A

Project Report

On

“FACE RECOGNITION”

By

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TY [CSE-II]

Under The Guidance

Of

Mr. R. G. Bisen

(DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING)

Submitted to

Mahatma Gandhi Mission’s College of Engineering, Nanded (M.S.)

Under

DR. BABASAHEB AMBEDKAR TECHNOLOGICAL UNIVERSITY, LONERE

Academic Year 2022-23

A Project Report on

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In partial fulfillment of the requirement for the degree of

BACHELOR OF TECHNOLOGY

In

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Certificate

This is to certify that the project entitled

“***FACE RECOGNITION***”

*being submitted by **Mr. Md Khizar Sufiyan& Mr. Shaikh Noman Ahmed** to the Dr. Babasaheb Ambedkar Technological University, Lonere, for the award of the degree of Bachelor of Technology in Computer Science and Engineering, is a record of bonafide work carried out by them under my supervision and guidance. The matter contained in this report has not been submitted to any other university or institute for the award of any degree.*

Mr. R. G. Bisen

Project Guide

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ABSTRACT

Facial recognition is a way of identifying or confirming an individual's identity using their face. Facial recognition systems can be used to identify people in photos, videos, or in real-time. Facial recognition is a category of biometric security.

The camera detects and locates the image of a face, either alone or in a crowd. The image may show the person looking straight ahead or in profile.

The face capture process transforms analog information (a face) into a set of digital information (data) based on the person's facial features. Your face's analysis is essentially turned into a mathematical formula. The numerical code is called a faceprint. In the same way that thumbprints are unique, each person has their own faceprint.

An attendance system using Face Recognition feature with OpenCV library of Python. You can create a dataset of your face and train the system with that dataset, with this trained model we implemented attendance system to recognize the face and mark the attendance of user using provided user id.

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Chapter 1

INTRODUCTION

Face recognition is different from face detection. In face detection, we had only detected the location of human faces, and we recognized the identity of faces in the face recognition task.

Face Recognition is a technology capable of identifying or verifying a person's face with digital masking from image or video. So many methods in face recognition systems. Face recognition uses biometrics to map facial features from an image or video. Face recognition can help verify the personal identity from the face of a person. With these features of face recognition, we think face recognition can help people to verify attendance. In today's digital age, face recognition is very helpful in this era. Especially for work areas that require attendance verification. Maybe some parts are now relying on technology to verify attendance. But some still use traditional methods that take a long time. Therefore face recognition is very helpful in terms of verifying attendance to speed up the process of recording and verifying the person [5].

Face recognition is one of the most intensively studied technologies in computer vision, with new approaches and encouraging results reported every year. Face recognition approaches are generally classified as feature-based and holistic approaches. In holistic based approaches, recognition is done based on global features from faces, whereas in feature-based approaches, faces are recognized using local features from faces.

A face recognition system is a perfect way to solve these problems. Using face detection, student's faces will be taken in realtime while the student is learning in class without them noticing and the learning process will be smooth. Students also can be attentive without being disturbed to sign for their attendance and lost some of the information that is given by the lecturer. As for the lecturer, there is no hassle to keep all the student's attendance registers for reports later because the attendance is automatically generated by the system. The data generated for the report will be accurate and there will be no more misleading data since the chances for students to forge the documents are eliminated [10].

There are many algorithms available in the market for face recognition. This broad computer vision challenge is detecting faces from videos and pictures. Many applications can be built on top of recognition systems. Many big companies are adopting recognition systems for their security and authentication purposes.

1.1 Use Cases of Recognition Systems

Face recognition systems are widely used in the modern era, and many new innovative systems are built on top of recognition systems [12].

There are a few used cases :

- Finding Missing Person
- Identifying accounts on social media
- Recognizing Drivers in Cars
- School Attendance System

Several methods and algorithms implement facial recognition systems depending on the performance and accuracy.

1.2 Traditional Face Recognition Algorithm

Traditional face recognition algorithms don't meet modern-day's facial recognition standards. They were designed to recognize faces using old conventional algorithms.

OpenCV provides some traditional facial Recognition Algorithms.

- Eigenfaces
- Scale Invariant Feature Transform (SIFT)
- Fisher faces
- Local Binary Patterns Histograms (LBPH)

These methods differ in the way they extract image information and match input and output images [11].

LBPH algorithm is a simple yet very efficient method still in use but it's slow compared to modern days algorithms.

1. Geometric: Is based on geometrical relationship between facial landmarks, or in other words the spatial configuration of facial features. That means that the main geometrical features of the face such as the eyes, nose and mouth are first located and then faces are classified on the basis of various geometrical distances and angles between features.

2. Photometric stereo: Used to recover the shape of an object from a number of images taken under different lighting conditions. The shape of the recovered object is defined by a gradient map, which is made up of an array of surface normals (Zhao and Chellappa, 2006) [1].

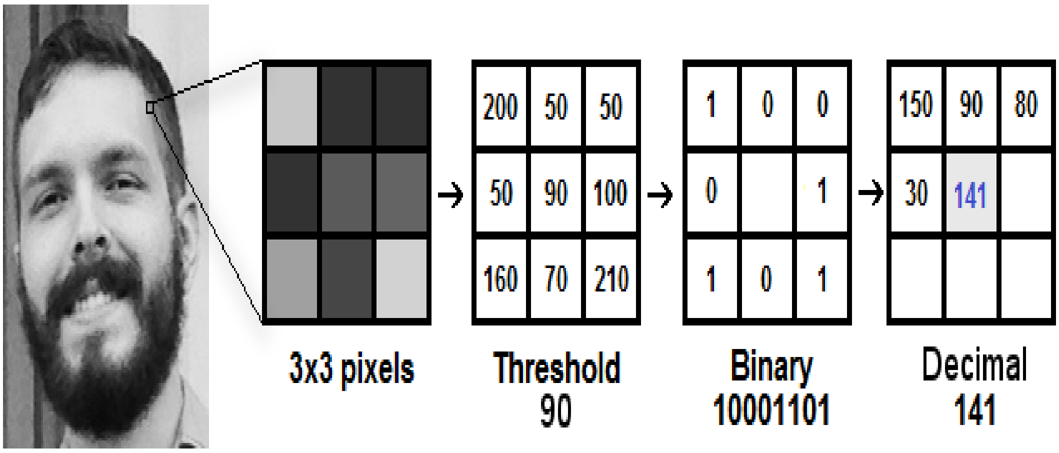


Fig. 1.1: Black and white picture

1.3 Deep Learning For Face Recognition

There are various deep learning-based facial recognition algorithms available.

- DeepFace
- DeepID series of systems,
- FaceNet
- VGGFace

Generally, face recognizers that are based on landmarks take face images and try to find essential feature points such as eyebrows, corners of the mouth, eyes, nose, lips, etc. There are more than 60 points [5].

