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Detection and Recognition of Suspicious Faces at Public Places through Entry Level Surveillance Video Footage

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ABSTRACT

Security and Surveillance of public places is most important for safety purposes. There are several existing systems for Security and Surveillance, but the existing video surveillance system just stores the data in a storage device. These footages may be used just after the unexpected/adverse incidents had occurred, for reaching a conclusion. The proposed system will analyze the surveillance video for detection of faces. These detected faces would then be compared with the already available suspicious face directory. For comparison of detected and suspicious faces, various face recognition techniques would be studied and implemented.

Keywords
Public Safety, Surveillance, Video Footages, Pixel Classification, Color, Face Recognition.

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I. INTRODUCTION

Many incidences take place around the globe every day which includes some or the other sort of criminal activities. Such activities threaten people all over the world. People involved in such activities are none other than humans who are trained in such criminal activities. Consider, the 9/11 attack which was one of the unfortunate attack and was quite shocking for entire world. It was the day of 11th September, four teams of terrorists hijacked jetliners departing from Boston, Newark, New Jersey and Washington DC. One by one they crashed the planes. Almost 3,000 people were killed during the 9/11 terrorist attacks. Life of the people would have been saved if suspicious faces of the terrorists would be detected at the airport itself using entry level Surveillance Video Footage. The 19 militants associated with the Islamic extremist group al-Qaeda did the 9/11 attacks, the police forces were having the database of the suspects. If the comparison of these suspects was made with the database at the entrance itself, then they would be arrested before the attacks which would save lives of the people.

So, public safety is one of the main constraints in the world of terrorism. This public safety motivated us to develop a system where suspicious faces can be detected and recognized at public places through entry level surveillance video footage before they do any further attacks. Our proposed system will save many lives and will establish a good safety from the world of terrorism.

II. LITERATURE SURVEY

Various papers explain about the methods to detect faces from live videos, thus after a study of those papers we understood in [1] that various color models are used for detection of skin pixels on a face. The paper compares each of the skin color models namely, HSI(Hue, Saturation, Intensity), YCbCr(Luminance, Cb: chrominance-blue, Cr: chrominance-red) , RGB(Red, Green, Blue) for better accuracy. The proposed method combines all the three color models and then detects the face with a minimum execution of time. YCbCr shows better accuracy and precision rate compared to other color models.

In [2] it explains the use of Live Video Acquisition to detect the presence of humans captured by CCTV and Webcam with Face Detection and Tracking. Taking into consideration the lighting condition, the human faces were detected from the CCTV camera. [3]Explains face

recognition can be done by extracting the coordinates of features such as width of mouth, eyes and pupil and compare the result with the existing database and return the closest record. PCA (Principal Component Analysis) is developed in order to overcome expensive computation. It is used to represent high dimensionality training set into a lower dimensional subspace.

In [4], the proposed method can rapidly detect skin and non-skin color pixels, which in turn dramatically reduce the CPU time required for the protection process. The skin region is detected using the YCbCr color model. They extracted the images from the web pages and then applied skipping technique on the extracted images. Skin color detection on the input image with skipping a predetermined number of pixels was performed. Later the CPU time of the detection process for both the classic and skipping techniques was recorded.

[5]Explains a human face detection scheme by combining a novel hybrid color models and Viola-Jones face detector. This hybrid skin color model RGB-CbCrCg was proposed for classifying skin and non-skin pixels. The extraction of skin region is carried out using a set of bounding rules optimized employing multi-objective differential evolution method. Afterward the segmented face regions are identified using Viola-Jones algorithm.

The technique in paper [6] uses an image-based approach towards artificial intelligence by removing redundant data from face images through image compression using the two-dimensional discrete cosine transform (2D-DCT). It extracts features from face. Feature vectors are constructed by computing DCT coefficients. A self-organizing map (SOM) using an unsupervised learning technique is used to classify DCT-based feature vectors into groups to identify if the subject in the input image is “present” or “not present” in the image database.

The purpose of [7] paper is to categorize and evaluate the algorithms which are used to obtain and analyze the information contained in face images. Given a single image, the goal of face detection is to identify all image regions which contain a face regardless of its three-dimensional position, orientation, and lighting conditions. Such a problem is challenging because faces are non-rigid and have a high degree of variability in size, shape, color, and texture. Numerous techniques have been developed to detect faces in a single image.

