

Different approaches for human face detection leading to real time face analysis: A survey

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Abstract: Now a day's recognition of faces is very popular to identify or recognize a person. Face recognition plays a major role for security, surveillance and in forensics. Before recognizing the faces, first we need to detect the face and extract the vital features from the face image and then classification is performed on the face image for recognition process. Face detection is the initial step for face recognition. In this paper we discussed about some of the methods used for face detection and also face recognition. In addition to this, the advantages and disadvantages of the surveyed methods are also stated which will help for further development and improvement of the system leading to improved face analysis works.

Keywords: Face Detection, Face Recognition, Feature Extraction, Image Processing.

I. INTRODUCTION

Face Recognition is used widely in biometric systems. Now- a-days face recognition plays a vital role in many applications such as Human Computer Interaction, Information Security (e.g. Online banking), Virtual Reality, biometric (e.g. passport, driving license), Access Controls, Law Enforcement etc. Some of the biometric features like finger print, palm print, Hand Geometry, iris also used for Human recognition. But drawbacks with these approaches are they require a physical person.



Fig. 1 An example of Real Time Face Analysis based on human face detection [12].

So face recognition is more popular because this system does not need a direct co-operation from a person. It recognizes the person without instructing the person. So recognition of faces has beneficial features when correlated to the biometrics of others.

II. FACE RECOGNITION

Face Recognition [1,2] can be performed by following the steps below.

Step1: Face Detection

In this step, detect the face in the image. Pre-processing is performed to do noise removal in the image. Pose variations, facial expressions, illumination conditions, background, lighting conditions are the major challenges for detecting the faces.

Step2: Feature Extraction

In this step, relevant information (features) is extracted which is useful for further processing. Here it considers the presence of eyes, eyebrows, nose, lips, mouth, ears etc. in the image.

Step3: Classification

In this step, compare the input image with already trained image dataset for identification. If the input image matches by any features of the image in the trained images database then that image is considered as known image otherwise not.

There are three approaches for Face Recognition. One of the approach is based on the features i.e., extract the features of the face like eyes, lips, nose, cheeks, ears and calculate their measurements and put in to the structural classifier for further processing. Second approach is based on the holistic i.e., consider an entire region of face as input while detecting the faces. Third approach is based as hybrid i.e., consolidation of both features and entire face region is considered.

III. BACKGROUND AND LITERATURE REVIEW

In 1960's, Automatic face recognition was developed. In 1970's, measurements and locations of face features were computed manually. In 1990's, Principal Component analysis was introduced which is the standard linear algebraic technique for reducing the number of variables in face recognition. In 1991's, faces can be recognized automatically in real time by using the residual error for detection of face while using the technique of Eigen faces. In 2000's, the testing can be performed on some high resolution images and 3D images and get improved results when compared to the previous ones. Some of the difficulties are also met while recognizing faces in conditions such as lighting conditions, angle, and facial expression. Modern face recognition systems have challenged this illumination conditions and tried to give the better results and also leading to real time face detection and face analysis techniques.

IV. RELATED WORK

R. Bhaiswar, P. Kshirasagar, Ambarish A. Salodkar [3] worked on the face detection by using Genetic algorithm which is more robust from noise and gives the global optimum value. To find the head part of the image Ellipse model is used.

Siddharth Bhavsar, Niraj Achari, Bhavin Pandya [4] worked on the face detection based on Video. Here face detection is done in four modules such as Motion Detection, Face Skin and Geometry Verification and finally Eye feature verification.

Mr. Steven Lawrence Fernandes, Dr. GJosemin Bala [5] worked on the live face detection. Here Image Quality Assessment parameters are used for feature extraction for better results.

G. Shree devi, M. Munir Ahmed Rabbani, A. Jaya [6] worked on amalgamate dataset. These dataset is normalized by determining the median value for principal components of face. Instead of using the mean, median is considered for normalization because median gives better results when heterogeneous data is taken.

Archana Vijayan, Shyma Kareem, Dr. Jubilant J Kizhakkethottam [7] worked on gender transformed faces. With the help of SVM classifier, faces are recognized. Gender transformation is done by medical treatment i.e.,

Hormone Replacement Therapy (HRT) which alters the appearance of the body and face of a person. Changes in the face due to the HRT affect the face recognition system. So, a particularly intended face recognition is developed. Initially detect the face and eye and then perform alignment and cropping of the face image. Finally face recognition is done by using binary classifier SVM Classifier.

V. COMPARISON OF DIFFERENT ALGORITHMS FOR FACE RECOGNITION

A.A Novel approach for Face Detection in Complex Background Using Genetic Algorithm, 2012-by Roshan Bhaiswar, et.al.

