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> ABSTRACT Face is a multidimensional structure and requires good computational techniques for detection and recognition 7

in order to mark attendance of the class The detection is performed using skin color detection and viola and jones algorithm . Viola and Jones algorithm uses integral image for feature computation, Adaboost learning technique for feature selection and an cascade classifiers for efficient and fast detection.

> Face recognition is done by Principal Component Analysis (PCA) where face images are projected onto a new face space that encodes maximum variation among known faces. The new face 1

consists of a set of eigen vectors and are called eigen faces , these eigen faces

> may not correspond to general features such as lips, nose, eyes etc. The eigen face approach uses PCA for recognition of face images. This is performed by projecting previously extracted face image onto a new set of face space that represent significant variations among known face images. The detected test face 7

is

> matched against the faces stored in the database for recognition. The 1

PCA mainly accounts for dimensionality reduction of training set of face.This face detection and recognition technique is used for marking attendance of the class Contents 1 Introduction 1.1 Detection . . . . . 1.1.1 Viola and Jones method . . . . . 1.1.2 Skin detection

chart . . . . . 5 5 6 9 14 15 16 17 17 18 18 19 20 20 21 22 23 26 Chapter 1 Introduction Face recognition is mainly

used in video surveillance , human computer interface, Image database management **16**

and for authentication and security purposes. Image based attendance monitoring system is a computer applicable system capable of de- tecting and recognizing a person in a class group image. The main objective of the project is to eliminate the traditional roll call in a class room which is time consum- ing. The approach involves capturing a group image which is subjected to detection using skin detection, Viola and Jones Algorithm. The detected faces are projected on new face space where it is compared against previously stored face images .Once the match is found the attendance is marked 1.1 Detection The detection is achieved using two different algorithm 1.1.1 Viola and Jones method Viola and Jones object detection frame work is one of the most widely used real time objection algorithm . The learning speed is slow but has high detection rate .The detection is done using haar features .The given image is converted into an in- tegral image and haar filters are run over the subwindow for detection .The algorithm consists of cascade classifiers which consists of set of stages each involving certain number of features selected using Adaboost learning algorithm. The classifier ob- jective is to increase detection rate by discarding subwindows in which no faces are present and to pass the subwindows on to next stage which maybe a face. The viola and Jones algorithm is preferred over skin detection method because of its higher detection rate. 1.1.2 Skin detection method Colour is one of the important features

of human faces. The skin color chosen as a feature to detect the face has many advantages. **11**

The method of Colour

processing is much faster when compared to facial features **11**

processing. It is found to be robust even with changes in orientation and scaling. The main disadvantage of any colour processing method is that it is highly sensitive to illumi- nation, colour changes. In this project, we have used an algorithm based on skin colour classification using RGB, YCbCr and HSI colour models. 1.2 Recognition The face image is recognized by projecting it to a new face space where the im- age is represented using set of eigenvectors also called as eigen faces . This face image is matched to a face which is stored in database and is represented by linear combination of Eigen faces . The matching is done by finding Euclidean distance which finds the closest match.The dimensionality reduction is done using Preincipal component analysis(PCA) which results in increased computational speed. Chapter 2 Literature Survey 2.1 Viola and Jones face detection A face detector has to tell if the given image consists of human face and if so the position of human face .Face detection can be achieved using Viola and Jones algorithm which is a robust algoritm having slow learning rate but high detection rate. The characteristics of Viola and Jones algorithm are: â€¢ Robustness - very high detection and low false-positive rate â€¢ Real time - performs real time face detction The algorithm has four stages: 2.1.1 Haar Feature Selection All human faces have some similar properties and these regularities can be matched by using haar features.

