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RESEARCH ARTICLE

Limited person face recognition by Principal Component Analysis (PCA) and Histogram

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Abstract

Face recognition system is a computer application which automatically identifies person from digital image from source. Face recognition involves: Face detection, feature extraction and matching with database images. Face is detected from images by using Viola-Jones algorithm using MATLAB, and some features like eye, nose and mouth are also extracted. Then face is recognized by PCA method by using latent and in Histogram method by using median value by comparing it with stored database of the images.

INTRODUCTION

1.1 PROJECT SUMMARY:

In this project we will discuss about face detection and recognition. There have been many attempts made to solve human face recognition problem. The early approach was based on grey level images. The objective of this project is to develop an efficient algorithm with low complexity, with maximum number of face detection and recognition with less error. The light condition of image plays an important role for quality of binary masks.

1.2PROBLEM STATEMENT:

After acquiring the live images from the web camera, persons are detected and recognized at that time with help of passport sized photo provided by them earlier.

1.3DETALIED DESCRIPTION:

The face is the feature which distinguishes a person and face recognition system automatically identifies person from digital image from a provided source. In recent times face recognition system is widely used in real-world applications. A face recognition system are used to monitor the dangerous persons and track criminals and for many other application. A face recognition system extracts various feature of face and person is identified on these extracted features and finally the system produces the results in terms of identified and non-identified persons.

1.4EXPECTED OUTCOMES:

Here the live images or frames acquired from the web-cam are passed through face detection algorithm. After detecting the face in the frame the face features are extracted from images. The extracted features are compared with feature of database. For matched features the person name is tagged with his/her name.

1.5VIOLA-JONES ALGORITHM:

There are many methods of face detection:

- Viola-Jones algorithm[3],
- Rowley's neural networks classifier[3][2],

- Sung and Poggio's correlation templates matching scheme based on image invariants,
- Model based detection is another category of face detection.

II.DETECTION OF FACE

2.1VIOLA-JONES METHOD:

Face detection is the process that determines the locations and sizes of human face in the digital images. It detects facial feature and ignores remaining things. Computer vision is the science and technology of machine that see and seeing in this case means that the machine is able to extract from an image some information which is necessary for solving some tasks. As a scientific discipline, computer vision is concerned with the theory behind artificial systems that extracts information from images. The face area is highlighted by red color box with some features of the face. The cascade object detector uses the Viola-Jones algorithm [3] to detect people's faces, noses, eyes, mouth, upper body etc. The feature by detection framework universally involves the sum of image pixels within rectangular areas. As such, they bear some resemblances to Harr basis functions [2], which have been used previously in the realm of image-based object detection. However, since the feature used by Viola-Jones [3], all rely on more than one rectangular area, they are generally more complex. The figure at right illustrates the four different types of features used in the framework. The value of any given feature is always simply the sum of the pixels within clear rectangles subtracted from the sum of the pixels within shaded rectangles. As it is to be expected, rectangular features of this sort are rather primitive when compared to alternatives such as steerable filters. Although they are sensitive to vertical and horizontal feature, their feedback is considerably coarser. However, with the use of an image representation called the integral image, rectangular feature can be evaluated in constant time which gives them considerable speed advantage over their more sophisticated relatives. Because each rectangular area in a feature is always adjacent to at least one rectangle, it follows that any two-rectangle feature can be computed in six array references, any three- rectangle feature in eight , and any four-rectangle feature in just nine. The speed with which features may be evaluated does not adequately compensate for their number. For example in standard 24*24 pixels sub-window, there are a total of 1, 62,336 possible features and it would be prohibitively expensive to evaluate them all. Thus, bounding box. The input image I, must be a grayscale or true color (RGB) image. [2]

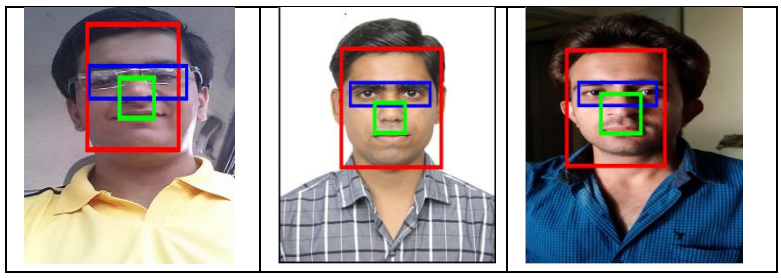

FIG. 1: FEATURE DETECTION BY VIOLA-JONES METHOD

2.2TO DETECT A FEATURE:

Define and set up your cascade object detector using the constructor.Call the step method with the input image, I, the cascade object detector object, detector, points (PTS), and any optional properties. See the syntax below for using the step method.BBOX = step (detector, I) returns BBOX, an M-by-4 matrix defining
M bounding boxes containing the detected objects. This method performs multiscale object detection on the input image, I. Each row of the output matrix, BBOX, contains a four-element vector, [x y width height], that specifies in pixels, the upper-left corner and size of a bounding box. The input image I, must be a grayscale or truecolor (RGB) image. [2][3]

III. RECOGNITION

3.1HISTOGRAM:

Histogram or Frequency Histogram [3] is a bar graph. The horizontal axis depicts the range and scale of observations involved and vertical axis shows the number of data points in various intervals that are the frequency of observations in the intervals. The pixel intensities are plotted along the x-axis and the number of occurrences for each intensity represents the y-axis. Histograms [3] are popular among statisticians. Though they do not show the exact values of the data points they give a very good idea about the spread of the data and shape.The histogram is a

valuable tool used to view the intensity profile of an image. It provides information about the contrast and overall intensity distribution of an image. The image histogram is simply a bar graph of the pixel intensities. [1]
Recognizing is done through histogram based methods. Here apply histogram calculation for face recognition, for every extracted feature, histogram of that feature is calculated and match their histogram with feature database. First we match eye, if face will match it will check the nose histogram matching otherwise it will check the next image and leave that image and so on. After matching of the entire feature then it match the face from database. The algorithm given below worked for face recognition with success rate of 60%. [1]

3.2PROPOSED METHOD TO RECOGNIZE FACE:

In proposed method system consists of various steps: face detection, feature extraction, and recognition. There is a database of features of face images which is using for recognition .[2] An input image is use for the detection of face from that database of image and displayed in a separated window with histogram.[5] Following are the various steps which used during the face recognition system:

- Registration of face in database
- Face detection
- Feature extraction
- Face recognition

FLOWCHART:

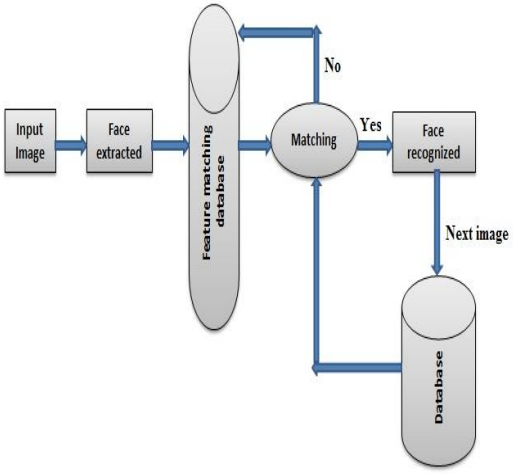

FIG.2 FLOWCHART: HISTOGRAM METHOD

ALGORITHM FOR FACE RECOGNITION BY HISTOGRAM:

Step1: First the Input is detected by the camera.
Step2: Then face is extracted & then feature is matched with the database which is created by the programmer.
Step3: Matching is done.
Step4: If the input image is matched with the database image then face is recognized. If image is not matched then goes to database and take second image.
Step 5: Face is recognized.