The paper [8] includes the Face recognition which mentions two methods. One using geometrical features, this technique involves computation of a set of geometrical features such as nose width and length, mouth position and chin shape, etc. from the picture of the face we want to recognize. This set of features is then matched with the features of known individuals. A suitable metric such as Euclidean distance (finding the closest vector) can be used to find the closest match. Although the face cannot be viewed in detail its overall geometrical configuration can be extracted for face recognition. Even the Face recognition using template matching strategy, is used to extract whole facial regions (matrix of pixels) and compare these with the stored images of known individuals. Once again Euclidean distance can be used to find the closest match. However, these involve extensive pre-processing and transformation of the extracted grey-level intensity values.

III. EXISTING SYSTEM

Criminal record generally contains personal information about particular person along with photograph. To identify any criminal, we need some identification regarding person, which are given by eyewitnesses. On the basis of the information provided by the eyewitness, the criminal involved in the crime will be identified manually.

So, from [20],the video retrieval is a basic functionality used in many video based applications, the efficient technique of retrieving videos has become hour's need. Today most of the video retrieval systems majorly concentrate on text as a query for retrieving videos which is non-perceptive to user’s intuition, arising the need of content based video retrieval (CBVR). The content based video retrieval (CBVR) majorly depend on the contents of videos like color, texture, shape etc. To make CBVR better than previous is nowadays necessity in any video based application.

The problems in existing system can be listed as:

a. The quality and resolution which are captured through the videos are poor and hard to recognize the face.

b. An eyewitness exists in the system, who if observes a person from certain angle might not be able to recognize the person.

c. The footages are just generated and stored and not checked unless we get full-fledged details of the suspect after an event.

d. Sometimes the eyewitness may not be able to draw, the face of criminal.

e. If we maintain the criminal details manually and physically, the details of the suspect tend to wear out with time.

Skin pixels in RGB Color Model:

Using the RGB color model[14], the RGB (i.e. Red, Green, Blue) values from an image can be extracted which further detected the skin pixels in that image if the RGB values lies in the given range.

$$90<R<255 \quad (1)$$
$$45<G<255 \quad (2)$$
$$45<B<255 \quad (3)$$
$$R-G>23 \quad (4)$$
$$R-B>29 \quad (5)$$

Conversion formulae from RGB to YCbCr:

The RGB values which are retained are then converted to YCbCr(Y: Luminance, Cb: chrominance-blue, Cr: chrominance-red) by using the matrix formula given below. YCbCr color space is used because of its advantage over lower resolution potential of human visual system for color with respect to luminosity.

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$$\begin{bmatrix} Y \\ Cb \\ Cr \end{bmatrix} = \begin{bmatrix} 0.299 & 0.587 & 0.114 \\ -0.169 & -0.331 & 0.5 \\ 0.5 & -0.81 & -0.81 \end{bmatrix} \times \begin{bmatrix} R \\ G \\ B \end{bmatrix},$$

Skin color range for YCbCr:

The values which lie in the defined range of YCbCr color space are considered as skin pixels.

120 <= Y < = 235 (7)

95<= Cr <=240 (8)

110<=Cb<=240 (9)

Conversion between RGB and HSI Model:

[22]RGB color model describes an image as a combination of primary colors, whereas, HSI((H: Hue, S: Saturation, I:Intensity) describes colors using comparisons as color, vibrancy, brightness. So we convert RGB values to HSI by using the conversion formulae given below

Steps to be followed:

1. Read a RGB image
2. Represent the RGB image in the range [0 1]
3. Find HSI components

$$\theta = \cos^{-1}\left\{\frac{\frac{1}{2}\left[(R-G)+(R-B)\right]}{\left[(R-G)^2+(R-B)(G-B)\right]^{1/2}}\right\} \quad \textbf{(10)}$$

4. $$H(\text{Hue}) = \begin{cases} \theta & \text{If } B<=G \\ 360-\theta & \text{If } B>G \end{cases} \quad \textbf{(11)}$$

5. $$S(\text{Saturation}) = 1 - \frac{3}{(R+G+B)}\left[\min(R,G,B)\right] \quad \textbf{(12)}$$

6. $$I(\text{Intensity}) = \frac{1}{3}(R+G+B) \quad \textbf{(13)}$$

Skin color ranges for HSI Color Model:

0 <= H <= 0.25 (14)

0.15 <= S <= 0.9 (15)

When the values obtained by conversion lie in the range of HSI, skin pixels are obtained. Skin pixels were detected using the HSI color model. To subtract the background and only keep the face, watershed segmentation will be used.

