



FOUNDATION UNIVERSITY ISLAMABAD

Facial Expression based Authentication System for an ATM

Submitted by

F131ABCSE017 – Nouman Altaf
F131ABCSE035 – M Owais Ghafoor
F131ABCSE036 – Rabia Akram
F131ABCSE059 – Sohaib Shabbir Butt

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Project Advisor
Sir. Sajid Ali Khan

Project Coordinator
Dr. Shariq Hussain

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DEDICATION

We dedicate this disquisition to our project supervisor **Mr Sajid Ali Khan** and project co-ordinator **Dr Shariq Hussain** who taught us that the best kind of knowledge is what you have acquired for the sake of self-improvement. We also dedicate all our work to our families and all those who prayed for us. We are also grateful to our teachers and all of our friends for their unconditional and endless support and helping us out in the crucial phases of our 4 years degree programme. It would not have been possible to achieve our intended goals without all of you.

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STATEMENT OF ORIGINALITY

We namely **Nouman Altaf, Rabia Akram, Sohaib Shabbir Butt** and **M Owais Ghafoor** submitting thesis titled “**Facial Expression based Authentication System for an ATM**”.

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Sohaib Shabbir Butt, 13-06-2017

Rabia Akram, 13-06-2017

Nouman Altaf, 13-06-2017

M Owais Ghafoor, 13-06-2017

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CERTIFICATE OF APPROVAL

It is certified that Project titled “**Facial Expression based Authentication System for an ATM (FEAS-ATM)**”, presented on 13th June, 2016, has been duly approved by the evaluation committee.

Advisor:

(Sir Sajid Ali Khan)

(Date)

SDP Coordinator:

(Dr. Shariq Hussain)

(Date)

QEC Rep:

(Dr. Arif Jamal)

(Date)

ABSTRACT

The purpose of this final year project report is to provide a detail description of our project named as “FEA-ATM” in all aspects.

An expression based Authentication system that is explicitly designed for the Automated Teller Machine users, which will support all kind of users from educated to layman by replacing ATM card with facial expression authentication for providing secure and easy access to the user account and makes ATM intelligent enough to recognize users and give them access to their accounts. Unique framework is designed for the FEAS-ATM system which includes face detection, face recognition, feature extraction, expression classification and authentication. FEAS_ATM achieved maximum accuracy and reduced execution time of facial Expression recognition.

Currently FEAS_ATM performs authentication on frontal face and is able to detect faces in low illumination so improvements could be done by introducing non-frontal face authentication, increased illumination and enhanced recognition rate.

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LIST OF ABBREVIATIONS

| TERM | DEFINATION |
|-----------------------|--|
| .NET framework | A programming infrastructure made by Microsoft for developing, deploying and running applications and services that uses .net technologies e.g. desktop applications and web services. |
| AR | Accuracy Requirement |
| AS | Assumption |
| ATM | Automated Teller machine |
| Alternative | A choice limited to one of two or more possibilities, as of things, propositions, or courses of action |
| Attribute | Is a property or characteristic about an entity |
| Authentication | Any process by which a system verifies the identity of a User who wishes to access it. |
| Authentication Server | It is an external entity and can be considered as a subsystem which can also be known as server. |
| CI | Communication Interfaces |

| | |
|---------------------------------|---|
| <i>Dataset</i> | A collection of data. |
| <i>DC</i> | Design Constraint |
| <i>DF</i> | Desired Features |
| <i>DP</i> | Dependencies |
| Efficiency | Measures how well the system utilizes disk space, memory, processor capacity, or communication bandwidth. |
| EF | Essential Features |
| External Interface Requirements | Describe a class of requirements that define the connections between the software application/system being specified and any outside hardware or software system/application. |
| Facial Expression | Seven universal face expressions i.e. Happy, Sad, Angry, Fear, Disgust, Surprise, and Neutral. |
| FER | Facial Expression Recognition. |
| Feature | A prominent or distinctive part, quality or characteristic. |

| | |
|-------------------------|--|
| FEAS-ATM | Facial Expression based Authentication system for an ATM |
| FR | Functional Requirement |
| Frontal face | Directed toward, or situated at the front of camera. |
| Functional Requirements | Define what the system/application will do. They describe the observable behaviors the system will exhibit. Use Cases are elaborated into functional requirements |
| GUI | Graphical User Interface |
| Hack | To gain access to a computer/system illegally |
| HD | High Dimension |
| HI | Hardware Interfaces |
| IC | Implementation Constraints |
| Non- Frontal Face | Face having head movement and not directly facing camera or face that is out of range of camera. |
| OF | Optional Features |

| | |
|-------------|---|
| PIN | Personal Identification Number |
| Platform | A place or opportunity for public discussion |
| PR | Performance Requirement |
| SER | Security Requirement |
| SI | Software Interfaces |
| Stakeholder | Any person who has interaction with the system. |
| Skimmer | A small device that scans a credit card and stores the information contained in the magnetic strip. |
| Skimming | An electronic method of capturing a victim's personal information used by identity thieves. |
| UC | Use Case |
| User | Someone who interacts with the FEAS-ATM |

Chapter 1

INTRODUCTION

1.1 Brief

The purpose of this document is to collect, analyse and define high-level needs and features of the “Facial Expression based Authentication System for an ATM” (FEAS-ATM) project. It focuses on the scope and context of use of FEAS-ATM system in order to gain better understanding of the project, product functionality, operating environment, implementation constraints and the major concepts that are developed.

It exclusively briefs about the targeted audience of project and its user interface, hardware and software requirements. It defines the perspective of each stakeholder how they will see the product and its functionality. It allows developers to be clear on the goals of the software and on what they should focus on. Furthermore, it allows them to save time on communication, minimizes development efforts, gives feedback to customer, eliminate task duplication, and breaks down problems into parts. The details of how the FEAS-ATM fulfils these needs are detailed in the use-case and supplementary specifications.

1.1.1 Intended Audience and Document Overview

This document is intended for the development team, the project managers, testers, supervisor, coordinator, FEAS-ATM users, documentation writer and project evaluation panel or any other individual who is interested in FEAS-ATM. The report has been organized approximately in order of increasing specificity so that the developers and project managers could get familiar with the report easily.

Readers interested in the history of the product should focus on the **Chapter 1 (Introduction)**, which provides the overview of existing system, literature review, and problem definition along with context diagram, user needs, Acronyms and definitions. The remainder of this document includes six chapters and appendixes.

Chapter 2 (Introduction to proposed system), provides the detailed introduction of the system functionality for the audience who has to become accustomed to the various features of FEAS-ATM in order to effectively advertise it. It includes background of the project, problem description, project objectives, scope of project and its features and functionalities.

Readers who wish to further explore the functions of FEAS-ATM in more detail should read on to **Chapter 3 (Requirement specification)**, which provides the requirements specification in detailed terms and a description of the different system interfaces such as hardware interface and software interface. Functional requirements are listed. Readers interested in the non-technical aspects of the project should read this chapter. It covers performance, safety, security, and various other attributes that will be important to users.

Chapter 4 (Design Specification), explains the design of the product, its system architecture design, high level design and detail design is elaborated through sequence and class diagrams.

Chapter 5 (Test Specification), testers or developers interested in testing can explore this section for several types of test cases which are implemented to test the product.

Chapter 6 (Conclusion), includes the summary of project results and future work.

The Appendixes in the end of the document includes the data dictionary and Group Log of FEAS-ATM.

1.2 Existing System

An automated teller machine (ATM) is a computerized machine that allows customers to gain access to their bank accounts with the help of ATM debit card and PIN number. It permits the customer to perform several transactions such as cash withdraw, pay bills, make deposit etc. also known as “automated banking machine”.

But there exist vulnerable side of this Machine like hacking of data by skimmer, a device use to sniff data from any ATM card from its magnetic tape. In this way money gets stolen very easily from the customer’s account. Moreover if the customer lost the card or damage magnetic strip he/she can’t withdrawal the money unless he approaches the bank.

To overcome all these problems we have developed a new framework for ATM known as “Facial Expression based Authentication system for an ATM” (FEAS-ATM).

1.3 Literature Review

Some of the books and research papers that we review before and b/w the development of the project are given below:

1.3.1 Research paper no 1

“A neural AdaBoost based facial expression recognition system”

1.3.1.1 Abstract:

This paper leads the discussion and study about improving execution time and recognition accuracy. Few algorithms are Franco and Treves (2011) gave a solution to propose PCA algorithm but the accuracy is 84.5%, Kumar, Yadav and Patil (2012) proposed Gabor feature extraction with PCA and the results are 60-70% accurate. Technique proposed in this paper includes Viola Jones descriptor for detection of face components then feature extraction space is reduced/down sampled to improve execution time using Basel transformation. Thousands of facial features are extracted using Gabor feature extraction technique and also those features represent different facial detection patterns. To improve classification speed Adaboost Hypothesis is applied which will select few hundred features from thousands of extracted features. A 3 layers neural network classifier which is trained using back propagation algorithm is then used to further process the selected features. JAFFE and YELE facial expression database are used to train the system and also for its testing. Combination of Basel and Adaboost is used for the reduction of expression dataset. You will be amazed to know that Basel down sampling is never been used before for facial expression recognition. So it's an innovation for improving speed and accuracy. Proposed technique gave an accuracy of 96.83 and 92.22% the average recognition rate for mentioned databases JAFFE and YELE and execution time required for 100X100 pixel

size is 14.5ms. The results show that neutral expression has the weakest accuracy 92.23% in JAFFEE and 86.16 in Yale. This is due to the reason that increases in muscle deformation also increase the accuracy, which neutral face has low deformation.