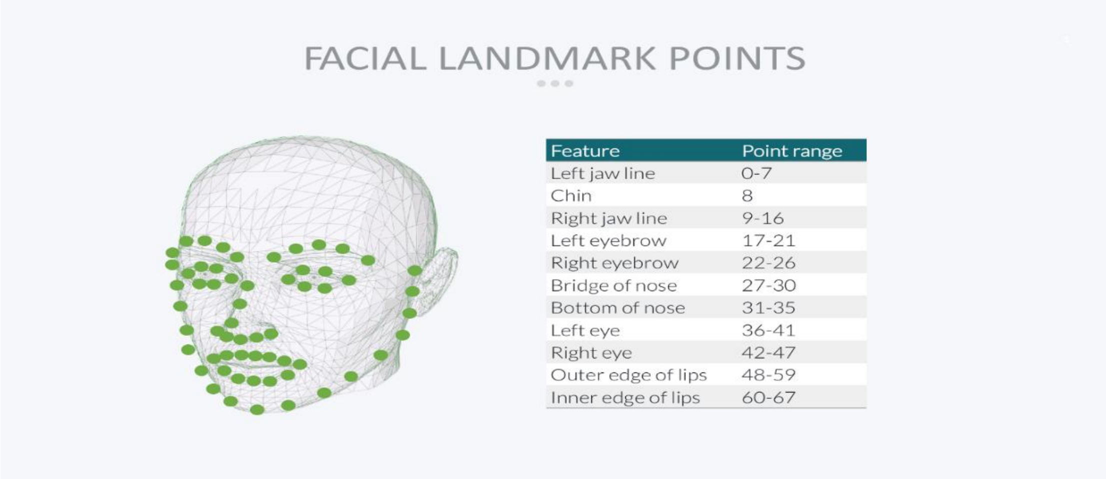


Fig. 1.2: Facial Landmark Points

1.4 Steps Involved in Face Recognition

1. **Face Detection**: Locate the face, note the coordinates of each face located and draw a bounding box around every faces.
2. **Face Alignments**. Normalize the faces in order to attain fast training.
3. **Feature Extraction**. Local feature extraction from facial pictures for training, this step is performed differently by different algorithms.
4. **Face Recognition**. Match the input face with one or more known faces in our dataset.

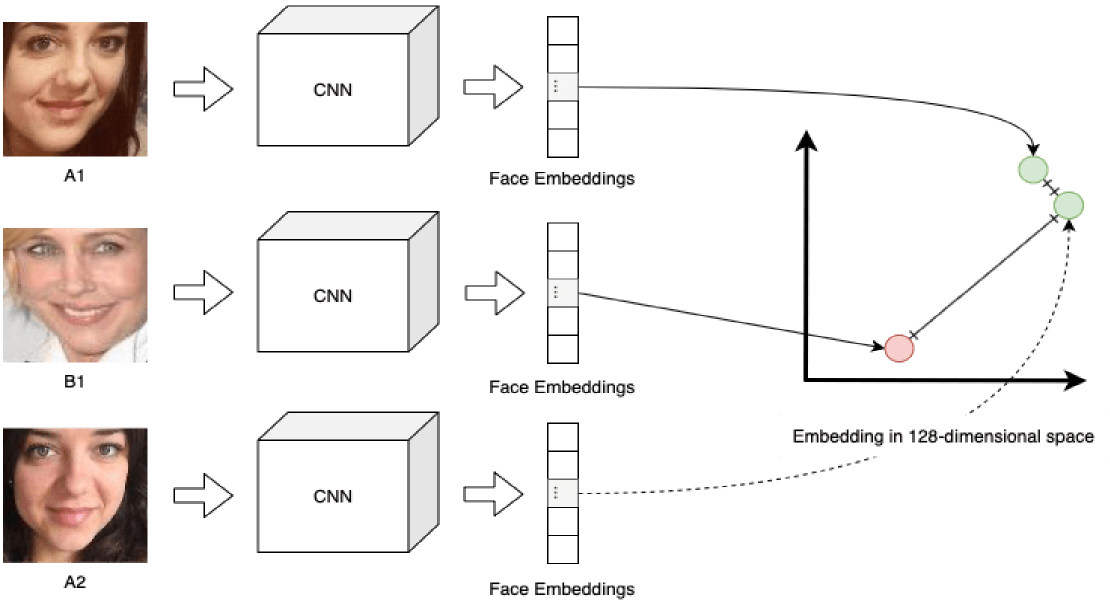


Fig. 1.3: Implementation Of Face recognition

This article focuses on implementing face recognition using the library face recognition, built on deep learning techniques and promises accuracy greater than 96% using a single training image [9].

1.5 FACE DETECTION:

Face detection involves separating image windows into two classes; one containing faces (traning the background (clutter). It is difficult because although commonalities exist between faces, they can vary considerably in terms of age, skin colour and facial expression. The problem is further complicated by differing lighting conditions, image qualities and geometries, as well as the possibility of partial occlusion and disguise. An ideal face detector would therefore be able to detect the presence of any face under any set of lighting conditions, upon any background. The face detection task can be broken down into two steps. The first step is a classification task that takes some arbitrary image as input and outputs a binary value of yes or no, indicating whether there are any faces present in the image. The second step is the face localization task that aims to take an image as input and output the location of any face or faces within that image as some bounding box with (x, y, width, height) [6].

The face detection system can be divided into the following steps:-

1. **Pre-Processing:** To reduce the variability in the faces, the images are processed before they are fed into the network. All positive examples that is the face images are obtained by cropping images with frontal faces to include only the front view. All the cropped images are then corrected for lighting through standard algorithms.

2. **Classification:** Neural networks are implemented to classify the images as faces or nonfaces by training on these examples. We use both our implementation of the neural network and the Matlab neural network toolbox for this task. Different network configurations are experimented with to optimize the results.

3. **Localization:** The trained neural network is then used to search for faces in an image and if present localize them in a bounding box. Various Feature of Face on which the work has done on:-

   Position Scale Orientation Illumination

Chapter 2

LITERATURE SURVEY

Face detection is a computer technology that determines the location and size of human face in arbitrary (digital) image. The facial features are detected and any other objects like trees, buildings and bodies etc are ignored from the digital image. It can be regarded as a specific ‘case of object-class detection, where the task is finding the location and sizes of all objects in an image that belong to a given class. Face detection, can be regarded as a more general case of face localization. In face localization, the task is to find the locations and sizes of a known number of faces (usually one). Basically there are two types of approaches to detect facial part in the given image i.e. feature base and image base approach. Feature base approach tries to extract features of the image and match it against the knowledge of the face features. While image base approach tries to get best match between training and testing images [10].

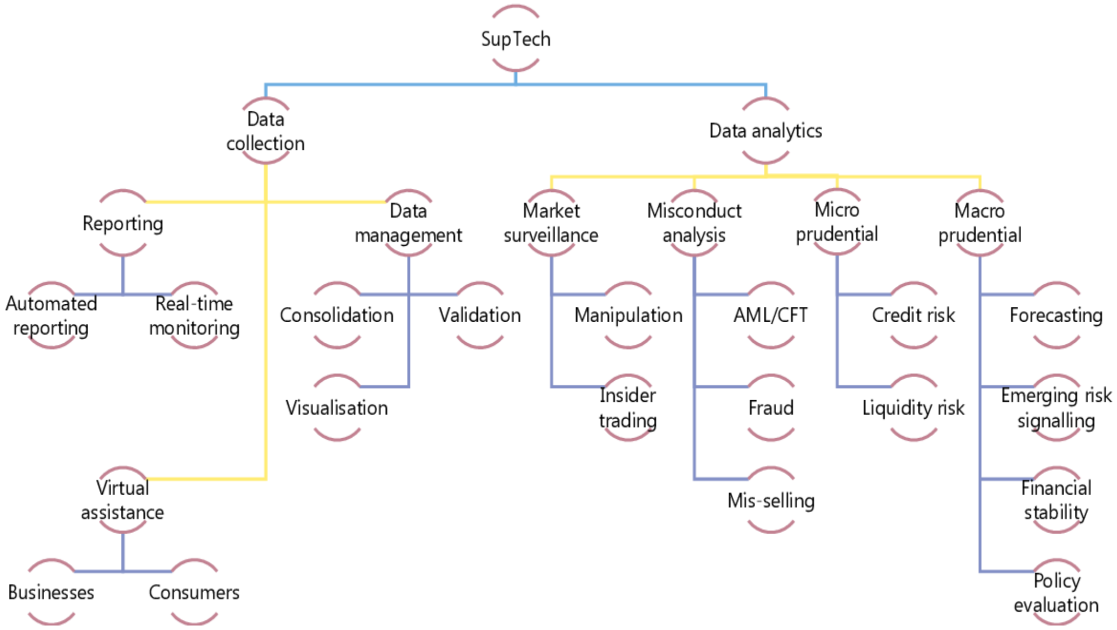


Fig. 1.4: detection methods

2.1 FEATURE BASE APPROCH:

Active Shape Model Active shape models focus on complex non-rigid features like actual physical and higher level appearance of features Means that Active Shape Models (ASMs) are aimed at automatically locating landmark points that define the shape of any statistically modelled object in an image. When of facial features such as the eyes, lips, nose, mouth and eyebrows. The training stage of an ASM involves the building of a statistical.

