of multiple systems into a single one making it a smart and intelligent system. It works as an all in one system for alarm, surveillance, security, and recognition. This multifarious system is

particularly introduced to replace the existing security systems and come up with a more smart approach towards security. (Dilip Raja,2016)

## 2.Hardware & Software Requirement

This multifarious security system is developed using an advanced hardware device and software programs. Although the security system operates on a specific algorithm, the physical appearance of the security system can be customized according to the user needs. The system uses IDE which promotes accessibility of using built-in libraries for implementing different functions. The system works on the following technology:

2.1 Hardware Components Used

This system is powered by the raspberry pi which is a kind of minicomputer and possesses the size as that of a credit card. Raspberry Pi consumes a lot less power than a traditional computer system and has the same computational capabilities as that of a computer. (Menezes et al., 2015).

2.1.1 Raspberry Pi 3 Model B+ With Power Cable

This is the latest Raspberry Pi unit available in the market. It consists of a 1.4GHz   64bit quad-core computation unit, 1GB SDRAM, extended 40-pin GPIO header, an HDMI port, a CSI camera port for connecting the camera, 4 USB ports, a Micro-SD slot, Micro USB 5V power input, DSI display port, and an ethernet port.
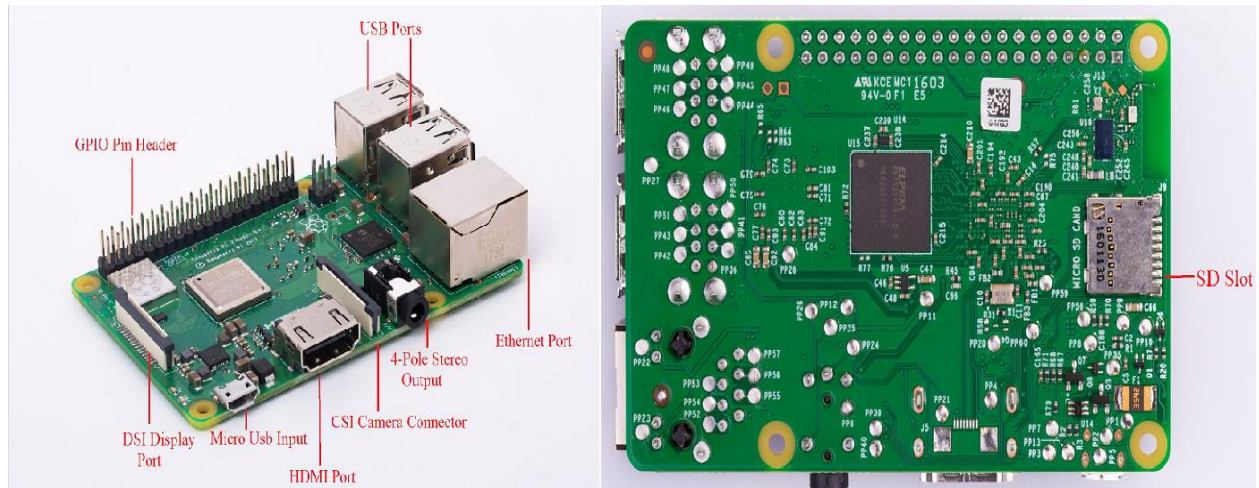
2.1.2 Raspberry Pi Camera Module

This appliance proves to be the most crucial instrument of the system, it is attached to the CSI port. The camera unit is manually made functional through the command line.

2.1.3 HDMI Cable

This cable is used to broadcast video and audio. The cable is connected in the HDMI port.

2.1.4 Micro-SD card

The Micro-SD card acts as a container for the captured media. Raspberry Pi supports an sd card up to 32GB of storage which can be inserted in the SD slot found on the back side, HDD drive can be connected if the user desires some extra storage

2.1.5 Buzzer Speaker

The buzzer is in the form of a tiny round speaker which can be used to produce musical sounds or interface alarm sounds. This speaker is PTH solderable and operates on a voltage between 3.5V and 5V.

