Face Recognition System

A Report for the Evaluation 3 of Project 2

Submitted by

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BONAFIDE CERTIFICATE

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1.Abstract

Face recognition from image or video may be a standard topic in biometrics analysis. Several public places typically have surveillance cameras for video capture and these cameras have their vital price for security purpose. it's wide acknowledged that the face recognition have vie a very important role in closed-circuit television because it doesn't would like the object's cooperation. the particular benefits of face based mostly identification over different biometry area unit individuality and acceptance. As human face may be a dynamic object having high degree of variability in its appearance, that produces face detection a tough downside in computer vision. during this field, accuracy and speed of identification may be a main issue. The goal of this paper is to judge varied face detection and recognition strategies, offer complete resolution for image based mostly face detection and recognition with higher accuracy, better response rate as associate initial step for video police work. resolution is proposed supported performed tests on varied face wealthy databases in terms of subjects, pose, emotions, race and light-weight

Face recognition technology is the least intrusive and fastest biometric technology. It works with the most obvious individual identifier – the human face. Instead of requiring people to place their hand on a reader (a process not acceptable in some cultures as well as being a source of illness transfer) or precisely position their eye in front of a scanner, face recognition systems unobtrusively take pictures of people's faces as they enter a defined area.

Every face has numerous, distinguishable landmarks, the different peaks and valleys that make up facial features. Each human face has approximately 80 nodal points. Some of these measured by the Facial Recognition Technology are:

- Distance between the eyes
- Width of the nose
- Depth of the eye sockets
- The shape of the cheekbones
- The length of the jaw line

These nodal points are measured creating a numerical code, called a faceprint, representing the face in the database.

2. Introduction

A facial recognition system is a technology capable of identifying or verifying a person from a digital image or a video frame from a videosource. There are multiples methods in which facial recognition systems work, but in general, they work by comparing selected facial features from given image with faces within a database.

Face recognition is that the task of characteristic AN already detected object as a known or

unknown face. Often the matter of face recognition is confused with the matter of face detection Face Recognition on the opposite hand is to come to a decision if the "face" is somebody known , or unknown, victimization for this purpose a information of faces so as to validate this input face.

2.1 Purpose

As shopper and enterprise face recognition solutions proliferate, there square measure a range of how that face recognition is presently getting used. Here square measure a number of the foremost current face recognition applications: -

(a) Mobile Face Recognition
(b) Device/App Security
(c) Geofencing
(d) Biometric Surveillance

Currently gaining support as a potential tool for averting terrorist crimes, facial recognition is already in use in many law enforcement areas. Software has also been developed for computer networks and automated bank tellers that use facial recognition for user verification purposes

2.2 Scope

A face recognition system is a computer application for automatically identifying or verifying a person from a digital image or a video frame from a video source. One of the ways to do this is by comparing selected facial features from the image and a facial database. It is typically used in security systems and can be compared to other biometrics such as fingerprint or eye iris recognition systems. Some facial recognition algorithms identify facial features by extracting landmarks, or features, from an image of the subject's face. For example, an algorithm may analyze the relative position, size, and/or shape of the eyes, nose, cheekbones, and jaw. These features are then used to search for other images with matching features. Other algorithms normalize a gallery of face images and then compress the face data, only saving the data in the image that is useful for face recognition

3. The Overall Description

Identification is a more complex task than verification. In this case, the FRS is provided a probe image to attempt to match it with a biometric reference in the gallery (or not). This represents a one-to-many problem. In addition, we need to further differentiate between closed-set identification problems and open-set identification problems. In a closed-set identification problem we want to identify a person that we know is in the reference database or gallery. Open-set identification is more complex in that we do not know in advance whether the person to be identified is or is not in the reference database. The outcome of these two identification problems will be interpreted differently. If there is no match in the closed-set identification, then we know the system has made a mistake. However, in the open-set problem we do not know whether the system made a mistake or whether the identity is simply not in the reference database in the first instance. Identification systems are different from verification systems because an identification system seeks to identify an unknown person, or unknown biometric. Identification systems are described as a 1-to-n matching system, where n is the total number of biometrics in the database. Forensic databases, where a government tries to identify a latent print or DNA discarded at a crime scene, often operate as identification systems.

