AUTOMATIC ATTENDANCE SYSTEM

A REPORT SUBMITTED FOR THE COURSE NAMED PROJECT - III (CS400)

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DECLARATION

In this submission, I have expressed my idea in my own words, and I have adequately cited and referenced any ideas or words that were taken from another source. I also declare that I adhere to all principles of academic honesty and integrity and that I have not misrepresented or falsified any ideas, data, facts, or sources in this submission. If any violation of the above is made, I understand that the institute may take disciplinary action. Such a violation may also engender disciplinary action from the sources which are not properly cited or permission not taken when needed.

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This is to certify that the report entitled Automatic attendance system submitted by Gooty Saiteja, has been carried out under my supervision and that this work has not been submitted elsewhere for a degree, diploma or a course.

Signature of Supervisor
(Dr N. Kishorjit Singh)

ABSTRACT

The project has created a working Automated Facial Recognition System for IIIT Manipur and its students. With the use of Open CV library through programming language, Microsoft Visual Studio, OpenCV consists of Voila and Jones machine learning algorithms for face detection and extraction. The system is programmed fully with Microsoft Visual Studio 2022.

The motivation behind this project was to help Students, to make it easier for them to record their attendance by not having to be dependent with Card-systems, as Student cards are often lost and paid to replace. This means they cannot prove their identity and record attendance instantly. The card-system is also at fault often with inaccurate attendance recordings, as it can be tricked or fooled, when individuals are able to record attendance for others. In the event when card system is offline, paper-based system have to be used in this event. This makes more time consuming for students and makes it harder for them to focus on the lecture/lab sessions.

The project's main objective was to find out if the Facial recognition system is effective at recording attendance of students than Card-based system/paper-based system that is currently in place. By implementing the Automated Facial Recognition Attendance System with the students, it would be more effective at recording attendance, as most factor being that it saves, the students, valuable time and makes it easier for them to record their attendance.

ACKNOWLEDGMENT

I would like to express my sincere gratitude to several individuals for supporting me throughout my Project. First, I wish to express my sincere gratitude to my supervisor, Dr N. Kishorjit Singh, for his enthusiasm, patience, insightful comments, helpful information, practical advice and unceasing ideas that have helped me tremendously at all times in my project and writing of this thesis. His immense knowledge, profound experience and professional expertise has enabled me to complete this project successfully. Without his support and guidance, this project would not have been possible. I could not have imagined having a better supervisor in my study.

-Gooty Saiteja

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LIST OF SYMBOLS AND ABBREVIATIONS

x	-	Face vector
W	-	Feature vector
Y	-	Vector of eigenfaces
µ	-	Average face vector
ATAS	-	Automatic attendance system
RGB	-	Red, Green, Blue
HSV	-	Hue, Saturation & value
SIFT	-	Scale-invariant feature transform
MFDA	-	Multi-features discriminant analysis
PCA	-	Principal Component Analysis
LDA	-	Linear Discriminant Analysis
LBPH	-	Local Binary Patterns Histogram
SVM	-	Support Vector Machine
NFC	-	Near field technology
RFID	-	Radio frequency identification

1 INTRODUCTION

1.1 PROJECT BACKGROUND

Being a student in IIIT Manipur for 3 and half years, it has been difficult to record attendance. It was mainly paper-based attendance system. Even the card-based system is still very slow at times, where it takes more than 4-5 seconds to record attendance.

It isn't just myself, with this problem. Many students and friends, have the same problem. The Automated Facial Recognition Attendance System is a system that helps the students record their attendance without a card. It has a Facial Recognition feature which automatically detects and instantly records attendance of the detected students.

Automated Facial Recognition Attendance System allows students, not to worry about student cards, whether it is forgotten at home or lost, they can still come into university and have their attendance recorded in their respective classes. It also helps the university by reducing students sing-in other students, as the Automated Facial Recognition Attendance System is foolproof, because it only records attendance when the right person is in the right place to be signed it.

1.2 PROBLEM STATEMENT/MOTIVATION

There are no applications at IIIT Manipur that centralizes this information. For example, when there are, more or less, 100 students in a single classroom, it will take a long time for each one to scan their student cards to record attendance as each one has to queue to touch their respective cards into the card reader. This is hard, as the queue moves very slow if the card-system is slow as well, leading to late class start. This could put mental stress into the students, leading to not being able to concentrate and learn important topics in class. It will be better if there was a system, where all students could come and shit down and they will be singed in automatically. This makes the class flow smoothly as the lecturers/staff can just carry on with the class and do not have to wait for the students to finish recoding their attendance for the class.

1.3 PROJECT AIM AND OBJECTIVES

The aims of the Automated Facial Recognition Attendance System are helping the students by:

- Record attendance without the use of student cards, through their face
- Record Multiple attendance at the same time

The belief is that the Automated Facial Recognition Attendance System would solve the difficulties for students who find it hard to record their attendance on daily-basis.

The objectives of the project are:

- Critically review the Literature Review
- Select appropriate software development life cycle methodology
- Analyze and determine the requirements for the Automated Facial Recognition Attendance System
- Produce designs for the Automated Facial Recognition Attendance System
- Develop and Implement the Automated Facial Recognition Attendance System
- Test and Evaluate the Automated Facial Recognition Attendance System
- Determine possible future improvements/suggestions for the Automated Facial Recognition Attendance System

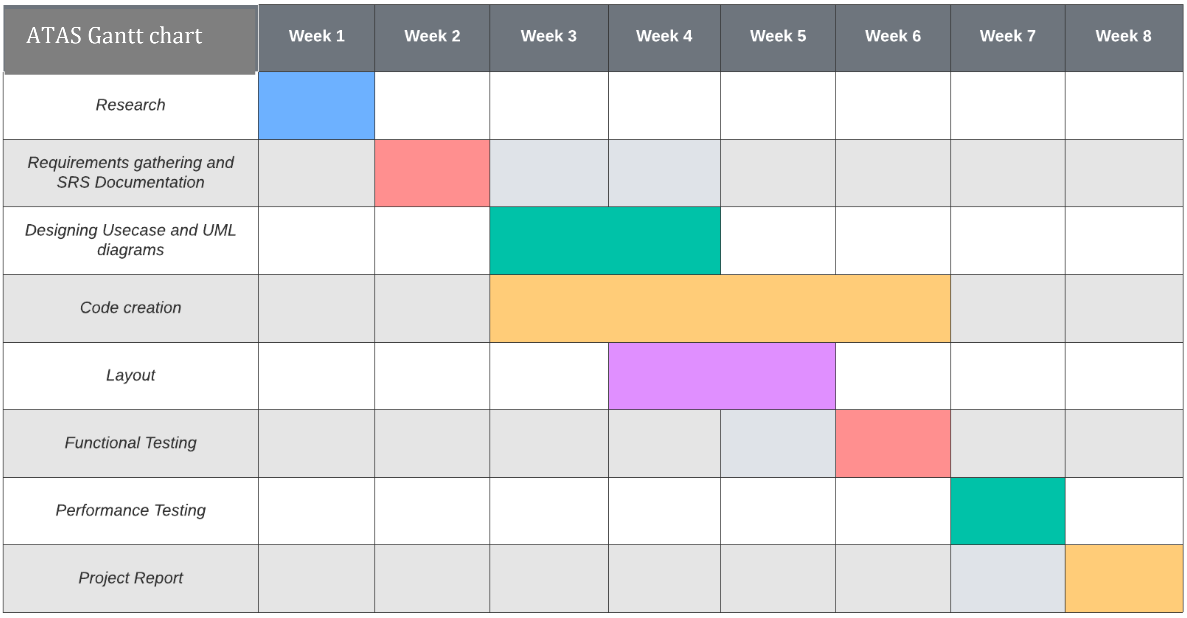
1.4 OVERVIEW OF THIS REPORT

The report structure is shown below:

Section	Details
1. Introduction	Project background, Problem Statement, Project Aim & Objectives and Report Structure are discussed in this section.
2. Analysis & Requirements	This chapter discusses requirements gathering techniques, functional and non-functional requirements.
3. Design	This chapter contains Interface design and Database design.