2.1.6 GPIO Breakout Board

This device is used to lead out Raspberry Pi pins to breadboard to avoid damage in GPIO.

2.1.7 BreadBoard

A prototyping board used to develop electric circuits. In this system, the buzzer is connected to Raspberry Pi with the help of a breadboard.

2.2 Software Platforms Used

2.2.1 Raspbian

Raspbian is an operating system freeware which is specifically developed to work with the Raspberry Pi hardware unit. It is a Debian OS which comes with pre-loaded packages and bundles contained in it

2.2.2 Python IDE

Python is the most ubiquitous programming language used in the present time. The main advantages of using python are the enhanced readability, accessibility to a large number of packages and its compatibility with extensive libraries.

2.2.3 Open Source Computer Vision

OpenCV is a free and an open source library which is used with python to implement computer visions. This system requires OpenCV to import various classifier for face related operations. In this paper, OpenCV acts as the backbone for algorithms involving computer visions.

2.2.4 NumPY

Numpy is a rudimentary package used in python for the scientific computation of powerful N-dimensional array. Besides that, Numpy aids in the facial identification and detection methods.

3.The Multifarious Set-Up

The smart system introduced in this paper is capable of triggering different security modules under different circumstances, also the system is able to notify the authorities about the presence of unwanted elements. (Abaya et al., 2014).

3.1 Framework of the system
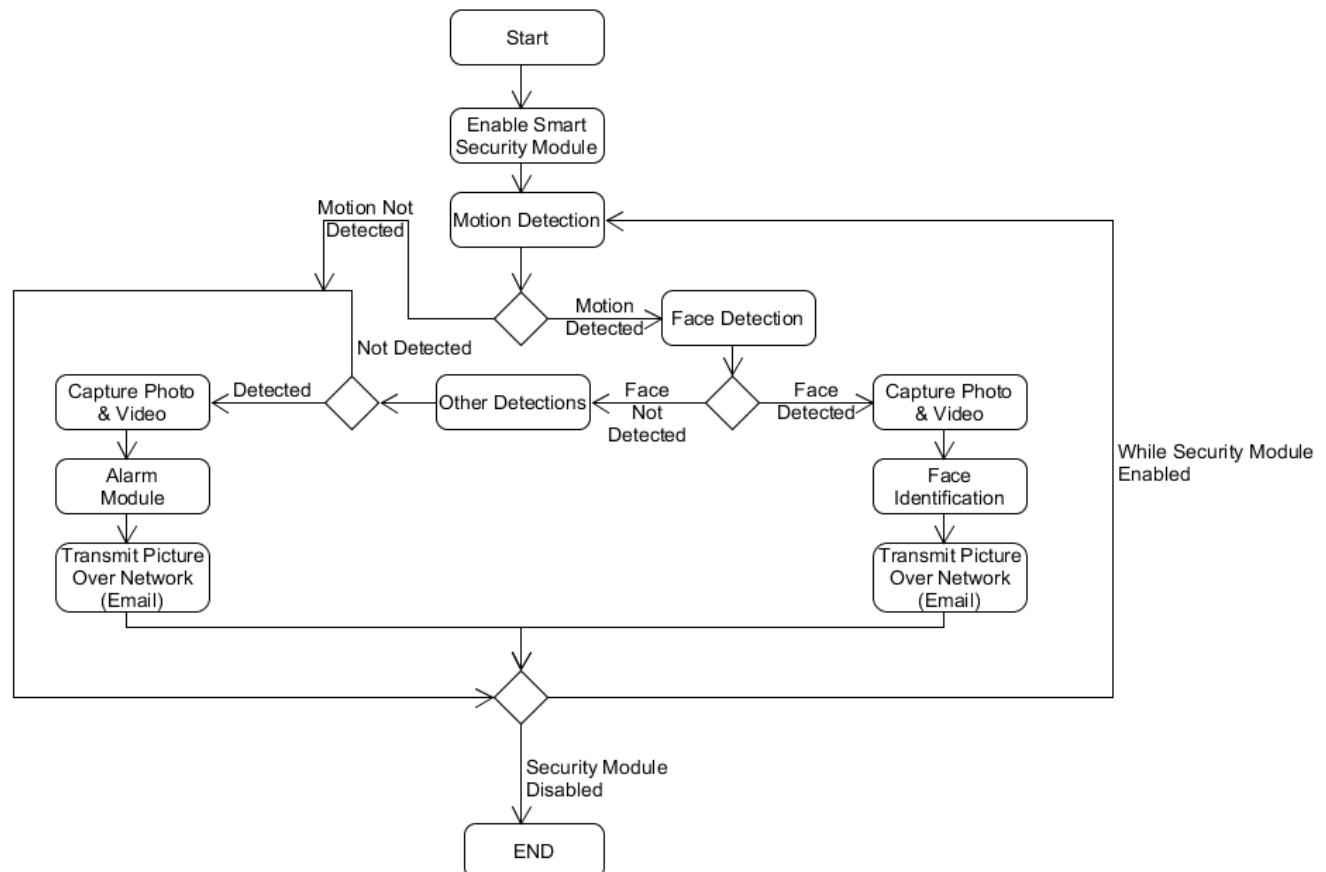
This security system can be installed anywhere according to the user requirement. The multifarious system can be installed in the server room which can detect fire, it can be placed in the car garage in order to prevent thefts and so on. The system consists of two modules; the first module is the video recording module which simply acts as a surveillance system and the second module is the smart security module which is capable of taking different actions according to the type of motion detected. The motion in the security module is processed in the following ways:

1. The first step is to set up Raspberry Pi, install python and import all the necessary packages and libraries.OpenCV and Numpy are the two extensions required to be imported. The second step requires opening up the terminal and enabling the camera module, after this step the camera module is tested out.
2. In this step, the security module is enabled through python using functions. Users get to chose between two modes of operation among the surveillance module and the smart

security module. When the user opts for the smart security module the control flows into the program depicted above.

3. The next step is to detect motion through the background subtraction algorithm. The program remains in the motion detection unit until a motion is not detected or until the security module is enabled. If the security module is disabled then the program goes into the end state. (Ansari et al., 2015).

4. If there is any motion detected then the control flows into the face detection unit. The face is detected using the haar cascade. If a face is detected by the system then it captures a photo and a short video of the face using the camera module. The system performs face identification operation on the captured photo and recognizes the face. Whenever a particular face is encountered again the system works on identifying the face and after successfully identifying the human, it notifies the person authorized. The captured photo is transmitted to the user using the email function, User needs to specify the 'email address and password from which he wants to send the notification from' and the 'email address he wants to send the notification to'. This phase exhibits the most distinctive feature possessed by this system

5. The system starts looking for any other peculiar motion if it is unable to find a human face. This involves the same motion detection algorithm used above; if the system detects any other movements like that of fire or smoke then the system captures a photo and a video, triggers the alarm module and sends the captured photo to the authorized user by the aid of email. The body of the email function contains 'from email', 'from email password' and 'to email' credentials, the user also needs to specify the 'email update interval' which would aid in sending the notification email once in a specified time interval. The system will automatically login to the email account using the credentials specified and will send the notification message on the desired email address.

6. In the last step, the algorithm verifies whether the smart security module is enabled or not. If the security module is disabled by the user then the algorithm ends and if it is still in the enable state then the control moves to the motion detection unit and the algorithm elaborated above keeps on working until the module is not disabled.

3.2 Techniques used

There are different algorithms being used by every unit under the smart security module. All the algorithms used are elaborated below:

3.2.1 Background Subtraction

This algorithm is made functional using the python and OpenCV. The motion detection algorithm initially treats the image without any motion as of the preceding frames. Then the raw video stream is accessed from the Raspberry Pi camera. Then the Dropbox API (Register into the Dropbox core API) is grabbed. (Adrian Rosebrock,2015)

Integrate with the dropbox: Firstly, it is needed to be checked whether the dropbox has to be used or not. If yes, then an authorization has to be passed for the session the dropbox has to be used for; then it proceeds towards the video processing and motion detection.