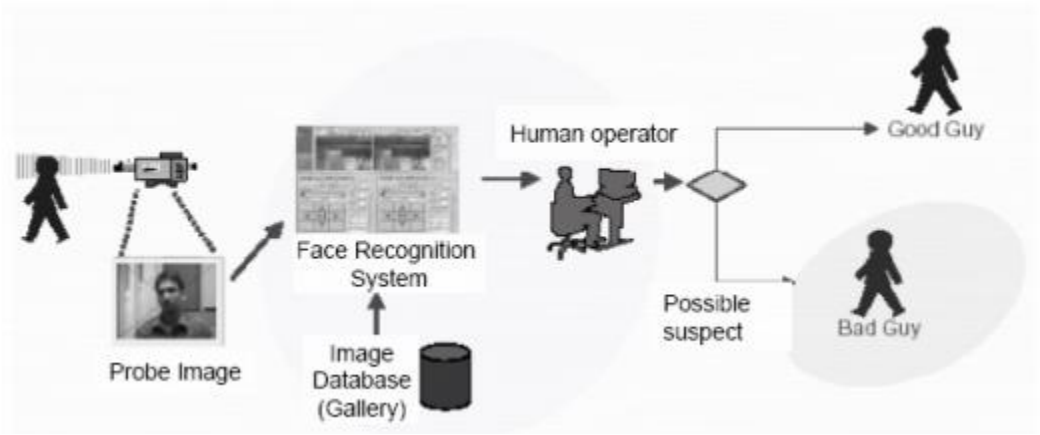

Fig 1.1 How Face Recognition System works

The following four-stage process illustrates the way biometric systems operate:

- Capture - a physical or behavioral sample is captured by the system during enrollment.
- Extraction - unique data is extracted from the sample and a template is created.
- Comparison - the template is then compared with a new sample.
- Matching - the system then decides if the features extracted from the new sample are matching or not.

When the user faces the camera, standing about two feet from it. The system will locate the user's face and perform matches against the claimed identity or the facial database. It is possible that the user may need to to move and reattempt the verification based on his facial position. The system usually comes to a decision in less than 5 seconds.

3.1 Product Perspective

- **Fast face processing:** Our biometric face recognition system performs fast and accurate detection of face in live video stream.
- **Live face detection:** A conventional face identification system can be easily cheated by placing a photo of another person in front of a camera. Our face recognition system is able to prevent this kind of security breach by determining whether a face in a video stream belongs to a real human or is a photo
- **Face image quality determination**: A quality threshold can be used during face enrolment to ensure that only the best quality face template will be stored into database.
- **Tolerance to face posture:** Our face recognition system has certain tolerance to face posture that assures face enrolment convenience: rotation of a head can be up to 10 degrees from frontal in each direction (nodded up/down, rotated left/right, tilted left/right).
- **Multiple samples of the same face**: Biometric template record can contain multiple face samples belonging to the same person. These samples can be enrolled with different face postures and expressions, from different sources and in different time thus allowing to improve matching quality.
- **Identification capability:** Our system functions can be used in 1-to-1 matching (verification), as well as 1-to-many mode (identification).

- **Fast face matching**: The JUSTLOOK 3.2 face template matching algorithm compares 100,000 faces per second.
- **Compact face features template:** A face features template occupies only 2.3 Kilobytes, thus our applications can handle large face databases.
- **Features generalization mode**: This mode generates the collection of the generalized face features from several images of the same subject. Then, each face image is processed, features are extracted, and the collections of features are analyzed and combined into a single generalized features collection, which is written to the database. This way, the enrolled feature template is more reliable and the face recognition quality increases considerably.

