AUTOMATED FACE DETECTION SYSTEM USING VIOLA JONES ALGORITHM FOR CRIMINAL DETECTION

Aneena Elizabeth Chandy,Febin Antony,Jibiya Benny,Sarath S Shankar,Jisha Mariam John,
Department of Computer Science And Engineering, Peermade, Kuttikanam
Mar Baselios Christian College Of Engineering And Technology, Idukki, Kerala, India

Abstract: This paper presents a criminal detection framework that could help policemen to recognize the face of a criminal or a suspect is proposed. A client-server video based face recognition framework is used here. The framework applies face detection at the client side and face recognition at the server side. The face detection stage uses Viola Jones algorithm supported by Open CV. The face recognition stage is based on Local Binary Pattern Histogram (LBPH) is recently proposed algorithm for face feature extraction which is implemented using python. In this method LBP image is segmented into local regions and histogram of each is extracted and are concatenated to form a face descriptor. It mainly consists of three parts, namely face representation, feature extraction and classification. Face representation represents how to model a face and determines the successive algorithms of detection and recognition. The most useful and unique features of the face image are extracted in the feature extraction phase. In the classification the face image is compared with the images from the database. The proposed face detection and recognition is implemented using Android studio and Open CV library, and tested using Android Smartphone and Pcs.

IndexTerms **- Face detection, Face recognition, Open CV, LBPH**

I. INTRODUCTION

In this modern era of automation many scientific advancements and inventions have taken place to save labor, increase the accuracy and to ameliorate our lives. The face of a human being conveys a lot of information about identity and emotional state of the person. Face recognition is an interesting and challenging problem, and impacts important applications in many areas such as identification for law enforcement, authentication for banking and security system access, and personal identification among others. Computer vision focuses on duplication or emulation of human vision. The face plays a major role in our social intercourse in conveying identity and emotion. The human ability to recognize faces is remarkable. Modern Civilization heavily depends on person authentication for several purposes. Face recognition has always a major focus of research because of its non-invasive nature and because it is peoples primary method of person identification. Automated Face Detection System is the advancement that has taken place in the field of automation replacing traditional Criminal Identify activity. These systems are widely used in different organizations. Traditional method of Face detection for Criminals very time consuming and becomes complicated when the strength is more. Automation of Face detection for Criminal System has edge over traditional method as it saves time and also can be used for other security purposes. A Automated Face detection for Criminals System which is developed using bio-metrics, in our case face, generally consists of Image Capturing, Database development, Face detection, Pre-processing, Feature extraction, and Classification stages followed by Post-processing stage.

In this paper a criminal detection framework is proposed. A client-server video based face recognition framework is used here. The framework scenario is as following: The policeman capture a video for a criminal or a suspect using a camera is mounted at a distance from the entrance to capture the frontal images of the Criminals. Face detection and tracking is done at the client side. Then the video frames containing the detected and tracked face are sent to the server where a video based face recognition is done at the server side. The personal information record for the recognized person is sent back from the server to the policeman mobile phone. Along with the videos a policeman can also send photos of any suspect. This paper focuses on the development of the face detect-track system on Android platform at the client side. The face detection stage uses Viola Jones detector supported by Open CV. The face recognition is done at sever side by Local Binary Pattern with three parts, namely face representation, feature extraction and classification. The process of person identification by using face recognition can be split into three main phases. These are face representation, feature extraction and classification. Face representation is the first task, that is, how to model a face. In the feature extraction phase, the most useful and unique features of the face image are extracted. With these obtained features, the face image is compared with the images from the database. This is done in the classification phase. The output of the classification part is the identity of a face image from the database with the highest matching score, thus with the smallest differences compared to the input face image. Also a threshold value can be used to determine if the differences are small enough. After all, it could be that a certain face is not in the database at all. A simple framework of these system is shown in Fig 1.1 below:

