Face Recognition System For Surveillance

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Abstract: In this paper, we are proposing a face recognition system for surveillance systems. The implementation of the proposed system includes face detection and face recognition. The algorithms and libraries used in this face recognition system is Local Binary Pattern Histograms (LBPH) and Haar Cascade Classifier. It is a real-time video-based system developed using OpenCV. Whenever a suspicious face is detected, it is identified and a notification is sent to the appropriate authorities. Using local binary patterns, the recognition of faces can be done effectively in all lighting conditions and with high accuracy.

IndexTerms: **LBPH, Haar Cascade Classifier, Feature Extraction, OpenCV, Webcam, CCTV**

I. INTRODUCTION

Face recognition has been one of the hardest challenges in computer vision as our faces are very complex objects with unique identifiers. Taking into consideration these features, developing a model to recognize an image from a known database should be done in minimum time and maximum accuracy. This has been the driving force behind the excellent development in the recent years.

Face recognition is a monumental achievement in the field of computer vision as it has been very useful in cases where surveillance of a wide area such as a parks, malls or airports can be done effectively and has helped our security forces recognize known criminals. The recent terrorist attacks on our country has proved that we need a proper infrastructure to place cameras at public places and help the security forces of our nation to battle such threats using face recognition. Face recognition can also be used to avoid ATM thefts which are prevalent in the nation[1].

By training the available dataset of the known criminals to the face recognition models, it can create a database of the known criminals to be used as reference by police or the army. Face recognition finds its applications in other security applications such as unlocking personal devices like phones and laptops. Its main use is in the surveillance systems where quick actions have to be taken in case of unauthorized access to an area or to recognize persons of known criminal background.

II. PROPOSED METHODOLOGY

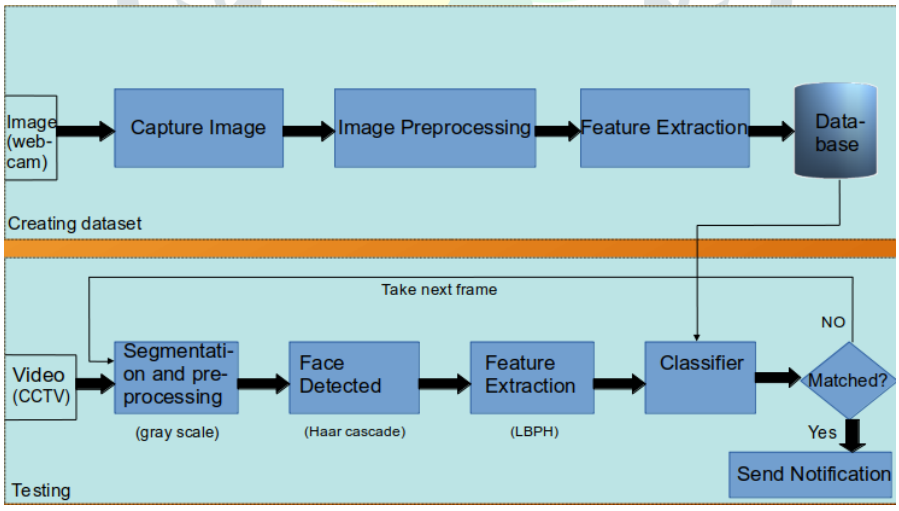

Figure 1: System Architecture

A webcam can be used to generate an initial dataset of images for a person. This is converted to grayscale to avoid any illumination issues altogether and feature extraction is performed. The result of these operations is stored in a database to store the recognition model of a person. Now, when a CCTV is enabled with this module, it scans for any potential faces and the preprocessing of the image along with feature extraction is done. For preprocessing, appropriate algorithm is used [6]. Finally, these extracted features are compared with the trained database of our system and an appropriate action is taken.

This system has four steps:

Step 1: Create Dataset
To create a dataset of a person's face, a webcam will be used and 30 to 45 images will be captured. The images are then converted to grayscale. One ID will be assigned to every person and then the captured images will be stored in separate folder.

Step 2: Face Detection
Haar feature-based cascade classifier is an effective object detection algorithm. It was proposed by Paul Viola and Michael Jones in their paper "Rapid Object Detection using a Boosted Cascade of Simple Features" in 2001. Haar Cascade is a machine learning based approach which uses the concept of features proposed in the paper to identify objects in an image or video. The algorithm collects a lot of positive and negative images[4]. Positive images are the images with faces and negative images are the images without faces. These are needed to train the classifier and extract features from them. Features consist of numerical information extracted from the images used to distinguish an image from another.

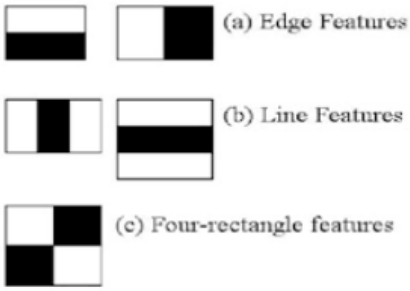

Figure 2: Haar Features

Consider the edge feature shown above. It focuses on the eyes of a person's image. It relies on the property that the region of eyes is often darker than the region of nose and cheeks. Basically, we apply each and every feature on all the training images. For every feature applied, the best threshold that classifies the positive and negative images with minimum error rate is selected. Thus, the region of interest is found out (e.g. eyes) and used for further recognition process.

Step 3: Feature Extraction
Local Binary Pattern (LBP) is a simple and effective algorithm. It was first described in 1994. When LBP is combined with histograms of oriented gradients (HOG) descriptor, it improves detection performance on some datasets.
In LBPH, the input image is initially converted to grayscale. A part of this image is converted into 3x3 matrix[2]. Each pixel has an intensity. The central value is considered as a threshold. If the intensity of the neighbouring value is greater than or equal to the threshold value, then binary 1 is assigned else binary 0 is assigned to that pixel.
Then we need to convert this value to decimal values and set it to the central value of matrix which is actually a pixel from the original image. Hence, we have a new image representing better characteristics of original image.