Detecting motion in the video stream: The motion is detected using the background subtraction algorithm, the frames without any motion are treated as the previous frames and the area under surveillance is considered as unoccupied. The new frames are captured using the dynamic video flow. The image from the new frame is converted to a grey color image with a fixed frame size and is blurred to ignore the noise and focus on the structural image. An average weighted mean between the previous frames and the new frames is taken and then the weighted average is subtracted from the new frame, the difference is the frame delta. (Maddalena, L., & Petrosino, A.,2008)

The frame delta is threshold in order to find the regions that thus corresponds to motion in the video stream. If the regions are larger than the min area(specified in the code) then it can be considered that motion has been found in the new frame. The background is considered as black and the foreground as white, an assumption is made that no motion is detected in the background and the foreground is taken into account. The motion is bounded by drawing a box around the motion frame(foreground white frame) and the area under surveillance is updated to 'occupied'. The motion frame is stored in the form of an image (jpeg format). The same image is uploaded to the dropbox.

Followed up, the last time at which the dropbox has been updated and the current time at which the Dropbox needs to be updated is compared. If a long time has been passed then the dropbox will be updated using the Dropbox API. (El Harrouss et al., 2015).

3.2.2 Face Detection And Face Identification

The system uses two of the salient computer visions characteristics; face detection and face identification. These two features enable the computer to identify and recognize a human face. The methods used in the process are Haar cascade and the local binary patterns histogram:

Face Detection: The face detection technique is implemented using Python and OpenCV, faces are detected using haar cascades or haar classifiers. Haar uses special kind of windows to detect faces. These windows are placed symmetrically on the face picture which acquires the haar features from the face. One single feature is determined using one haar window. The haar value is calculated by subtracting the 'value under the white part' from the 'value under the black part'. (Ramiz Raja,2017)

Haar Windows:

Face Identification: The face identification feature introduced in this paper makes the system self-sufficient, powerful and independent. Face identification is implemented using the approach of 'Local Binary Patterns and Histograms' also known as LBPH. A histogram is a statistical representation of data, the data can be in the form of a numeral collection of age or income. This method works on creating a histogram for every individual face; if a new face is encountered by the camera module then this algorithm works on creating a new histogram and saving it for later use and if an existing face is encountered then the system develops the histogram for the face and compares it with all the existing histograms . If the match is successful then the system returns a tag name associated with the picture and sends it to the authorized user. Photos of each individual is stored in a separate folder by the specific name of the person which can be later on amended by the authorized user. (Ramiz Raja,2017)

LBPH operates 9 pixels at a time; performs binary operating on the pixels and generates a binary number which is transformed into a decimal number. The histogram developed is a collection of decimal numbers obtained after processing the entire facial pixels. The histograms act as the unit of face identification for the raspberry pi system.