1.3.2 Research paper no 2

“Boosted NNE Collection for Multicultural Facial Expression Recognition”

1.3.2.1 Abstract

The common universal facial expression recognize cross cultural facial expression including Japanese, Chinese, European and American. Many new techniques introduces by the Ghulam Ali et al. Like SVM (Support Vector Machine), Neural network (NN), local binary pattern, rule-based classifiers and K nearest neighbor (KNN) etc use for expression classification. Ghulam Ali et al. said instead of using whole face only consider facial components (eyebrows, eye, etc) as a lot of work has been done on those and through such technique satisfactory result gained. In the race of solving problems of facial expressions consider multiple classifier decisions instead of using single classifier decision. Moreover neural network based ensemble classifier for facial recognition is made to enhance the accuracy of classifier and for combining the decisions of multiple classifiers. Multi-objective genetic algorithm is applied to get the optimal of ensemble classifier. Acquisition and representation of multicultural dataset are major problems of multicultural facial expression classification. Three databases JAFFE, TFED and RadBoud used to overcome these problems. To check the presence of expression they used KNN, NB (Nave Bayes classifier) and SVM classifier. Further for system performance evaluation they used established dataset verification strategy. Four types of classifier considered for the classification of expressions those are BNN (binary neural network), KNN, SVM and

Naïve Bayes classifier so that finally this plan worked out accurately. Experimental result 93.75% got with the combination of NNE collection, with NB predictor and using HOG descriptor. This is best in order to get satisfactory result of multicultural facial expression recognition. But on few confuse facial expression still future work is need due to visual representation, facial structure and difference in number of samples.

1.3.3 Research paper no 3

“Facial expression recognition in dynamic sequence an integrated approach”

1.3.3.1 Abstract

This paper is about automatic facial expression which extracts prominent features from videos without any pre-processing of subjective and without requiring any additional data for frames selection. Proposed technique uses machine learning method in parallel with human reasoning to achieve dynamic changes in expressions in a better way. When expression recognition system receives image sequence It is mandatory to detect facial regions first so for this purpose viola jones detector is used. Face detection here is used only for the initiation of group wise registration. After face detection our next step is to detect features for these purpose key features are landmarked (eye, lips, nose). To align faces in static or dynamic data these landmark features are used to eliminate rotation and scaling effect. Through these landmarks deformations in video could be captured for further feature analysis. Traditional base algorithm is then used here to select neutral face image or first frame as template and wrap all images on it. Then global shape model, appearance, local texture can be used as knowledge to short the searching. Machine learning method can be used to locate optional landmarks (i.e. linear regression, graphical

models). For facial sequences Group wise registration is applied successfully displacement between landmarks and other relative measurements like lip curvature, eye size are taken for expression recognition after landmarks tracking, geometric features can be extracted from result. In following 4 regions (cheek region, eye brow region, outer eye corner wrinkle, and forehead region) a Gabor filter is applied to extract an energy value that helps to obtain texture feature for learning expressions. These textures and geometric features are used for each video sequence. For classification of gathered data two techniques can be used 50% stratified split, one half for testing and other one is for training. The other technique contains stratified 10x10 fold cross validation which produce models using given data. 6 classifiers are used J48, FRNN, VQNN, random forest, SMO-SVM and logistic. And Database used for this purpose is MMI. Accuracy by Proposed method is 71.56 %. It is noticed that Happiness and surprise are easily identified by automatic classifiers and also human participants but remaining expressions faces difficulties in identification.

1.4 Problem Definition

In order to ease customer's life and to provide convenient withdrawal service, banking system introduced Automated teller machine (ATM), But there exist vulnerable side of this service as it has become easy to hack users account by skimming data from ATM card with the invention of skimmers, stolen, lost or forgotten ATM card by the customers and transactions performed by other person on behalf of user which is against bank rules. Above mentioned problems leads to lost the customer's trust on banking system which could be very dangerous for banking business.

To overcome all these problems we have the proposed FEAS-ATM system which replaces ATM card with facial expression authentication with face recognition. This technology will ensure the greater security of user and it also makes things simple as well.

Chapter 2

Proposed System

2.1 Introduction

This section provides the detailed introduction of the system functionality for the audience who has to become accustomed to the various features of FEAS-ATM in order to effectively advertise it. It includes background of the project, problem description, project objectives, scope of project and its features and functionalities.

2.2 Overview

In present era of technology, we intensely need applications which are practicable, easy and user friendly not only for common but also for special people. Many applications exist for human behaviour understanding, detection of mental disorders, and synthetic human expressions in the domain of automatic facial recognition systems.

Judging mental state of a person is one of the difficult tasks. The Best way to understand an emotional state of a person is through facial expressions (i.e. happy, sad, fear, disgust, surprise and anger). The automated analysis of facial expression (FER) is a challenging task in the field of computer vision. It's implementation is not restricted to mental state identification only but also applicable in the security domain, automatic counselling systems, face expression synthesis, lie detection, music for mood, automated tutoring systems, operator fatigue detection etc.

Much work has been done on the static analysis where facial expression recognition had been performed on still images. While facial expressions are naturally dynamic, they are not easy to detect ,so the focus of the study is now shifted to find new methods which would be helpful to implement facial expression recognition in daily use with the improve accuracy, lower computational cost, and less memory consumption.

Therefore we proposed “Facial Expression based Authentication system for an ATM” (FEAS-ATM) as the name depicts it’s a system, which will support all kind of users from educated to layman by replacing ATM card with facial expression authentication for providing secure and easy access to the user account and makes ATM intelligent enough to recognize users and give them access to their accounts.

2.3 Problem Description PD

Following problems led us to design FEAS-ATM.

PD 1: Hacking of data on ATM has become so common and easy now days. Hackers hijack user’s data by skimmer, a device use to sniff data from any ATM card’s magnetic strip. ATM hackers place a skimmer over usual card slot of an ATM and as soon as customer inserts his/her card, skimmer reads all its data. After reading the card, it is placed on a dummy card that becomes exact replica of the skimmed card. In this way money gets stolen very easily from customers account.

PD 2: If the customer lost the card or damages magnetic strip he can’t withdrawal the money unless he approaches the bank.

PD 3: Sometimes customer forgets to bring the card with him/her at ATM booth he/she can’t perform money transactions.

PD 4: Most of the times transactions are performed by someone other than user which is against the rules of bank.

Above mentioned problems lead to lost the customer trust on banking system which could be very dangerous for banking business.

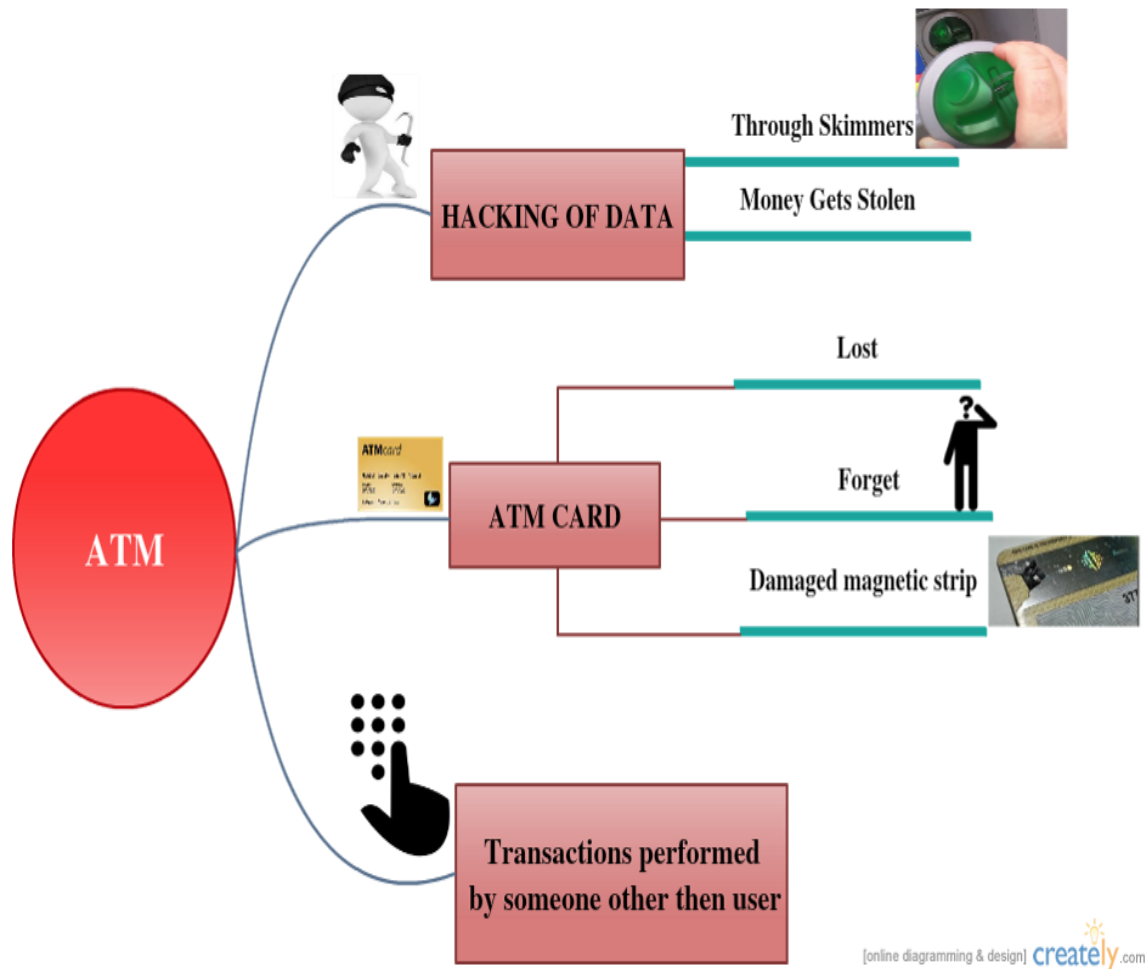


Figure 2. 1 Problem Definition Mind Map

2.4Solution SOL

To overcome all these above mentioned problems.