One of the approaches used for face detection is Genetic algorithm [3]. Genetic algorithm comes under Adaptive heuristic search algorithm. Genetic algorithms are more robust compared to the conventional AI and is more efficient for solving the optimization problems.

Pre-processing:

Take RGB image as input image and then convert it into Grey Scale image for further processing and then image is resized as similar to the original image.

Then the image is processed for noise removal that means to avoid unnecessary data. And then, using Canny Edge Detector, edge of the image is detected.

To apply genetic algorithm for face detection, an ellipse model is constructed. The ellipse model finds location where the most suitable match exists by moving throughout the whole image. This process applies GA for the optimization of parameters of the ellipse.

Steps for Proposed algorithm:

Step1: Initialization of the Parent Population

Here Population means collection of chromosomes which are selected as randomly. Each chromosome in the population has fixed length and a chromosome is represented as a binary string of the set {0,1}. A chromosome have five optimization parameters which are X-coordinate of the ellipse, Y-coordinate of the ellipse, length of major axis, length of minor axis and angle of face. Each parameter occupies equal size. The population is stored in genotype data structure in matrix form.

Step2: Evaluations

A fitness value is assigned to the each chromosome based on their performance to solving the problem.

Step3: Selection

For select the superior fitness values of chromosomes concede Roulette wheel selection procedure. Next generated population directly inherit the chromosome which having the highest fitness value.

Step4: Cross-over

The cross-over operator are performed on pair of chromosomes which having the better fitness values and produce two off-springs.

Step5: Mutation

After Selection, the new population is generated. If the chromosomes in the population are not same then mutation operator is performed on the population with a mutation rate.

Step6: Conditional test

If it satisfies the predefined condition then get the best chromosome otherwise returned to Step2.

Ellipse Model:

Ellipse model is used to detect facial region. The five parameters of the ellipse model (X coordinates of the ellipse, Y coordinates of the ellipse, length of major axis, length of minor axis, Orientation of face) are converted into one string member of the population whose cost function will be evaluated by algorithms. By using these parameters head search algorithm is activated to find the faces.

Advantages:

- a) Produce accurate results with less computational cost.
- b) Ellipses can be detected within a reasonable time.
- c) Robust to noise and occlusion.

Disadvantages:

- a) GA's do not scale well with complex background.
- b) Repeated fitness function is not good for population with more chromosomes.

B. Face Detection based on Video, 2013-by Siddharth Bhavsar, et.al.

In this system, Face detection [4] can be done in four steps Steps for Proposed algorithm:

Step1: Motion detection:

In this, video is taken as a raw data that is any video format like .avi file and decompressed into frames. Each frame consist collection of pixels. The continuous frames are compared to calculate the number of pixels changed from one frame to another frame. This technique is called as "Frame differencing". Image segmentation is the fundamental approach for motion detection. Threshold plays vital role in Image segmentation. The frame differencing satisfies the predefined threshold value then considered that frame as output otherwise not.

Step2: Verification of skin on the face

In this, the motion detected part of video is processed to find the pixels meet the HSV value based on the skin colour or not.

Step3: Verify the Geometry of Face

In this, the Geometry of the detected region which is the output of above step is calculated by find the ratio of length and breadth of the face. The ratio is compared with threshold value. If the ratio satisfies the threshold value then detected region is sent to the next module.

Step4: Verification of Eye Feature

The detected region is checked with face features such as position of eyes, nose, mouth etc. It is tried to match with a low resolution image of a typical face that is focused on its features. If detected region meets the certain threshold value, then that region is the most probable face region in the video.

Advantages:

- a) It works on the moving objects. It does not consider the remaining still objects.
- b) The output of this system is taken as input for further face recognition systems.

Disadvantage:

It can't recognize the face correctly when the image has extra features such as the person wearing eye glasses, having beard etc.

C. Developing a Novel Technique for Face Live ness Detection, 2013-by Mr. Steven Lawrence Fernandez et.al. Live face detection [5, 10] can be done by using Image Quality Assessment (IQA) parameters such as calculation of Ratio of Peak Signal to noise, Normalized Absolute Error, Ratio of Signal to Noise, Mean of the Square Error, Total Edge Difference, Maximum Difference, Structural Similarity Index and Average of the Departure.

Steps for Live Face Detection:

Step1: Load face image as an input.

Step2: Face image is processed for resized.

Step3: Apply the Gaussian filter to remove the noise in input image.

Step4: From the filtered image, extract the features.

Step5: Image Quality Assessment is applied.

Step6: To check the given input image is live or fake, Classification is performed by Quadratic Discriminant Analysis.

Advantage:

It consider the macro features of face i.e., eye movement and mouth action. So it provides the additional security.

Disadvantage:

Need more computation time for extracting the features.

D. Face Recognition using Principal Component Analysis with Median for Normalization on a Heterogeneous Dataset, 2013-by G. Shree devi, et.al.