Table 1 Outline

1.5 GANTT CHART



ATAS Gantt chart	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
Research	🟦							
Requirements gathering and SRS Documentation		🟥						
Designing Usecase and UML diagrams			🟩	🟩				
Code creation			🟧	🟧	🟧	🟧		
Layout				🟪	🟪			
Functional Testing						🟥		
Performance Testing							🟩	
Project Report								🟧

Table 2 Gantt chart

2 SYSTEM ANALYSIS

2.1 DIFFERENT TYPES OF ATTENDANCE MANAGEMENT SYSTEM

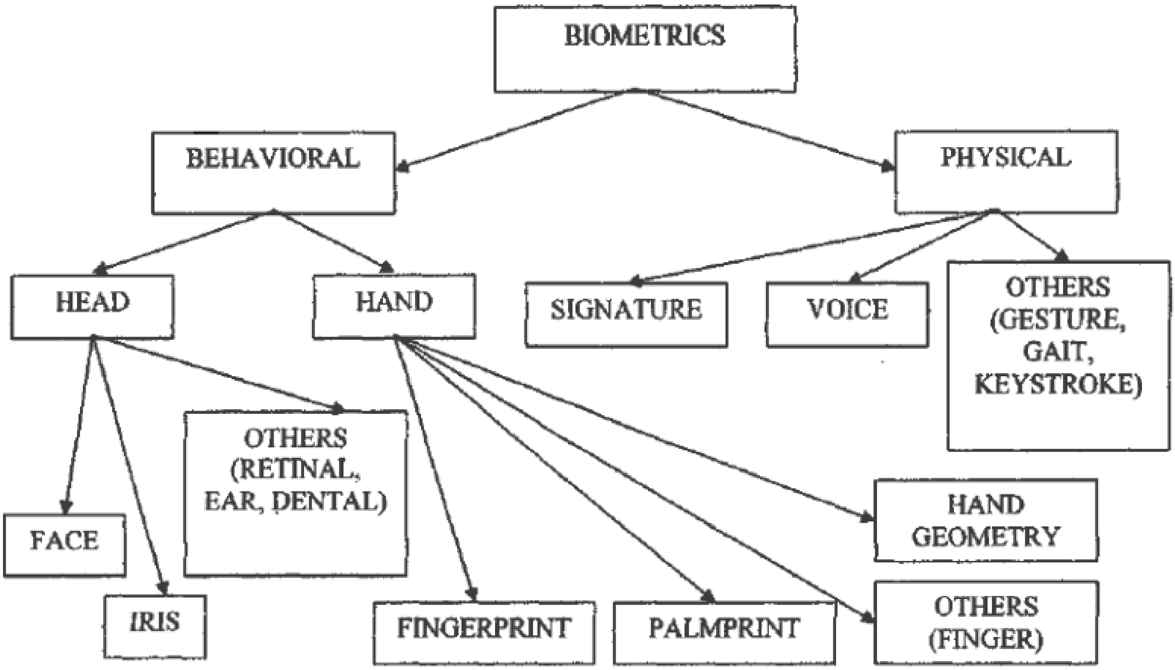


Figure 1 - Types of Biometric Techniques

2.2 FACE RECOGNITION STEPS & TECHNIQUES

Usually, two steps are included in facial recognition. At first, detection occurs and then compared with the databases for verification. Face as a biometric feature was less reliable due to variations in illumination conditions, poses, and expressions. 3D facial recognition methods resolved the reliability issues like pose change and lighting. With the advancement of technology, different techniques improved the situation and face became a more secure biometric feature as compared to other characteristics e.g., fingerprint etc. Following image explains different facial recognition techniques:

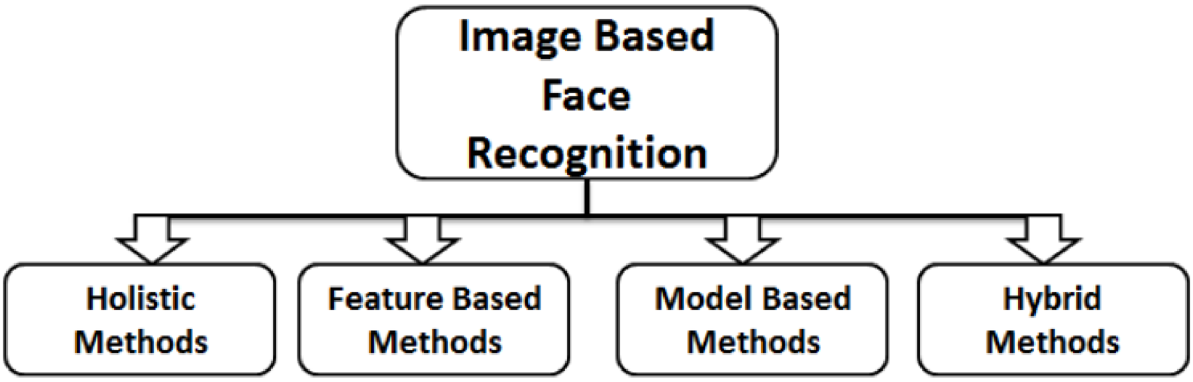


Figure 2 - Types of face recognition systems

2.2.1 Holistic Approach

In this approach, the entire face is considered as a solitary feature for identification and acknowledgement. It analyzes the similarities of the entire face, overlooking individual highlights like eyes, mouth, nose etc. These schemes are portrayed into two sections as appeared in the figure.

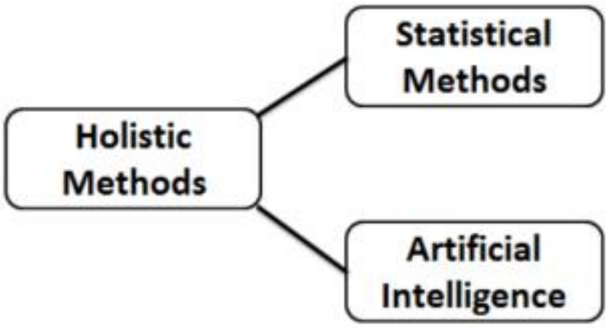


Figure 3 - Types of Holistic methods

2.2.2 Feature Based Technique

Inverse to the holistic approach, features based approach consider every individual element of the face: eyes, nose, mouth, mole, ears and match the similarities between the pictures. Another approach in face recognition encompasses, recognition with methods for hexagonal feature location. The approach takes a shot at the bases of edge location for face location and recognition utilizing the hexagonal facial. Heuristic parameters center around the nose segment of the collected pictures followed by grey scale changes and change of intensity. Another research work in which the face acknowledgement is finished by the assistance of edge data refined by the assistance of diminished sample size. The shading highlight in case of HSV shading space of the pictures of the facial segment is considered. The skin areas are recognized utilizing the shade and immersion characteristics. Skin highlight of the face is utilized as a part of piece approach, this examination system utilizes the procedures like piece approach and the RGB shading space. Gabor filter is used to extract the features.

2.2.3 Technique based on Models

Model-based feature acknowledgement is another approach. The 3D facial model can be procured utilizing both dynamic and inactive means. The extensively utilized active 3D picture procurement technique is infrared information, which ventures laser beam onto an object and records its appearance coming about best and exact 3D model's recognition. Stereo Imaging is the procedure for the securing of the 3D show, in which at least two cameras at the same time are catching a scene from various points. Clear data is procured utilizing different data from various angles. 3D to 2D confronting acknowledgement that the technique is displayed, utilizing SRC and CCA for acknowledgement, outcome demonstrating a better performance with low computational cost. Another model "Partner Predict" (AP) was presented abolish to posture, light and impression variations. AP technique adequately dealt with the individual variations. A discriminative model was presented to reduce age heterogeneity issues in confront acknowledgement, utilizing scale-invariant feature transform (SIFT) and multi-scale neighborhood binary patterns for restricted descriptors and presented multi-features discriminant analysis (MFDA) algorithm to compare down the local descriptors, outcomes were facial acknowledgement development in the influence of ageing (Wong Y., 2011)

2.3 PROCEDURES

This section describes the procedures and steps of the system. It consists of following processes.

- Obtaining the images
- Detection of face
- Turbulence removal/pre-processing
- Development of the databases
- Face recognition and analysis
- Attendance

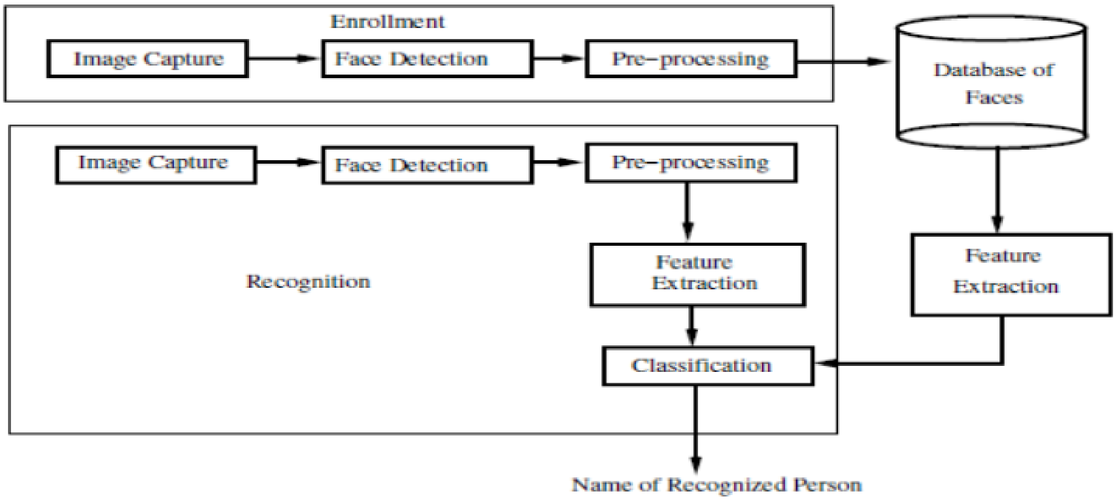


Figure 4 - System Architecture

2.3.1 Obtaining the images

Images of the students are captured as soon as the students enter the classroom. The preferred size of the image is 640x480, to avoid resizing. Resizing affects the quality of the image and thus the performance of the system may be affected.

2.3.2 Detection of Faces

Performance of the face recognition system is improved using appropriate and effective face detection algorithm. Feature invariant method, methods based on the geometry of faces and machine learning are a few methods used for exposure to faces. Voila and Jones' method of face recognition has the highest detection rate. It is very efficient and fastest to date. The AdaBoost learning algorithm is mostly used as a classifier. This algorithm has been observed to perform well in different conditions of light.