SOL 1: We searched several biometric solutions i.e. finger print recognition, voice recognition, face recognition. Face recognition domain was the one we selected for further research it contained many flaws as shown in figure 2.2 to overcome these flaws we dig deeper and found the solution “Facial expression recognition “which is new and advanced technique to be introduced in ATM by replacing Card See figure 2.3. System named as FEAS-ATM (Facial Expression Authentication System Base ATM).

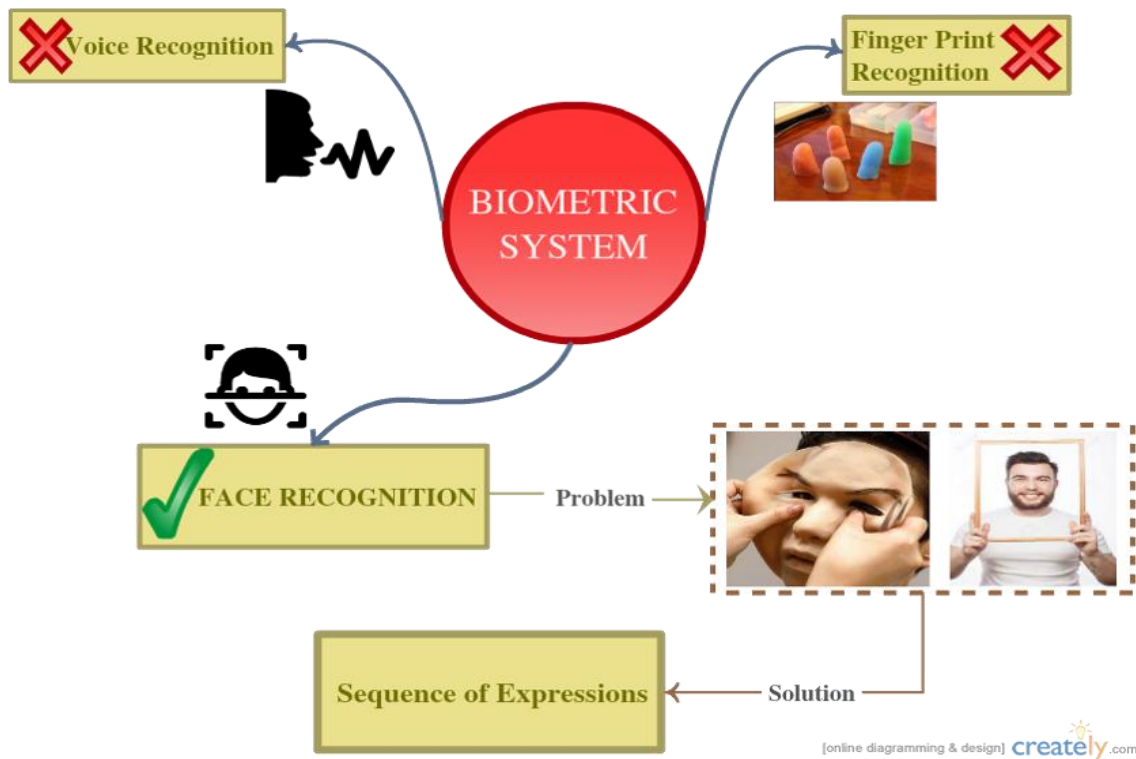


Figure 2. 2 Possible Solutions

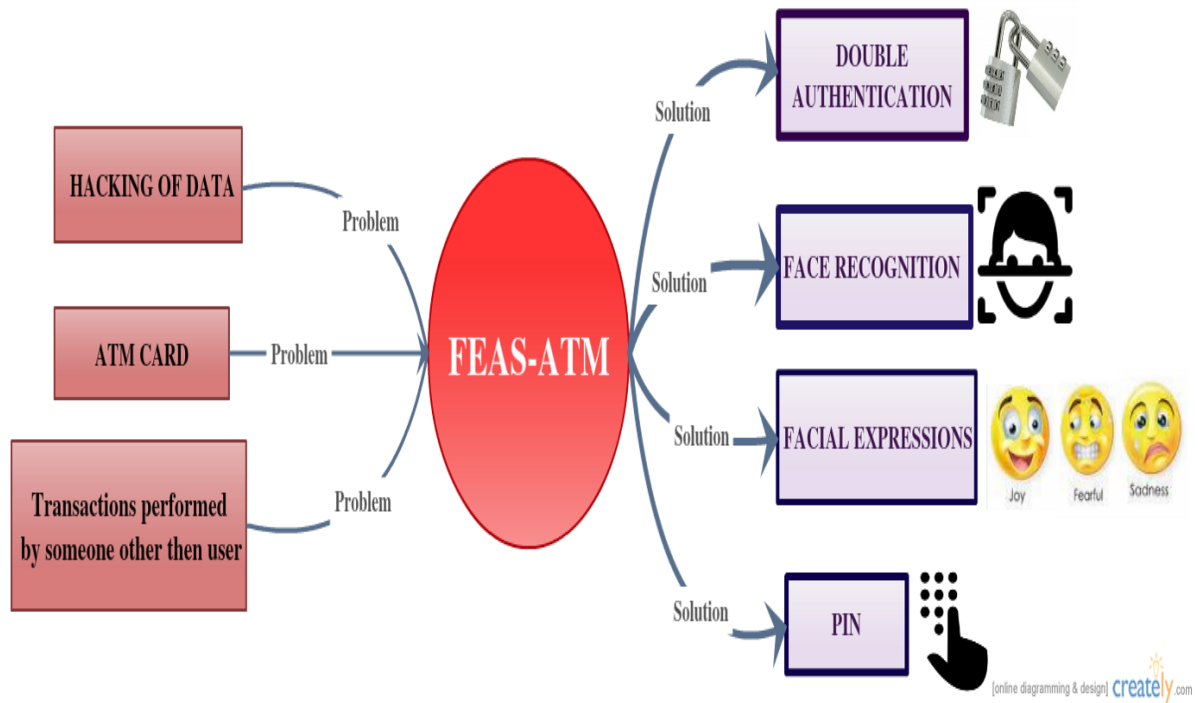


Figure 2. 3 Proposed Solution

2.5 Objectives OB

OB 1: Purpose of the proposed FEAS-ATM system is to replace ATM card with facial expression authentication system including face recognition.

OB 2: This technology will ensure the greater security of user and it also makes things simple as well.

OB 3: Our Project Goal is to achieve maximum accuracy and reduce execution time of facial Expression recognition.

OB 4: Bringing back the customers trust is also included in our goals.

2.6 Product Scope

The FEAS-ATM is software that is embedded on ATM machine which replaced the ATM card authentication with sequence of facial expressions (i.e. happy, sad, and angry) provided by the user for logging in to his/her account(s) securely and easily.

This technology will ensure the greater security of user and it also makes things simple as well. The facial expression recognition measure is an added layer of identification on top of the traditional PIN required to access user account.

Our Project Goal is to achieve maximum accuracy and reduce execution time of facial Expression recognition. So that we will be able to provide a system which is highly secure and also gives high performance in face detection. Bringing back the customers trust is also included in our goals.

All activities directly related to the purpose are considered to be in scope. All other activities not directly related to the purposes are considered to be out of scope. For example, issues concerning non-frontal face and changes in physical appearance of person are not within the scope of this project.

2.7 Product Features

The main function of FEAS-ATM is to recognize user then gather sequence of expressions and perform authentication on them for providing secure access to user account.

This section will give brief overview of features and functionalities FEAS-ATM will perform. These features are grouped into three major categories: essential, desirable and optional features. Essential features are the major functions the product must perform or

must let the user perform. Desirable features are those that must be completed if certain conditions are met, it will provide benefit to the system and enhance its accuracy, whereas optional features gives developer the opportunity to provide additional features to make system more efficient.

2.7.1 Essential Features (EF)

EF-1: Face detection

- Camera will be remain active on FEAS-ATM
- When human will appear camera will capture and detect the face to make sure if it's human or not.