Haar features are basically rectangular features and each fea- ture corresponds to a particular location in face subwindow. The value of the haar feature is given by Value = âˆ‘(pixels in black area) - âˆ‘(pixels in white area) 2.1.2 Creating an Integral Image In an integral image, each pixel is given by the summation of pixels to the left and pixels above it. Integral image provides considerable speed advantage when compared to actual image in applying haar features. 2.1.3 Adaboost Training In a standard 24 by 24 pixel sub window, there are maximum of 1,62,336 possible features, and it is tedious to evaluate all the features on test image. Thus, the detec- Figure 2.1: Rectangular HAAR features Figure 2.2: Input image and Integral image tion scheme employs AdaBoost learning algorithm which selects the best features and trains classifiers that use these features. This algorithm linearly combines a set of weighted weak classifiers to form a strong classifier. 2.1.4 Cascading Classifiers Cascading classifiers consists of a set of stages in which corresponds to a strong classifier. All the features are grouped into a number of stages where each stage consists of a fixed number of features. Each classifier consists of a set of features that are required in detection of face and rejection of non faces. Each stage determines whether a given sub-window not a face or maybe a face.The face is detected if and only if it passes through all the classifiers. Figure 2.3: Cascading classifiers 2.2 Skin detection method An overview of the proposed system being used for face detection contains

of a training and detection stage. In the proposed colour-based approach used in face detection the 2

following three widely known and used

colour spaces namely RGB , HSV and YCbCr are used to construct the proposed Hybrid model. Bounding planes or the rules for constraining of each skin colour subspace are constructed from their respective skin colour distributions. In the beginning step of the detection stage, the mentioned bounding rules are made use to segment the skin regions of input 2

image given to the skin detection algorithm. Then

a combination of morphological operations is applied to the skin regions extracted in order to eliminate possible non- face skin regions. The 4

proposed approach is restricted to colour images. 2.2.1 RGB-HS-CbCr Model â€¢ Skin Colour Bounding Rules : The set of images used for training were analysed

in the RGB , HSV and YCbCr spaces. In RGB space, the 4

3 channels do not have well-distinguished skin colour regions. In the

HSV space, the H (Hue) channel shows significant dis- crimination of the skin colour regions. In the RGB space , appropriate skin colour rules 4

are used . Based on the observational analysis , it is concurred that the two subspace

Cb- Cr is a strong discriminant of skin colour. 2

In the HSV space, it is observed that the

hue and saturation values produce the most noticeable segregation between skin and non-skin regions. 4

Each pixel that fulfils the defined rules

is classified as a skin colour pixel. 26

â€¢

Skin Colour Segmentation : The proposed combination consisting the bounding rules from all the three sub- spaces RGB, HS and CbCr is named the RGB- HS - CbCr skin colour model. Al- though skin colour segmentation is considered to be a low- level 2

extraction, the precise segmentation of the regions are crucial . This

segmentation technique, which uses all 3 colour spaces, was designed in order to boost the accuracy of face detection. 2

The resulting segmented skin colour regions appear to have three issues in common: â€“ Regions are fragmented and consist a few holes and gaps often . â €“ Multiple faces of close proximity may result in erroneous 2

labelling. â€“ The Extracted resultant

skin colour regions may not necessarily be face regions 2

of the subject , but

there are also possibilities that certain regions of the skin may belong to exposed limbs (arms and legs) and also background and foreground objects that have a high degree of similarity to skin colour. 2

2.2.2

Morphological Operations The next step of the face detection system involves the use of morphological op- erations to refine the skin regions that are extracted from the segmentation step. The first step is a simple hole filling operation to fill any holes or gaps in individual blobs. For opening narrowly connected blobs we subtract the image obtained from 4

the main binary image for a specified number of times, finally separating the narrowly con- nected regions. As the subtraction leads to loss in size of the individual blobs our final morphological operation includes a dilate function used to maintain a particular size of the skin detected individual blobs. 4

2.3 Eigen Face Approach The

Eigen face approach is an efficient method which can be used in face 1

recog- nition beacuse of its ease of implementation,

speed and its learning capability. Eigen faces are basically the set of Eigen vectors which are used in Computer Vision prob- lem of human face recognition. 1