2.3.3 Pre-processing

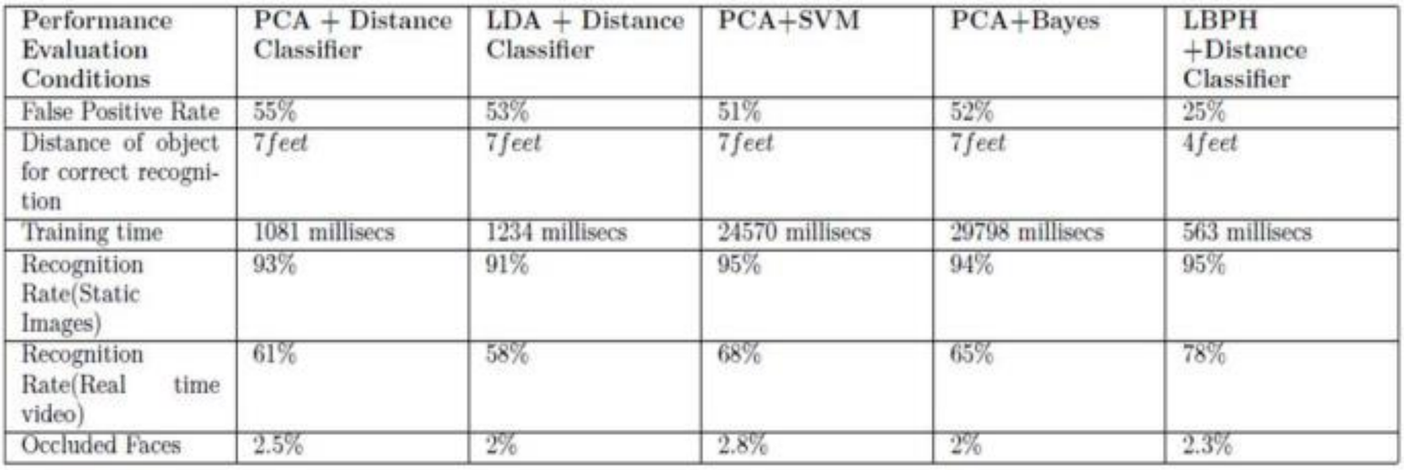
In this process, the image of the face undergoes Histogram equalization and the size is altered to 100x100. Histogram equalization is most practiced Histogram normalization procedure. This resizing procedure, increases the range of intensities of the images which improves the contrast of the image and thus image becomes clearer.

2.3.4 Database Development

When choosing a biometric-based system, enlistment of everyone in databases becomes necessary. The images are collected and then the required body feature is extracted, which in this specific case is a face. Preprocessing processes are applied to it and the images are stored in the databases.

2.4 FACE RECOGNITION & ANALYSIS

The execution of a Face Recognition system additionally depends upon the character extraction and their grouping to get the exact outcomes. Feature extraction is an accomplished utilizing feature-based strategy or all above-explained systems. In some comprehensive procedures, utilization of dimensionality diminishment is done before characterization. Analyzing the aftereffects of various holistic methodologies utilized for feature extraction.



Performance Evaluation Conditions	PCA + Distance Classifier	LDA + Distance Classifier	PCA+SVM	PCA+Bayes	LBPH +Distance Classifier
False Positive Rate	55%	53%	51%	52%	25%
Distance of object for correct recognition	*7feet*	*7feet*	*7feet*	*7feet*	*4feet*
Training time	1081 millisecs	1234 millisecs	24570 millisecs	29798 millisecs	563 millisecs
Recognition Rate(Static Images)	93%	91%	95%	94%	95%
Recognition Rate(Real time video)	61%	58%	68%	65%	78%
Occluded Faces	2.5%	2%	2.8%	2%	2.3%

Figure 5 - Comparison of different holistic algorithms

Principal Component Analysis (PCA) was the first algorithm that was introduced to represent faces closely. In PCA the face pictures are expressed utilizing eigenfaces and their relating projections along each eigenface. Rather than utilizing all the dimensions of a picture, just important measurements are considered to represent the picture. Scientifically a picture utilizing PCA is expressed as: $x= WY + \mu$ in this equation, x represents face vector, W is feature vector, Y represents a vector of eigenfaces and μ symbolizes the average face vector. These projections (feature vectors) are then utilized as classification includes in face acknowledgement. Later Fisherazs Linear Discriminant Analysis (LDA) was proposed, in which the proportion of between-class dissipate, and inside-class scramble amplifies. PCA does not consider the discriminative data in the information though LDA stores the discriminative data in the information. LDA does not work effectively in poor conditions of light. Nearby Binary Pattern Histogram (LBPH) is as of late proposed algorithm for face highlight extraction. In this technique, LBP picture is portioned into local areas and the histogram of each is extricated and are connected to create a face descriptor. The precision of a system actualized utilizing PCA and LDA are influenced by the size of the database which isn't the situation in LBP. PCA is utilized for characters extraction and Support Vector Machine (SVM) is utilized for the classification. SVM is as of late proposed algorithm which is a compelling example grouping algorithm. For design acknowledgement SVM finds the ideal partition of nearest focus points in the training set. This partition should be possible straightly or non-linearly.

Face recognition consists of two procedures, extraction followed by classification. The previously mentioned highlight extractors joined with classifiers are thought about in different true situations, for example, lighting conditions, Unintentional facial component changes 16 (blocked faces), Expressions. Framework Performance is likewise assessed in terms of acknowledgement rate, remove, false positive rate, the time taken for preparing. False Positive Rates are ascertained by considering 60 ongoing picture outlines in the above table. It has been watched that LBP based calculation gives slightest false positive rate and great acknowledgement rate as it accurately separates between the obscure and known faces. LDA can make rectify segregation between the pictures just if the separation is given in the database (for instance pictures at various lighting conditions). Separation likewise plays as a basis in this framework show as the picture frames are caught when a man goes into the room and face region is resized. So, the face area captured at around 4feet and 7feet give better outcomes for LBPH and different algorithms separately. For a Training information of 150 pictures preparing time is ascertained.

2.5 ALGORITHMS FOR FACE DETECTION, EXTRACTION AND MATCHING

2.5.1 OpenCV Library

OpenCV (Open-Source Computer Vision Library) is an open-source computer vision and machine learning software library. The library has more than 2500 optimized algorithms, the library has more than 2500 optimized algorithms, which includes a comprehensive set of both classic and state-of-the-art computer vision and machine learning algorithms. These algorithms can be used to detect and recognize faces, identify objects, classify human actions in videos, track camera movements, track moving objects, extract 3D models of objects, produce 3D point clouds from stereo cameras, stitch images together to produce a high resolution image of an entire scene, find similar images from an image database, remove red eyes from images taken using flash, follow eye movements, recognize scenery and establish markers to overlay it with augmented reality, etc. (team, 2018) The OpenCV Library includes Viola and Jones, which from literature review, it is knows as one of the best algorithms for face detection and extraction algorithm. It also includes Eigen Object Detector which will be can be used to match the faces stored in the database against the face from camera.

2.6 PROGRAMMING LANGUAGE & DATABASE

Programming language chosen to implement the algorithms is Python. This is used as an integrated software development environment, used to develop computer programs for Microsoft Windows, as well as web sites, web applications and web services. Reason for this choosing is that the component of Microsoft video Studio includes built-in tools include a forms designer for building GUI applications and Local Database built in. Local DB is created specifically for developers. It is very easy to install and requires no management, yet it offers the same T-SQL language, programming surface and client-side providers as the regular SQL Server Express. In effect the developers that target SQL Server no longer have to install and manage a full instance of SQL Server Express on their laptops and other development machine. (Nixon, 2018)

2.7 PROPOSAL ANALYSIS

To determine the requirements, the initial project proposal was analyzed. This helped produced a series of Functional and Non-Functional requirements. The requirements were determined using FURPS – Functional, Usability, Reliability, Performance and Security. FURPS is a model for classifying software quality attributes. The requirements were partially implied in the proposal but since both Functional & Non-Functional requirements are necessary for the application to be successful, it was advised to look into it further. After the completion of the system, a questionnaire is handed out to a range of students who participated in creation of the system, to gather their feedback and update the system based on the suggestions. This will also help to know if the system is the right implemented solution to the problem identified.