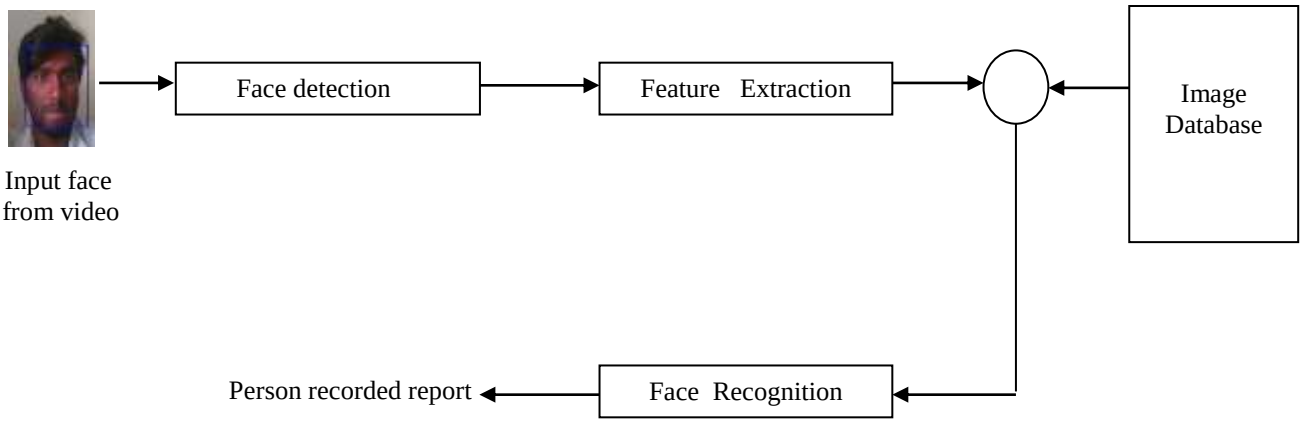

Fig 1.1 Proposed detection framework

II. RELATED WORK

The task of face recognition has been actively researched in recent years. This literature review present an overview of face recognition and its applications. Face recognition is an important research problem in numerous fields and disciplines. Face recognition is a biometric approach that employs automated methods to verify or recognize the identity of a living person based on his/her physiological characteristics. Face recognition is applied for criminal detection in many researches. The research work in proposed [1] the design of an Android application which compares multiple faces using Eigen faces algorithm based on principal component analysis. At the client side, the Android mobile user takes an image or a video as an input and then passes it to the web server using HTTP method. At the server side, an image or video match with the existing criminal information record in a database is done. The proposed system in [2] recognizes the criminal using images from live streaming CCTV. The system compares these images with the criminal information in database records, then displays a specific information if the image matches with the database content. In the face detection stage it uses the HAAR's algorithm and for recognition stage it uses the EIGEN values.

There are many researches applied in the computer vision field handled real time face detection and tracking. Support Vector Machine [3] is a computer vision supporting application. A Support Vector Machine application for detecting vertically oriented and unclouded frontal views of human faces in grey level images The Research work in [4] presented a model that is composed of two-mode tracking: short range tracking mode, and long range tracking mode. The first mode is used for changes in scaling and appearance. The second mode is used to capture fast and abrupt motion by particle filter and Continuously Adaptive Mean Shift (CAM Shift). The authors in [5] used three basic detectors that trained by local binary pattern (LBP) and boosting algorithm. It is expanded for multi-view face detection. To accelerate the face tracking process, they proposed a robust facial pose estimation algorithm and the face matrix partition scheme. The research [6] work in proposed a face tracking algorithm using real time camera. They used Haar-like features to detect the face object, Optical Flow for tracking stage, and Shi and Tomasi algorithm to extract feature points.