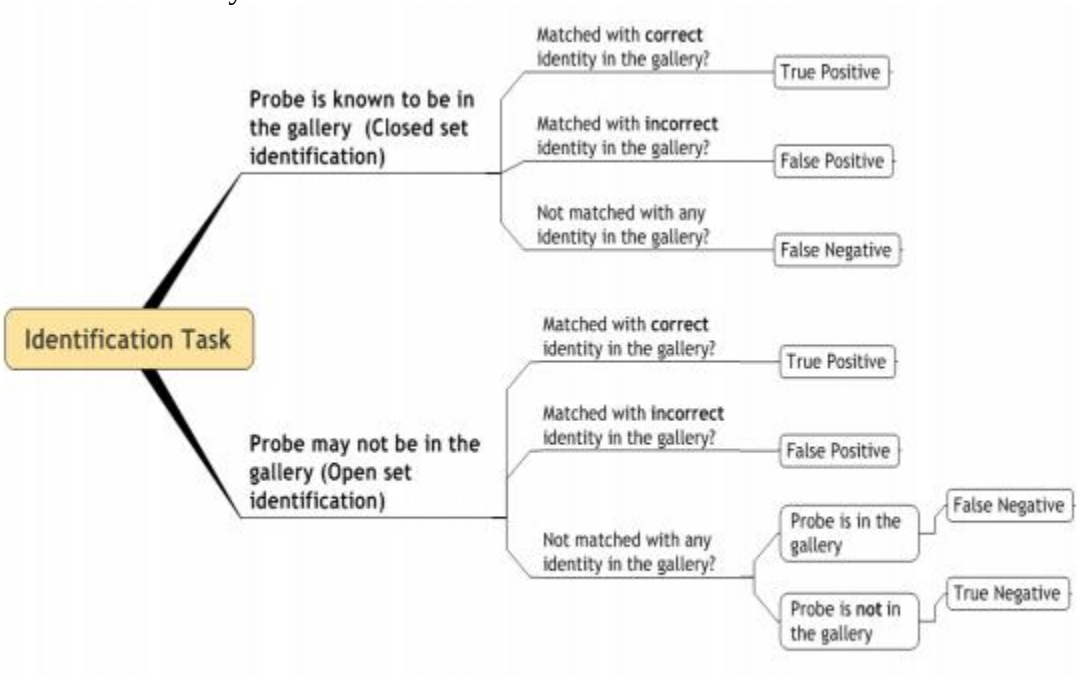

Fig 1.2 Identification task in Face Recognition system

3.1.1 System Interfaces

Operating System: Linux, Windows (7 and above), MacOs Sierra
Hardware: 4Gb RAM, Web Camera, 500GB Hard Disk
Network: Ethernet (high speed recommended)

Database: MySQL, MongoDB

Camera Requirements:

- Distance from camera
- Camera focus
- Image/Video resolution
- Use case
- Speed
- Security

- Location

3.1.2 Interfaces

Every face has various distinguishable markers, the peaks and valleys that make up facial features. These landmarks are called nodal points. Some of the nodal point measured by the algorithm we have used are:

- Distance between the eyes
- Width of the nose
- The shape of cheekbones
- The depth of the eye sockets
- The length of the jaw line

These nodal points are measured creating a numerical code, called a face print, representing the face in the database. The proposed face recognition system follows series of steps to match the input image. These are:

Detection:

Canny algorithm is used to detect a live face in a scene of the image.

Alignment:

Once the face is detected, the system determines the head's position, size and pose.

Measurement:

The system then measures the features of the nodal points such as distance between the eyes, width of nose etc. It is actually the measurement of pixels at the edges and creates a template.

Representation:

The system translates the template into a unique code. A set of numbers is used to represent the features on a subject's face.