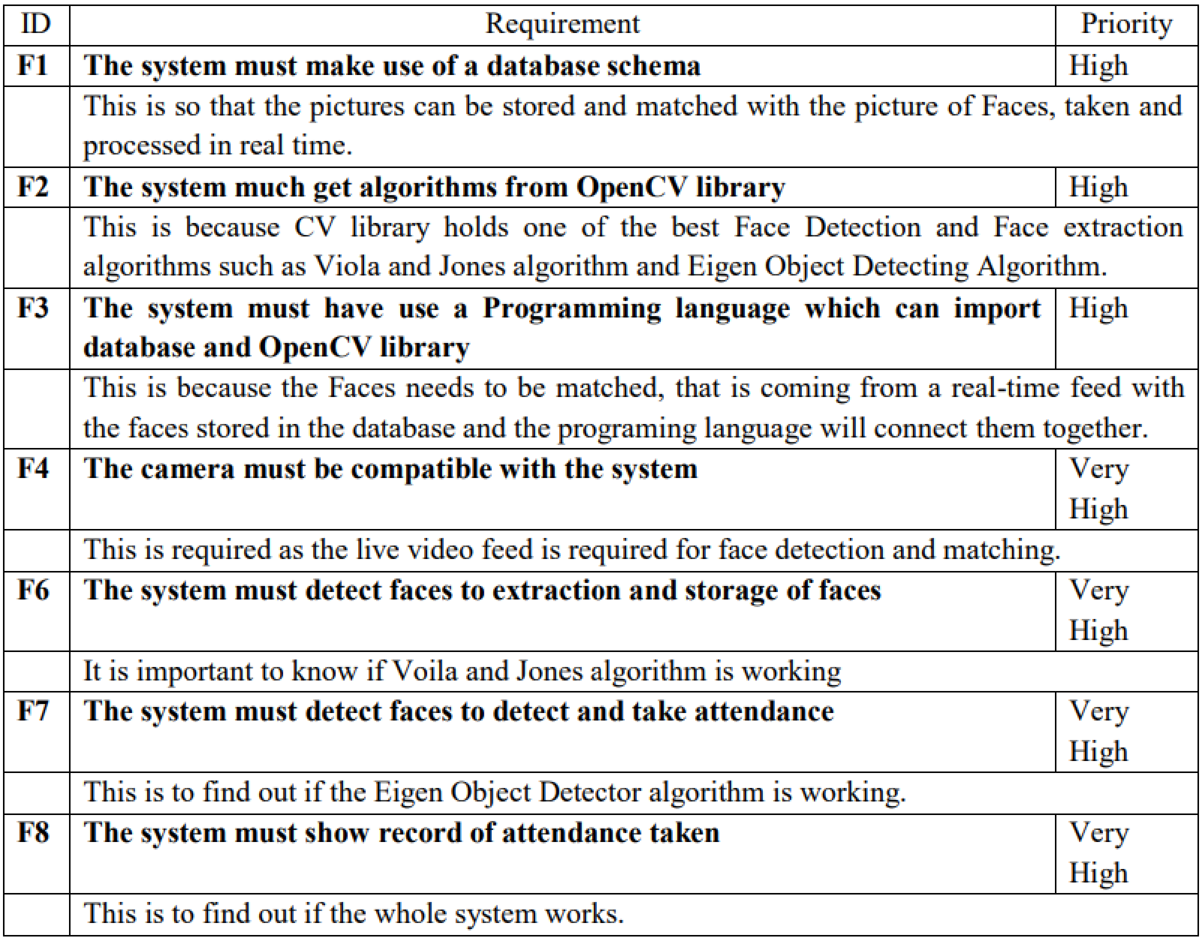
2.8 RESEARCH

This is an important factor in finding techniques, to get a better understand of the system, research was carried out. The research was done by reading books, journals, articles and websites. This researched helped to know, the steps, techniques and algorithms that could be used to create the artefact.

2.9 REQUIREMENTS SUMMARY

2.9.1 Functional Requirements

Looking at all the research results, the functional requirements for the were determined. These are the requirements that deal directly with the functionality of the application. The functionality requirements can be seen in Table 3: Functional Requirements.

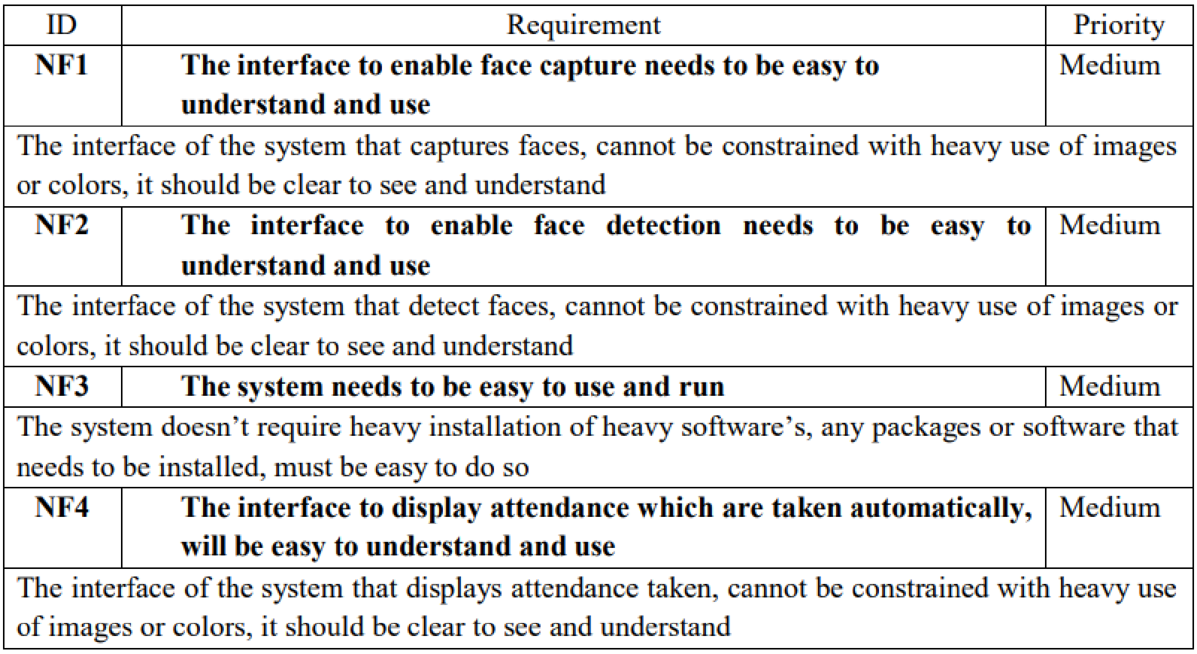


ID	Requirement	Priority
F1	**The system must make use of a database schema**	High
	This is so that the pictures can be stored and matched with the picture of Faces, taken and processed in real time.	
F2	**The system much get algorithms from OpenCV library**	High
	This is because CV library holds one of the best Face Detection and Face extraction algorithms such as Viola and Jones algorithm and Eigen Object Detecting Algorithm.	
F3	**The system must have use a Programming language which can import database and OpenCV library**	High
	This is because the Faces needs to be matched, that is coming from a real-time feed with the faces stored in the database and the programing language will connect them together.	
F4	**The camera must be compatible with the system**	Very High
	This is required as the live video feed is required for face detection and matching.	
F6	**The system must detect faces to extraction and storage of faces**	Very High
	It is important to know if Voila and Jones algorithm is working	
F7	**The system must detect faces to detect and take attendance**	Very High
	This is to find out if the Eigen Object Detector algorithm is working.	
F8	**The system must show record of attendance taken**	Very High
	This is to find out if the whole system works.	

Table 3 Functional Requirements

2.9.2 Non-Functional Requirements

The Non-Functional requirements do no directly deal with the functionality of the system. The Non-Functional requirements can be seen in Table 4: Non-Functional Requirements.



<table>
<tr><th>ID</th><th>Requirement</th><th>Priority</th></tr>
<tr><td><b>NF1</b></td><td><b>The interface to enable face capture needs to be easy to understand and use</b></td><td>Medium</td></tr>
<tr><td colspan="3">The interface of the system that captures faces, cannot be constrained with heavy use of images or colors, it should be clear to see and understand</td></tr>
<tr><td><b>NF2</b></td><td><b>The interface to enable face detection needs to be easy to understand and use</b></td><td>Medium</td></tr>
<tr><td colspan="3">The interface of the system that detect faces, cannot be constrained with heavy use of images or colors, it should be clear to see and understand</td></tr>
<tr><td><b>NF3</b></td><td><b>The system needs to be easy to use and run</b></td><td>Medium</td></tr>
<tr><td colspan="3">The system doesn’t require heavy installation of heavy software’s, any packages or software that needs to be installed, must be easy to do so</td></tr>
<tr><td><b>NF4</b></td><td><b>The interface to display attendance which are taken automatically, will be easy to understand and use</b></td><td>Medium</td></tr>
<tr><td colspan="3">The interface of the system that displays attendance taken, cannot be constrained with heavy use of images or colors, it should be clear to see and understand</td></tr>
</table>

Table 4 Non-Functional Requirements

2.10 ETHICS

Since the system deals with sensitive data of Coventry University students, there needs to be ethical considerations that had to be made. The initial ethical concern was that since it is not ethical to capture live pictures of students without their consent, it was decided only a handful of participants would volunteer to participate in creation of the system, to test the system and to review the system.

2.11 CONCLUSION

Different approaches in automated attendance management systems are researched and explained, based on them, it can be concluded that, manual procedures are annoying and time consuming. The risk of proxy/false attendance is very high with manual procedures. Automated systems are more secure and reliable, the best being Face recognition-based attendance systems proving to be the most efficient system. They are secure, time-saving and dependable to use because Face as a biometric methodology is broadly adequate for the overall population, and face recognition tools can meet the accurateness and demands of accurate and effective attendance system. Cost is also not an issue with this system because installing some specialized hardware for using it is not required, usually a camera and a computer are enough in this methodology. The system takes attendance at the time of entry and exit of students in the classroom, face recognition and detection are continuously carried out in 3D technology during lectures/classroom. Although it needs improvement with regard to different lighting conditions, it is comparatively better than other systems like Bluetooth, NFC, Mobile and RFID which are not fool proof, costly to implement and cannot guarantee an effective and efficient attendance system. Face recognition-based attendance systems on the other hand, uses different algorithms such as, Voila and Jones which is very good at face recognition and SVM and Bayesian which are comparatively better at classifying faces. Face recognition uses different techniques and approaches like Hybrid approach which results have shown that it is the best to use, as it makes use of two different methods. In this modern era, most researches are being carried out in hybrid methodologies which makes used of Face-Recognition technology, therefore it is best to use Face Recognition based Attendance Management System for secure, fool-proof, efficient and effective attendance recording. These findings will be useful and closely considered when it is time to make the functional and non-functional requirements for the system.

