Efficient Use of Background Subtraction Algorithm For Facial Recognition Application

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Abstract- *Facial Recognition refers to identifying a person by using his biometrics to map facial features from a photograph or video. The recognition begins by capturing the persons image and the process is called face detection. Then we perform segmentation of dynamic and new objects in a scene. This process is often called background subtraction or foreground segmentation. This is a very critical early step used in most computer vision. The primary goal of this paper is to analyse the existing facial recognition innovations and further improve the security against offenders and prevent the fraud use of an individual's personality. Here we consider one such example where we depict street security issues and their solutions.*

Keywords- Face Recognition, fisherface, SVD, PCA, Background Subtraction.

I. INTRODUCTION

This paper essentially focusses on how we can improve the security features and protect the individual's security.

There are various applications like video surveillance, street security, payment applications where security is a priority. In all of these applications the first step is detection and separation of the moving object (foreground) from the stationary object (background) in a video sequence. For this these applications use Background Subtraction Algorithm. This step is very critical and comes very early in the entire process.
By the use of age-old security measures like passwords and PINS in critical applications of leading organizations and government offices keeping an individual's security intact has been challenging.These applications attract cyber imposters and frauds as the passwords and PINS do not provide strong identity checks.

This challenge can be met by using an individual's physiological characteristics like fingerprint, face, ear, iris, retina, palmprint etc. This paper revolves around how we can efficiently use these characteristics of an individual [1] and elevate the security affirmation provided by an organization.

In this paper we discuss about the problem caused by vehicles in traffic because of abrupt halting. Occurrence of such sudden obstacles can cause huge risk to an individual's life. Hence with the use of certain applications if we are able to warn other drivers on road then we can prevent or lessen the mis happenings significantly.

The other segments of the paper include calculation to determine how highlight extraction is done by projections. These calculations are based on fisherface PCA (Principle segment examination) and SVD (single esteem deterioration). Later the paper also presents two papers which were comprehended and used for the premise in this explanation. Further, productive calculations, execution of dataset precedents and outcomes are also included. Finally, the paper demonstrates the future extent of this discussion.

II. OPTIMAL LINEAR PROJECTION THEORY BASED FACE RECOGNITION

Principal Component Analysis (PCA) method is used to reduce the number of variables during facial recognition. There are numerous PCA methods one such being the fisherface.Fisherface is believed to be superior to other techniques.

Principal Component Analysis considers the total variance in the data and transforms the original variables into a smaller set of combination.

The PCA method is shown by the following formula:

$$y = A^T x \qquad (1)$$

In the above equation vector y is represented as a projection of vector x on domain A.

We don't need to design classifiers for these models as faces can be recognized by using Euclidean distance. As PCA uses Eigen vectors [3] the generated vectors are not correlated to each other.

Fisherface [4] method is used to obtain features of an image. For this it uses Fisher's Linear Discriminant (FDL) method which is also known as Linear Discriminant Analysis (LDA). Then we use minimum Euclidean for matching the facial characteristics of different images. The procedure of the algorithm is as follows.

Given that K is the total number of each person, C is the total number of people and N is the total number of images, then the total number of Eigenfaces [3][9] is equal to N-1. The determinant obtained by the above considerations S_w and S_{bare} as follows:

$$Sw=\sum_{i=1}^{c}\sum_{j=1}^{k}(y_j - M_i)(y_j - M_i)^T \quad (2)$$

$$Sb=\sum_{i=1}^{c}(M_i - M)(M_i - M)^T \quad (3)$$

Here M_i = Mean vector of the ith class and M = Mean vector of all the classes. After obtaining the c-1 D feature vectors,the faces are then recognised using the predetermined feature vectors[2].

The next method used for facial image reconstruction and recognition is **SVD (Singular Value Decomposition).** It consists of the face space that best defines the changes in known faces. The singular vectors of the known faces define the basis of the face space. The identification is carried out by comparing the projections of a new image onto this face space with the available projections of known spaces.

