

IoT BASED SMART SECURITY SYSTEM USING FACE DETECTION AND RECOGNITION

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ABSTRACT

This paper proposes an IoT based smart security system using face detection and recognition. This system gives a smart approach for monitoring since all the present system just keep records of the events happening in front of the camera while this system alerts the owner. Once the PIR sensor detects any motion the raspberry pi camera module capture the image .This system uses the face recognition to reduce the errors occurred due to motion detection modules. System recognizes the face in the captured image and alerts the owner if unknown person is present in the image.

Basically, in this paper, face detection and recognition algorithm based on LBPH approach is presented. LBPH (Local Binary Pattern Histogram) is a visual descriptor which is used for face recognition tasks. Also, CNN (Convolutional Neural Network) is another approach which is originally based on biological process and it is used for conveying the weight of particular image to recognize that image. In the proposed technique, the image is divided into multiple pixels and from that pixel threshold value is calculated. By using this value facial expressions, features of eyes, nose and lightning effects are calculated. Likewise, all the features are calculated and easily face is detected.

KEYWORDS: Internet of things, RFID, Security, Algorithm, Sensor, Camera.

I. INTRODUCTION

Security is the most important aspect that everyone is looking for now a day, as the increase in theft activities is large now a days. Since, everyone wants security, it is important to have efficient system for the security purpose. Although there are many systems are used for security such as CCTV. CCTV keeps the records of all the events happening on front of it. But it does not give any alert. While using CCTV, anyone can check the recording whenever there is any suspicious activity detect. Beside the CCTV, continuous recording requires high power supply continuously.

Besides the CCTV, the other systems are used for security purpose such as voice unlock, fingerprint scanner, retina scanner, RFID systems. These systems have some drawbacks like one of these is high power consumption which can increases the maintenance cost of the system. While the proposed system is efficient than these above-mentioned system as well as with low maintenance cost.

To make the security system more powerful the proposed system is giving the extra features like alert and combination of detection and recognition algorithms. The term recognition is complex because in this term, algorithm has to find out many features of all the images and it has to choose the right one among them. There are multiple features are used for recognition like nose, eyes, facial expressions, viewpoint etc. Most of the time these features are same. So, it is quite difficult to find out correct face among all images. But apart from this, recognition method is more powerful because it has ability to give accurate result among all the inputs. In pattern analysis and computer vision, automatic recognition of faces is considered as one of the fundamental

problems. Computer vision is one of another approach present in this paper which gives face detection and recognition for people that are an extremely fascinating application for the Internet of Things.

Internet of Things (IoT): Now a days, with business situation the Internet of Things is rapidly increasing technology. It is the conjunction of internet, wireless network, and computing. Wireless sensor networks are the center of the IoT. It mainly connects the physical things like vehicle, buildings and various devices with embedded intelligent sensors. Proposed system uses the Raspberry pi 3 module, PIR sensor, GSM, Raspberry Pi camera. IoT connects these devices to carry information from one device to another. So, with the help of IoT it is easy to handle multiple devices in real time systems projects.

II. METHODOLOGY

(a) Design of the proposed system

The proposed system presents the recognition and detection methods. Detection and recognition are the both approaches which are basically used for strong security system. Internet of Things is the communication platform in this system. It helps to transfer data from one devise to another.