The eigenfaces approach usedfor facial recognition was first proposed by Kirby and Sirovich (1987) and was later used by Turk and Pentland in the classification of faces .They used appearance based approach for face recognition which involved capturing the

variation in a collection of face im- ages and using this variation to encode and compare the individual face images in a suitable manner. The approach for Eigen faces 1

began with the search of representaion of facial images with reduced dimension. PCA is used on a set of

face images to obtain a set of basis images. These basis images are nothing but basis features and are known as Eigenfaces.These basis images can be linearly combined to obtain any face in the training data set If the training set consists of M face images, PCA can be used to obtain N basis images where N is always less than or equal to M. As the number of eigen face chosen increases the reconstruction error increase but in order to have reduced dimension the number chosen is always less than M inorder to achieve dimensionality reduction. In Eigen face approach a face

> image with N x N pixels is considered a point in N2 dimensional Space.[**14**

5] The recognition involves efficient extrication of useful information from

> a face image, encoding and matching the face encoding with **25**

train- ing set

> of faces encoded similarly. A simple approach to extracting the information content in a face image is to capture the variation in a collection of face images. We need to find the **1**

covariance matrix for

> the training set of face images that is the principal components for the **22**

distribution of face images.

> We can display Eigen vector as a face since each **1**

eigen vector is a contribution of each face images. These Eigen faces can be linearly combined to represent each image in the training set.

> The number of face images in the training set is always greater than or equal to the **15**

possible eigen faces. The faces

> in the training set can be even approximated by using the Eigen vectors which have large Eigen values. **1**

The Eigen vectors with largr Eigen values correspont to

most variance in the set of face images. Lesser the 1

number of Eigen faces used higher is the computational efficiency. 2.3.1

Eigen Values and Eigen Vectors In linear algebra, the Eigen vectors of a linear operation is a non-zero vectors 12

whose direction does not change when linear transformation is applied to it,The linear transformation involves multiplication of a scalar. Scalar assosciated with the eigenvector (X) is called the Eigen value (Î»). [5]This can be given by

AX = Î» X, where A is a Vector valued function. (A â^' Î»I)X = 0, where I is the Unity matrix. This is a homogeneous system of equations and form fundamental linear algebra. We know that a non-trivial solution exists if and only if D(AI) = 0, where D is the determinant. 5

Under evaluating this equation we obtain a n degree polynomial and is known as

characteristic polynomial of A. If A is N x N then there exists n roots of the characteristic polynomial. Thus there exists n Eigen values of A which satisfies the equation. AXi = Î»i Xi , where i 5

ranges from 1 to n. There exists n linearly independant Eigen vectors if all the eigen values are distinct,spanning over an n dimensional Euclidean space with unique directions. 2.3.2 Face Image Representation The representation involves conversion of m face images of size N x N to a column vector

of size N2.Each face image is represented by Î“1,Î“2,Î“3,..,Î“M. 5

The Each face image consists of a feature vector

stored in a N x N matrix. This multi dimensional vector is changed to one dimensional vector 1

or column vector. Figure 2.4: Multidimensional vector to column vector 2.3.3 Mean and Mean Centered Images This involves removing DC component from all the mages that is the common features shared by all the images are removed so that each image is left with unique features. The

mean face is given by Î¨ = (1/M) âˆ‘Mi =1 1

Î“i The Normalised face images are given by the formula Ï‚i = Î“i â€² Î¨ ,where Î“i repre- sents ith face image 2.3.4 Covariance Matrix

A covariance matrix is constructed as: C = AAT ,where A = [Î¦0 ,Î¦1,..,Î¦m] of size N2 x N2. Eigen vectors corresponding to this covariance matrix is to be calculated, 8

but it will be a tedious process which would generate N2 eigen vectors each of size N2 x 1 dimension .If there are M images then the number of eigen faces selected should be equal or less than M. This problem is solved using dimensionality reduc- tion where eigen vectors are found using covariance of reduced dimension given by C= AAT ,where A =[Î¦0, Î¦1, .., Î¦M] of size M x M Consider eigen vector vi of AAT such that AT Avi = uivi Premultiply both side by A ,we have AAT Avi = uiAvi From this it can be seen Avi is the eigen vector of AAT . 2.4