Face detection that aims to detect the presence and subsequently the position of human faces in an image, is often the first important step in automated facial image analysis. This paper [7] present a skin color-based face detection algorithm model in YCbCr that employs a human skin color model, which takes into account the luminance Y in classifying skin and non-skin pixels. Another study take place in field of robust real-time face detection [8] in this face detection framework that is capable of processing images extremely rapidly while achieving high detection rates. This paper brings together new algorithms and insights to construct a frame work for robust and extremely rapid visual detection. There are three key contributions. The first is the introduction of a new image representation called the "Integral Image" which allows the features used by our detector to be computed very quickly. The second is a simple and efficient classifier which is built using the Ada Boost learning algorithm to select a small number of critical visual features from a very large set of potential features. The third contribution is a method for combining classifiers in a "cascade" which allows background regions of the image to be quickly discarded while spending more computation on promising face-like regions.

The authors in [9] presents a Visual tracking essentially deals with non-stationary data, both the target object and the background, that change over time. The model update, based on incremental algorithms for principal component analysis, includes two important features: a method for correctly updating the sample mean, and a for getting factor to ensure less modelling power is expended fitting older observations.

III. PROPOSED SYSTEM

n this paper, attention is focused in detecting and tracking faces in videos. Initially criminal images are stored in database along with his bio data. This software contains front end and back end applications where front end is used to visualize the output and back end is used to store data. Prisoner face detecting system can be used in police department. The proposed automated Criminal Face system is based on face recognition algorithm. When a person enters the camera view his image is captured by the camera at the entrance. Face region is then extracted and pre-processed for further processing. As not more than two persons can enter the

classroom at a time face detection algorithm has less work. Face Recognition proves to be advantageous than other systems. When the criminal face is recognized it is fed to post-processing.

Face detection achieves a real-time performance through Viola-Jones framework where its detection rates are competitive with some of the best methods to date in terms of both performance and running time. Face tracking provides a solution to handle the real-time conditions. At the client side, the aim is to detect a face object and track it during the catching task, and empower the clients to review the face tracking functionality in different conditions. Viola-Jones algorithm is used for face identification. For following stage, Local Binary Pattern [10] is utilized because it can deal with features like changes in shape, orientation and can diminish the level of false positive came about by Ada Boost course.

The proposed face detect-track system on Android platform is tested on real time captured videos. In order to lower the demand of computational power of the proposed system, the Viola-Jones face detection algorithm is executed every 15^{th} frame. The face recognition which considers both shape and texture information to represent face images based on Local Binary Patterns for person independent face recognition. The face area is first divided into small regions from which Local Binary Patterns (LBP), histograms are extracted and concatenated into a single feature vector.

3.1. MODULE DESCRIPTION

3.1.1 Image Capture

The Camera is mounted at a distance from the entrance to capture the frontal images of the Criminals. The captured image is preferred to be of the size 640x480 to avoid resizing of the image in the back-end as we observed resizing may sometimes results in poor performance. For the demonstration purpose camera in the laptop is used can be extended for future works.

3.1.2 Face Detection

A proper and efficient face detection algorithm always enhances the performance of face recognition systems. Various algorithms are proposed for face detection such as Face geometry based methods, Feature Invariant methods, Machine learning based methods. Out of all these methods Viola and Jones proposed a framework which gives a high detection rate and is also fast. Viola-Jones detection algorithm is efficient for real time application as it is fast and robust.

In order to detect faces given a large variability of faces in the training dataset, a cascade of classifiers is required to quickly and iteratively discriminate between face and non face. People face appearance can greatly differ from one person to another. The variability of face images get even more complex when lighting exposure varies and when people do not face the camera. Therefore face detection algorithms cannot easily handle this large variability and cannot discriminate between training negative and positive samples using a single thresholding operation. Cascade of classifiers in viola jones algorithm are often used as in the works of [15] to deal with this issue and is used as a boosting system such as the Ada Boost system [16]. A cascade of classifiers is used to train the process. Each classifier is associated with a threshold which is obtained from the error calculation for the positive samples. The threshold is given by the maximum error among the 99% of the best errors. All samples giving an error above this threshold are discarded from the next classifying stage where a new training is performed on the remaining samples. The discarded samples are assumed to be non-face samples.