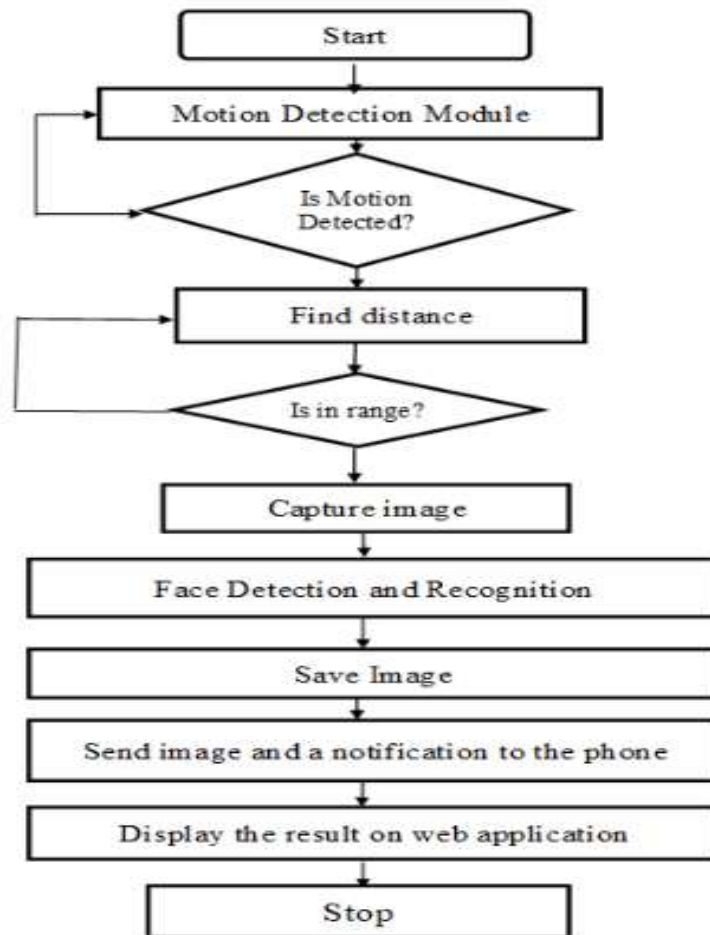


Fig-1: Flowchart of Proposed System

With the help of PIR Sensor, system detects the motion only when some object is come in front of it. After that system finds the accurate distance between object and camera. If the object is in distance then it captures the image. For capturing image Raspberry Pi camera is used. After this process firstly detection module is activated. With the help of LBPH algorithm it detects face in between the image. Then recognition takes place and the new image is compared with the images stored in database. The new image saves in database. After completion of

recognition module if there is an unauthorized person detected then system will send alert to user on their mobile phone in the form of text message. The history of unauthorized person is saved on web application, So, user can see the whole date whenever he/she wants.

(b) LBPH Algorithm:

LBPH is the abbreviation for Local Binary Pattern Histogram. LBP is the simple but very efficient texture operator in all the algorithms related to the recognition process. It labels the pixels of an image by thresholding the neighborhood of each pixel. After it considers the result as binary number. LBP was first described in 1994 and has found to be better feature for the texture classification. Very firstly, only the LBP method is described for the detection and recognition purpose but after that LBP is combined with Histograms of oriented gradients (HOG) descriptor. HOG is used to improve the detection performance considerably on same datasets. Using the LBP combined with histograms we can represent the face images with a simple data vector. Like detection process, LBP is also used for recognition process. LBP gives better result in both processes.

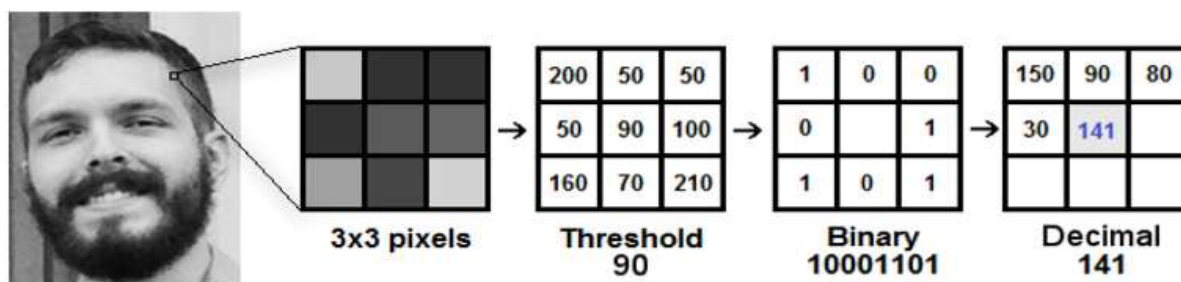
LBPH consists of different parameters. These parameters are basically used for dividing images into different pixels and it helps to calculate the integrated image and threshold value.