3.2.3 The Alarm Module

The alarm module is implemented using python IDE. The first step is setting up the hardware components which comprises of buzzer speaker, GPIO breakout boards and breadboard. The GPIO pins present on the circuit is connected to the GPIO breakout board.
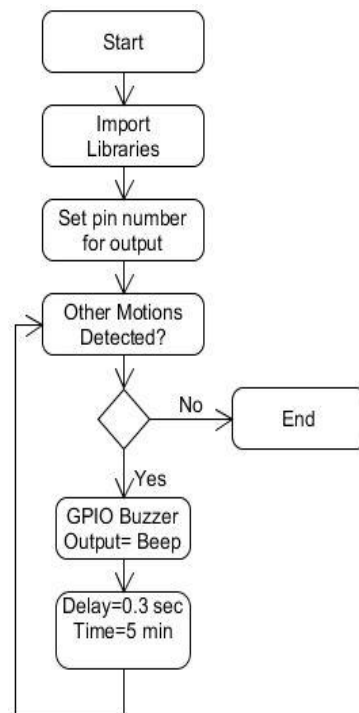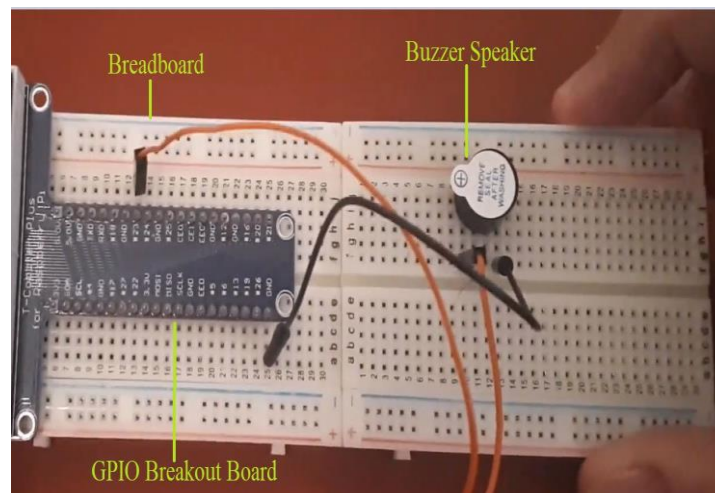
Once the hardware is installed successfully, then the alarm module is made functional using the code implementation in python. First the Rpi.GPIO, time and sleep modules are imported which aids in commanding Raspberry GPIO ports, channels, time and delay time. Next, the buzzer output port is mentioned, the port mentioned should have a number present on the breadboard. The last step is to command the buzzer to beep whenever any nonhuman motion is detected, the buzzer beeps for 5 minutes with a delay in sound for 0.3 seconds giving a burst effect in the sound. (Ardumotive_com,2018).

4.Gaps and Suggested Paths

The background subtraction algorithm is a widely used method for detecting movements or any newly introduced objects in the environment. The thresholds present are believed to be adjusting with the time, also a unique threshold is assigned to every pixel. The major

shortcoming of this technique is that it cannot engage with a sudden change in the conditions of lighting.

Haar and LBPH classifiers differ on a huge term. The accuracy of LBPH is far less than the haar cascade but LBPH has the capability to operate in low light conditions. Haar classifiers take more time to train and is a bit complex to implement and train as compared to the LBPH classifier.

To overcome the above problems, this paper uses both the haar and lbph operation algorithms. Also, the paper solves the problems of using multiple security systems at a time to enhancing security strategies by introducing the alarm system into the system for fire and smoke-related problems. To make the security system easy to implement and understandable the background subtraction approach is used, this makes the system easy to re-program manually. This characteristic of the system gives the freedom to the users to re-compile the whole unit according to their wish.

Conclusion

The path adopted in this paper is used to deliver an efficient and smart security surveillance system. This system exhibits the features of an exigency alarm and the capabilities of face detection and identification. The system provides a secure environment with a feature of regular updates in the dropbox. If compared to the traditional security system this system is robust to break through. The face detection and identification features of this autonomous system mark it as a distinct system. Additionally, the system triggers an alarm in the state of crisis and also uploads an image in the user dropbox from the live video stream to keep the user up to date about the events happening at the location under surveillance. The system provides the features of multiple devices in a relatively low price range on a single board. This makes the system reliable, economical, customizable, efficient and portable

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The system also has a room for improvement, it can be updated by installing an additional sensor which would provide a better idea of the ongoing scenario. The features of the system can be modified to such an extent where it can take necessary actions at the time of calamity. This includes automatically notifying the fire department about the fire, to guard the car garages or homes against thefts and notifying the police department if any human face is detected between a particular time frame. Above all, the system's priority is to deliver dependability to its users and cover all the aspects where the security is required. With the presence of this system there is no need to install any additional systems, thus the name – Multifarious Smart Security System.

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