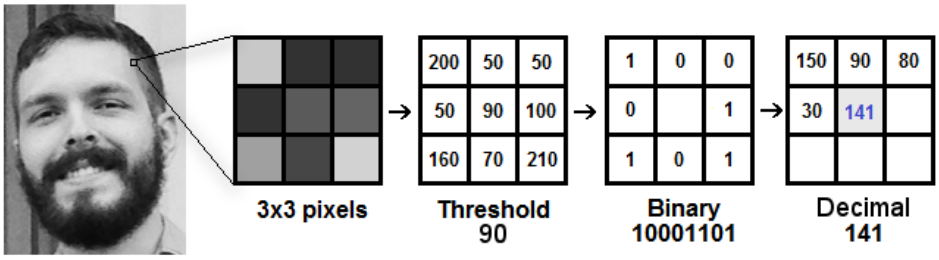

Figure 3: Linear Binary Pattern

Now, we need to create histograms of the new image. For this, the new image is divided in 8x8 cells or regions with their own Grid X, Grid Y and intensity grids. These histograms are generated one per region and these histograms are concatenated to represent the entire image.

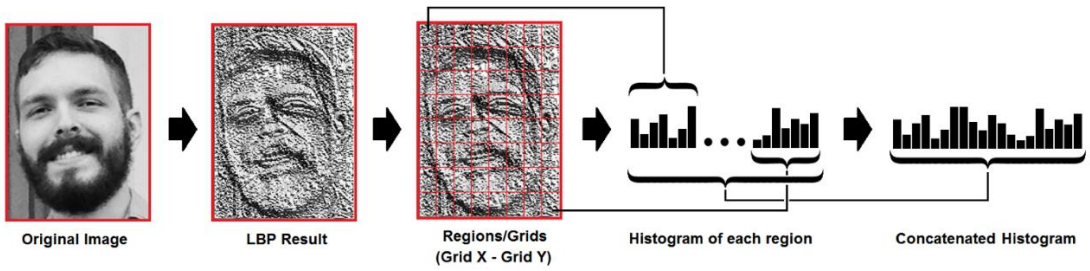

Figure 4: Histogram of Oriented Gradients

Now, when a face is detected on the live feed of the CCTV, the features are extracted again and the Euclidean distance is calculated to see if they match with the histogram of the stored images in the databases. A confidence value is calculated; lower the confidence better the face matching.

Step 4: Classification (Face Recognition)
The classified features are fed to classifier. K-nearest neighbour classifier is used for classification and Euclidean distance classifier is the most common of all[1]. The minimum distance value between features stored and test image feature value gives recognition rate. The Euclidean distance formula is :

$$D = \sqrt{\sum_{i=1}^{n}(hist1_i - hist2_i)^2}$$

III. RESULTS

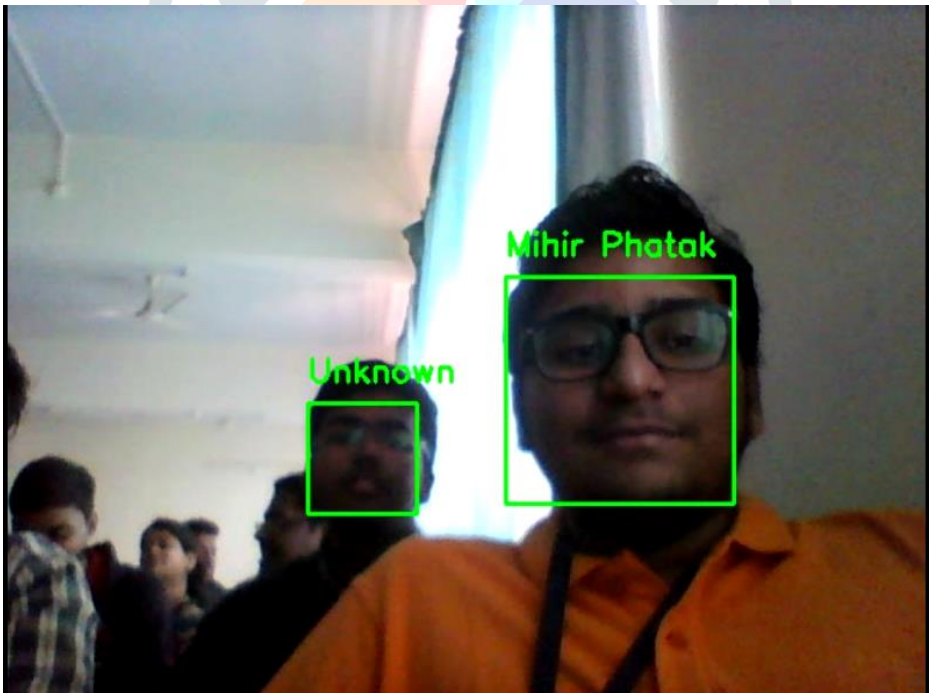

Figure 5: Face Recognition

Thus, face recognition module has been successfully implemented using Haar Cascades and LBPH. This system has a very high accuracy when the dataset is stored in all lighting conditions. This system can give accuracy upto 70% and can be increased using a large dataset in all conditions.

IV. CONCLUSION

Surveillance system is used to monitor the behaviour and activities of suspicious people. The used algorithms are one of the most accurate methods[5] used for facial recognition in a surveillance system. The CCTV will capture the person's image and recognize it using this system. Whenever a match is found, a notification will be sent accordingly. This system works in all lighting conditions.

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