1. **Radius:** Radius represents the circular portion around the central pixel. It is simply used to build the circular local binary pattern. It is usually set to 1 always. The value present in the middle of this portion is the threshold value which is used for recognition process.
2. **Neighbors:** Neighbors are the points build to the circular local binary pattern. If points are increases then it also increases computational costs. It usually set to 8. With the help of this points threshold value is calculated.
3. **Grid X:** The number of cells in horizontal direction are usually known as Grid X. If a greater number of cells are present then it gives finer grid which improves dimensionality of the resulting feature vector. It is also usually to set 8.
4. **Grid Y:** The number of cells in vertical direction are known as Grid Y. It includes at least 8 points in vertical portion of the radius.

A. Training of the Algorithm: Training is the most important part of any algorithm. For real time system, training is needed because system has to work in efficient manner. To do so, we need to use a dataset with the facial images of the people we want to recognize. Training of algorithm means use of dataset of the facial images of persons we want to recognize. For that it is needed to save all the features of every person into dataset. For instant output, there should be an ID or particular sign to every image to recognize input image in few seconds.

B. Applying the LBP algorithm: By highlighting the facial characteristics, LBPH is use intermediate image that describes the original image in a better way. Based on the parameter’s radius and neighbor, the algorithm uses concept of sliding window.

The image below shows the procedure:



From the above image, here should be some conclusion regarding to the features of the human face as follows:

1. Suppose there is an image with grayscale.
2. That grayscale has to be converted into window of 3×3 pixels.
3. It can be also represented as a 3×3 matrix which has the intensity of each pixel (0-255).
4. Then, the middle value of that matrix is considered as threshold value of the whole matrix which is basically calculated with the help of vertical and horizontal cells.
5. This value is used to define the new values from the 8 neighbors.
6. For each threshold value, there should be a new binary value. When the threshold is equal or higher, then there should be a value 1 and if value is less than threshold then the value is 0.
7. Now, the matrix will contain only binary values (ignoring the central value). We need to concatenate each binary value from each position from the matrix line by line into a new binary value (e.g. 10001101).
8. Then, we convert this binary value to a decimal value and set it to the central value of the matrix, which is actually a pixel from the original image.
9. At the end of this procedure (LBP procedure), we have a new image which represents better the characteristics of the original image.

Such processes are carried out with the help of bilinear interpolation. LBP has also been used in many other applications of biometrics, including eye localization, iris recognition, fingerprint recognition, palmprint recognition, gait recognition and facial age classification.

C. Convolutional Neural Network (CNN):

CNN implies that the network employs a mathematical operation called convolution. It is a specialized kind of linear operation. CNN are also known as shift invariant or space variant artificial neural network. CNN have the important applications in image and video recognition, financial time series, image classification, etc.

Convolutional neural networks are based on the biological process. In that, the connectivity pattern is crucial. CNN uses the approach of biological neuron system that is, in human neuron system there are multiple number of neurons are present. These neurons act like storage of multiple operations. Likewise, CNN is also stored all the recognition operations in it.

Design of CNN:

- Convolutional neural network is firstly including following layers:

1. Input layer
2. Output layer
3. Hidden layer

The core building block of CNN is called as convolutional layer. A set of learnable filters is included in the layer's parameters. But layer's parameter has a small receptive field and extend through the full depth of the input volume.

- ReLU layer

The abbreviation of Rectified Linear Unit is called as ReLU. It applies non-saturating activation function. The advantage of ReLU layer is, it can effectively remove negative values from activation map by setting them to zero. Without affecting the receptive field of convolutional layer, ReLU increases the non-linear properties of the decision function of the overall network.

- Pooling Layer

In convolutional neural network, pooling plays an important role. Pooling is a form of non-linear down sampling.

The pooling layer operates independently on every depth slice of the input and resizes it spatially. The most common form is a pooling layer with filters of size 2×2 applied with a stride of 2 down samples at every depth slice in the input by 2 along both width and height, discarding 75% of the activations.

III. RESULTS AND DISCUSSION



Fig 2: Face Detected

The fig 2 shows the first step of this experiment. When any kind of suspicious activity is happened, system gets activated and from the input it finds the human face/ faces from that image. Likewise, not only one but LBPH finds multiple number of faces accurately.