3 DESIGN

3.1 INTRODUCTION

This chapter focuses on the systematic approaches to be adopted to guide help in the starting to the completion of the project, it will mainly focus on a development life cycle model and its advantages and disadvantages. The chapter aims to conclude with why the methodology was chosen for the duration of the project and the reasons behind choosing it. If the correct methodology is chosen and followed correctly, it should help to ensure the project stays on schedule.

3.2 LIFE CYCLE

3.2.1 Prototype Model

In Prototype Model, a throw-away prototype is built with potentially few features included to closely understand the requirements. The prototype is not the complete system because many of the features are not built in the prototype, it is simply a prototype of what the final system will look like so that the client/user can get close feel of the system before the final system is even built.

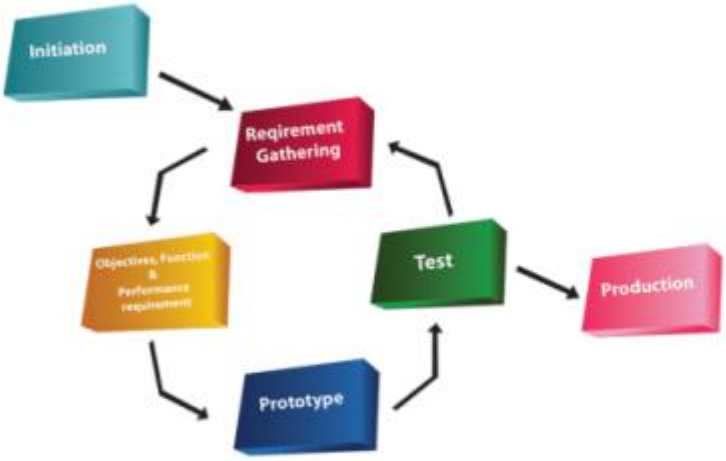


Figure 6 - Prototype Model

Advantages of Prototype Model to the project:

- Errors can be detected much earlier in the lifecycle since therefore requirements can be changed with the feedback of the client, who are the students and myself in this case, if the error is time consuming to fix, as the project will have to be delivered on time.
- Feedback can be gathered early on in the development lifecycle through prototypes, this means that the feedback received from supervisor and participants students can be applied earlier than later in the lifecycle, saving time and helping to complete the project on schedule. This also means that the final system will satisfy the problem identified, as feedbacks from both supervisors and students will be regularly inputted in very prototype developed.

Disadvantages of Prototype Model to the project:

- Prototype have to be regularly developed which means, this could lead to continuous implantation and repairing, which could be time consuming.
- This methodology could increase problems, such as getting attached to prototype built and using that prototype design to the final system rather than changing it according to the feedback received. This means the final system cannot be according to the requirements and the requirements are not met.

3.3 JUSTIFICATION OF CHOSEN LIFECYCLE

The chosen lifecycle methodology to be followed by the system was Prototype Model. This methodology was chosen because it allows to work on different aspects of the system requirements separately, this allows to get feedbacks on different prototypes very quickly and allows changes to be made, so that the final system matches with the requirements specified. Furthermore, it also helps to see that the project schedule, Gantt chart, is accurate and achievable. The chosen lifecycle has different variations which can be used, chosen is that Evolutionary Prototyping variation is very effective for myself. It is first time making a system which requires different components to be researched and implemented because usually this was done in a group which meant shared workload and made it easier as each member were allocated certain aspects of the system. However, as this time it is an individual work, Evolutionary Prototyping lifecycle helps to create a prototype and keep adding new prototypes on top of the initial prototype and tested along with the components of the first prototype, i.e., Database+FacesCaptured, will have to bear in mind that the first prototype must be robust. This is better than the Waterfall Model as the waterfall model needs have all the requirements stated, along with the design and by the time it is coding stage, it could be late to make changes to the requirements, if a requirement proved to be hard to do or time-consuming, this could lead to delay in project schedule, prolong the delivery of the system and add additional constraints to other aspects of the project, i.e., Write-ups.

3.4 DESIGN

3.4.1 Main Screen

This is the first screen the user will see, upon starting the system. Although there was no requirement for how the interface of the 'Main screen' should look like. The requirement of other interfaces was to be easy to understand and use. The interface of the system that Home Screen, is not constrained with heavy use of images or colors and it is clear to see and understand.

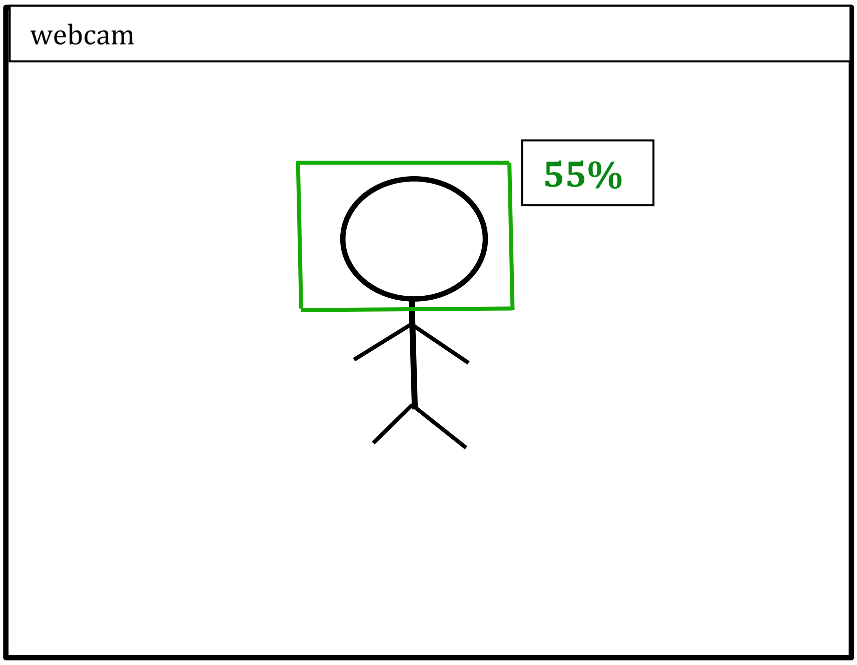
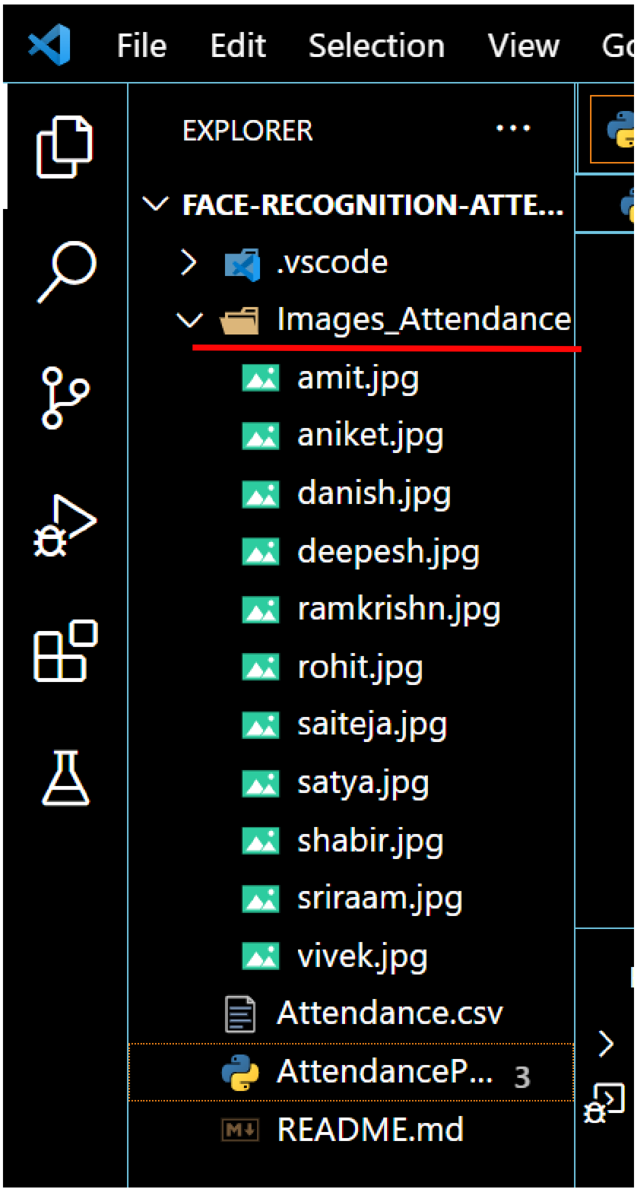


Figure 7 - Main Screen

- The webcam will automatically be launched when the system is opened to capture the faces of students.
- Following the capture of the image, the matching process will go through all images in the images folder to find the matching image.
- You will see the percent match between the captured image and the image in the images folder.
- As a result of matching percentage attendance, the corresponding student will be marked as present or absent.

3.4.2 Adding Faces

- In order to match the captured image with all student images, we must create a list of all student images.
- In order to accomplish this, we create an images folder and store the clear face visible photos of all the students in it.
- Every time a face is captured, it is matched against all of the faces stored in this folder.