Matching:

After coding, the system will then compare the input image with the images in the databases to find the potential match. If the features of input image are similar to that of any of the images stored in database, it is said to be matched/ identified/ verified.

3.1.3 Hardware Interfaces

The hardware block consists of PIC microcontroller and LCD display.
1. Peripheral Interface controller (PIC):8-bit PIC is a Harvard architecture microcontroller developed by Microchip Technology. The salient features of PIC are as follows:
Code efficiency: There are separate buses for instruction and data. The throughput rate is increased due to simultaneous access to both data and program memory (Harvard Architecture).
Less number of instructions.
Static operation: It is fully static. If it tops the clock, all the register contents are maintained.
High output drive capability.
Most instructions are single cycled.

Low cost, wide availability and serial programming capability.
B. LCD display: Liquid Crystal Display (LCD) is a flat panel electronic-visual display which is used to display the result of matching. In the proposed system, 16x2 (16 characters/ row, 2rows) LCD has been used.
Serial port interface consisting of RS232 and Universal Asynchronous Receiver/Transmitter (UART) establishes serial communication between PC and PIC microcontroller. An input image is fed to PC containing MATLAB. It is processed and face is detected. If the image is matching with any of the images in the database, PC sends (with the help of MPLAB programming) through serial port interface unit a character, say, 'M' to the microcontroller. The microcontroller interprets it as the matching condition and asks LCD to display 'Match found'. If the image is not matching with any of the images in the database, PC sends another character, say, 'N'.

3.1.4 Software Interfaces

The software and hardware implementation of the project involve image source, MATLAB (software for image processing), MPLAB IDE & Compiler (software's for interfacing to PIC), PIC microcontroller, RS232 cable and LCD display. The details are discussed in the following section. The block diagram of facial recognition system with hardware interfacing consists of hardware and software parts.
A. Software block: Face detection and recognition operations are carried out in this part. Hence, the software block is the main part that performs matching.
B. PC with MATLAB software: MATLAB (Matrix Laboratory) is a programming language that allows matrix manipulations, implementation of algorithms, interfacing with programs that are written in any other languages like C, C++, Java etc. The image is represented as a 2- dimensional matrix. Different image processing tools available in MATLAB help in implementing face detection and recognition algorithm.
Image: It is the image at our hand which is to be tested for matching. The features/ edges of the input image are extracted and detected as per canny edge detection algorithm.
Image database: It is a collection of large number of images. We use two kinds of databases. One is train database whereas the other one is test database. Input image is an image from test database. Images of many people are stored in train database. Train database needs to be updated time and again so that maximum number of images can be matched with reliability.

3.1.5 Communications Interfaces

The new system contained the function of human-face recognition and take advantage of the present one. Face detection is to find faces in one image by the trained cascade classifiers.
face detection process is a pure calculation process, and most of the results of face detection research papers are obtained by detecting images on personal computer platform.The main functions are shown as follows:
A. Human-face recognition: The owners' face information is used as the standards recognition. It must verify the feature of the human face before using vehicle.
B. Message alarming: When someone try to thieve the vehicle, the message can be send to the owners' mobile phone as soon as possible without any noise.
C. GPS: The GPS system is designed such that at any point, a GPS module on earth has a clear view of at least four satellites.
D. GSM: GSM digitizes and compress data then sends it down a channel with two other streams of our user data, each in its own time slot.

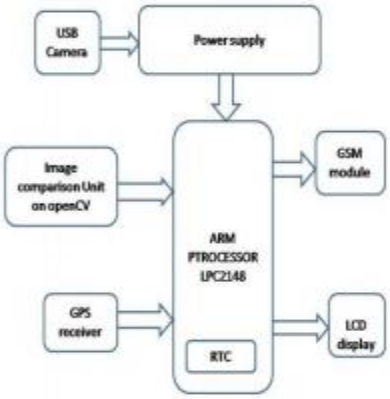

Fig 1.3 Communication mechanism

3.1.6 Memory Constraints

Specify any applicable characteristics and limits on primary and secondary memory. Don't just make up something here. If all the customer's machines have only 128K of RAM, then your target design has got to come in under 128K so there is an actual requirement. You could also cite market research here for shrink-wrap type applications "Focus groups have determined that our target market has between 256-512M of RAM, therefore the design footprint should not exceed 256M." If there are no memory constraints, so state.