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File Edit Shell Debug Options Window Help
average_pooling2d_23 (AveragePo (None, 4, 4, 528) 0 concatenate_69[0][0]
average_pooling2d_24 (AveragePo (None, 1, 1, 1024) 0 concatenate_72[0][0]
conv2d_435 (Conv2D) (None, 4, 4, 128) 85664 average_pooling2d_23[0][0]
conv2d_454 (Conv2D) (None, 4, 4, 128) 67712 average_pooling2d_23[0][0]
Flatten_24 (Flatten) (None, 1024) 0 average_pooling2d_24[0][0]
Flatten_22 (Flatten) (None, 2048) 0 conv2d_435[0][0]
Flatten_23 (Flatten) (None, 2048) 0 conv2d_454[0][0]
dropout_24 (Dropout) (None, 1024) 0 Flatten_24[0][0]
dense_22 (Dense) (None, 256) 524544 Flatten_22[0][0]
dense_23 (Dense) (None, 256) 524544 Flatten_23[0][0]
dense_24 (Dense) (None, 256) 262400 dropout_24[0][0]
dropout_22 (Dropout) (None, 256) 0 dense_22[0][0]
dropout_23 (Dropout) (None, 256) 0 dense_23[0][0]
main (Dense) (None, 5) 3285 dense_24[0][0]
aux1 (Dense) (None, 5) 3285 dropout_22[0][0]
aux2 (Dense) (None, 5) 3285 dropout_23[0][0]
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Total params: 7,422,295
Trainable params: 7,422,783
Non-trainable params: 512
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image captured
Comparing the image
Unable to Recognize
Sending SMS
Sending Email
sending
sending
Sending image to Database
connect successful!!
INSERT INTO homeauto (photo) VALUES (%)

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Fig 3: Shows that features of input images. This step is Recognition module.

Fig 3 shows the features of the human face which is recognized by the system. It is the comparison of features of saved in database and new input image. This process is carried out in Raspbian operating system. After comparing the features, it shows predicted person.

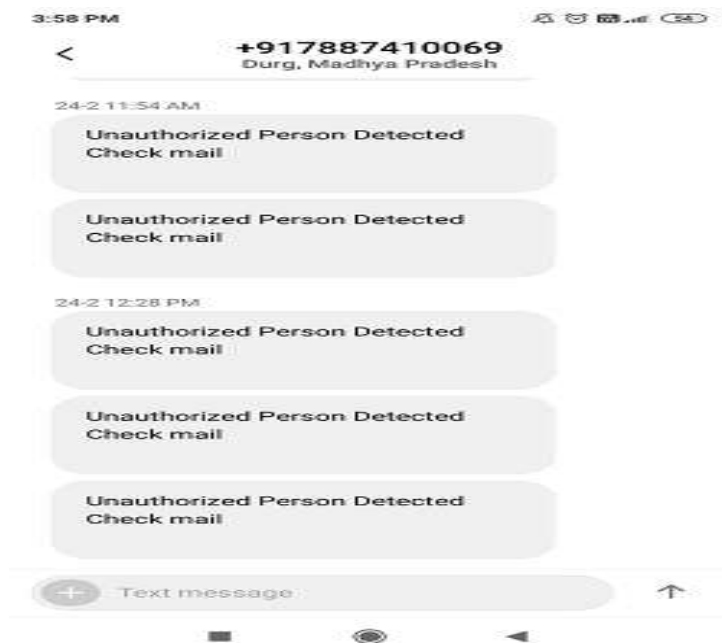


Fig-4: Text message sent on user's Mobile phone

Fig 4 shows the text messages which are sent by the system to users's mobile phone. For sending this text messages system used GSM module. This is the alert of suspicious activity happened.