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FACE-RECOGNITION-ATTE...
  .vscode
  Images_Attendance
    amit.jpg
    aniket.jpg
    danish.jpg
    deepesh.jpg
    ramkrishn.jpg
    rohit.jpg
    saiteja.jpg
    satya.jpg
    shabir.jpg
    sriraam.jpg
    vivek.jpg
  Attendance.csv
  AttendanceP...  3
  README.md
```

Figure 8 - Add Student

3.4.3 Real-Time Face Detection & Attendance

This is the screen, where the faces stored in the images folder gets matched against the real-time video face, coming from the camera. The requirement stated that the interface to enable face detection needs to be easy to understand and use. As seen in the figure 7, The interface of the system that detects face and matches against the images, is not constrained with heavy use of images or colors and it is clear to see and understand.

- Following a match between the face and the image, the system must mark the student's attendance.
- Once the perfect match has been detected, the system retrieves the name of the detected student, along with the date and time of the match.
- Once the system has retrieved all the information, it opens an Excel spreadsheet and writes it there.

3.5 DEVELOPMENT TOOLS

The Automated Facial Recognition attendance system is developed during this phase. It includes user interface, programming language Python built in Visual Studio 2022 and the data of the system. See justification in section 3.3 CV library – Algorithms – Voila and Jones algorithms and Eigen Object Detector algorithm. See justification in section 3.3. The chosen approach is Evolutionary Prototyping method as discussed. Therefore, the development includes producing the first robust prototype, if it matches the requirements, other prototypes are added into it.

4 IMPLEMENTATION AND TESTING

4.1 INTRODUCTION

Face recognizers generally take face images and find the important points such as the corner of the mouth, an eyebrow, eyes, nose, lips, etc. Coordinates of these points are called facial-features points, there are such 66 points. In this way, a different technique for finding feature points give different results.

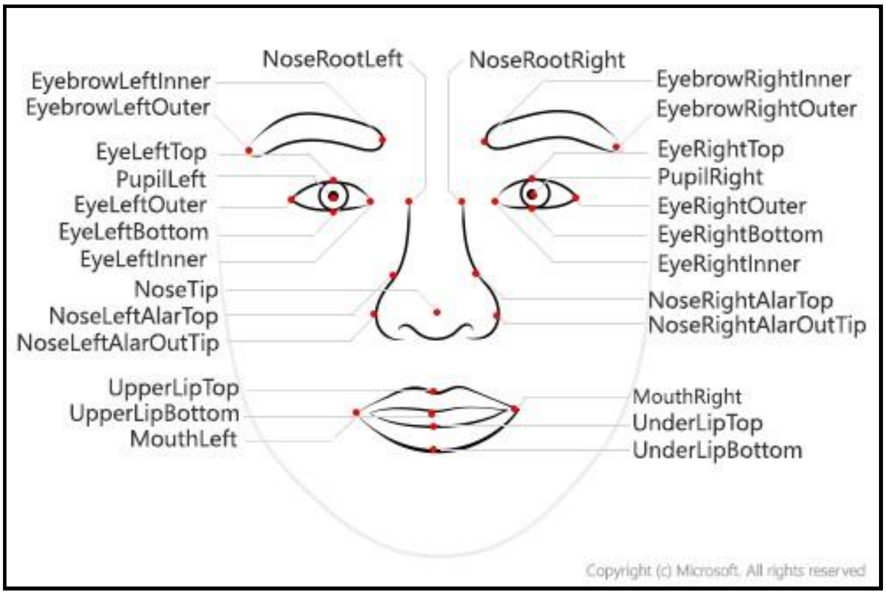


Figure 9 - Face recognition model

Steps involved in a face recognition model:

1. **Face Detection:** Locate faces and draw bounding boxes around faces and keep the coordinates of bounding boxes.
2. **Face Alignments:** Normalize the faces to be consistent with the training database.
3. **Feature Extraction:** Extract features of faces that will be used for training and recognition tasks.
4. **Face Recognition:** Matching of the face against one or more known faces in a prepared database.

4.2 IMPLEMENTATION

Steps to Build the Face Recognition System Install Libraries:

We need to install 2 libraries in order to implement face recognition.

dlib: Dlib
is a modern C++ toolkit containing machine learning algorithms and tools for creating complex software in C++ to solve real-world problems.

```
# Installing dlib
pip install dlib
```

face recognition: The face recognition library, created and maintained by Adam Geitgey, wraps around dlib facial recognition functionality.

```
# Installing face recognition
pip install face recognition
```

OpenCV for some image pre-processing.

```
# Installing opencv
pip install opencv
```

Import Libraries

We have to import the downloaded libraries to build the system

```
import cv2
import numpy as np
import face_recognition
```

Loading Images

After importing libraries, we need to load an image.

face_recognition library loads images in the form of BGR, in order to print the image, we should convert it into RGB using OpenCV.

```
imgelon_bgr = face_recognition.load_image_file('elon.jpg')
imgelon_rgb = cv2.cvtColor(imgelon_bgr,cv2.COLOR_BGR2RGB)
cv2.imshow('bgr', imgelon_bgr)
cv2.imshow('rgb', imgelon_rgb)
cv2.waitKey(0)
```

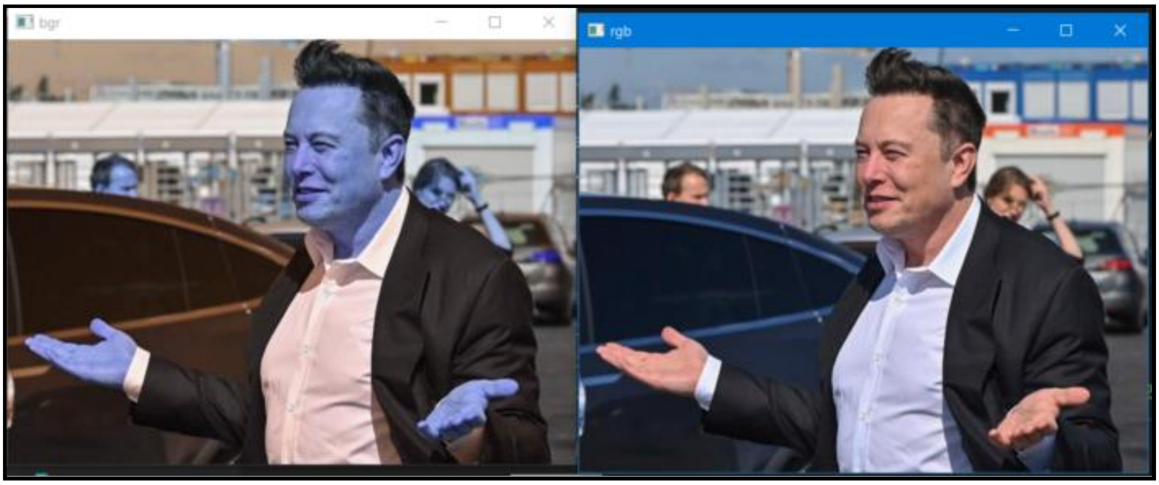


Figure 10 - BGR to RGB

As we see RGB looks natural so you will always change the channel to RGB.

Find Face Location and Draw Bounding Boxes

We need to draw a bounding box around the faces in order to show if the human face has been detected or not.

```
 imgelon =face_recognition.load_image_file('elon.jpg')
 imgelon = cv2.cvtColor(imgelon,cv2.COLOR_BGR2RGB)
 #----------Finding face Location for drawing bounding boxes-------
 face = face_recognition.face_locations(imgelon_rgb)[0]
 copy = imgelon.copy()
 #-------------------Drawing the Rectangle-------------------------
 cv2.rectangle(copy, (face[3], face[0]),(face[1], face[2]),
(255,0,255), 2)
 cv2.imshow('copy', copy)
 cv2.imshow('elon',imgelon)
```

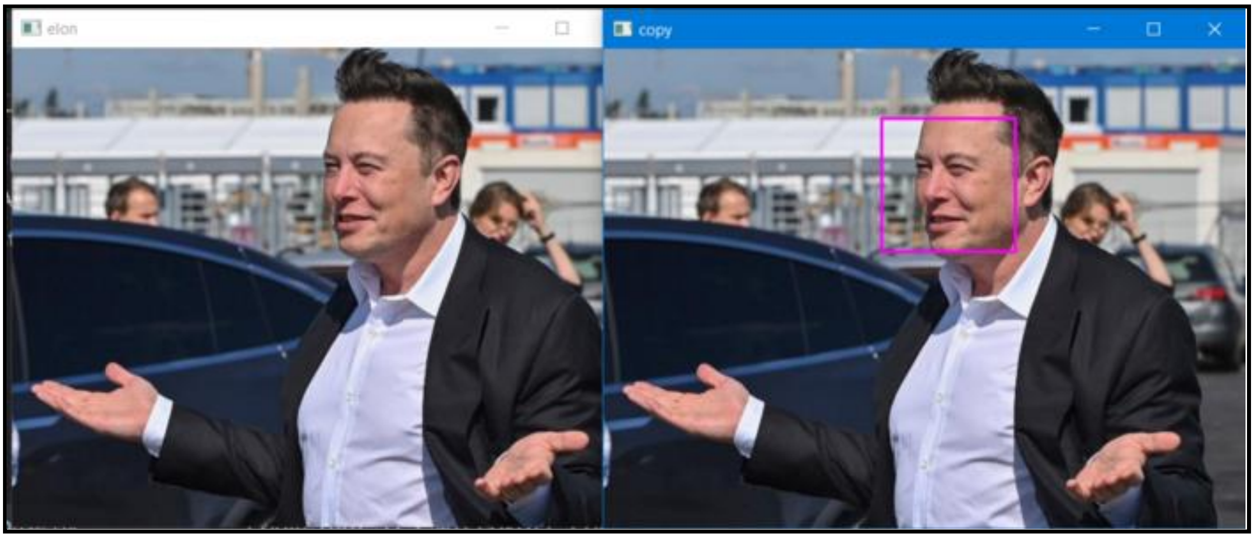


Figure 11 - Face recognition

Train an Image for Face Recognition

This library is made in such a way that it automatically finds the face and work on only faces, so we don’t need to crop the face out of pictures.

Training:

At this stage, we convert the train image into some encodings and store the encodings with the given name of the person for that image.