3.1.7 Operations

It is important for users to make sure that the facial recognition supplier or vendor has the capability and track record to deliver fully integrated operational systems. The Bio Face evaluation showed that implementation expertise is not widespread and could represent a significant risk.

Steps in Face Recognition algorithm:

Detecting a face: Detecting a face in a probe image may be a relatively simple task for humans, but it is not so for a computer. The computer has to decide which pixels in the image is part of the face and which are not. In a typical passport photo, where the background is clear, it is easy to do, but as soon as the background becomes cluttered with other objects

Normalization: Once the face has been detected (separated from its background), the face needs to be normalized. This means that the image must be standardized in terms of size, pose, illumination, etc., relative to the images in the gallery or reference database. To normalize a probe image, the key facial landmarks must be located accurately. Using these landmarks, the normalization algorithm can (to some degree) reorient the image for slight variations. Thus, it is essential that the probe is as close as possible to a standardized face. Recognition can only succeed if the probe image and the gallery images are the same in terms of pose orientation, rotation, scale, size, etc. Normalization ensures that this similarity is achieved—to a greater or lesser degree.

Feature extraction and recognition: Once the face image has been normalized, the feature extraction and recognition of the face can take place. In feature extraction, a mathematical representation called a biometric template or biometric reference is generated, which is stored in the database and will form the basis of any recognition task. It is in this process of mathematical transformation (feature extraction) and matching (recognition) of a biometric template that particular algorithms differ significantly in their approach.

3.1.8 Site Adaptation Requirements

This document describes the matter from the user's purpose of read. It in short describes the problem domain of face detection. Then the document delivers an easy and actual problem description, whereby the user states precisely what he/she would love the face detection system to try and do. we tend to specialize in the tasks to be resolved instead of the interface required finding them.
The user needs a face detection system given a picture, the goal of the face detection system is to work out whether or not or not their area unit any faces within the image and, if present, return the face location. The system ought to operate at period to form for a passive and fully automatic Access system. A user would solely be needed to square before of the camera so as to be recognized. the most motivation for a face detection system is that the user wouldn't be needed to position his/her face into a set size box up order to be recognized by the face recognition system. Other reasons for a face detection system area unit that it's the primary step: Face localization seeks to work out the position of one face inside an image; the detection drawback is simplified since the input image contains only 1 face. Facial feature discoverion seeks to detect the presence and site of options, like the mouth, nose, eyes, lips, ears, etc.; the detection drawback is simplified since the input image contains only 1 face. Facial expression recognition identifies the emotional states of humans, e.g. happy, sad, anger.

3.2 Product Functions

OPENCV: We propose a new approach for detecting human faces from color images under complex conditions such as non-uniform illumination, arbitrary image background. In face recognition Image processing algorithms is used. In the process of inputting human face, the USB camera, which could fix on to the PC, will used for acquiring the image of human face. Next step is that the image of human face would be processed by the main chip. The system will call the police and send the message to the owner; and also send the position of the vehicle by GPS. The initializing process means that initializing the system to set the hardware and software, and then the multiple mission modules is started. OpenCV perform more than 500 functions, some of the functions as shown in the Fig.4 OpenCV 2.1 has several modules: Cxcore: core libraries. Basic structures, algebra and other math. Drawing functions. CV: computer vision.
Processing functions. cvaux: auxiliary functionality (some experimental). HighGUI: image and video I/O. Image displaying, and basicGUI.
ML: machine learning. Learning and classification algorithms. Lots of functionality: Basic algebra operations, Image/matrix manipulation, Dynamic data structures. Image processing: filtering, edge/corner detection, histogram analysis, morphological operations.