Eigen face space The eigen vectors of covariance matrix AAT is given by vi.vi which resembles 5

ghostly faces are eigen faces.Only â€™Kâ€™ eigen faces with maximum variance that is the one which correspond to higher eigen values are considered. . Face image is projected on to eigen face space is given by â„¦k=uT (Î“k â€² Î¨) where K<M 2.5 Recognition The test

image is projected on to a new face space. The 24

vector â„¦ obtained is given as â„¦ = uT

(Î“ â€² Ï‚) The distance of â„¦ to each face is calculated using euclidean distance which is given by Îµk = (â„¦ â€² â„¦k)2 Where K 1

ranges from 1 to M and â„¦k câ€šorresponds to Kth face. The minimum Îµk euclidean distance obtained from face class corresponds to the matched image. Chapter 3 Software Requirements Specification The implementation of the project was done using Matlab. Face detection was also done using OpenCv 3

.1 Matlab Matlab is a high performance language for technical computation, visualisation and programming in easy to use environment. 13

Matlab provides variety of usess which include development of algorithm, data aquisition, data analysis , exploration ,visual graphics ,scientific and engineering projects. Matlab also provides a variety of toolboxes which consists of a set of reference standard algorithms which ease problem solving. Examples of some of

the impor- tant toolboxes available are Neural network, signal processing, image processing , wavelets. The Matlab GUI allows user to create their own custom apps. It integrates two primary tasks of app building which involves laying out visual components and al- lowing to quickly move between code development in an integrated version and visual design in canvas.

3.2 OpenCv OpenCV(Open Source Computer Vision) 21

is alibrary of programming functions, that ismainly aimed at real-timecomputer vision. The application areas of OpenCV in- clude 2D and 3D feature toolkits, Ego motionestimation, Facial recognition system, segmentation and recognition, motion understanding, human-computer interaction, gesture recognition, motion tracking, augmented reality etc. 3.3 python Pythonis awidely

used high-level programming language that is for general-purpose programming. 18

Python has a

design philosophy that emphasizes on code readability and a syntax that allows programmers to express concepts in fewer lines of code than in languages such as C++ or Java.The language provides constructs that are intended to enable the writing of clear programs on both a small and large scale. Python sup- ports multiple programming paradigms, including object oriented, imperative, func- tional programming, and also procedural styles. It has a comprehensive and 6

large standard library. Chapter 4 System Design

4.1 Block Diagram Figure 4.1: Block Diagram 19

In this block diagram a class group image is taken.The group image is subjected to detection through viola and Jones algorithm .The detected faces are then subjected to recognition using Eigen faces and PCA by comparing it against the stored data set. Once the faces are recognised the attendance is marked. Chapter 5 Implementation Implementation Involves five important steps â€¢ Training Set â€¢ Capturing a group image â€¢ Detection of faces â€¢ Recognition of faces â€¢ Marking attendance 5.1 Training set The training set consists of eleven different students with five images each, thus creating a training set of 55 images.Each subset consists of mainly front images with different facial expressions and rotation along left and right directions. The images were taken using different cameras in a classroom. The images are stored in jpg format. Figure 5.1: Single face image with different expressions 5.2 Testing condition â€¢ Illumination âˆ' Varying

intensity of light on face may affect the recognition, just as bright light results in 9

image saturation. â€¢ Size variation âˆ’ The variation of the size of Image may alter the recognition accordingly.

â€¢

Expression âˆ’When a expression of a person is changed the orientation of face organs are changed thus changing the feature vectors accordingly. Therefore the new expressions alters recognition procedure. 1

5.3 Capturing group image Group image is captured on an android device of 16MP resolution Figure 5.2: Group image 5.4 Face detection face detection is achieved using two different methods â€¢ viola and jones object face detection â€¢ skin detection method 5.4.1 Viola and Jones face detection Figure 5.3: Flowchart for viola and jones algorithm The group image is subjected to viola and jones algorithm which consists a set of classifiers to detect faces. Figure 5.4: Detected faces 5.4.2 Face detection using skin tone segmentation Figure 5.5: Flowchart for skin colour detection The detection method involves extracting the skin regions from the image and segmenting the face regions for recognition. The detection efficiency is very low compared to viola and jones face detection method. Figure 5.6: Face detection using skin colour segmentation 5.5 Face recognition using eigen faces The detected faces are subjected to recognition by comparing to the stored data set 5.5.1