```
train_elon_encodings = face_recognition.face_encodings(imgelon)[0]
```

Testing:

For testing, we load an image and convert it into encodings, and now match encodings with the stored encodings during training, this matching is based on finding maximum similarity. When you find the encoding matching to the test image you get the name associated with train encodings.

```
# lets test an image
test = face_recognition.load_image_file('elon_2.jpg')
test = cv2.cvtColor(test, cv2.COLOR_BGR2RGB)
test_encode = face_recognition.face_encodings(test)[0]
print(face_recognition.compare_faces([train_encode],test_encode))
```

face_recognition.compare_faces returns **True** if the person in both images are the same other it returns **False**.

Building a Face Recognition System

Import Necessary Libraries

```
import cv2
import numpy as np
import face_recognition
import os
from datetime import datetime
from email.mime.text import MIMEText
from email.mime.multipart import MIMEMultipart
import smtplib
```

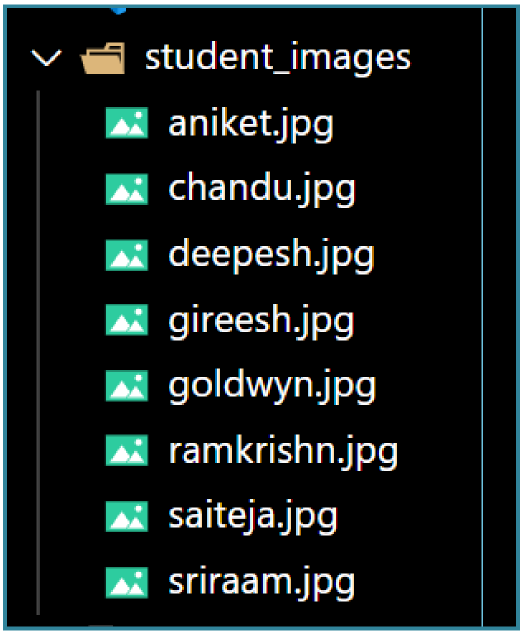
Define a folder path where our training image dataset will be stored

```
path = 'student_images'
```

Note: for training, we only need to drop the training images in the path directory and the image name must be person_name.jpg/jpeg format.

for example:

As we see in my student_images path I have 8 persons. Hence our model can recognize only these 8 persons. We can add more pictures in this directory for more persons to be recognized.



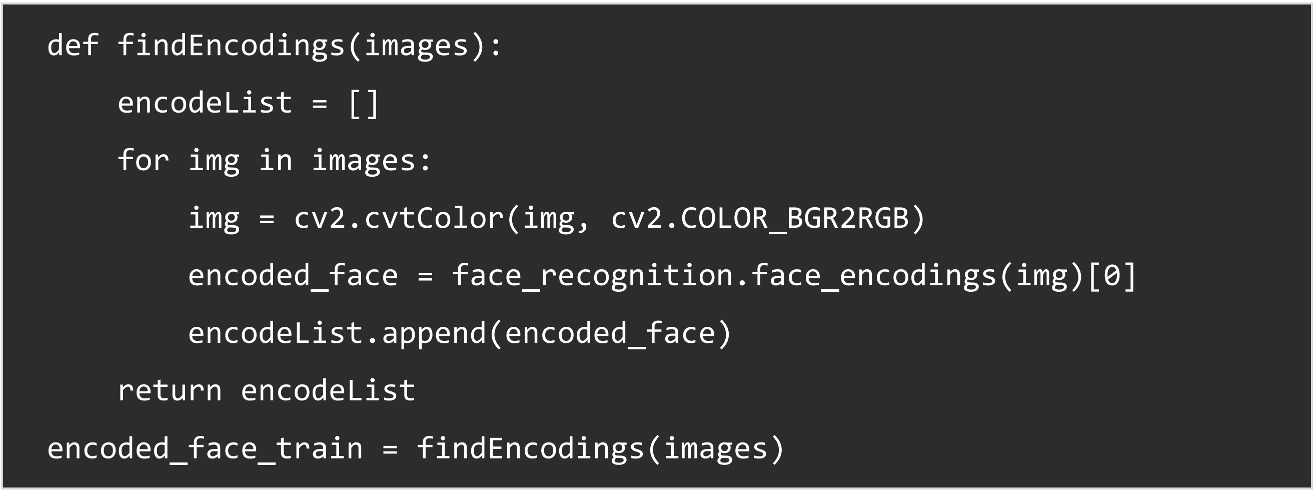
student_images
- aniket.jpg
- chandu.jpg
- deepesh.jpg
- gireesh.jpg
- goldwyn.jpg
- ramkrishn.jpg
- saiteja.jpg
- sriraam.jpg

Figure 12 - Students list

- Now create a list to store person_name and image array.
- Traverse all image file present in path directory, read images, and append the image array to the image list, and file-name to classNames.

```
images = []
classNames = []mylist = os.listdir(path)
for cl in mylist:
curImg = cv2.imread(f'{path}/{cl}')
images.append(curImg)
classNames.append(os.path.splitext(cl)[0])
```

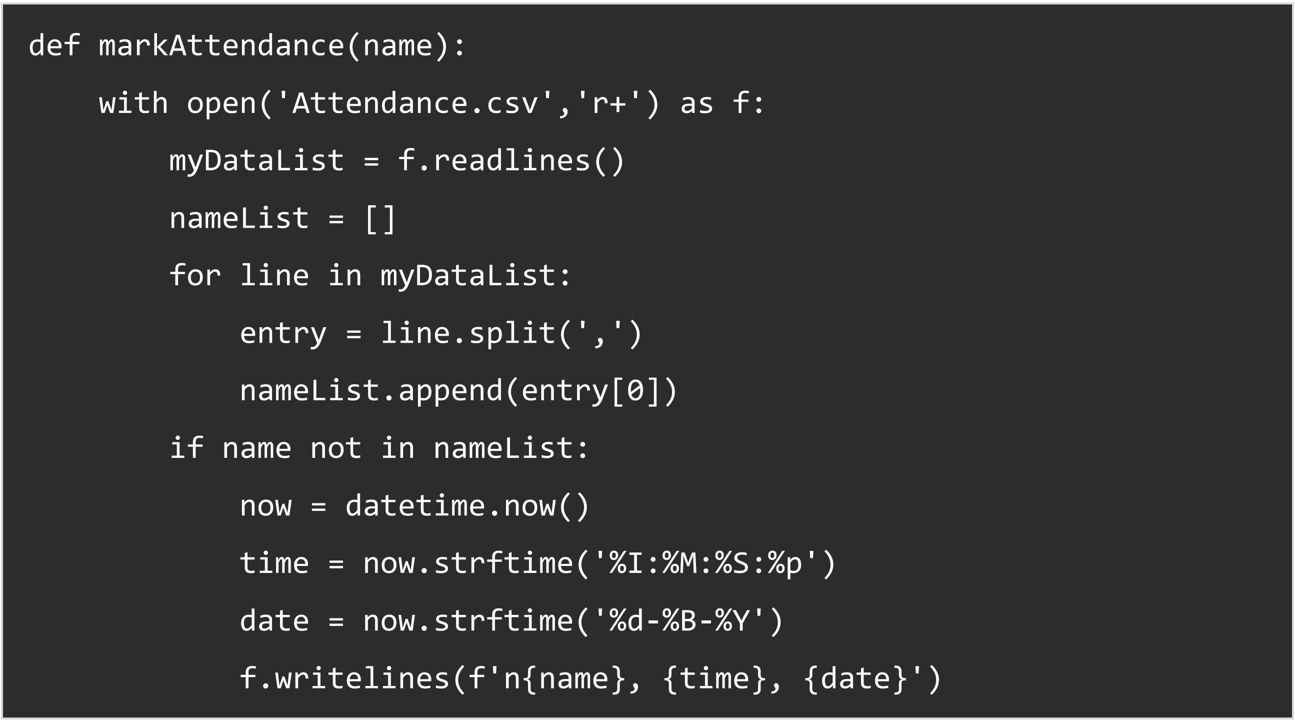
- create a function to encode all the train images and store them in a variable **encoded_face_train**



```
def findEncodings(images):
    encodeList = []
    for img in images:
        img = cv2.cvtColor(img, cv2.COLOR_BGR2RGB)
        encoded_face = face_recognition.face_encodings(img)[0]
        encodeList.append(encoded_face)
    return encodeList
encoded_face_train = findEncodings(images)
```

- Creating a function that will create a Attendance.csv file to store the attendance with time.

  Note: here you need to create Attendance.csv file manually and give the path in the function.