Structural analysis: connected components, contours, distance transform, template correlations, Hough transform, shape fitting, Motion analysis and tracking: optical flow, movement segmentation, tracking, Object recognition: PCA, SVM, .Basic GUI: I/O handling, image loading and saving.
CvSize Pixel-accurate size of a rectangle.
typedef struct CvSize {
int width; int height;
} CvSize;
width Width of the rectangle
height Height of the rectangle
/* Constructor */
inline CvSize cvSize (int width, int height)

3.3 User Characteristics and Constraints:

Weaknesses Face recognition is not perfect and struggles to perform under certain conditions. "Face recognition has been getting pretty good at full frontal faces and 20 degrees off, but as soon as you go towards profile, there've been problems." Other conditions where face recognition does not work well include poor lighting, sunglasses, and low resolution images. Another serious disadvantage is that many systems are less effective if facial expressions vary. Even a big smile can render in the system less effective

B. Effectiveness Critics of the technology complain that the London Borough of Newham scheme has, as of 2004, never recognized a single criminal, despite several criminals in the system's database living in the Borough and the system having been running for several years. This information seems to conflict with claims that the system was credited with a 34% reduction in crime - which better explains why the system was then rolled out to Birmingham also. An experiment by the local police department in Tampa, Florida, had similarly disappointing results. Safe house International Limited, an Australian company, patented software including iMotion and iCount systems. The company claimed this system were able to track moving people and calculate the number of people in a crowd. After 9/11, the software was considered “commercially attractive” by the US administration. It was later revealed by David Mapley, a US shareholder of Safe House International Limited) that the software actually never worked.

C. Privacy concerns Despite the potential benefits of this technology, many citizens are concerned that their privacy will be invaded. Some fear that it could lead to a “total surveillance society,” with the government and other authorities having the ability to know where you are, and what you are doing, at all times. This is not to be an underestimated concept as history has shown that states have typically abused such access before.

D. Recent improvements in 2006, the performances of the latest face recognition algorithms were evaluated in the Face Recognition Grand Challenge (FRGC). High-resolution face images, 3-D face scans, and iris images were used in the tests. The results 328 indicated that the new algorithms are 10 times more accurate than the face recognition algorithms of 2002 and 100 times more accurate than those of 1995. Some of the algorithms were able to outperform human participants in recognizing faces and could uniquely identify identical twins. Low-resolution images of faces can be enhanced using face hallucination. Further improvements in high resolution, megapixel cameras in the last few years have helped to resolve the issue of insufficient resolution.

3.4 Assumptions and Dependencies

A possible future application for facial recognition systems lies in retailing. A retail store may have cash registers equipped with cameras; the cameras would be aimed at the faces of customers, so pictures of customers could be obtained. The camera would be the primary means of identifying the customer, and if visual identification failed, the customer could complete the purchase by using a PIN. After the cash register had calculated the total sale, the face recognition system would verify the identity of the customer and the total amount of the sale would be deducted from the customer's bank account. Hence, face-based retailing would provide convenience for retail customers, since they could go shopping simply by showing their faces, and there would be no need to bring debit cards, or other financial media. Wide-reaching applications of face-based retailing are possible, including retail stores, restaurants, movie theaters, car rental companies, hotels, etc.e.g. Swiss European surveillance: facial recognition and vehicle make, model, color and license plate reader

4. Specific Requirements

Access management systems are thought of to be mission-critical and period systems and thus should operate properly below many alternative things and circumstances. For a totally automatic face recognition system, face detection and face localization are important and the terribly 1st steps to developing such a system]. The background composition is one of the most factors for explaining the difficulties in face detection Face detection in access management systems got to observe faces in any background, that means the background can be rough-textured and with nice variability the one most dominant drawback with a face recognition system or alternative biometric systems is accuracy and that they don't perform well below the various totally different things and circumstances that are encountered in day-today life. The two most vital characteristics for a face detector are its detection and error rate. The detection rate of a face detector is outlined because the magnitude relation between the amount of correctly detected and also the range of actual faces. The error is softened into 2 types of error namely;

False positives – a picture sub-region is asserted to be a face, but is not.