3.1.3 Pre-processing

The detected face is extracted and subjected to pre-processing. This pre-processing step involves with histogram equalization of the extracted face image and is resized to 100x100. Histogram Equalization is the most common Histogram Normalization technique. This improves the contrast of the image as it stretches the range of the intensities in an image by making it clearer.

3.1.4 Database Development

As we chose biometric based system enrolment of every individual is required. This database development phase consists of image capture of every individual and extracting the bio-metric feature, in our case it is face, and later it is enhanced using pre-processing techniques and stored in the database.

3.1.5 Feature Extraction and Classification

The performance of a Face Recognition system also depends upon the feature extraction and their classification to get the accurate results. Feature extraction is achieved using feature based techniques or holistic techniques. Local Binary Pattern Histogram (LBPH) is recently proposed algorithm for face feature extraction. In this method LBP image is segmented into local regions and histogram of each is extracted and are concatenated to form a face descriptor. Support Vector Machine (SVM) is used for the classification. SVM is recently proposed algorithm which is an effective pattern classification algorithm. For pattern recognition SVM finds the optimal separation of closest points in the training set. This separation can be done linearly or non-linearly. In real world scenario we require a multi-class classification.

Support Vector Classification, a SVM type, is used for multi-class classification. So Face Recognition involves in two stages, feature extraction and classification. It has been observed that LBP based algorithm gives least false positive rate and good recognition rate as it correctly differentiates between the unknown and known. In the feature extraction phase, the most useful and unique properties of the face image are extracted. With these obtained features, the face image is compared with the images from the

database. This is done in the classification phase [11, 12]. The output of the classification part is the identity of a face image from the database with the highest matching score, thus with the smallest differences compared to the input face image. Also a threshold value can be used to determine if the differences are small enough.

3.1.6 Post-processing

In the proposed system, after recognizing the faces of the Criminals, the name and their details is displayed.

3.2 THE PROPOSED FACE DETECT-TRACK CYCLE

The proposed face detect-track cycle deals with frames generated in the real-time in which N is the number of the captured frames. The detection takes its role at the first frame and at every m frames to allow other faces to be detected and then tracked. The detection stage determines faces windows, and removes any faces not found longer. In every tracking iteration the face is preserved by distinctive and efficient features. The features extraction method produces the facial points to be used in the optical flow function. After the detection stage the previous frame, the face points, and the next frame as inputs to predict the face location in the next frame. After m frames, the system will start a new detect track cycle, as shown in fig.1.2.