a) facial model from a training set containing images with manually annotated landmarks.

   ASMs is classified into three groups i.e. snakes, PDM, Deformable templates.

b) 1.1) Snakes: The first type uses a generic active contour called snakes, first introduced by Kass et al. in 1987 Snakes are used to identify head boundaries [8,9,10,11,12]. In order to achieve the task, a snake is first initialized at the proximity around a head boundary. It then locks onto nearby edges and subsequently assume the shape of the head. The evolution of a snake is achieved by minimizing an energy function, E snake (analogy with physical systems), denoted as E snake = Einternal + EExternal Where Einternal and E External are internal and external energy functions .Internal energy is the part that depends on the intrinsic properties of the snake and defines its natural evolution. The typical natural evolution in snakes is shrinking or expanding. The external energy counteracts the internal energy and enables the contours to deviate from the natural evolution and eventually assume the shape of nearby features—the head boundary at a state of equilibria. Two main consideration for forming snakes i.e. selection of energy terms and energy minimization. Elastic energy is used commonly as internal energy. Internal energy is vary with the distance between control points on the snake, through which we get contour an elastic-band characteristic that causes it to shrink or expand. On other side external energy relay on image features. Energy minimization process is done by optimization techniques such as the steepest gradient descent. Which needs highest computations. Huang and Chen and Lam and Yan both employ fast iteration methods by greedy algorithms. Snakes have some demerits like contour often becomes trapped onto false image features and another one is that snakes are not suitable in extracting non convex features [18].

2.1.1 Deformable Templates:

Deformable templates were then introduced by Yuille et al. to take into account the a priori of facial features and to better the performance of snakes. Locating a facial feature boundary is not an easy task because the local evidence of facial edges is difficult to organize into a sensible global entity using generic contours. The low brightness contrast around some of these features also makes the edge detection process. Yuille et al. took the concept of snakes a step further by incorporating global information of the eye to improve the reliability of the extraction process.

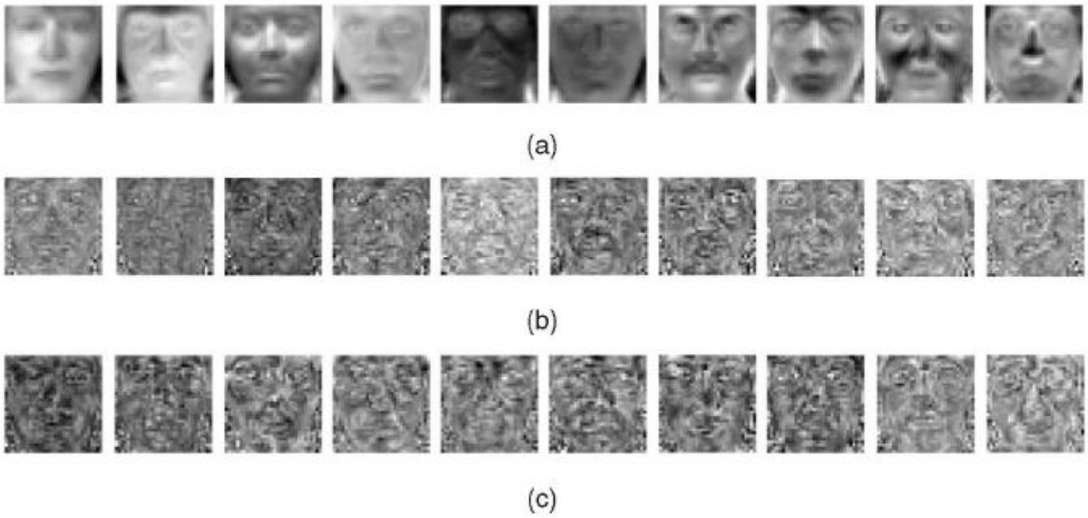
Deformable templates approaches are developed to solve this problem. Deformation is based on local valley, edge, peak, and brightness. Other than face boundary, salient feature (eyes,nose, mouth and eyebrows) extraction is a great challenge of face recognition. E = Ev + Ee + Ep + Ei + Einternal; where Ev, Ee, Ep, Ei, Einternal are external energy due to valley, edges, peak and image brightness and internal energy [14].

2.1.2 PDM (Point Distribution Model):

Independently of computerized image analysis, and before ASMs were developed, Researchers developed statistical models of shape . The idea is that once you represent shapes as vectors, you can apply standard statistical methods to them just like any other multivariate object. These models learn allowable constellations of shape points from training examples and use principal components to build what is called a Point Distribution Model. These have been used in diverse ways, for example for categorizing Iron Age broaches .Ideal Point Distribution Models can only deform in ways that are characteristic of the object. Cootes and his colleagues were seeking models which do exactly that so if a beard, say, covers the chin, the shape model can \override the image" to approximate the position of the chin under the beard. It was therefore natural (but perhaps only in retrospect) to adopt Point Distribution Models. This synthesis of ideas from image processing and statistical shape modelling led to the Active Shape Model.The first parametric statistical shape model for image analysis based on principal components of inter-landmark distances was presented by Cootes and Taylor in. On this approach, Cootes, Taylor, and their colleagues, then released a series of papers that cumulated in what we call the classical Active Shape Model [16].

2.2 LOW LEVEL ANALYSIS:

Based on low level visual features like color, intensity, edges, motion etc.Skin Color BaseColor is avital feature of human faces. Using skin-color as a feature for tracking a face has several advantages. Color processing is much faster than processing other facial features. Under certain lighting conditions, color is orientation invariant. This property makes motion estimation much easier because only a translation model is needed for motion estimation.Tracking human faces using color as a feature has several problems like the color representation of a face obtained by a camera is influenced by many factors (ambient light, object movement, etc [17].



(a) (b) (c)

Fig. 1.5: face detection

Majorly three different face detection algorithms are available based on RGB, YCbCr, and HIS color space models.In the implementation of the algorithms there are three main steps viz.

(1) Classify the skin region in the color space,

(2) Apply threshold to mask the skin region and

(3) Draw bounding box to extract the face image.