3.3PCA (PRINCIPAL COMPONENT ANALYSIS):

Real-world data sets usually exhibit relationships among their variables. These relationships are often linear, or at least approximately so, making them amenable to common analysis techniques. One such technique is principal component analysis ("PCA"), [6] which rotates the original data to new coordinates, making the data as "flat" as possible.PCA [6] is a method of transforming a number of correlated variables into a smaller number of uncorrelated variables.Given a table of two or more variables; PCA generates a new table with the same number of variables, called the principal components. Each principal component is a linear transformation of the entire original data set.The coefficients of the principal components are calculated so that the first principal component contains the maximum variance (which we may tentatively think of as the "maximum information"). The second principal component is calculated to have the second most variance, and, importantly, is uncorrelated (in a linear sense) with the first principal component. Further principal components, if there are any, exhibit decreasing variance and are uncorrelated with all other principal components.PCA is completely reversible (the original data may be recovered

exactly from the principal components), making it a versatile tool, useful for data reduction, noise rejection, visualization and data compression among other things.[4],[8].

- Similar to how Fourier analysis is used to decompose a signal into a set of additive orthogonal sinusoids of varying frequencies, PCA decomposes a signal (or image) into a set of additive orthogonal basis vectors or eigenvectors.The main difference is that, while Fourier analysis uses a fixed set of basic functions, the PCA basis vectors are learnt from the data set via unsupervised training. PCA can be applied to the task of face recognition by converting the pixels of an image into a number of eigenface feature vectors, which can then be compared to measure the similarity of two face images. PCA can be used as a first step to reduce the dimension of the measurement space.Usually this phenomenon is circumvented by scaling the vector z such that the numerical values of the elements all have unit variance.But we are comparing only eigenvalue in this project and display the result.Let training image set I consist of N images each having size a×b pixels. Using conventional row appending method converts each of the images into a×b dimensional column vector. [4],[8].

$$I = \{i_1, i_2, \ldots\ldots i_N\} \qquad (1)$$

- Covariance matrix c of training image set are calculated by using equation (2).[4][7]

$$c = \frac{1}{N}\sum_{n=1}^{N} (i_n - \bar{i})^T (i_n - \bar{i}) \qquad (2)$$

- Where is the mean vector of all images in the training set. Eigenvalue and eigenvectors of covariance matrix is calculated using equation (3).[4]

$$cv = \lambda v \qquad (3)$$

- Where λ denotes the eigenvalues of c, and v stands for the corresponding eigenvectors. Note that the rank of the covariance matrix is N, hence at most N number of eigenvectors can be computed.[4]

$$U = (i_n - \bar{i}) \times v \qquad (4)$$

- Where n = 1, 2... N. the Eigenvectors found, U have a face like appearance, they are called Eigen faces [6]. Sometimes, they are also called as Ghost Images because of their weird appearance. After the face space has been constructed, the feature vectors are formed as a linear combination of the eigenvectors of the covariance matrix. Project an image into the face space with the help of equation[4] and

$$P_n = U^T \times (i_n - \bar{i}) \qquad (5)$$

- Where Pn, n = 1, 2... N are the vector of weights associated with the eigenvectors in c. [4], [7].
- **FLOWCHART OF FACE RECOGNITION BY PCA:**

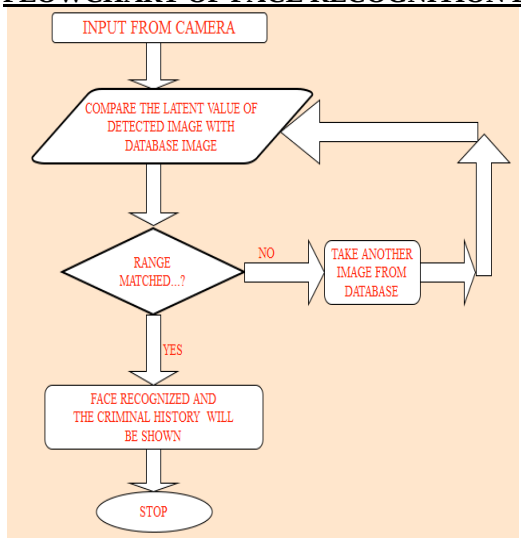

FIG.3: FLOWCHART-PCA

Algorithm for PCA:

- **Step 1:** First the face is detected by viola-jones method.
- **Step2:** Then capture image is converted into principle component and now we can compare the Eigen (latent) value of the capture image with Eigen (latent) value of database image.
- **Step 3:** If face is recognized correctly process will stop and then user information with its name will be shown.
- **Step 4:** If face is not recognized then step 2 & 3 follow respectively.