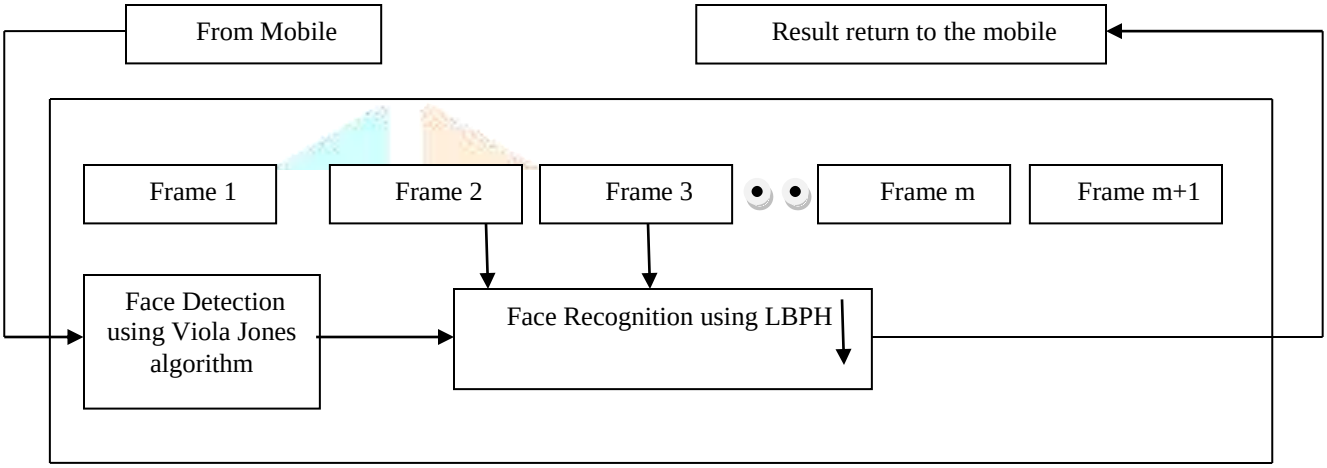

Fig 1.2: The proposed face detection pipeline diagram

IV. RESULTS AND DISUCUSSION

In this section, we describe the experiments conducted to test and verify the accuracy of the system using a larger dataset. The results of the experiments played a key role in the design of the real-time system.

4.1 SOFTWARE AND HARDWARE TOOLS

Android Platform supports many APIs introduced by Google Company. Android studio is used as an environment for system implementation. It is supported by Android Software Development (SDK).In addition, we used Open CV library [13] to take the benefits of optimized implementation of its functions. Open CV is a programming library aims to focus on real-time image processing. It deals with multiple programming languages like python and platforms like Android. However, Open CV library cannot work in Android platform without Android Open CV manager [14] which manages Open CV library binaries on the end users' devices. The most important built-in function used in the proposed system is Viola-Jones.

4.2 USER-EXPERIENCE RESULTS

The proposed face detect-track system on Android platform is tested on real time captured videos. In order to lower the demand of computational power of the proposed system, the Viola-Jones face detection algorithm is executed in every frame. The system show performance in terms of Frame per Second (FPS), False Negatives (FN) rate, and False Positives (FP) rate when tested on real time videos. When a face is detected from a video, 20 frames of each detected faces are stored in the database. It tests sixteen pixels around each single pixel in the image.

For an experimental setup a Camera is mounted at a distance from the entrance to capture the frontal images of each person. The videos were captured in an indoor environment. The participant was placed in front of the camera. From each video the frames are captured change in illumination means half the image were recorded with full lighting and the others with reduced lighting, changing background such that we use various colored cardstock to change the background color of the videos, with variation of facial expressions means the participants' facial expressions were not restrained sometimes laughing, funny faces, serious faces,etc. For each person, 20 frames of each detected faces are stored in the database. Then for the experimental setup a small duration video clip from the mobile or capture real time photo using mobile is send to the server. Faces present in an image are detected by a squared

scanning window of 20x20 pixels. This relatively small window size allows small faces to be detected which often occur in video surveillance videos. The content of the image bounded by a scanning window represents the image to be detected as face or non face by the cascade of classifiers. To avoid large computational cost of the search procedure and to avoid multiple overlapping results, the scanning window looks for faces every 5 pixels across the entire image. In order to detect faces with sizes bigger than the scanning window dimension, a hierarchical search is deployed where faces are searched. Then the face detection and recognition is take place. In the recognition stage the system compares these images with the criminal information in database records, then display a specific information if the image matches with the database content. In the proposed algorithm, different type of face images have been recognized.

Based on algorithm, the face image of an unknown identity is compared with face images of known individuals from a large database. In the fig 1.3 we can see the input facial images used for input for face recognition are given below:

Facial image 1 Facial image 2 Facial image 3

Fig 1.3: Different Input Facial Image

And also in the fig 1.4 we can see the facial images that are stored in the database which compared with the input facial images. If the input face images are found or the more similarities face images are matched in the database then we say the face images is successfully recognized.

Database image1 Database image 2 Database image3

Fig 1.4: Facial Image from the database

The following table shows overall face recognition rate:

Table 1: Recognition rate

Number of face images stored in database	Number of input face images compared with database	Recognized image	Unrecognized image	Recognition rate
500	500	480	20	99%

In the table 1 the recognition rate is almost 100%. We recognize the face images from the database face images by comparing between input face image and database image. From the experimental result, it is seen that it satisfies all the requirements to recognize the face images.