3.1Watershed Segmentation

An ideal method for image segmentation is proposed in [9]which combines the watershed transform and region-based level set method. The watershed transform is first used to pre segment the image so as to get the initial partition of it. The region-based level set method is then applied for extracting the boundaries of objects on the basis of the presegmentation. The consumed time does not depend on the size of the image but the number of presegmented regions because only label level set function is updated instead of the level set function for each pixel. Therefore, the proposed method is computationally efficient. Moreover, the algorithm can localize the boundary of the regions exactly due to the edges obtained by the watersheds.

3.2PCA (Principal Component Analysis)

[10][11]The skin pixels along with some objects (mouth, eyes, nose) can be extracted out of original image data by means of a mathematical tool called Principal Component Analysis (PCA) which is used for Face recognition. The task of facial recognition is discriminating input signals (image data) into several classes (persons). The input signals are highly noisy (e.g. the noise is caused by differing lighting conditions, pose etc.), yet the input images are not completely random and in spite of their differences there are patterns which occur in any

input signal. Such patterns, which can be observed in all signals could be in the domain of facial recognition and also the objects in any face as well as relative distances between these objects. These characteristic features are called eigenfaces in the facial recognition domain (or principal components generally). [12]states that, by means of PCA one can transform each original image of the training set into a corresponding eigenface. An important feature of PCA is that one can reconstruct any original image from the training set by combining the eigenfaces.

IV. PROPOSED SYSTEM

4.1 Capturing Frames from live videos

The system needs to capture the frames from live video in order to perform several computations to provide a valid output. These frames can be extracted from a live video using several methods.

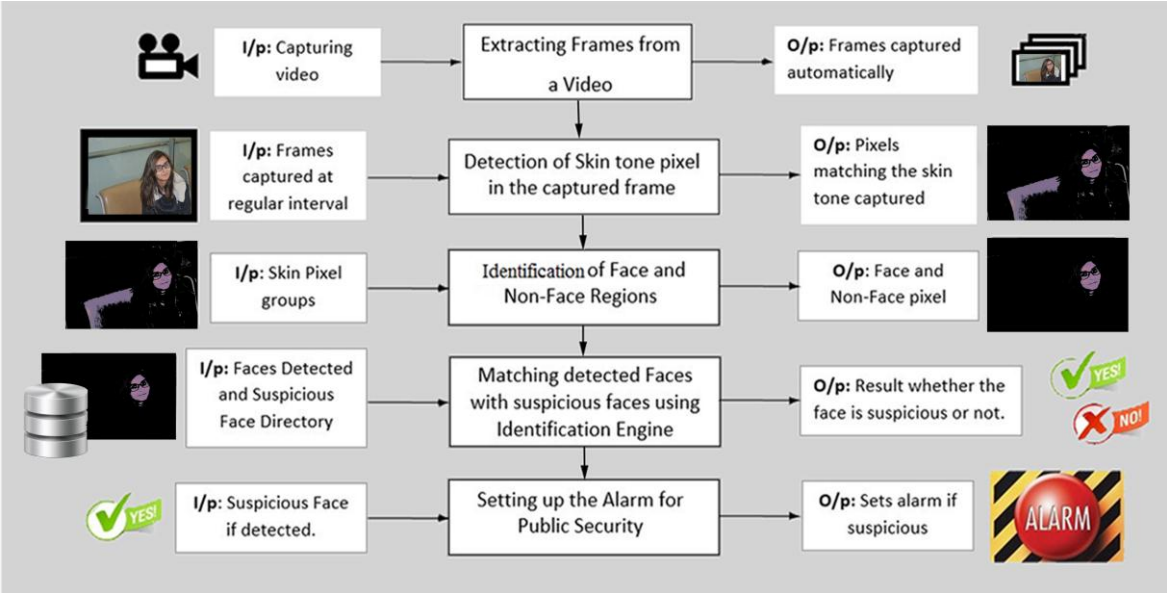

Fig 1: Flow Diagram of Proposed Framework of Detection and Recognition of Suspicious Faces at Public Places through Entry Level Surveillance Video Footage.