In our system, Heterogeneous data is (various age groups like old, middle aged, kids) taken as input. PCA [8] is a mathematical procedure that performs a dimensionality reduction by extracting the principal components of the multidimensional data [9]. PCA is used for normalize the data by noise removal. Median is the better approach for measures of central tendency when data is skewed [6].

Steps for Proposed System

Step1: Initially a dataset is constructed which consists of trained images of equal size.

Step2: RGB image is converted into Grey scale image for further processing

Step3: Convert each face which is in 2-D image data into a 1-D face vector.

Step4: To perform Normalization, construct a matrix. Each row in the matrix specifies the face information of the one person in dataset. And calculate Median vector for each column in that matrix.

Step5: Normalization on image means common features are removed from each face i.e., each face contains unique features obtained by subtracting the median vector from the corresponding column with each column value.

Step6: Eigen Vector and Eigen Values are calculated.

Step7: Reconstruct all the faces in trained dataset based on Eigen vectors.

Step8: Eigenvectors in lower dimensional space and higher dimensional spaces are mapped correspondingly. Because Eigenvectors (also called as Eigen faces) has original dimensionality of the face vectors.

Step9: Reconstruct the faces in the heterogeneous data set.

Step10: Individual image in the trained data set is the amalgamation of the Eigen faces plus the median image. Calculate the weight vector for all images in the dataset. A strange face is considered calculate the weight vector for that strange face and compared with weight vectors of the images in training data set.

If weight vector of the strange face is similar to the any one of the weight vector of images in the dataset, then that strange face is declared as known face otherwise not.

Advantages:

- a) It is efficient approach when worked with heterogeneous dataset.
- b) Reliability and Robustness.

Disadvantages:

- a) Each face must be taken as same size.
- b) Scaling can be done smoothly.
- c) Needs more time to learning so update the face in dataset is difficult.

E. Face Recognition across gender transformation using SVM Classifier, 2016-by Archana Vijayan, et.al.

Gender Transformation [11] can be done by replacing the sex hormone in a person. Then that person is identified as transgender person. This approach is also known as Hormone Replacement Therapy which is also termed as Medical Alteration. This Transgender Hormone Replacement Therapy changes the person physical

appearance like texture of skin, body hair, face expressions etc. Our system recognizes the faces of these medically altered faces. So develop a particular-based face recognition system. Initially face is detected and then detect eye region, then perform alignment and cropping. Using Patch Based Local Binary Patterns represent the face images and then finally recognize the face by binary classifier SVM Classifier[7].

Steps for Proposed system:

Face recognition of medically altered face is performed. Here Medical alteration means gender transformation done by Hormone Replacement Therapy which causes the changes in person physical appearance of the face and body.

Step1: Detect the Face and Eye image:

Face Detection:

- Using Viola-Jones method face is detected.
- For fast feature extraction generate an integral image initially.
- Construct classifier by selecting small number of useful extracted features using AdaBoost.
- And then, crop face image into face region then compute the global threshold.
- By using this, binary image is obtained from intensity image.
- Eye Detection:
- Generate Fourier transformed image and ASEF filter for accurate Eye detection.
- Eye centre coordinates and false positives are detected and then face region is segmented

Step2: Perform Alignment, cropping and affine transformation on the face image:

Affine Transformation:

- Maintaining the co linearity of points and ratio of distance.
- Translation and rotation can't be done separately.

Alignment:

Eye centre coordinates which are obtained from eye detectors are used for aligning the face image. By using eye centre coordinates perform rotating, scaling and cropping operations on the image to set the size of reference image.

Cropping:

Crop the face means divide the face into regions such as eyes (left eye, right eye), nose, mouth.

Step3: Representation and Face Recognition:

Representation:

Represent the alignment and cropped images by performing Three-Patch Local Binary Patterns.

Face Recognition:

Faces are detected using Support Vector Machine (SVM) which uses the set of classifiers. Each classifier gives its decision. Voting rule is applied for take final decision.

Advantages:

- Frames which are not identified by Face and Eyedetectors are discarded.
- Detect only real features in face and in particular area with the help of segmentation.

Disadvantages:

- Process can run slowly.
- Expensive for computational process.

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VI. CONCLUSION

In this paper we discuss the various face detection algorithms such as genetic algorithm, novel technique for live face detection and face detection based on video which give the better results for further face recognition process and also discuss some face recognition algorithms such as how to normalize the heterogeneous data based on principal component analysis with median and recognising the gender transformation of faces with SVM Classifier which is helpful for the future work.

Live face detection is a better approach for identifying the faces with any illumination conditions such as complex background and even for the person having various poses. Also PCA is used to recognize the faces by using central tendency measure median for normalize the heterogeneous data. These all techniques can thus lead to an advanced real time face analysis.

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