V. CONCLUSION

In this paper, a criminal detection framework is presented. This framework is a client-server video based face recognition surveillance in the real-time. This paper focuses on the implementation of the client side face detection and tracking on Android smartphones. The face detection is implemented using Viola-Jones ready-to-use function provided by Open CV library. Face recognition system by use of feature extraction with Local Binary Patterns. It mainly consist of three parts, namely face representation, feature extraction and classification. Face representation represents how to model a face and determines the successive algorithms of detection and recognition. The most useful and unique features of the face image are extracted in the feature extraction

phase. In the classification the face image is compared with the images from the database. This method represents the local features of the face and matches it with the most similar face image in the database.

REFERENCES

[1] Viraj, M. Pradip, T. Pankaj and M. hweta, "Criminal Detection Using Eigenfaces Approach on Android Device," International Journal of Computer Science and Information Technologies, vol. VI, no. 1, pp. 539-541, 2015.

[2] M. Prathamesh, R. Vedant, M. Suraj, K. Avinash and S.V.Wankhade, "Criminal Tracking System using CCTV," Imperial Journal of Interdisciplinary Research, vol. II, no. 7, pp. 206-208, 2016.

[3] Edgar Osuna, Robert Freund, Federico Girosit.1997b. “Training support vector machines: an application to face detection”. In Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition.

[4] V. Q. Nhat, S.-H. Kim, J. H. Yang and G. Lee, "Real-time Face Tracking with Instability using a Feature-based Adaptive Model," Intrenational Journal of Control, Automation and Systems, vol. 13, no. 3, pp. 725-732, 2015.

[5] J. L. a. K. W. Lei Xu, "Real-Time And Multi-View Face Tracking On Mobile Platform," in IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), Prague, pp. 1485-1488, 2011.

[6] R. Andreas, A.-F. Fernando and K. Stefan, "Face Tracking Using Optical Flow," in International Conference of the Biometrics Special Interest Group (BIOSIG), Darmstadt, pp. 1-5, dol. 10.1109/BIOSIG.2015.7314604, 2015.

[7] Son Lam Phung, Abdesselam Bouzerdoum, and Douglas Chai,D. A novel skin color model in YCBCR color space and its application to human face detection. In: IEEE International Conference on Image Processing, Vol. 1, pp 289-292, 2002.

[8] Paul Viola, Michael J. Jones "Robust Real-Time Face Detection," International Journal of Computer Vision, vol. 57, no. 2, pp. 137-154, 2004.

[9] David A. Ross, Jongwoo Lim, Ruei-Sung Lin, Ming-Hsuan Yang , “Incremental learning for robust visual tracking,” International Journal of Computer Vision, vol. 77, no. 1-3, pp. 125-141, 2007.

[10] M. Grudin, “On internal representation in face recognition systems”. Pattern Recognition , 33(7):1161 1177, 2000.
.

[11] M. Kirby and L. Sirovich, “Application of the Karhunen-Loeve procedure for the characterization of human faces” IEEE Transactions on Pattern A nalysis and Machine Intelligence , 12(1):103{108, 1990.

[12] S. Z. Li and A. K. Jain (eds.), “ Handbook of Face Re cognition” Springer-Verlag, Secaucus, NJ, 2005

[13] Doxygen, "OpenCv Open Source Computer Vision," OpenCv , 18 December 2015. [Online]. Available: http://docs.opencv.org/3.1.0/d7/d8b/tutorial_py_lucas_kanade.html#gsc .tab=0. [Accessed 8 December 2016].

[14] T. Nisarg and K. Salil, Mastering OpenCV Android Application Programming, Packt Publishing, 2015

[15] Jones M.J. Viola, P. Robust real-time face detection. International Journal of Computer Vision, 57(2):151-173, 2004.

[16] Freund Y. and Schapire RE. A decision-theoretic generalization of on-line learning and an application to boosting. Journal of Computer and System Sciences, 1997