Crowley and Coutaz suggested simplest skin color algorithms for detecting skin pixels. The perceived human color varies as a function of the relative direction to the illumination. The pixels for skin region can be detected using a normalized color histogram, and can be normalized for changes in intensity on dividing by luminance. Converted an [R, G, B] vector is converted into an [r, g] vector of normalized color which provides a fast means of skin detection. This algorithm fails when there are some more skin region like legs, arms, etc.Cahi and Ngan [27] suggested skin color classification algorithm with YCbCr color space.Research found that pixels belonging to skin region having similar Cb and Cr values. So that the thresholds be chosen as [Cr1, Cr2] and [Cb1, Cb2], a pixel is classified to have skin tone if the values [Cr, Cb] fall within the thresholds. The skin color distribution gives the face portion in the color image. This algorithm is also having the constraint that the image should be having only face as the skin region. Kjeldson and Kender defined a color predicatein HSV color space to separate skin regions from background. Skin color classification in HSI color space is the same as YCbCr color space but here the responsible values are hue (H) and saturation (S). Similar to above the threshold be chosen as [H1,S1] and [H2, S2], and a pixel is classified to have skin tone if the values [H,S] fall within the threshold and this distribution gives the localized face image. Similar to above two algorithm this algorithm is also having the same constraint [13].

2.3 MOTION BASE:

When use of video sequence is available, motion information can be used to locate moving objects. Moving silhouettes like face and body parts can be extracted by simply thresholding accumulated frame differences. Besides face regions, facial feature scan be located by frame differences.

2.3.1 Gray Scale Base:

Gray information within a face canalso be treat as important features. Facial features such as eyebrows, pupils, and lips appear generallydarker than their surrounding facial regions. Various recent feature extraction algorithms searchfor local gray minima within segmented facial regions.In these algorithms, the input imagesare first enhanced by contrast-stretching and gray-scale morphological routines to improvethe quality of local dark patches and thereby make detection easier. The extraction of darkpatches is achieved by low-level gray-scale thresholding. Based method and consist three levels. Yang and huang presented new approach i.e. faces gray scale behaviour in pyramid (mosaic) images. This system utilizes hierarchical Face location consist three levels. Higher two level based on mosaic images at different resolution. In the lower level, edge detection method is proposed. Moreover this algorithms gives fine response in complex background where size of the face is unknown [14].

2.3.2 Edge Base:

Face detection based on edges was introduced by Sakai et al. This workwas based on analysing line drawings of the faces from photographs, aiming to locate facial features. Than later Craw et al. proposed a hierarchical framework based on Sakai et al.‘swork to trace a human head outline. Then after remarkable works were carried out by many researchers in this specific area. Method suggested by Anila and Devarajan was very simple and fast. They proposed frame work which consist three steps i.e. initially the images are enhanced by applying median filter for noise removal and histogram equalization for contrast adjustment. In the second step the edge image is constructed from the enhanced image by applying sobel operator. Then a novel edge tracking algorithm is applied to extract the sub windows from the enhanced image based on edges. Further they used Back propagation Neural Network (BPN) algorithm to classify the sub-window as either face or non-face [15].

2.4 FEATURE ANALYSIS:

These algorithms aimto find structural features that exist even when the pose, viewpoint, or lighting conditions vary, and then use these to locate faces. These methods aredesigned mainly for face localization.

2.4.1 Feature Searching:

Viola Jones Method:

Paul Viola and Michael Jones presented an approach for object detection which minimizes computation time while achieving high detection accuracy. Paul Viola and Michael Jones [39] proposed a fast and robust method for face detection which is 15 times quicker than any technique at the time of release with 95% accuracy at around 17 fps. The technique relies on the use of simple Haar-like features that are evaluated quickly through the use of a new image representation. Based on the concept of an ―Integral Image‖ it generates a large set of features and uses the boosting algorithm AdaBoost to reduce the overcomplete set and the introduction of a degenerative tree of the boosted classifiers provides for robust and fast interferences. The detector is applied in a scanning fashion and used on gray-scale images, the scanned window that is applied can also be scaled, as well as the features evaluated.

Gabor Feature Method:

Sharif et al proposed an Elastic Bunch Graph Map (EBGM) algorithm that successfully implements face detection using Gabor filters. The proposed system applies 40 different Gabor filters on an image. As are sult of which 40 images with different angles and orientation are received. Next, maximum intensity points in each filtered image are calculated and mark them as fiducial points. The system reduces these points in accordance to distance between them. The next step is calculating the distances between thereduced points using distance formula. At last, the distances are compared with database. If match occurs, it means that the faces in the image are detected. Equation of Gabor filter [17].

2.5 CONSTELLATION METHOD:

All methods discussed so far are able to track faces but still some issue like locating faces of various poses in complex background is truly difficult. To reduce this difficulty investigator form a group of facial features in face-like constellations using more robust modelling approaches such as statistical analysis. Various types of face constellations have been proposed by Burl et al. They establish use of statistical shape theory on the features detected from a multiscale Gaussian derivative filter. Huang et al. also apply a Gaussian filter for pre-processing in a framework based on image feature analysis.Image Base Approach.

2.5.1 Neural Network

Neural networks gaining much more attention in many pattern recognition problems, such as OCR, object recognition, and autonomous robot driving. Since face detection can be treated as a two class pattern recognition problem, various neural network algorithms have been proposed. The advantage of using neural networks for face detection is the feasibility of training a system to capture the complex class conditional density of face patterns. However, one demerit is that the network architecture has to be extensively tuned (number of layers, number of nodes, learning rates, etc.) to get exceptional performance. In early days most hierarchical neural network was proposed by Agui et al. The first stage having two parallel subnetworks in which the inputs are filtered intensity values from an original image. The inputs to the second stage network consist of the outputs from the sub networks and extracted feature values. An output at the second stage shows the presence of a face in the input region. Propp and Samal developed one of the earliest neural networks for face detection . Their network consists off our layers with 1,024 input units, 256 units in the first hidden layer, eight units in the second hidden layer, and two output units. Feraud and Bernier presented a detection method using auto associative neural networks. The idea is based on which shows an auto associative network with five layers is able to perform a nonlinear principal component analysis. One auto associative network is used to detect frontal view faces and another one is used to detect faces turned up to 60 degrees to the left and right of the frontal view. After that Lin et al. presented a face detection system using probabilistic decision-based neural network (PDBNN) [49]. The architecture of

PDBNN is similar to a radial basis function (RBF) network with modified learning rules and probabilistic interpretation [14].

2.6 LINEAR SUB SPACE METHOD

Eigen faces Method:

An early example of employing eigen vectors in face recognition was done by Kohonen in which a simple neural network is demonstrated to perform face recognition for aligned and normalized face images. Kirby and Sirovich suggested that images of faces can be linearly encoded using a modest number of basis images. The idea is arguably proposed first by Pearson in 1901 and then by HOTELLING in 1933 .Given a collection of n by m pixel training. Images represented as a vector of size m X n, basis vectors spanning an optimal subspace are determined such that the mean square error between the projection of the training images onto this subspace and the original images is minimized. They call the set of optimal basis vectors Eigen pictures since these are simply the eigen vectors of the covariance matrix computed from the vectorized face images in the training set. Experiments with a set of 100 images show that a face image of 91 X 50 pixels can be effectively encoded using only50 Eigen pictures [18].

2.7 STATISTICAL APPROCH:

Support Vector Machine (SVM):

SVMs were first introduced Osuna et al. for face detection. SVMs work as a new paradigm to train polynomial function, neural networks, or radial basis function (RBF) classifiers .SVMs works on induction principle, called structural risk minimization, which targets to minimize an upper bound on the expected generalization error. An SVM classifier is a linear classifier where the separating hyper plane is chosen to minimize the expected classification error of the unseen test patterns.In Osunaet al. developed an efficient method to train an SVM for large scale problems ,and applied it to face detection. Based on two test sets of 10,000,000 test patterns of 19 X 19 pixels, their system has slightly lower error rates and runs approximately30 times faster than the system by Sung and Poggio . SVMs have also been used to detect faces and pedestrians in the wavelet domain [16].