III. LITERATUR SURVEY

In this section we analyse the existing researches and papers on different face recognition algorithms.

The paper "Image-based Face Detection and Recognition" was written by Faizan Ahmad et al[14]. In this paper evaluation and comparison of various face detection and recognition algorithms were done. Five datasets were trained and tested to evaluate for the same based on different positions, lighting, races and emotions.According to their research the highest recognition rate was obtained by Gabor algorithm whose 92.35%. This was a significant step towards video-based face detection and recognition.

The second paper reviewed was Chou-Hao Hsu and Chaur-Chin Chen's[13] research on "SVD-based Projection for Face Recognition". Their paper proposed a system where the database was ORL of 40 subjects achieving a total of 97.5% recognition rate. Thus, this system required much less memory than any other approaches. It also compares various recognition algorithms and provides the best solution. The section "An introduction to face recognition technologies" provides a basic overview of several existing algorithms like Eigenfaces, NeuralNetworks, Fisherface, etc. In this section Shang-Hun [12] explains the generic framework of the proposed system and how the recognizer overcomes several obstacles like camera positioning, illumination etc.

IV. EFFICIENT ALGORITHM

There are several complications that need to be tackled for an efficient face recognition system. These obstacles include illumination, race, positioning, rotation, hairstyle, spectacles, makeup, distortion etc. In order to resolve these challenges, we introduce a new system model which improves the precision and accuracy of recognition. This model tries to solve the problem to the best possible limit.

Unlike other algorithms this algorithm performs comparison, as it trains its dataset models using two different methods and obtains the most appropriate and acceptable results.

The following steps and the flowchart below explain the algorithm followed in a simplified manner:

Step 1:

In this step we train 2 dataset models using two different methods. The first dataset model is trained using fisherface, to extract features and we use k-nearest neighbor method as a classifier. The second dataset model is trained using SVD-based technique.

Step 2:

After we train the two dataset models, we will obtain a subset of the predicted subjects from the sets of the two trained models.

Step 3:

If the obtained subset contains more than one unique label, then we rank all the labels based on the minimum distance and choose the label with the lowest rank.

Step 4:

V. APPLICATION: TRAFFIC VEHICLE DETECTION ALGORITHM

Traffic vehicle detection algorithm is based on background subtraction technique. In this technique the stopped vehicle image will be divided into two parts: the foreground and the background. This technique tries to separate the foreground(vehicle) from the background. The following flowchart shows the division of image using this algorithm.

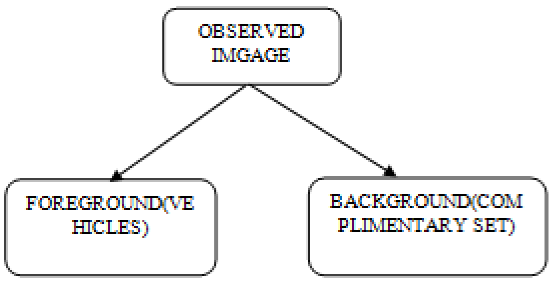

Fig.1 Pixel Sets of an Image

Here the entire process is divided into two stages: The Initialisation stage and the stopped vehicle detection stage. The initialisation stage refers to the initial background estimation. For this an averaging filter is applied in which the average value if the brightness of the given number of frames is calculated in each pixel of the image.Thus, the initial background estimation is done by collecting the information about pixel brightness for a long period of time.

Now the next task in background subtraction is to update the background estimation. To perform this our algorithm uses an exponential filter. After performing the background estimation, the object (vehicle) detection can be performed analysing the differences between the current image and the background in the module.

Our process is based on a current background estimation $BG_N$and a sequence of background estimations for various short intervals of timeBG_i (i= 0..N–1). We subtract the earliest background estimation from the current background estimation for the stopped vehicle detection.

Thus, the stopped vehicle detection stage comprises of the following steps:

This is the last step in which the face is recognized successfully and the desired output is obtained.