False negatives – a picture sub-region isn't declared as a face, once it's a face.

4.1 Functions:

4.1.1 Face Detection Module

Brief Description

This function should take the pictures from the camera then after necessary operations returns detected faces.

Initial Step-By-Step Description

The camera should send image data to server and the server should have enough capabilities to store image data coming from the camera in order to this module run correctly. Also necessary face object specification files (here xml files that stores face features) should be present in the system. (it will be default present in the system, but it is stated in case of deletion of files.)

1. The system takes image information from the camera.
2. The camera sends the image information to the server.

3. Server takes the image information and makes necessary image processing procedures like lighting correcting etc.
4. The program starts to search for faces with the given face specifications.
5. After searching all of the image file the program returns the coordinates of faces found in the image.
6. The physical places of the faces in the image are recorded in order to ease next detection job. 7. With the given coordinates the face images are cropped from the image and saved to another location and sent to 'Database and File Management Module'

4.1.2 Face Recognition Module

Brief Description

This function should take the pictures from the 'database and file management module 'then after necessary operations returns recognized faces.

Initial Step-By-Step Description

Some preprocessed face images should be available in the system in order to use this module.
1. The module takes the new coming and preprocessed face images from the 'database and file management' module.
2. The system starts to take newly coming face image information and starts to compare with the face database of students with the specific algorithms.
3. If an image record matches with a face image, this is declared to 'database and file management' module the image is present.
4. If an image is not matched a facial information in the database, then this face information is reported to 'database and file management' module and this record is added to database by this module.

4.1.3. Error Correction Module

Brief Description

This function handles the reported face recognition errors.

Initial Step-By-Step Description

1. In some time intervals, errors that are reported by the user is checked by this module.
2. If there is a mismatch between records, the system will try to take last successful match record from the database.
3. With the last successful record retrieved, this error will be tried to be handled.
4. If there is no successful record for mismatching, then it will renew the record of mismatched student in next lectures of classrooms

4.2 Performance Requirements

The servers should able to recognize image. The images should be checked after the server machine finishes recognition. Cameras are able to send views that are have enough resolution to recognize face.

4.3 Logical Database Requirements

Brief Description

It handles the database and file operations that take place between and along the face detection and face recognition modules.

Initial Step-By-Step Description

1. After face detection operation this should take the related image results.
2. After taking the image information this module should do necessary image processing operations for a better face recognition.
3. Also this module controls database operations about client side of system.
4. After face recognition the module saves images.

4.4 Design Constraints

When reporting, IEEE standards should be used and when drawing diagrams, UML standards will be used

5 Software System Attributes

5.5.1 Reliability

- Creates a highly accurate and secure biometric template of a user's face using sophisticated machine learning algorithms
- Enables users to authenticate using a 'selfie' which is compared with the stored biometric template
- Ensures a proper match once a secure authentication match, based on an accuracy score, is complete

5.5.2 Security

In this proposed system, there are several advantages as stated below,

1) Non-intrusive

2) Unique

3) Cheap Technology

4) Fast Identification

5) Contactless Authentication

5.6 Organizing the Specific Requirements

5.6.1 System Mode

It consists of two parts, which are Gesture Recognition Engine and User Interface Controlling, description is going to be made separately.