Chapter 3

THEORETICAL BACKGROUND

According to Literature, Student Attendance System by Face Detection, maintaining attendance is very important and compulsory in all the institutes for checking the performance of students. Every institute has its method in this regard. Some are taking attendance manually using the old paper old file-based approach and some have adopted methods of automatic attendance using some biometric techniques.

An automated attendance system based on face recognition is a biometric system where typically, it registers the attendance of each student present in a class by detecting and identifying all of their faces, and then this recorded information is ideally transmitted to a server device which may compute the attendance of each student and store and update the corresponding data in a database. Automated attendance systems are more reliable, rigid, and efficient than the traditional attendance systems and other biometric attendance systems, leading to better productivity and output of both the teachers and students, as well as better consumption of time .

An Automatic Attendance System Using Image Processing, maintaining attendance is very important and compulsory in all the institutes for checking the performance of students. Every institute has its method in this regard. Some are taking attendance manually using the old paper or file-based approach and some have adopted methods of automatic attendance using some biometric techniques. There are many automatic methods available for this purpose i.e. biometric attendance. All these methods also waste time because students have to make a queue to touch their thumb on the scanning device .

Face detection and recognition section detect face from the image capture by the camera, and the image of the face is crop and store. The element recognizes the images of student’s faces, which have been registered manually with their names and ID code in the record. Face recognition data and face identification data are verification into the record. Automatic face recognition (AFR) technology has seen a remarkable improvement in presentation over the past years, and such systems are now widely used for safety and marketable applications. An automatic system for human face recognition in a real-time environment for a university to mark the attendance of its employees [12].

3.1 Proposed Work

Systems design is the process of defining the architecture, components, modules, interfaces, and data for a system to satisfy specified requirements. Systems design could be seen as the application of systems theory to product development. The proposed automated attendance system can be divided into five main modules. The modules and their functions are defined in this section. The five modules into which the proposed system is divided are:

3.1.1. Image Capture

The Camera is mounted at a distance from the entrance to capture the frontal images of the students. And further process goes for face detection.

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,

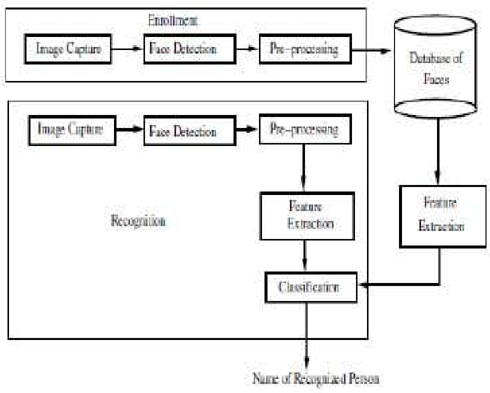


Fig. 1.6: System Diagram

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. [9] Hence we chose Viola-Jones face detection algorithm which makes use of Integral Image and AdaBoost learning algorithm as classier. We observed that this algorithm gives better results in different lighting conditions and we combined multiple haar classifiers to achieve a better detection rates up to an angle of 30 degrees [2].

3.1.3. Pre-Processing

The detected face is extracted and subjected to preprocessing. 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 more clear.

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. Post-Processing

In the proposed system, after recognizing the faces of the students, the names are updated into an excel sheet. The excel sheet is generated by exporting mechanism present in the database system. The database also has the ability to generate monthly and weekly reports of students attendance records. These generated records can be sent to parents or guardians of students. At the end of the class a provision to announce the names of all students who are present in the class is also included. This ensures that students whose faces are not recognized correctly by the system have the chance to send a ticket to staff. And thus giving them the ability to correct the system and make it more stable and accurate. The announcement system is implemented using text to speech conversion. Many algorithms and applications are available that can convert text to lifelike speech. Amazon polly is one such service which includes 47 lifelike voices spread across 24 languages. Amazon Polly delivers the consistently fast response times required to support real-time, interactive dialog. API’s are provided which return the audio stream to the system. The system also has the ability to send notification emails to staff and erp operators. The email would be sent using one of the many Web API’s available like Amazon SES. The system would use email API’s to send daily reports to every authorized staff. Push notifications can also be implemented in the system, notifications can be sent to both staff and students. Push notifications are real-time and can help improve the accuracy of the proposed system [3].

Chapter 4

METHODOLOGY

This paper uses the method of a systematic PRISMA review. By using this PRISMA method we can get focus reports from various researches. This method helps in making paper to review attendance technology using facial recognition. Figure 1 is a flow diagram report from the amount of research, journals, and articles used in this paper.

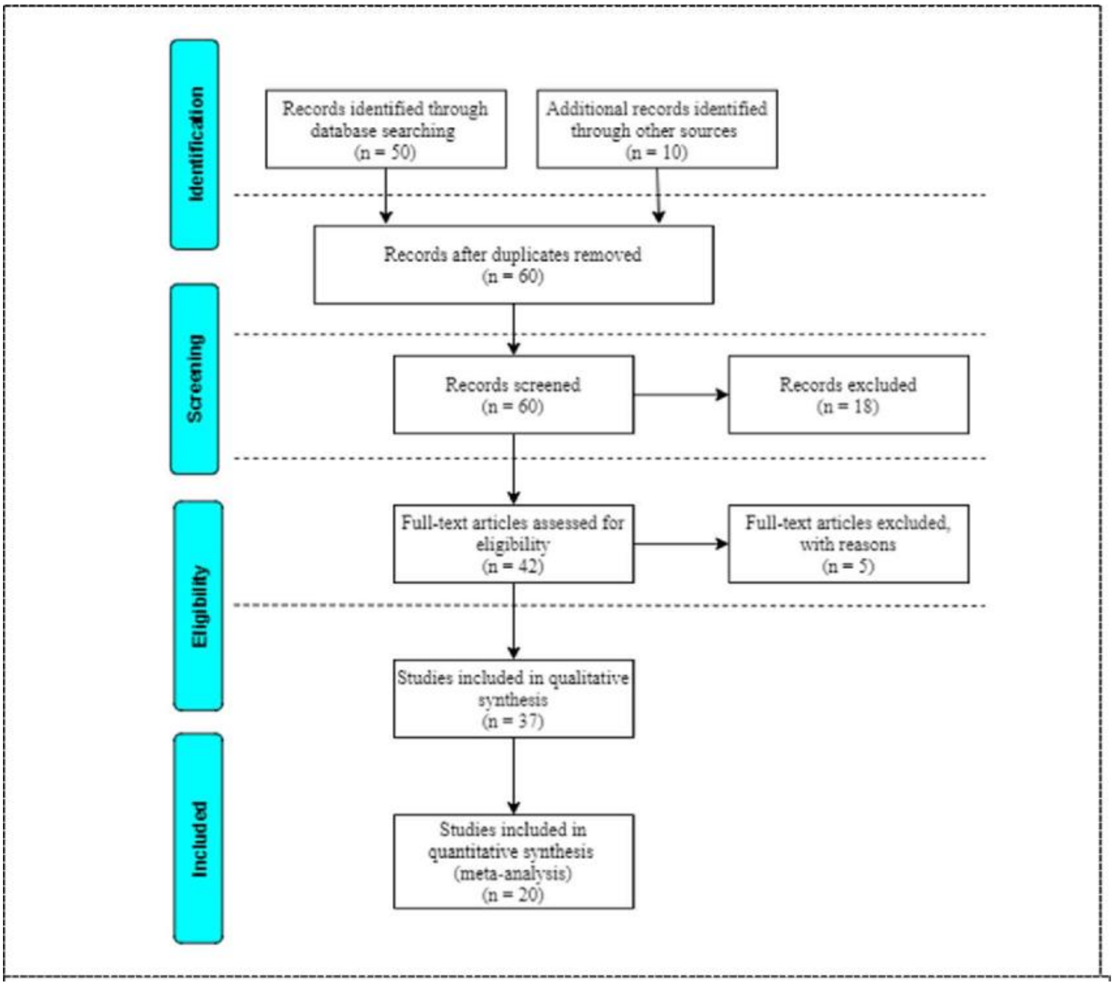


Fig. 1.7: PRISMA checklist methodology.