Software like MATLAB can be used for extraction of frames with much ease. The frames will be captured at regular intervals and sent further for processing.

4.2 Skin pixel detection [16][21]

The extraction of frames will further be passed for processing. The main aim is to detect skin pixels from the frames and eliminate the non-skin pixels. In order to obtain these, we need to convert RGB image into YCbCr image by using respective color conversion formulae. After the detection skin pixels there might be chances of detecting skin color pixels excluding face region. So, color models like HSI, YCbCr, HSV, RGB are used to detect the skin pixels in the image. After the skin pixels are detected, recognition is done with the help of feature extraction technique where (row mean, column mean, forward diagonal mean, backward diagonal mean, and triangular mean) are used to generate feature vector of these images. This technique helps to improve the performance of the system and improve the response time of the system.

V. COMPARATIVE STUDY OF EXISTING AND PROPOSED TECHNIQUES.

Let us tke a scenario where we have to find a criminal from the public places like malls or bus stations, railway stations. So at these places we cannot identify the person using their fingerprint or by iris scanning. So in the circumstances like this we have to use a face recognition system for finding the criminal from the crowd. In the earlier phases of development of face recognition system, Kohonen indicate that face recognition can be done using neural network. Later many people tried different techniques for face recognition using the feature recognition or using the edges[14]. Many of those got succeeded but for small database only. Face recognition system use principal component analysis (PCA) and DCT algorithm for face comparison[13][15]. PCA does the feature selection and dimension reduction. PCA method has a drawback of large computation and hence increases the computational time. To overcome the limitation of PCA, they introduced Linear Discriminant Analysis (LDA)[17]. But LDA also has some drawbacks, it has small sample size problem. In the field of face recognition, the main constraints are correctness and speed of detection and recognition of human faces. In this paper [18], they have compared the face detection techniques like Haar and Local Binary Pattern(LBP) which are used with Adaboost classifier which is machine learning meta algorithm. Haar is technique for object detection which is color independent, fast, accurate. Haar feature provides benefits not only like ad-hoc domain knowledge are implied but also a speed increase over pixel based systems. Here face recognition is done using the image feature set extracted from Haarlets applied on the image at various levels of decomposition. Here the image features are extracted by applying Haarlets on gray plane (average of red, green and blue[19]. Implementation of this system generates feature set which is too large. To solve this problem or to reduce complexity means limiting whole features set to the small number of critical features only, we use boosting algorithm, Adaboost Local Binary Pattern (LBP) is done by dividing an image into several small regions from which the features are extracted. In LBP we took a pixel and compare it with 8 neighbor pixels.

If the value of neighbor pixel is greater than or equal to current pixel, then make it one otherwise make it zero. Face image of person is compared with the face images of known persons from a database. If the input face images are found or the more similarities face images are matched in the database, then we say the image is successfully recognized. In LBP we divide the face images into small regions. Then histograms from each region are concatenated into one

spatially enhanced feature histogram. After comparing both that is Haar and LBP, Haar like features are relatively better but it has much false detection than LBP.

The obtained results of detection of skin region by using HSI, RGB, YCbCr Color Models:

Fig 4.2 Original Image

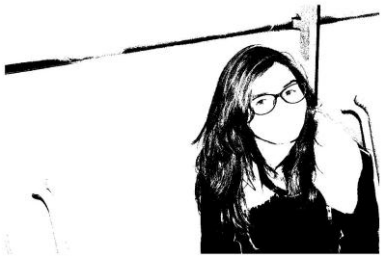

Fig 4.3Skin color detected using RGB color model

Fig 4.4 Skin color detected using YCbCr color model

Fig 4.5 Skin color detected using HSI color model

VI. CONCLUSION AND FUTURE SCOPE

The proposed system mainly focuses on public safety. The CCTV cameras installed at the public places will record live videos. These videos were further sent for processing. To detect the skin pixels in the image RGB, YCbCr, HSI color models were studied. These color models helped to segregate skin pixels and the non-skin pixels. For background subtraction watershed segmentation algorithm was studied. Further to reduce the dimensionality of the image and for feature extraction, PCA (Principal Component Analysis) algorithm was used. The detected skin pixels were then compared with the images in the criminal database to find a match. If the match was found, then the cops were notified about the detected suspicious face.

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