Mean face Mean face is obtained by using the formula Î¨ = (1/M) âˆ‘iM =1 Î“i where 1

Î“1, Î“2, Î“3, .., Î“M are training set images The mean face is calculated to eliminate dc component from training as well as test face images. Mean centered images or Normalised face images are also evaluated by using for- mula Ïˆi = Î“i âˆ’

Î¨ for further computations Figure 5 .7: Mean face 1

image 5.5.2

Eigen Face The eigenvectors corresponding to the covariance matrix define the Eigen face which have a ghostly face appearance 1

. Each face from the training set with a weighted sum of k eigen faces and mean face The test mean centered image is rep- resented in terms

of Eigen faces and is compared against the eigen vectors of 23

stored database using euclidean distance . Figure 5.8: Top twenty Eigen faces 5.6 Attendance sheet The recognised faces are marked present on the attendance sheet Figure 5.9: Attendance sheet Chapter 6 Result Analysis 6.1 Detection and Recognition Figure 6.1: Group image The above Image is given as input to Viola and Jones algorithm for face Detection. The detected faces are then subjected to

6.1.1 Detection Figure 6.2: Detected faces A total of 11 faces are detected using viola and jones algorithm.The detection accuracy is found to be 92 %. Detection Accuracy depends on these constraints â €¢ The algorithm works only on front facal images. â€¢ Maximum 45o roation along both horizontal and vertical axis â€¢ Overlaping of faces. 6.1.2 Recognition Figure 6.3: Positive and False match The recognition Accuracy is found to be 64% since 7 positive match and 4 false match was obtained. The recognition is greatly affected under varying lighting conditions.

In this project we implemented Image based attendance monitoring system in which detection was accomplished using Viola and jones algorithm over skin seg- mentation method since it had higher detection efficiency. The recognition was ac- complished using Eigen face and principal component analysis approach. The Eigen face and PCA approach provided fast and efficient results in different conditions of face orientation. However the approach is sensitive to varying light conditions. 7.2 Future Scope In this thesis we use Eigen face approach and Principal component analysis for face recognition.The approach involves reducing the dimension and representing each image by a linear combination of Eigen vectors also called as

error rate increases hence it is neces- sary to choose the value of K such that maximum dimensionality reduction occurs along with a good recognition efficiency Also the system provides appreciable re- sults under well constrained environment. It is necessary to make the system to work under unconstrained environments such as varying lighting conditions. Finally it is necessary to implement on Android platform so that marking of attendance can be directly made on the mobile device along with the dedicated attendance web server. References [1] Face recognition using eigen faces; A. P. Pentland and M. A. Turk [2] Face Recognition Using Principal Component Analysis Method; Liton Chandra Paul and Abdulla Al Sumam [3] Principle Component Analysis in Image Processing ;Pallavi M Sune ,Vijaya K Shandilya. [4] Rapid Object Detection using a Boosted Cascade of Simple Features; Paul Vi- ola and Michael Jones [5] Face Detection Using Skin Tone Segmentation ;Sayantan Thakur , Sayantanu Paul, Ankur Mondal [6] https://blog.cordiner.net/2010/12/02/ eigenfaces-face-recognition.com [7] https://en.wikipedia.org/wiki/Eigenface Appendix A Project Planning A.1 Gantt chart Figure A.1: Gantt chart The first phase involves study of detection using skin colour detection and Viola and jones method.The next phase includes recognition using Eigen faces and PCA. The last phase includes integration of detection and recognition algorithm for atten- dance monitoring using group images IMAGE BASED ATTENDANCE MONITORING SYSTEM IMAGE BASED ATTENDANCE MONITORING SYSTEM IMAGE

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