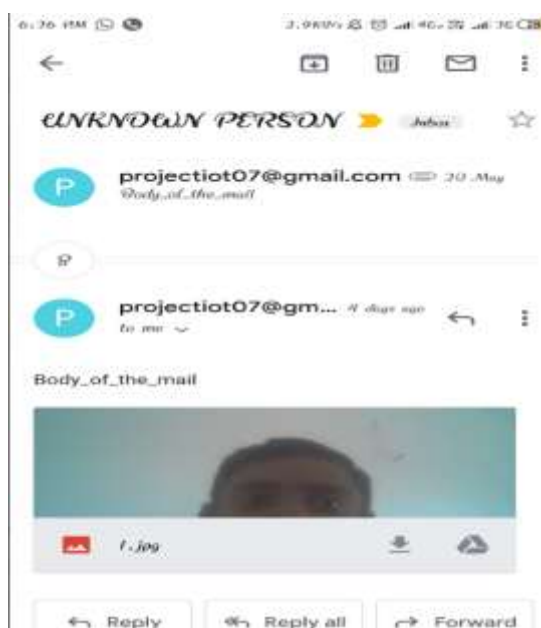


Fig-5: Email sent on user's personal Email ID

Fig 5 is the output of input image in which system recognize that person is unknown and that is send on Email of user. So, it will easily understand which person is came. With the help of text message and Email user can easily aware about suspicious activity.

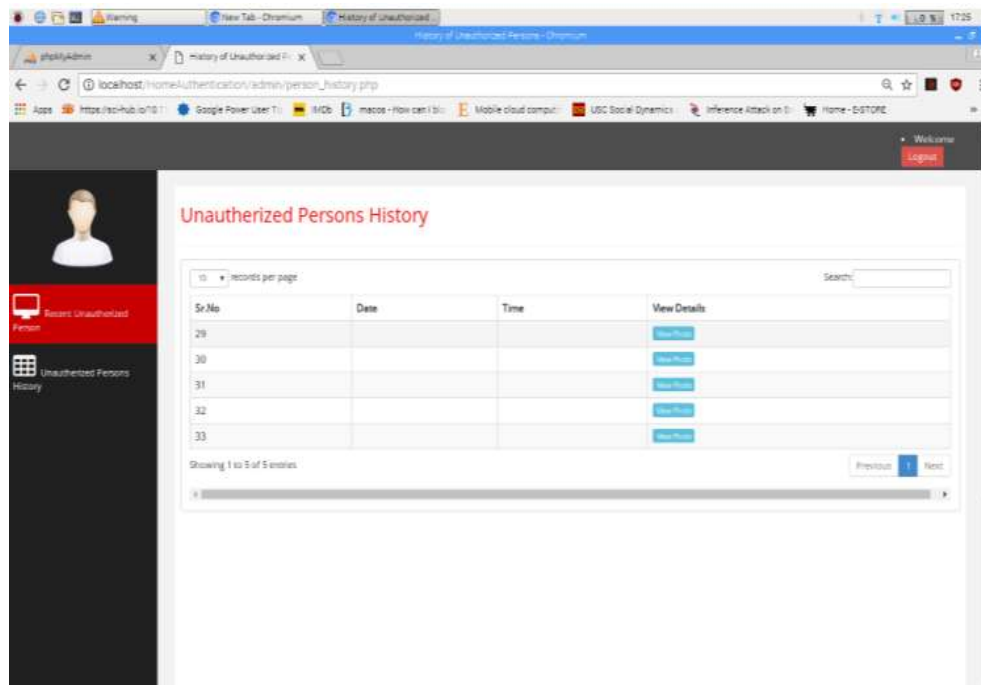


Fig-6: The history of unauthorized persons

Fig 6 shows that the history of unauthorized person with its arrival time, date and image. Hence, user can easily understand the person is front of camera is known or unknown. Also, it shows recent history of the unknown person.

IV. CONCLUSION

In this paper, we have designed and developed the security system through Internet of Things module and Raspberry Pi version 3. This system is real time system so it can give the result within few seconds. Basically, this system shows the person in front of camera is authorized for user or not and if and only if system sends the alert when unauthorized person is detected. This system is user friendly but it needs continuous power supply. Also, this system has low maintenance cost. User can get alert form anywhere and also able to see the image of person who is in front of camera. This system is installed very easily and people can use this system to all over areas where the security is needed. Also, user can see the history of unauthorized person anytime and anywhere.

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