```
def markAttendance(name):
    with open('Attendance.csv','r+') as f:
        myDataList = f.readlines()
        nameList = []
        for line in myDataList:
            entry = line.split(',')
            nameList.append(entry[0])
        if name not in nameList:
            now = datetime.now()
            time = now.strftime('%I:%M:%S:%p')
            date = now.strftime('%d-%B-%Y')
            f.writelines(f'n{name}, {time}, {date}')
```

- with open(“filename.csv”,’r+’) creates a file and ‘r+’ mode is used to open a file for reading and writing.

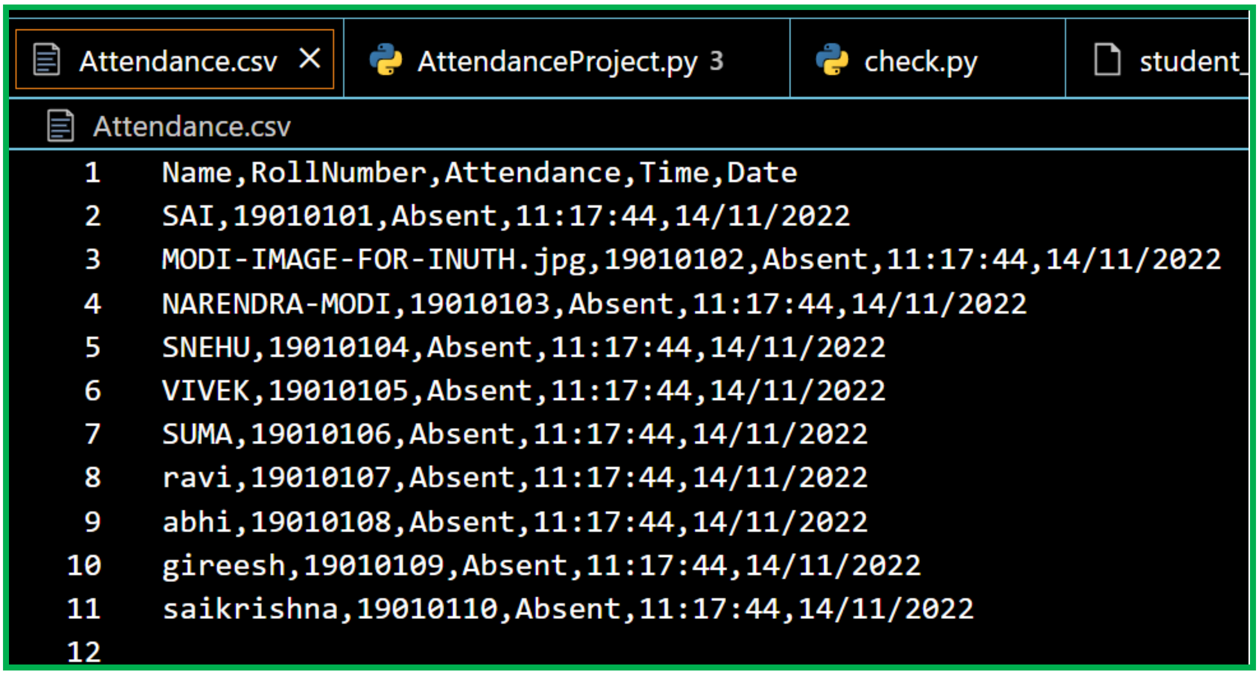
- We first check if the name of the attendee is already available in attendance.csv we won’t write attendance again.
- If the attendee’s name is not available in attendance.csv we will write the attendee’s name with a time of function call.

Read Webcam for Real-Time Recognition

```
cap  = cv2.VideoCapture(0)while True:
    success, img = cap.read()
    imgS = cv2.resize(img, (0,0), None, 0.25,0.25)
    imgS = cv2.cvtColor(imgS, cv2.COLOR_BGR2RGB)
    faces_in_frame = face_recognition.face_locations(imgS)
    encoded_faces = face_recognition.face_encodings(imgS,
faces_in_frame)for encode_face, faceloc in zip(en-
coded_faces,faces_in_frame):
        matches = face_recognition.compare_faces(encoded_face_train,
encode_face)
        faceDist = face_recognition.face_distance(encoded_face_train,
encode_face)
        matchIndex = np.argmin(faceDist)
        print(matchIndex)
        if matches[matchIndex]:
            name = classNames[matchIndex].upper().lower()
            y1,x2,y2,x1 = faceloc
            cv2.rectangle(img,(x1,y1),(x2,y2),(0,255,0),2)
            cv2.rectangle(img, (x1,y2-35),(x2,y2), (0,255,0),
cv2.FILLED)
            cv2.putText(img,name, (x1+6,y2-5), cv2.FONT_HERSHEY_COM-
PLEX,1,(255,255,255),2)
            markAttendance(name)
    cv2.imshow('webcam', img)
    if cv2.waitKey(1) & 0xFF == ord('q'):
        break
```

- Resize the image by 1/4 only for the recognition part. output frame will be of the original size.
- Resizing improves the Frame per Second.
- **face_recognition.face_locations()** is called on the resized image(**imgS**) .for face bounding box coordinates must be multiplied by 4 in order to overlay on the output frame.
- **face_recognition.distance()** returns an array of the distance of the test image with all images present in our train directory.
- The index of the minimum face distance will be the matching face.
- After finding the matching name we call the **markAttendance** function.
- Draw bounding box using **cv2.rectangle().**
- We put the matching name on the output frame using **cv2.putText().**

Attendance Report



```
Name,RollNumber,Attendance,Time,Date
SAI,19010101,Absent,11:17:44,14/11/2022
MODI-IMAGE-FOR-INUTH.jpg,19010102,Absent,11:17:44,14/11/2022
NARENDRA-MODI,19010103,Absent,11:17:44,14/11/2022
SNEHU,19010104,Absent,11:17:44,14/11/2022
VIVEK,19010105,Absent,11:17:44,14/11/2022
SUMA,19010106,Absent,11:17:44,14/11/2022
ravi,19010107,Absent,11:17:44,14/11/2022
abhi,19010108,Absent,11:17:44,14/11/2022
gireesh,19010109,Absent,11:17:44,14/11/2022
saikrishna,19010110,Absent,11:17:44,14/11/2022
```

Figure 13 - Attendance report

4.3 LIMITATIONS

Challenges faced by the face recognition system

Although building facial recognition seems easy it is not as easy in the real-world images that are being taken without any constraint. There are several challenges that are faced by the Facial Recognitions System are as follows:

- **Illumination:** It changes the face appearance drastically; it is observed that the slight changes in lighting conditions cause a significant impact on its results.
- **Pose:** Facial Recognition systems are highly sensitive to the pose, which may result in faulty recognition or no recognition if the database is only trained on frontal face view.
- **Facial Expressions:** Different expressions of the same individual are another significant factor that needs to be taken into account. Modern Recognizers can easily deal with it though.

- **Low Resolution:** Training of recognizer must be done on a good resolution picture, otherwise the model will fail to extract features.
- **Aging:** With increasing age, the human face features shape, lines, texture changes which are yet another challenge.

4.4 TESTING

4.4.1 Introduction

With the completion of the system implementation stage, the system needs to be tested in-order to be reliable and stable. Various features in the system must integrate and work as planned so that correct results can be produced. To fulfil this aim, a testing plan has been planned and conducted strictly. The testing was done on the personal computer where the system was created and implemented.

4.4.2 Testing Results

Test ID	Test Description	Expected result	Outcome
T1	BGR TO RGB	The scanned image must be converted from BGR to RGB.	PASS
T2	Image mapping	Scanned image must be mapped with all the images in the dataset.	PASS

T3	Facial Features Detection	When the camera is started Facial features must be correctly detected in Video Frame.	PASS
T4	Face Detection and Automatic Attendance	Face is identified with student name and attendance is marked accordingly.	PASS
T5	Student Name	The detected Student name matching the student’s face is displayed next to Detected image.	PASS
T6	Detecting Multiple faces	When multiple faces detected in the same video frame, the system should record attendance of both faces.	PASS

T7	Attendance Marking	There needs to be a correct attendance entry on the excel sheet	PASS
T8	Duplicate entries	Excel sheets should not have duplicate attendance entries	PASS
T9	Email Notification	Parents of absentee students should be notified via email	PASS
T10	Exception	As an exception, students who have obtained permission should be considered.	PASS

Table 5 Testing results

4.5 ACCEPTANCE TESTING

After implementation and personal testing, Acceptance Testing was performed with IIIT Manipur students who volunteered to participate in the project and gave their consent to use and store their data for this project. The students were simply asked to sit in front of the computer and see their attendance marked automatically. The overall feedbacks are shows below: -

Interface: Overall feedbacks on the interface were mostly positive, which indicates that the system easy to see and use, as people commented that the design of the system was simple.

Functionalities: The feedbacks were positive for functionalities, most students commented that they liked the ease just sitting down and their attendance recorded.
General comments: The feedbacks indicate that the show could be more effective at recording attendance than the current card-based system, if implemented right.
Future Suggestions: General suggestions include, better cameras should be used, and the system could replace the current card-based system in the future.

5 CONCLUSION

5.1 SUMMARY

The aims and objectives of The Automated Facial Recognition Attendance System were successfully met and therefore the overall project is considered successful. The system has shown strengths, going through months of development which included, prototypes of various features and functionalities. As testing is done to the system, it proves that the system is fully functional, stable and reliable to use, this is further confirmed by the user acceptance testing. Although there are always some bugs that will always be missed, even with intense testing, all knows bugs are detected and debugged off the system.

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