Description for Software Behavior of Gesture Recognition Engine:
Engine state can be thought of as major state of this part. This state makes gesture recognition from Gesture state by using Track, Hand Location and Hand Gesture, respectively.
Description for Software Behavior of User Interface Controlling:

In order to have ability to login, successful face recognition should be done to pass over authentication state. After the authentication state, the system goes to Main Menu state, which can be considered as the main state of the system.

5.6.2 Objects

Interface Object:
This object contains interface information, namely information of the menu, information of the screen of mobile device to build the corresponding user interface.
User Object:
This object contains hand information; position and orientation of the hand. Also face information of the user will be held in user objects. Position and orientation of the hand will be updated given by data comes from camera.

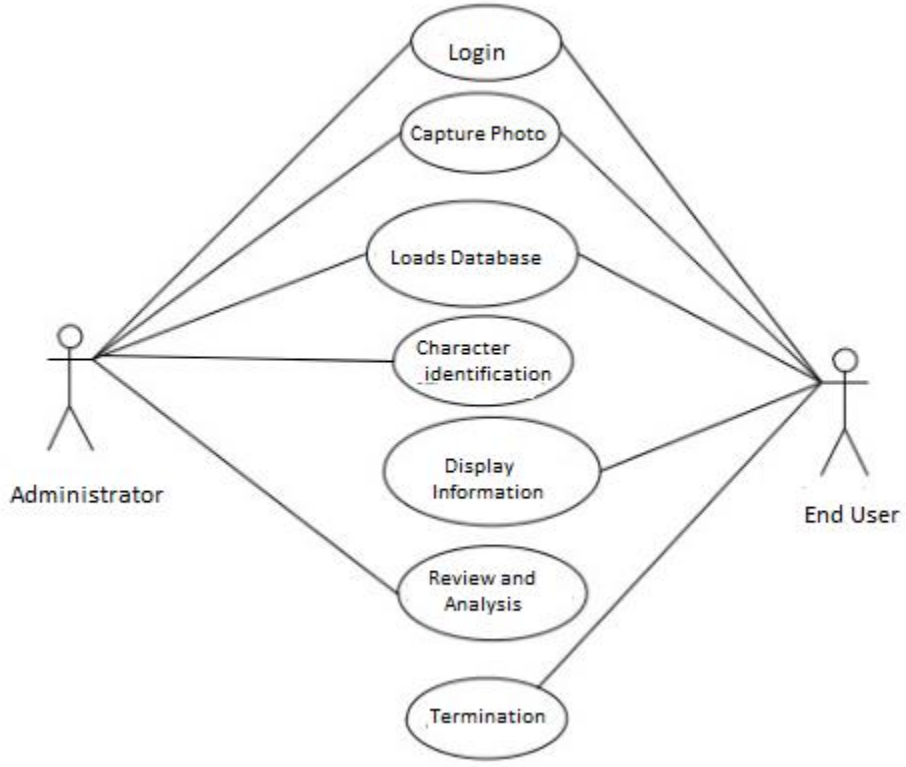

Fig 1.4 Use case diagram

Engine Object: This object contains dataset of gestures.

6.Proposed Model

Face recognition technology is the intrusive and the fastest biometric technology. It works with the most obvious individual identifier – the human face.
Instead of requiring people to place their hand on a reader or precisely position their eye in front of a scanner, face recognition unobtrusively take pictures of people's faces as they enter a defined area. There is no intrusion or delay and they do not feel "under surveillance".
Each face has numerous, distinguishable landmarks, the different peaks and valleys that make up facial features. Each human face has approximately 80 nodal points. Some of these measured by the Facial Recognition Technology are:

1. Distance between the eyes
2. Width of the nose
3. Depth of the eye socket
4. The shape of the cheekbones
5. The length of the jaw lines

These nodal points are measured using a numerical code, called a face print, representing the face in the database.

6.1 Response:

One of the strongest positive aspect of facial recognition is that it is non-intrusive. Verification or identification can be accomplished from two feet away or more, and without requiring the user to wait for long period of time or do anything more than look at the camera.

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