The criteria of the paper that we collected are those that meet the attendance system keywords using facial recognition. The journals, research, and articles that we collect are those of the last five years, namely 2015. From all the papers we collect, we prioritize papers that use English. After each person collects papers then we begin to do this PRISMA method to help us review papers with the theme of attendance using facial recognition.

In this PRISMA method, there are four steps that we do. The first is the identification stage, at this stage, we are looking for papers that fit our theme using the internet, and through platforms such as Science Direct, Springer Link, etc. The second stage is the screening stage, at this stage, we separate which papers fit the criteria and non-criteria. The third stage is eligibility, at this stage we begin to focus on papers that are in line with the theme that we will review. The last stage is included, the last stage is to focus this paper review using only paper that meets the final criteria.

The data that we take after reading all the records from the paper then collected and felt that the data is relevant to the theme. Table 1 shows that it has been extracted and analyzed from each relevant record [9].

4.1: Libraries using for Face recognition:

- **OpenCV:**

  OpenCV (Open Source Computer Vision Library) is an open-source computer vision and machine learning software library. which is built to provide a common infrastructure for machine learning algorithms and computer vision. It has thousands of optimized algorithms which can be used different purposes like detecting and recognizing faces, identifying objects and many more.

  We need it to take pictures using our webcam and some manipulation needed to be done in the image.

  To install the library you need to install pip in your system after that you can follow the steps in command prompt:

  pip install opencv-contrib-python

- **NumPy:**

  NumPy is the fundamental package for scientific computing in Python which provides a multidimensional array object other mathematical operations can be performed using this but simply speaking we just need it to convert our images into some form of an array so that we can store the model that has been trained.

  To install the library you can type a simple line of code in your command shell:

  pip install numpy

- **Python GUI (tkinter):**

  Tkinter is a simple GUI module used for implementing fairly simple GUI and helps us to interact with code in a simple way. Though for understanding the code its not important for you to know how it works.

- **Dlib:**

  Dlib is an open source suite of applications and libraries written in C++ under a permissive Boost license. Dlib offers a wide range of functionality across a number of machine learning sectors, including classification and regression, numerical algorithms such as quadratic program solvers, an array of image processing tools, and diverse networking functionality, among many other facets.

  Dlib also features robust tools for object pose estimation, object tracking, face detection (classifying a perceived object as a face) and face recognition (identifying a perceived face).

  A number of repositories use Dlib as the facial recognition engine for attendance monitoring frameworks. One such project from India offers an automated pipeline, including a webcam recognition framework and the automation of warning mails to students that were not registered by the system during an attendance period.

- **Face Recognition:**

  Recognize and manipulate faces from Python or from the command line with the world's simplest face recognition library. Built using dlib's state-of-the-art face recognition built with deep learning. The model has an accuracy of 99.38% on the Labeled Faces in the Wild benchmark. This also provides a simple Face Recognition command line tool that lets you do face recognition on a folder of images from the command line [5].

Chapter 5:

FACE RECOGNITION

Over the last few decades many techniques have been proposed for face recognition. Many of the techniques proposed during the early stages of computer vision cannot be considered successful, but almost all of the recent approaches to the face recognition problem have been creditable. According to the research by Brunelli and Poggio (1993) all approaches to human face recognition can be divided into two strategies:

(1) Geometrical features and

(2) Template matching.

5.1 FACE RECOGNITION USING GEOMETRICAL FEATURES

This technique involves computation of a set of geometrical features such as nose width and length, mouth position and chin shape, etc. from the picture of the face we want to recognize. This set of features is then matched with the features of known individuals. A suitable metric such as Euclidean distance (finding the closest vector) can be used to find the closest match. Most pioneering work in face recognition was done using geometric features (Kanade, 1973), although Craw et al. (1987) did relatively recent work in this area.

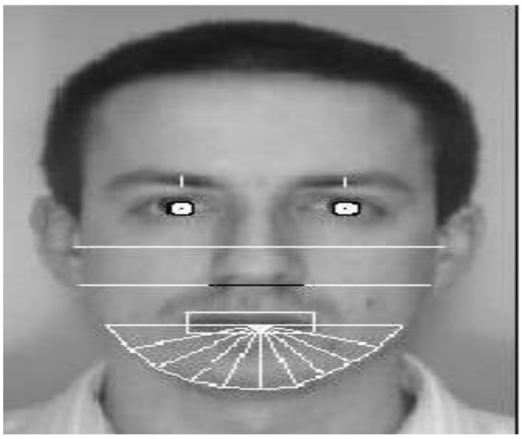


Figure. 1.8: Geometrical features (white) which could be used for face recognition

The advantage of using geometrical features as a basis for face recognition is that recognition is possible even at very low resolutions and with noisy images (images with many disorderly pixel intensities). Although the face cannot be viewed in detail its overall geometrical configuration can be extracted for face recognition. The technique's main disadvantage is that automated extraction of the facial geometrical features is very hard. Automated geometrical feature extraction based recognition is also very sensitive to the scaling and rotation of a face in the image plane (Brunelli and Poggio, 1993). This is apparent when we examine Kanade's(1973) results where he reported a recognition rate of between 45-75 % with a database of only 20 people. However if these features are extracted manually as in Goldstein et al. (1971), and Kaya and Kobayashi (1972) satisfactory results may be obtained [9].

5.1.1 Face recognition using template matching:

This is similar the template matching technique used in face detection, except here we are not trying to classify an image as a 'face' or 'non-face' but are trying to recognize a face.

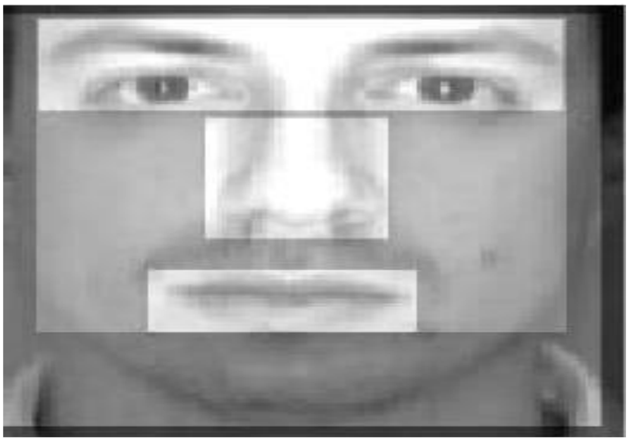


Fig.1.9: Face recognition using template matching

Whole face, eyes, nose and mouth regions which could be used in a template matching strategy. The basis of the template matching strategy is to extract whole facial regions (matrix of pixels) and compare these with the stored images of known individuals. Once again Euclidean distance can be used to find the closest match. The simple technique of comparing grey-scale intensity values for face recognition was used by Baron (1981). However there are far more sophisticated methods of template matching for face recognition. These involve extensive preprocessing and transformation of the extracted grey-level intensity values. For example, Turk and Pentland (1991a) used Principal Component Analysis, sometimes known as the eigenfaces approach, to pre-process the gray-levels and Wiskott et al. (1997) used Elastic Graphs encoded using Gabor filters to pre-process the extracted regions. An investigation of geometrical features versus template matching for face recognition by Brunelli and Poggio (1993) came to the conclusion that although a feature based strategy may offer higher recognition speed and smaller memory requirements, template based techniques offer superior recognition accuracy [8].