EF-2: Face recognition

- After face detection FEAS-ATM will recognize the person
- Scan line will show recognition process
- While system will match the face with the dataset in database through Authentication system

EF-3: Face authentication

- After the processes of matching face with stored dataset, Authentication system will return authentication
- Authentication will display welcome screen with the name and account details of user

EF-4: Feature Extraction

- Recognized face send to the feature extractor for feature extraction on the basis of which classifier will classify the expression.

EF-5: Acquiring expressions

- FEAS-ATM will ask for expressions one by one to further proceed with authentication process.
- FEAS-ATM can ask for any expression number from user's set of secret password expression

EF-6: User Gives sequence of expressions

- user will give expression as asked by system from secret expression password
- face should remain in front of camera

EF-7: Expression authentication

- FEAS-ATM will perform authentication by showing scan line over use's face
- Given expression will be sent to Authentication system for matching.

EF-8: Ask for PIN

- FEAS-ATM will ask for PIN to authenticate person through PIN too
- This step will provide double authentication process

EF-9: Maintain 10 images of expressions for each user in Database

- 10 images of all expressions should be maintained in dataset again each user
- These images will be used to match expressions given during authentication

2.7.2 Desirable Features (DF)

DF-1: Invalid User

- As stated in EF-2 during face recognition if user not found system should give message of invalid user

DF-2: Face Tracking

- System shall implement continuous tracking on face if face goes out of system and camera frame it will stop the authentication process.

DF-3: Authentication message display

- System shall display authentication message after each authentication process.

DF-4: Invalid expression Alert

- If expression doesn't match system will show invalid expression alert with sound to alert the user.

DF-5: 3 attempts for expression authentication

- If DF-4 occurs system will grant user 3 attempts per expression

DF-6: Block the user after 3 attempts

- If user still fails after DF-5 then account will be blocked, No further process will be carried out.

2.7.3 Optional Features (OF)

OF-1: Tutorial

- Before EF-1 tutorial will be displayed on screen of ATM
- When camera will detect human it will stop tutorial and display video on screen of FEAS-ATM

OF-2: Sound alert

- On every valid and invalid attempt of either PIN or Expression FEAS-ATM will generate sound to assure and interact with user.

OF-3: Stop authentication

- User can stop authentication any time by getting out of camera's frame

2.8 Context Diagram

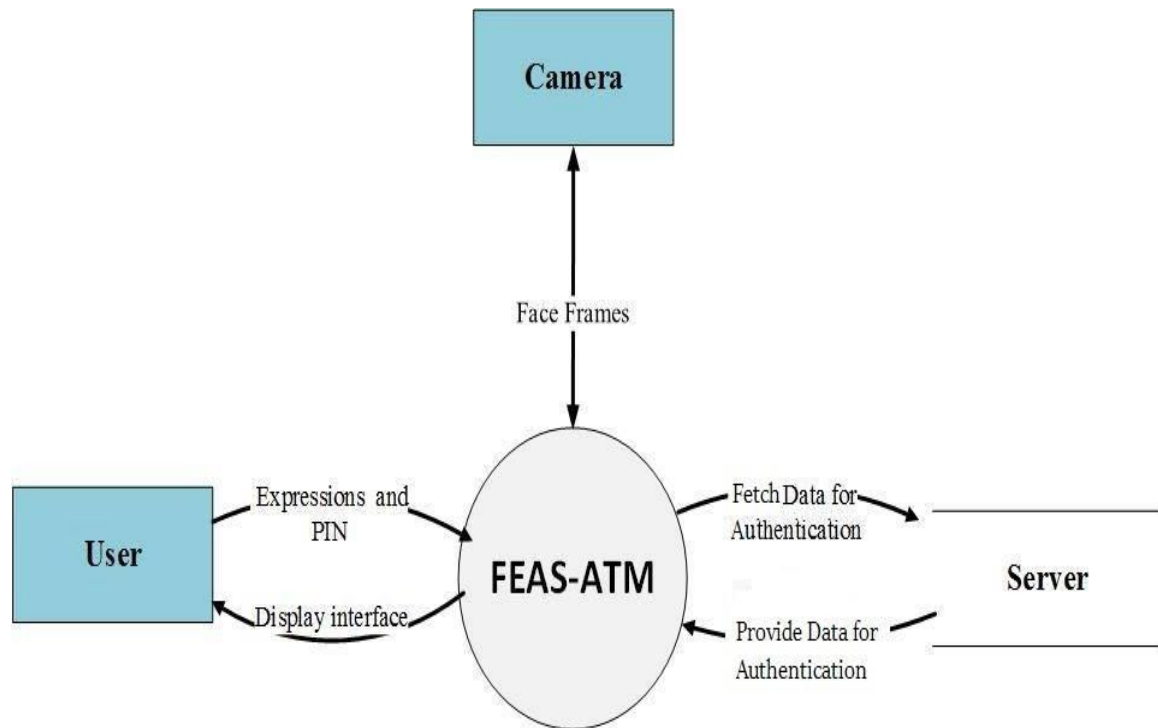


Figure 2. 4 Context Diagram of FEAS-ATM

2.9 Use Case View

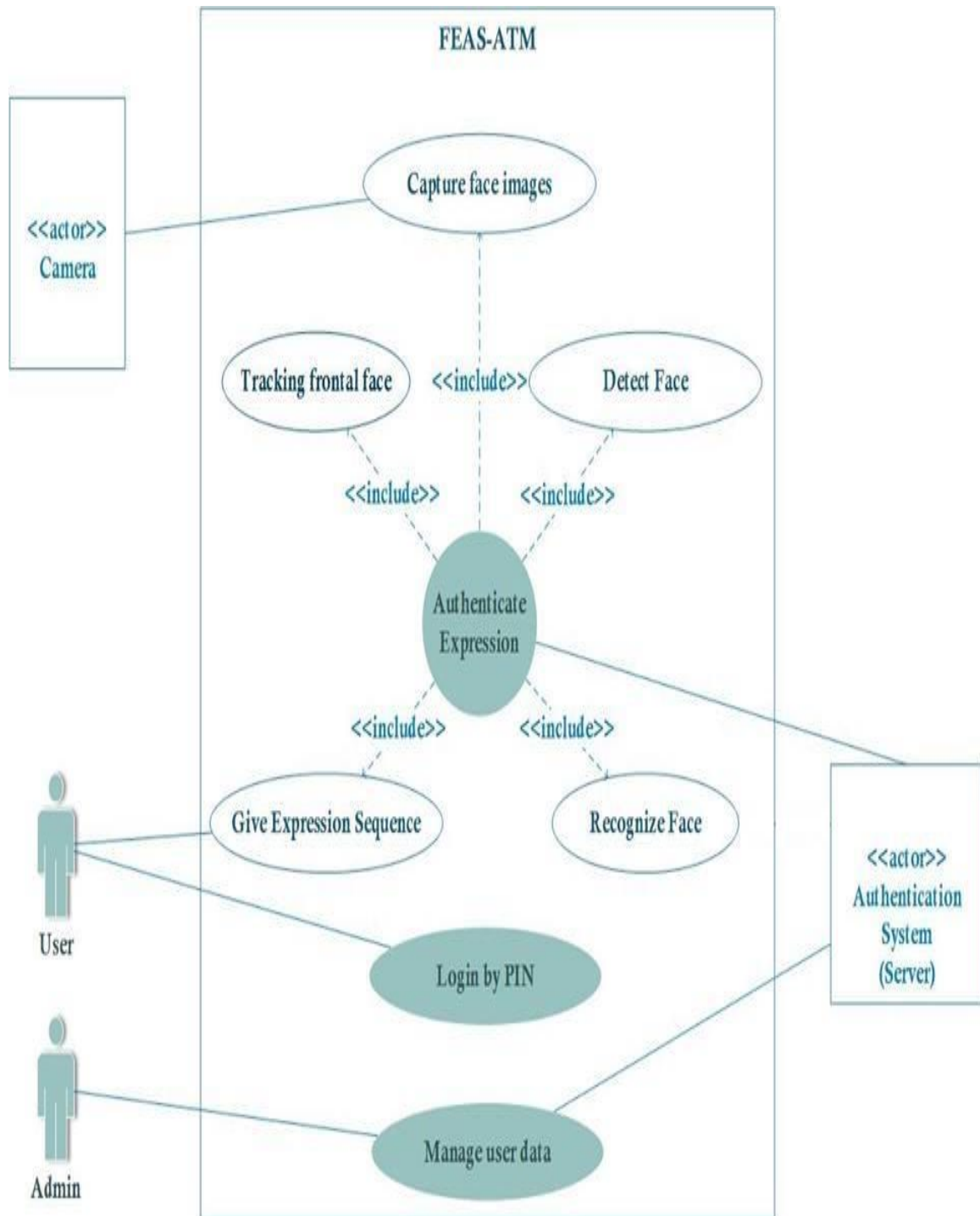


Figure 2. 5 Use Case View of FEAS-ATM

2.9.1 Actors

Following are the mentioned actors related to our project.