LIMITATION

- A drawback of PCA is that the results are not invariant to the particular choice of the physical units of the measurements. Each element of z is individually scaled according to its unit in which it is expressed.
- Changing a unit from, for instance, m (meter) to mm (micrometer) may result in dramatic changes of the principal directions.
- The result is mainly affected by variation in light intensity. (Table 3) [8].
- Complexity increases with increase in number of reference images.
  - **Precision=Correct/ (Correct+False Position) (A)**
  - **Recall=Correct/ (Correct+Missed) (B)**
  - **F1= (2*Recall*Precision)/(Recall+Precision) (C)**

  By equation (A), (B), (C) (FROM [8]) we get the result of precision, recall, F1

RESULT:

FIG. 4: RESULT BY PCA

FIG. 5: RESULT BY HISTOGRAM

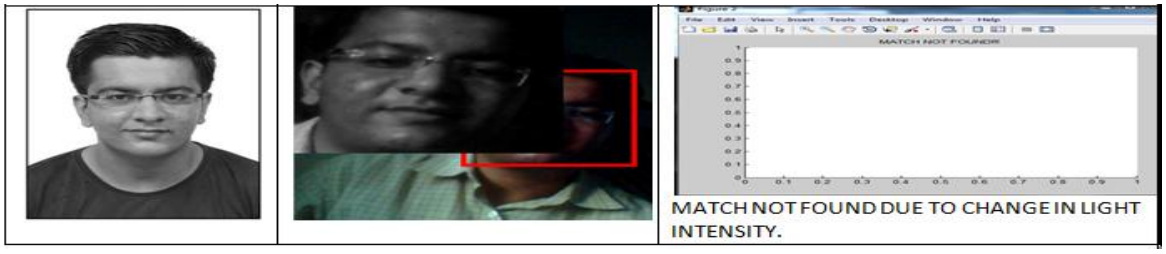

FIG. 6: RESULT BY PCA (not matched due to light intensity)

TABLE: 1 RESULT BY PCA AND HISTOGRAM.

NO. OF IMAGES IN DATBASE	DETECTION OF IMAGE	METHOD	RECOGNISED IMAGE	RECONITION (IN %)
5	100%	PCA	3 OUT OF 5	60%
5	100%	Histogram	2OUT OF 5	50%

TABLE: 2 RESULT BY PRECISION AND RECALL.

PERSON	RANGE OF FRAME	FACE DETECTED	FACE RECOG.	CORRECT	MISSED	FALSE POSITION	RECALL	PRECISION	F1
1	1-50	1	1(PCA)	6	4	0	0.6	0.86	0.7
1	1-50	1	1(HIST.)	5	5	1	0.5	0.83	0.62
2	1-50	2	1(PCA)	4	6	2	0.4	0.67	0.51
2	1-50	2	1(PCA)	3	7	2	0.3	0.60	0.40
2	1-50	1	1(HIST.)	3	7	2	0.3	0.60	0.40

TABLE: 3 RESULT BY VARIATION IN LIGHT INTENSITY.

VARIATION IN LIGHT INTENSITY	NO. OF FACE DETECTED	FACE RECOGNIZED	FACE RECOGNITION (%)
DARK	1 OUT OF 10 TIMES	1 OUT OF 10 TIMES	10%
DAY TIME	7 OUT OF 10 TIMES	7 OUT OF 10 TIMES	70%

FUTURE WORK:

- We can improve result by another method like wavelet and can get more accurate result about 80% to 90%.
- We can apply this system in school, colleges, organization, CID, police stations etc.
- We can improve this system with finger print and iris match security systems in place of face recognition.
- By creating database with more set of similar images and by comparing with one detected image we can get good result.

A. Conclusions

- We used feature-based method to recognize the face from database.
- We can improve by taking more no. of reference images.

- We conclude with the fact that our integrated approach to the detection, feature extraction and recognition is with high success.
  Our detections and recognition results, independently, are extremely competitive to the best detection and recognition results
- Further result can be improves by using more than one matching method.
- These other method can have different scales and rotations. It is also possible to improve the accuracy of the matching method by different approaches.

B. Acknowledgment

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