5.2 PROBLEM SCOP AND SYSTEM SPECIFICATION

The following problem scope for this project was arrived at after reviewing the literature on face detection and face recognition, and determining possible real-world situations where such systems would be of use. The following system(s) requirements were identified.

1. A system to detect frontal view faces in static images
2. A system to recognize a given frontal view face
3. Only expressionless, frontal view faces will be presented to the face detection&recognition
4. All implemented systems must display a high degree of lighting invariency.
5. All systems must posses near real-time performance.
6. Both fully automated and manual face detection must be supported
7. Frontal view face recognition will be realised using only a single known image
8. Automated face detection and recognition systems should be combined into a fully automated face detection and recognition system. The face recognition sub-system must display a slight degree of invariency to scaling and rotation errors in the segmented image extracted by the face detection sub-system.
9. The frontal view face recognition system should be extended to a pose invariant face recognition system.

Unfortunately although we may specify constricting conditions to our problem domain, it may not be possible to strictly adhere to these conditions when implementing a system in the real world [5].

5.3 BRIEF OUT LINE OF THE IMPLEMENTED SYSTEM

Fully automated face detection of frontal view faces is implemented using a deformable template algorithm relying on the image invariants of human faces. This was chosen because a similar neural-network based face detection model would have needed far too much training data to be implemented and would have used a great deal of computing time. The main difficulties in implementing a deformable template based technique were the creation of the bright and dark intensity sensitive templates and designing an efficient implementation of the detection algorithm.

A manual face detection system was realised by measuring the facial proportions of the average face, calculated from 30 test subjects. To detect a face, a human operator would identify the locations of the subject's eyes in an image and using the proportions of the average face, the system would segment an area from the image [7].

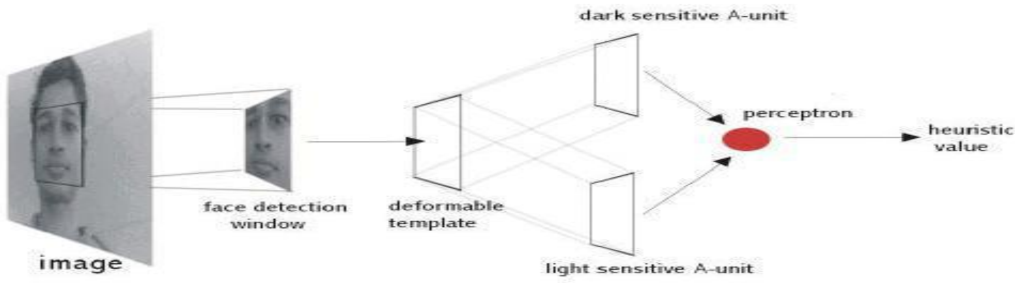


Fig.1.10: Implemented fully automated frontal view face detection model

A template matching based technique was implemented for face recognition. This was because of its increased recognition accuracy when compared to geometrical features based techniques and the fact that an automated geometrical features based technique would have required complex feature detection pre-processing.

Of the many possible template matching techniques, Principal Component Analysis was chosen because it has proved to be a highly robust in pattern recognition tasks and because it is relatively simple to implement. The author would also liked to have implemented a technique based on Elastic Graphs but could not find sufficient literature about the model to implement such a system during the limited time available for this project.

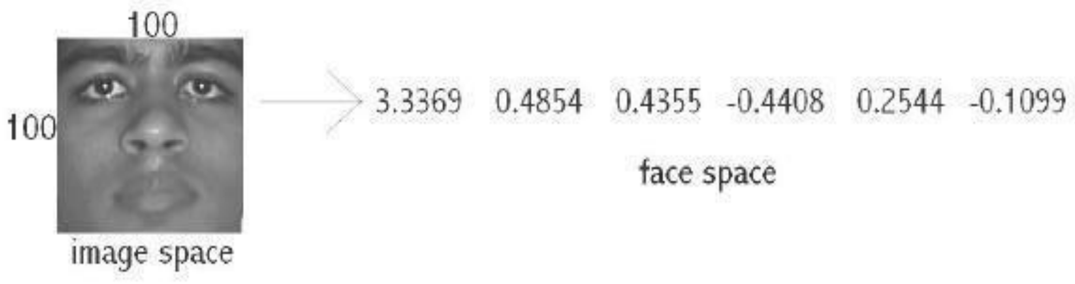


Fig 1.11: Principal Component Analysis transform from 'image space' to 'face space'.

Using Principal Component Analysis, the segmented frontal view face image is transformed from what is sometimes called 'image space' to 'face space'. All faces in the face database are transformed into face space. Then face recognition is achieved by transforming any given test image into face space and comparing it with the training set vectors. The closest matching training set vector should belong to the same individual as the test image. Principal Component Analysis is of special interest because the transformation to face space is based on the variation of human faces (in the training set). The values of the 'face space' vector correspond to the amount certain 'variations' are present in the test image Face recognition and detection system is a pattern recognition approach for personal identification purposes in addition to other biometric approaches such as fingerprint recognition, signature, retina and so forth. Face is the most common biometric used by humans applications ranges from static, mug-shot verification in a cluttered background [9].

5.4 FACE RECOGNITION DIFFICULTIES

- Identify similar faces (inter-class similarity)
- Accommodate intra-class variability due to
- head pose
- illumination conditions
- expressions
- facial accessories
- aging effects
- Cartoon faces

5.5 PRINCIPAL COMPONENT ANALYSIS (PCA)

Principal Component Analysis (or Karhunen-Loeve expansion) is a suitable strategy for face recognition because it identifies variability between human faces, which may not be immediately obvious. Principal Component Analysis (hereafter PCA) does not attempt to categorise faces using familiar geometrical differences, such as nose length or eyebrow width. Instead, a set of human faces is analysed using PCA to determine which 'variables' account for the variance of faces. In face recognition, these variables are called eigen faces because when plotted they display an eerie resemblance to human faces. Although PCA is used extensively in statistical analysis, the pattern recognition community started to use PCA for classification only relatively recently. As described by Johnson and Wichern (1992), 'principal component analysis is concerned with explaining the variance- covariance structure through a few linear combinations of the original variables.' Perhaps PCA's greatest strengths are in its ability for data reduction and interpretation. For example a 100x100 pixel area containing a face can be very accurately represented by just 40 eigen values. Each eigen value describes the magnitude of each eigen face in each image. Furthermore, all interpretation (i.e. recognition) operations can now be done using just the 40 eigen values to represent a face instead of the manipulating the 10000 values contained in a 100x100 image. Not only is this computationally less demanding but the fact that the recognition information of several thousand [4].

5.6 UNDERSTANDING EIGENFACES

Any grey scale face image I(x,y) consisting of a NxN array of intensity values may also be consider as a vector of N2. For example, a typical 100x100 image used in this thesis will have to be transformed into a 10000 dimension vector!