- Processing of binary image B_D.
- Information accumulation in matrix S about the duration of assigning each pixel to the object.
- Getting matrix B_S by binarizing matrix S.
- Objects marking and parameterization.
- Update of background estimations

Next step is binary image B_D postprocessing in order to connect small segments. To perform this, we apply morphological operations of opening and closing. It is also possible to use a predetermined mask for zeroing pixel values in the image B_D in areas not belonging to the roadway.

To account for the temporary detection threshold,we create Matrix S in order. It stores for each pixel the number of frames in which this pixel is classified as belonging to a stopped object. Based on the information in the image $B_{D,}$update of the matrix S is performed for each frame.

The result of the matrix S thresholding is the Binary image B_S.The threshold is set based on the required detection time.Finally, we perform marking and parametrization of selected objects basing on image B_S.During this procedure, we assign each object with a unique number. After which coordinates and area are calculated and too small objects are rejected.The exponential filter input is supplied with current image I_N, to update the current background estimation BG_N. Now BG_N will store information about the stopped vehicles in the street.

According to the binary image, B_D, we update the earlier background estimations BG_i (i= 0..N–1). The brightness value is averaged over all background estimations BG_i (i= 0..N–1), for pixels that belong to stopped vehicles. After a predetermined period of time, the background estimation queue shifts, the earliest estimation is rejected (BG_0 = BG_1, …, BGN–1 = BGN).

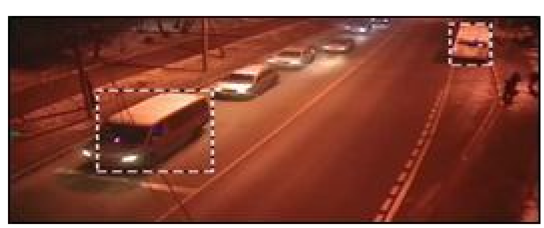

Figure 2. Detection of 3 stopped vehicles.

VI. ANALYSIS OF RESULTS

The work was performed on a computer with the following specifications: Intel Pentium core i5 processor with 1.7-2.4 GHz clock and 4GB RAM memory. Python language was used for the software development. The images (ORL images) were obtained using the AT&T Face database.

The dataset which we used were 10 different images each of 40 test persons. The images were captured in different illuminations and emotions such as crying, frowning etc, various physiological details like moustache beard and spectacles (all issues as discussed in earlier sections) were also altered.

Images of size 128 x 128[11] from original size of 320 x 243 for a total of 4 face recognition algorithms were used for the work. The ORL database which was used and the dataset trained were obtained from a paper on human face identification cited [15]. A dark homogeneous background was used behind the faces to tackle the background problem. The persons were made to stand in upright, frontal position (with slight pose changes).

The following are the results obtained for Stopped Vehicle Detection application.

TABLE I. RESULTS OF STOPPED VEHICLE DETECTION

Test video	Results		
	TP	*FN*	*FP*
1	4	0	0
2	3	0	0
3	4	0	0
4	2	0	0
5	2	0	0
6	1	0	1
7	1	0	0
8	1	0	0
9	1	0	0
10	3	0	0
11	22	0	1

VII. CONCLUSION AND FUTURE SCOPE

In conclusion, this paper involves a combination of SVD projections and PCA model along with fisherface method to gain more efficiency and accuracy in the results obtained. The efficiency is indeed improved and the recognition rates and accuracy of the images have increased, but there is still scope for better algorithms and results for changing face effects.

With this work, it is realized that Face recognition is highly challenging and crucial technique. Face recognition technique is non-intrusive which gives it an upper edge over all biometric technologies existing, this was also the main reason for choosing this topic.

In this paper we described one of the issues of traffic surveillance caused by vehicle stopping abruptly. To Address this issue, we introduced an algorithm to process video sequences from optical sensor performing traffic surveillance. The algorithm is based on background subtraction and designed to detect and localize stopped vehicles.

It is a hope and an endeavour that this paper helps increase more options and better opportunities in face recognizing techniques and through this it is also encouraged that others do the same and make this technology the best at our disposal.

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