- **User:** User mentioned in this use case is a person who uses FEAS-ATM.
- **Admin:** Admin is also a user of our system who can manage user data (e.g. create user, delete, and update users accounts).
- **Camera:** Camera is also an actor of our system because through this a system will gather live user data in form of face frames.
- **Authentication system:** It is an external entity and can be considered as a subsystem which can also be known as Bank server. FEAS-ATM's whole dataset will be deployed on bank database and through authentication system all communication between dataset and client will be done.

2.9.2 Use Case Explanation

UC-1: Authenticate Expression

UC-2: Manage User Data

UC-3: Login by PIN

UC-4: Capture Face Images

UC-5: Detect Face

UC-6: Track Face

UC-7: Give Expression Sequence

UC-8: Recognize Face

Chapter 3

Requirement Specification

3.1 Introduction

The main function of FEAS-ATM is to recognize user then gather sequence of expressions and perform authentication on them for providing secure access to user account.

3.2 Functional Requirements

This section gives detailed view of functionalities FEAS-ATM will perform.

Table 3. 1 Functional Requirements

| Req. ID | Title |
|----------------|------------------------------------|
| FR-01 | Face detection |
| FR-02 | Face recognition |
| FR-03 | Face Authentication |
| FR-04 | Acquiring expressions |
| FR-05 | Expressions By User |
| FR-06 | Expression Sequence Authentication |
| FR-07 | Ask for PIN |
| FR-08 | PIN Authentication |
| FR-09 | Login |
| FR-10 | Data Maintenance |
| FR-11 | Invalid User |
| FR-12 | Face Tracking |
| FR-13 | Authentication Message Display |
| FR-14 | Invalid expression Alert |
| FR-15 | Block User After 3 Wrong Attempts |
| FR-16 | Tutorial |
| FR-17 | Sound Alert |
| FR-18 | Stop authentication |

Categorizations of these Functional requirements are as given below.

3.2.1 System Functionalities

REQ ID: FR-01

Title: Face detection

Description: Detect human face in camera input

Priority: High

Dependent On: None

REQ ID: FR-11

Title: Invalid User

Description: Invalid User Message if user not found

Priority: Medium

Dependent On: FR-03

REQ ID: FR-12

Title: Face Tracking

Description: Track face movement in input frames of camera

Priority: Medium

Dependent On: FR-01

REQ ID: FR-13

Title: Authentication Message Display

Description: Display authentication messages for FR-03, FR-06 and FR-08

Priority: Medium

Dependent On: FR-03, FR-06, FR-08

REQ ID: FR-14

Title: Invalid expression Alert

Description: Generates an alert in case of wrong expression in FR-06

Priority: Medium

Dependent On: FR-06

REQ ID: FR-16

Title: Tutorial

Description: Tutorial Screen while FR-01 is being conducted

Priority: Low

Dependent On: None

REQ ID: FR-17

Title: Sound Alert

Description: Give Sound Alerts in case of a wrong attempt

Priority: Low

Dependent On: FR-03, FR-06, FR-08

3.2.2 User Functionalities

REQ ID: FR-05

Title: Expressions by User

Description: User gives required secret expression

Priority: High

Dependent On: FR-04

REQ ID: FR-07

Title: Enter PIN

Description: User is request to enter PIN in order to get access to Account

Priority: High

Dependent On: FR-06

REQ ID: FR-09

Title: Login

Description: Shows the Transaction Interface to the user

Priority: High

Dependent On: FR-08

REQ ID: FR-18

Title: Stop authentication

Description: User can stop authentication any time simply by going out of camera's frames

Priority: Low

Dependent On: FR-12

3.2.3 Admin Functionalities

REQ ID: FR-10

Title: Data Maintenance

Description: Database should have account details maintained for each user.

Priority: High

Dependent On: None

3.2.4 Authentication System Functionalities

REQ ID: FR-02

Title: Face recognition

Description: Recognize Detected face for further transactions

Priority: Low

Dependent On: FR-01

REQ ID: FR-03

Title: Face Authentication

Description: Matching process of detected face with Database

Priority: High

Dependent On: FR-02

REQ ID: FR-06

Title: Expression Authentication

Description: Detected Expressions sequence is sent and Matched with user Dataset

Priority: High

Dependent On: FR-05

REQ ID: FR-08

Title: PIN Authentication

Description: Match Entered PIN with Database Data

Priority: High

Dependent On: FR-07

REQ ID: FR-15

Title: Block User after 3 Wrong Attempts

Description: If user is unable to give expression over 3 times, System will block the user.

Priority: Medium

Dependent On: FR-06

3.2.5 Camera Functionalities

REQ ID: FR-19

Title: Capture Live stream

Description: Continuous stream of camera video for all detection and tracking

Priority: High

Dependent On: None

3.3 Use Cases

3.3.1 High Level Use Cases

UC-1:

Name: Authenticate Expression

Actors: Authentication system (Initiator).

Type: Primary

Description: Authentication process involves matching of facial expression sequence with database.

UC-2:

Name: Manage User Data

Actors: Admin (Initiator).

Type: Primary

Description: Admin can manage user data and can perform all CRUD operations on it.

UC-3

Name: Login by PIN

Actors: User

Type: Primary

Description: Authentication process involves matching of PIN with database to login

3.3.2 Full dress Use Cases

Full dressed use cases are explained below:

3.3.2.1 Use Case ID: UC-01

Use Case Name: Authenticate Expression

Scope: Authentication process involves matching of facial expression sequence with database.

Level: Sub-function

Primary Actor: User, Camera and Database

Stakeholders and Interests: ATM User: To access the ATM for transactions.

Pre-condition:

- System is fully launched with camera.
- Face detection process done successfully.
- User gave expression

Post-conditions:

- System successfully authenticates user.
- Displays successful authentication message

Main Success Scenario:

1. User friendly GUI.
2. Face detection successfully.
3. User Stand in front of camera.
4. Give correct Facial expression sequence.
5. Given facial expression match with the data base successfully.

6. System display message after processing.

| Action | Response |
|--|---|
| User will give sequence of facial expression | Sequence of facial expression matching with database and shows authentication message |

Alternative Flow:

1A- If expression not recognized then system will show message of un-authorized user.

Frequency of occurrence:

Continuous process for each new user

Special requirements:

- AR-2
- SER-8
- PR-2

3.3.2.2 Use Case ID: UC-02

Use Case Name: Manage User Data

Scope: Admin deals with the personal information of user included facial expression in which he can perform addition, deletion and up gradation etc.

Level: Sub-function

Primary Actor: Admin, Camera, user

Stakeholders and Interests:

User: User will provide facial expression for using the FEAS-ATM to perform transaction in ATM.

Admin: Admin perform operations like addition, deletion, up gradation of user information

Pre-condition:

- System is fully launched successfully.
- Data set of FEAS-ATM implemented.
- Camera is fixed.

Post-conditions:

- Admin successfully created user
- Admin can perform operations (insertion, deletion and up gradation etc.) successfully.

Main Success Scenario:

- System successfully launched in operating environment.
- Data set is successfully implemented.
- Admin can create user successfully.
- Admin can perform operations successfully.

| Action | Response |
|---|---------------------------------|
| 1. Admin create new user | User created successfully |
| 2. Admin do operations (Insertion, deletion and up gradation) | Operations perform successfully |

Alternative Flow:

1A.If creation of new user is not done successfully then message displays system is out of order.

2A.If admin can't do operation then message displays system is out of order.

Frequency of occurrence:

High (Continuous process for each new user)

Special requirements:

- PR-1
- PR-2

3.3.2.3 Use Case ID: UC-04

Use Case Name: Capture face frames

Scope: Camera will capture face frames and send these to system.

Level: Sub-function

Primary Actor: User and Camera

Stakeholders and Interests:

ATM User: To access the ATM

Pre-condition:

- System is fully launched with camera

Post-conditions:

- System capture face frames successfully.
- Face detection successfully done.

Main Success Scenario:

1. System installed with camera successfully.
2. Good illuminative factor.
3. System is running.
4. Face frames captured

| Action | Response |
|---------------------------------|---------------------------------|
| 1. User come in front of camera | Camera will capture face frames |

Alternative Flow:

1A. If Camera is unable to capture frames then message display system is out of order

Frequency of occurrence:

High (Continuously capturing face frames for every new user)

Special requirements:

- PR-1
- PR-2

3.3.3.4 Use Case ID: UC-08

Use Case Name: Recognize face

Scope: Face recognition is a process of authenticating detected face based upon existing dataset. Detected face will be sent to the Authentication system (bank database) through network for authentication of user. This will allow our system to get existing data about the user and facial expressions that are required for further authentication.

Level: Sub- function.

Primary Actor: User, Camera, Authentication system.

Stakeholders and Interests:

ATM User: To access the ATM.

Pre-condition:

- System is fully launched with camera
- Face detected successfully.

Post-conditions:

- System capture face frames successfully.
- Face detected successfully.
- Face recognized successfully.

Main Success Scenario:

1. Good illumination
2. User gives front face on camera
3. Continuous face tracking
4. Convert color images in gray scale images
5. High accuracy rate of face detection

6. Feature extraction done.
7. Face recognized successfully.
8. System display message

| Action | Response |
|--|---|
| 1. User come in front of camera | Camera capture face frames |
| 2. Generated face frames sent to authentication system | Authentication system will match face frames with the existing database |

Alternative Flow:

1A.If camera will unable to capture face frames then message display system is out of order.