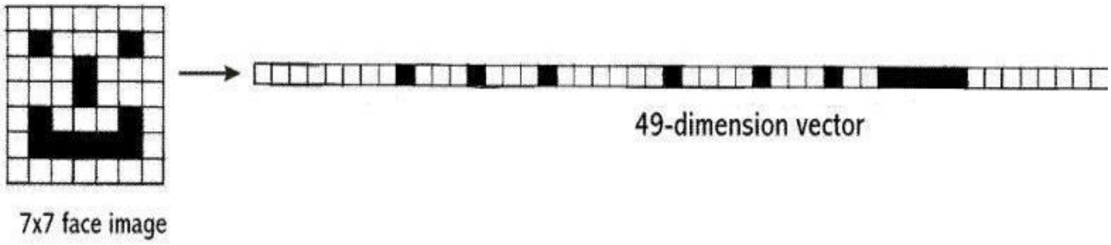


Fig.1.12: 7x7 face image transformed into a 49 dimension vector

This vector can also be regarded as a point in 10000 dimension space. Therefore, all the images of subjects' whose faces are to be recognized can be regarded as points in 10000 dimension space. Face recognition using these images is doomed to failure because all human face images are quite similar to one another so all associated vectors are very close to each other in the 10000- dimension space.

Fig 1.13: Eigenfaces

The transformation of a face from image space (I) to face space (f) involves just a simple matrix multiplication. If the average face image is A and U contains the (previously calculated) eigenfaces, f = U * (I - A)

This is done to all the face images in the face database (database with known faces) and to the image (face of the subject) which must be recognized. The possible results when projecting a face into face space are given in the following figure.

There are four possibilities:

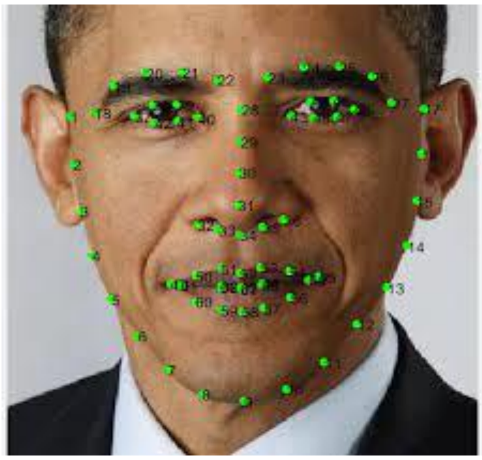
1. Projected image is a face and is transformed near a face in the face database
2. Projected image is a face and is not transformed near a face in the face database
3. Projected image is not a face and is transformed near a face in the face database
4. Projected image is not a face and is not transformed near a face in the face data

While it is possible to find the closest known face to the transformed image face by calculating the Euclidean distance to the other vectors, how does one know whether the image that is being transformed actually contains a face? Since PCA is a many-to-one transform, several vectors in the image space (images) will map to a point in face space (the problem is that even non-face images may transform near a known face image's faces space vector). Turk and Pentland (1991a), described a simple way of checking whether an image is actually of a face. This is by transforming an image into face space and then transforming it back (reconstructing) into image space. Using the previous notation, $I' = U^T * U * (I – A)$

With these calculations it is possible to verify that an image is of a face and recognise that face. O'Toole et al. (1993) did some interesting work on the importance of eigen faces with large and small eigenvalues. They showed that the eigen vectors with larger eigenvalues convey information relative to the basic shape and structure of the faces. This kind of information is most useful in categorising faces according to sex, race etc. Eigen vectors with smaller eigenvalues tend to capture information that is specific to single or small subsets of learned faces and are useful for distinguishing a particular face from any other face. Turk and Pentland (1991a) showed that about 40 eigen faces were sufficient for a very good description of human faces since the reconstructed image have only about 2% RMS. pixel-by-pixel errors [7].

5.7 IMPROVING FACE DETECTION USING RECONSTRUCTIN

Reconstruction cannot be used as a means of face detection in images in near real-time since it would involve resizing the face detection *window* area and large matrix multiplication, both of which are computationally expensive. However, reconstruction can be used to verify whether potential face locations identified by the deformable template algorithm actually contain a face. If the reconstructed image differs greatly from the face detection *window* then the *window* probably does not contain a face. Instead of just identifying a single potential face location, the face detection algorithm can be modified to output many high 'faceness' locations which can be verified using reconstruction. This is especially useful because occasionally the best 'faceness' location found by the deformable template algorithm may not contain the ideal frontal view face pixel area [6].



Output from Face detection system:

Heuristic x y width

978 74 31 60

1872 74 33 60

1994 75 32 58

2125 76 32 56

2418 76 34 56

2389 79 32 50

2388 80 33 48

2622 81 33 46

2732 82 32 44

Best heuristic location (94,65,20) 2936 84 33 40

2822 85 58 38

2804 86 60 36

2903 86 62 36

3311 89 62 36

potential face locations that have been identified by the face detection system (the best face locations it found on its search) are checked whether they contain a face. If the threshold level (maximum difference between reconstruction and original for the original to be a face) is set correctly this will be an efficient way to detect a face. The deformable template algorithm is fast and can reduce the search space of potential face locations to a handful of positions. These are then checked using reconstruction. The number of locations found by the face detection system can be changed by getting it to output, not just the best face locations it has found so far but any location, which has a 'faceness' value, which for example is, at least 0.9 times the best heuristic value that has been found so far. Then there will be many more potential face locations to be checked using reconstruction. This and similar speed versus accuracy trade-off decisions have to be made keeping in mind the platform on which the system is implemented. Similarly, instead of using reconstruction to check the face detection system's output, the output's correlation with the average face can be checked. The segmented areas with a high correlation probably contains a face. Once again a threshold value will have to be established to classify faces from non-faces. Similar to reconstruction, resizing the segmented area and calculating its correlation with the average face is far too expensive to be used alone for face detection but is suitable for verifying the output of the face detection system [13].

CONCLUSION

The computational models, which were implemented in this project, were chosen after extensive research, and the successful testing results confirm that the choices made by the researcher were reliable. The system with manual face detection and automatic face recognition did not have a recognition accuracy over 90%, due to the limited number of eigenfaces that were used for the PCA transform. This system was tested under very robust conditions in this experimental study and it is envisaged that real-world performance will be far more accurate. The fully automated frontal view face detection system displayed virtually perfect accuracy and in the researcher's opinion further work need not be conducted in this area.

The fully automated face detection and recognition system was not robust enough to achieve a high recognition accuracy. The only reason for this was the face recognition subsystem did not display even a slight degree of invariance to scale, rotation or shift errors of the segmented face image. if some sort of further processing, such as an eye detection technique, was implemented to further normalise the segmented face image, performance will increase to levels comparable to the manual face detection and recognition system. All other implemented systems displayed commendable results and reflect well on the deformable template and Principal Component Analysis strategies. The most suitable real-world applications for face detection and recognition systems are for mugshot matching and surveillance. There are better techniques such as iris or retina recognition and face recognition using the thermal spectrum for user access and user verification applications since these need a very high degree of accuracy. The real-time automated pose invariant face detection and recognition system proposed in chapter seven would be ideal for crowd surveillance applications. If such a system were widely implemented its potential for locating and tracking suspects for law enforcement agencies is immense.

The implemented fully automated face detection and recognition system could be used for simple surveillance applications such as ATM user security, while the implemented manual face detection and automated recognition system is ideal of mugshot matching. Since controlled conditions are present when mugshots are gathered, the frontal view face recognition scheme should display a recognition accuracy far better than the results, which were obtained in this study, which was conducted under adverse conditions.

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