2A. If face frames not sent to database for recognition of face then message display system is out of order.

Frequency of Occurrence:

High (Continuous process as every new user face will recognized for further process)

Special requirement:

- AR-1

3.4 System Sequence Diagram

3.4.1 Scenario 1: FEAS-ATM

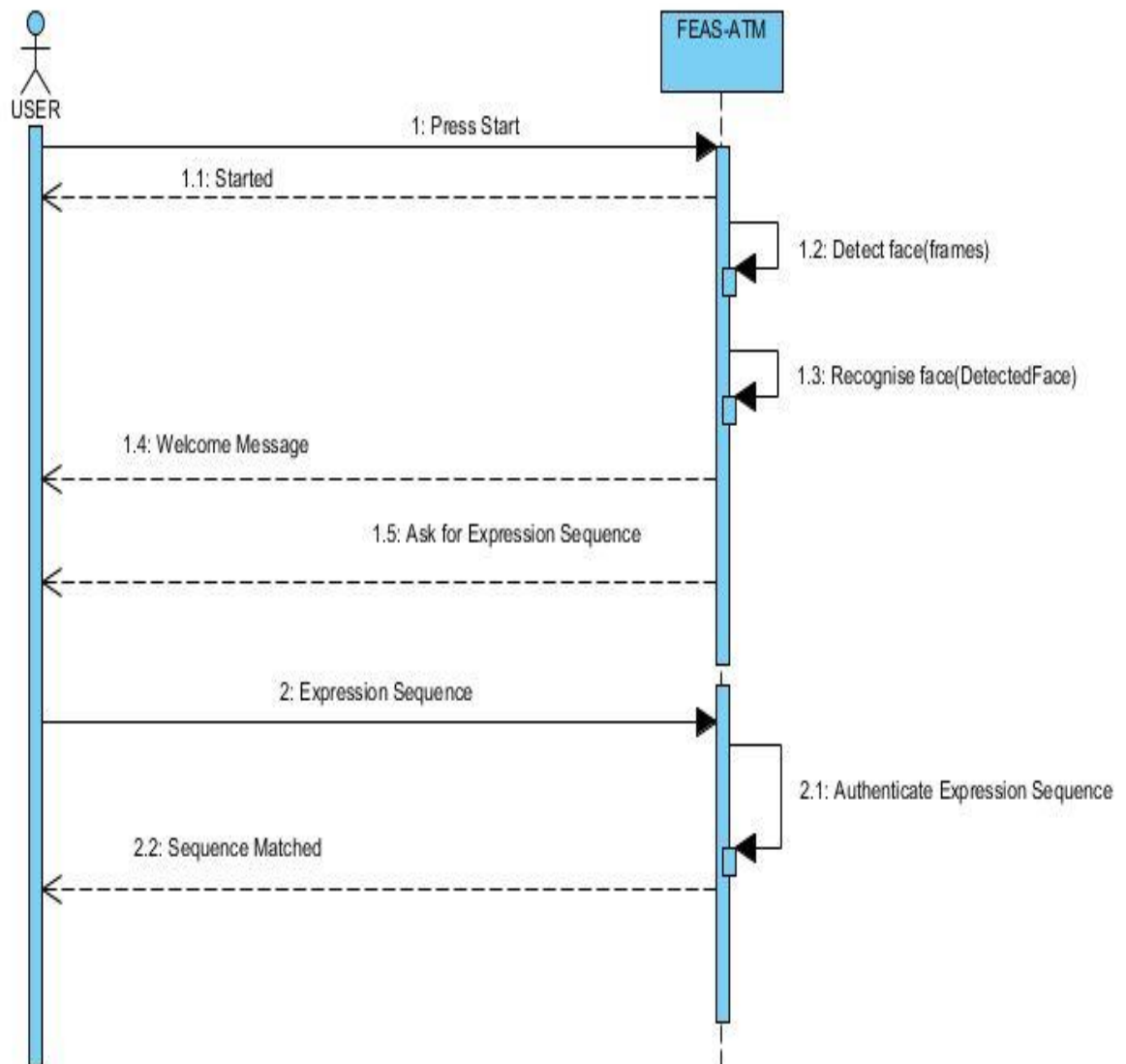


Figure 3. 1 System Sequence Diagram of FEAS-ATM

3.4.2 Scenario 2: Admin

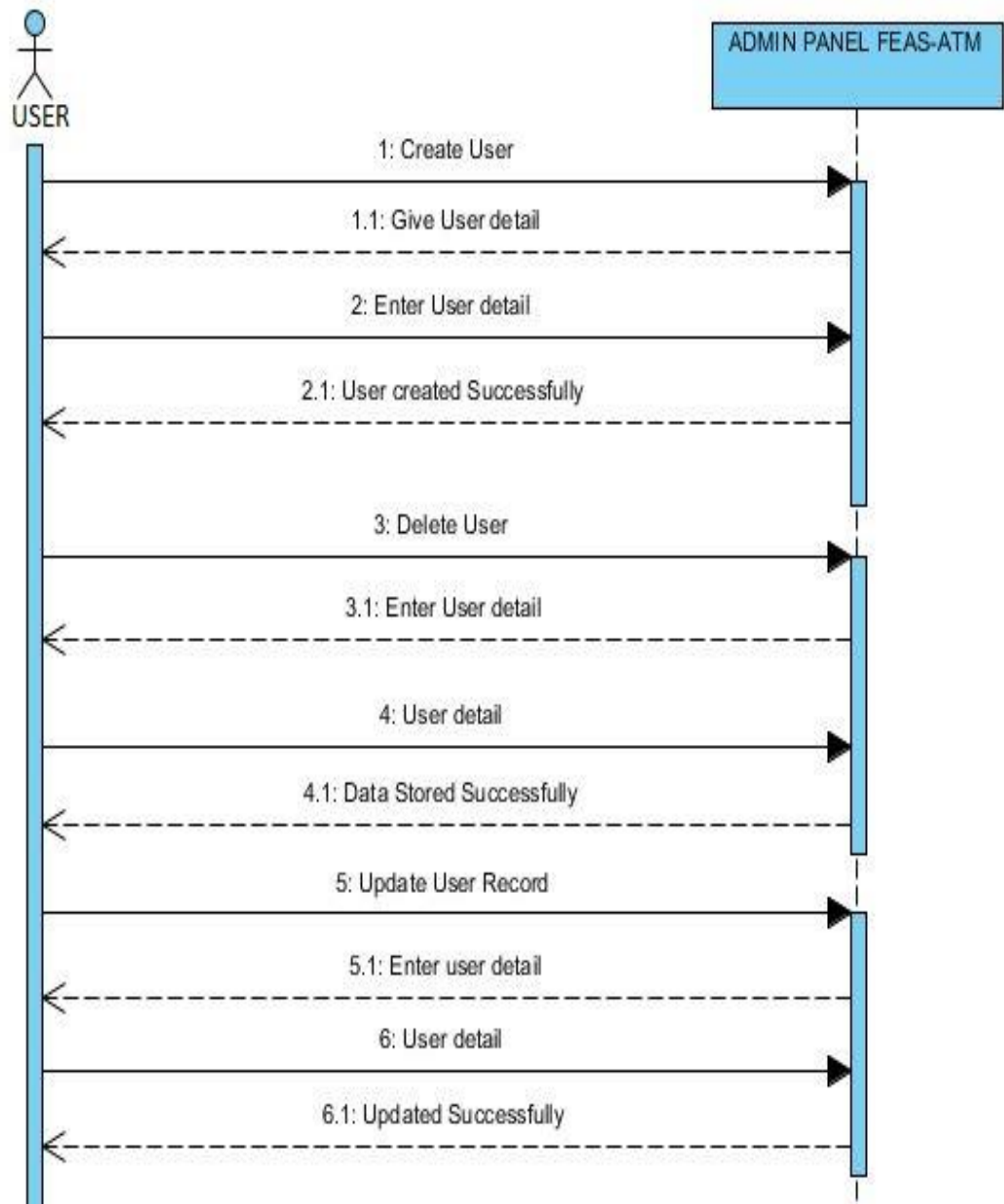


Figure 3. 2 System Sequence Diagram of Admin Panel

3.5 User Interface

This section provides the description of the different system interfaces such as hardware interface, software interface and communication interface.

3.5.1 FEAS-ATM User Interfaces

The FEAS-ATM user interface has been specifically designed by keeping their customers in mind, giving them convenience while they use ATM. The designer of product made sure at every point, that the customer spends most of the time using the device rather than figuring out how to use it.

Following are the graphic user interfaces of FEAS-ATM.

3.5.1.1 *Face Detection*

On face detection screen Scan line will move continuously over the image until face is not detected. And Notification dialog “LOOKING FOR YOU” will also remain on the screen during the whole face detection process. Behind these components a live stream is continuously running instead of this Angelina’s picture.

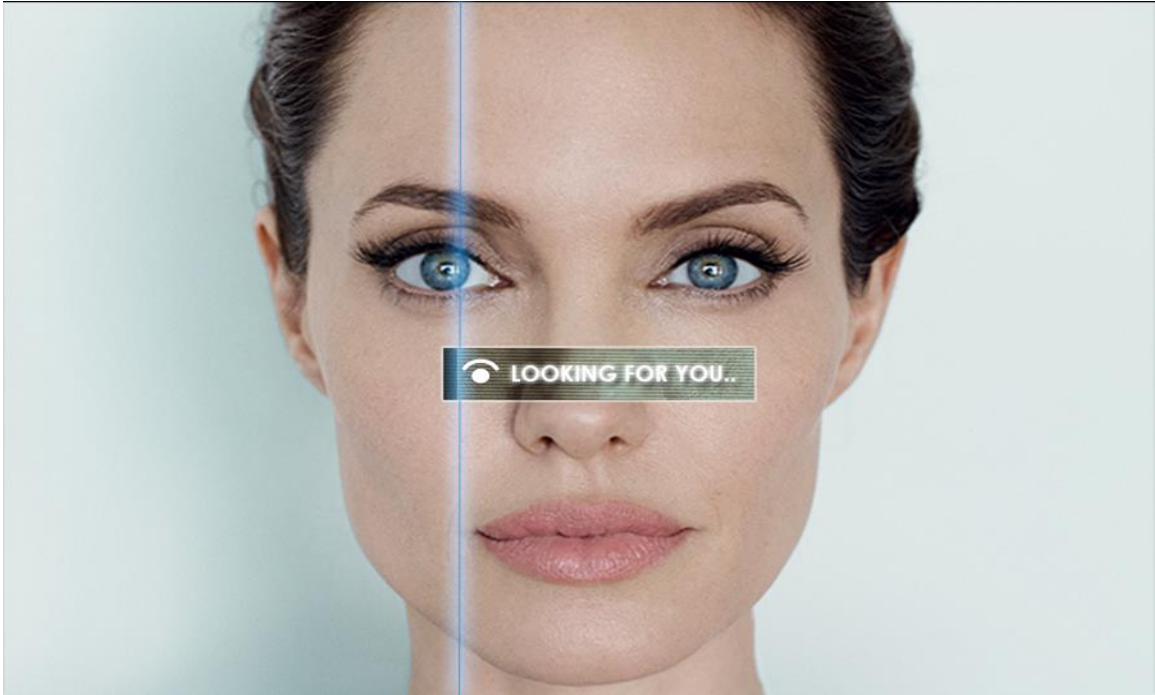


Figure 3. 3 Face Detection Figure

3.5.1.2 Welcome Screen

If user's face is recognized a welcome screen will prompt with the message of Welcome and user's account details as shown below

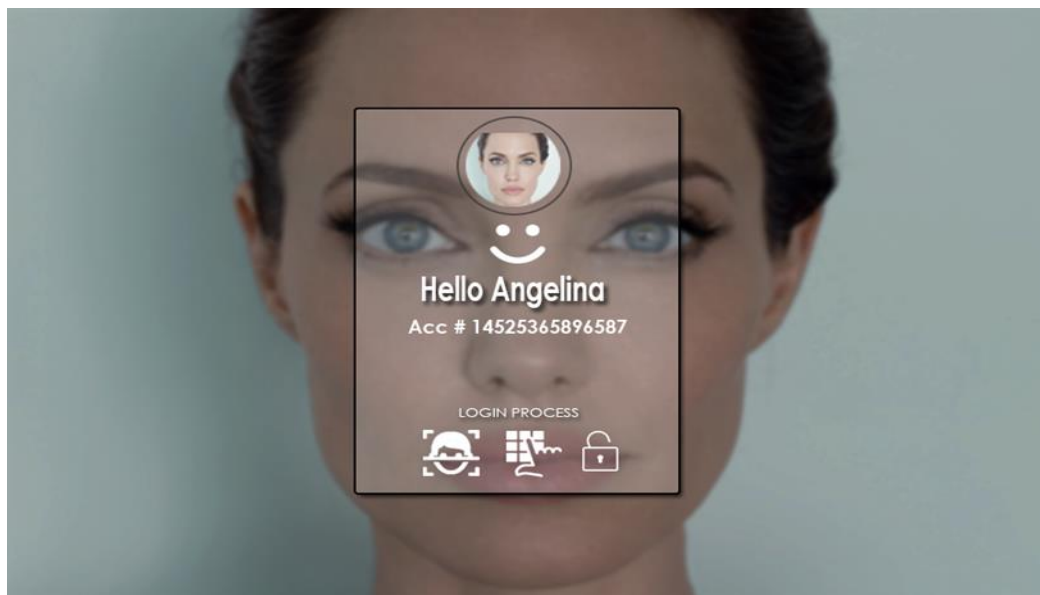


Figure 3. 4 Welcome User

3.5.1.3 Expression Acquisition

After user recognition FEAS-ATM will request for user's secret expression sequence which he/she will provide 3 expressions as asked by system in random manner. Authentication will be performed on this sequence to verify user.



Figure 3. 5 Expression Sequence Acquisition

3.5.1.4 Expression Sequence Verification (Successful)

Below screen shows the response of system if user gives correct secret expression sequence. After this response system will request user to enter PIN. After PIN authentication user will be granted access to his/her account.

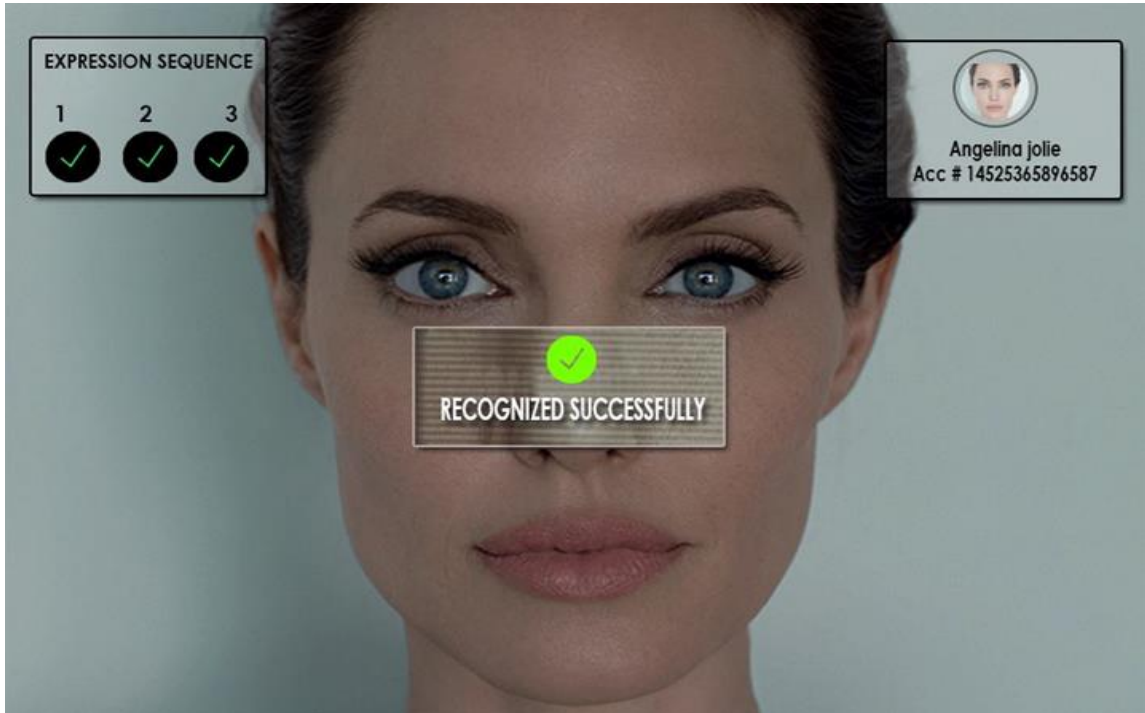


Figure 3. 6 Sequence Verification Response

3.5.1.5 Face Detection Negative Case

If face is not detected, mean person is not an authorized/ registered user of Bank so an error dialog will be displayed in front of user as given below.



Figure 3. 7 User Not Found

3.5.1.6 Invalid Expression Sequence

Figure shows the display screen of incorrect expression sequence response given by user after authentication. After this response user will be allowed to make three attempts to give expression sequence still if he/she fails to authenticate then user will be blocked by system.



Figure 3. 8 Invalid Expression Sequence Response

3.5.2 Admin Panel User Interfaces

3.5.2.1 Main Window



Figure 3. 9 Admin Panel

3.5.2.2 Create User Tab

The screenshot shows the 'FEAS ATM' application window. On the left is a blue sidebar with three menu items: 'Create User' (selected), 'Edit User', and 'About us'. The main area is titled 'Person Detail' and contains a 'Set Profile Picture' form. The form has two input fields: 'Name' with the value 'Nouman' and 'Account No' with the value '12345678912547'. Below the fields is an orange 'Next' button. A placeholder icon of a person is shown next to the 'Set Profile Picture' title.

Figure 3. 10 Create User_1

The screenshot shows the 'FEAS ATM' application window. On the left is a blue sidebar with three menu items: 'Create User' (selected), 'Edit User', and 'About us'. The main area is titled 'Live Stream' and contains a large black video feed. To the right of the video feed are three buttons: 'Train Recognizer', 'Start Recognizer', and 'Stop'. Below the video feed is a 'Face Adder' section with a 'Select Expression Type' dropdown menu, a grayscale image of a person's face, and two buttons: 'Extract' and 'Save'. To the right of the 'Face Adder' is a 'Training set Viewer' section with a dropdown menu and a 'Show' button. At the bottom right is an 'Expression Sequence' section with three dropdown menus labeled 'Exp 1', 'Exp 2', and 'Exp 3', and a 'Done' button.

Figure 3. 11 Create User_2

3.5.2.3 *Edit User Tab*

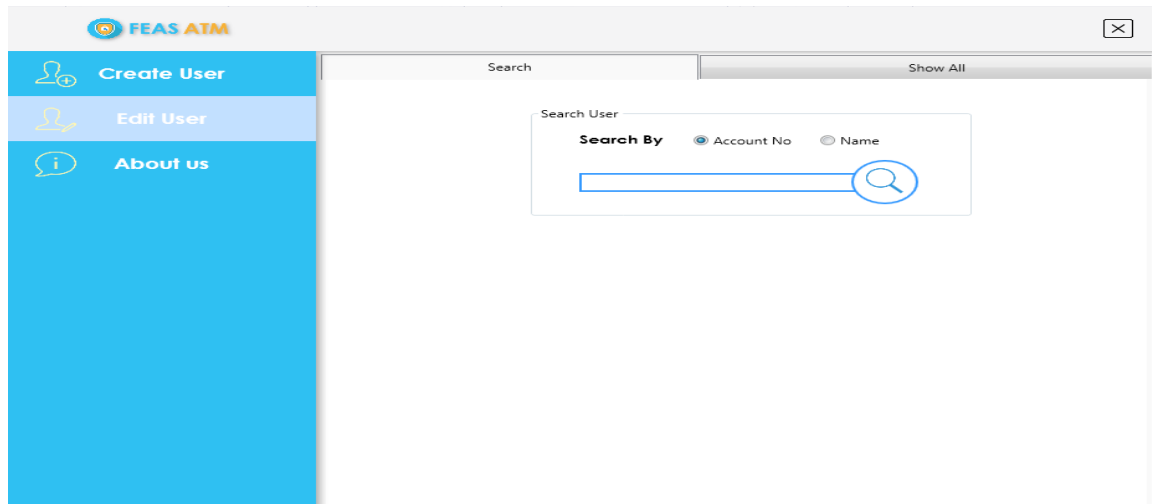


Figure 3. 12 Edit User_1

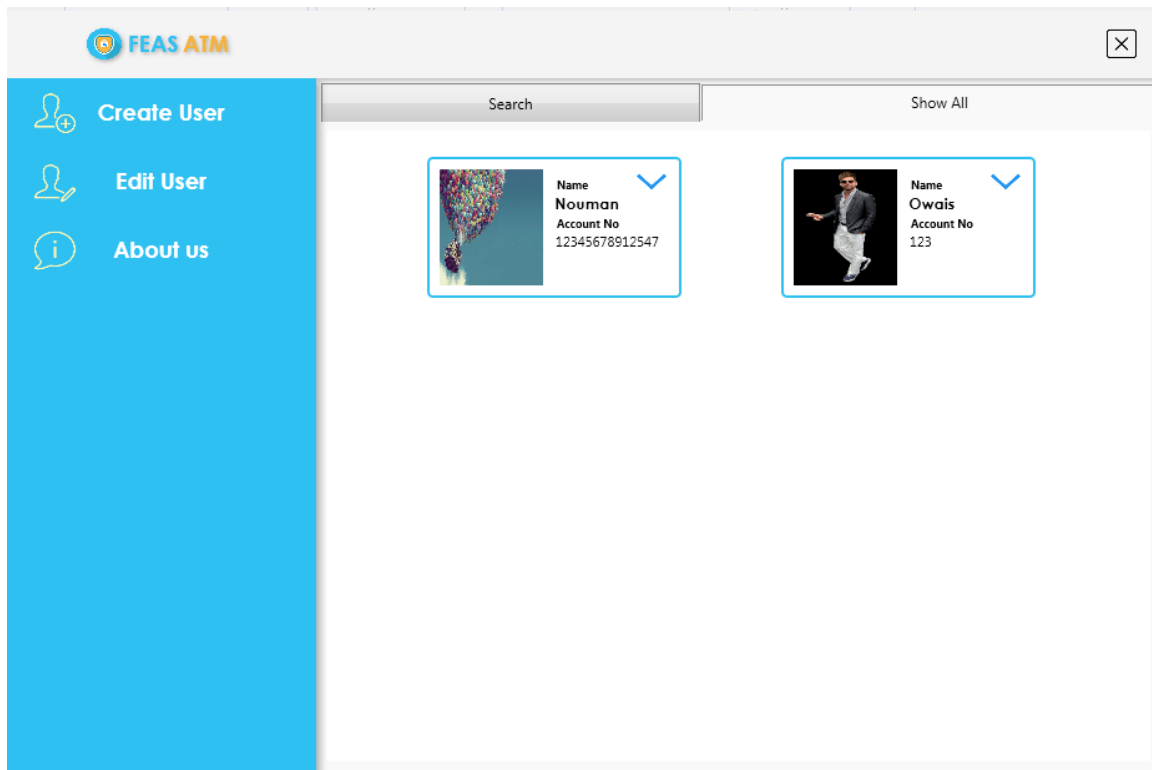


Figure 3. 13 Edit User_2

3.5.3 Hardware Interfaces HI

FEAS-ATM contains following hardware interfaces:

HI-1: Camera: The first hardware interface through which user will interact with the system. It is a platform which captures user face images and provides image streams to system for recognition of authorized person.

HI-2: PIN Pad: User will use it for insertion of PIN code. Similar in layout to a Touch tone or Calculator keypad, often manufactured as part of a secure enclosure.

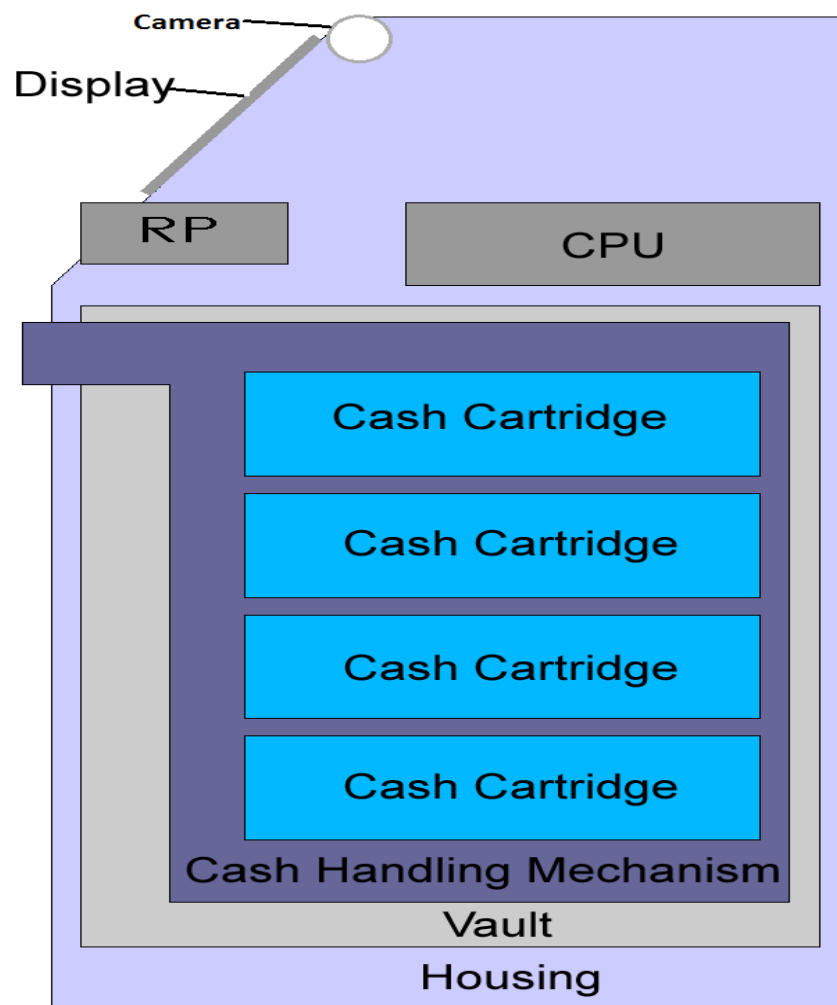


Figure 3. 14 Block Diagram of ATM Hardware

3.5.4 Software Interfaces SI

FEAS-ATM contains following hardware interfaces:

SI-1: Server: As server can be integrated with the existing network infrastructure so it is platform which provides communication for data processing including facial authentication etc.

3.5.5 Communications Interfaces

In this section communication between client and server is briefly defined. First of all, user live face frames will be captured and sent to the server. Server will authenticate user with pre stored user data from dataset. If user is an authorized person Server will extract user data from dataset consisting of expression sequence. Then extracted data and “User Matched” response will be sent to the client side. User is then required to express each expression one by one which will be authenticated on client side and only response will be sent to server.

CI-1: Network Protocols that will be used is (TCP).

CI-2: Communication between client and server will use secured channel so that all communication will be done in encrypted form.

3.6 Activity Diagram

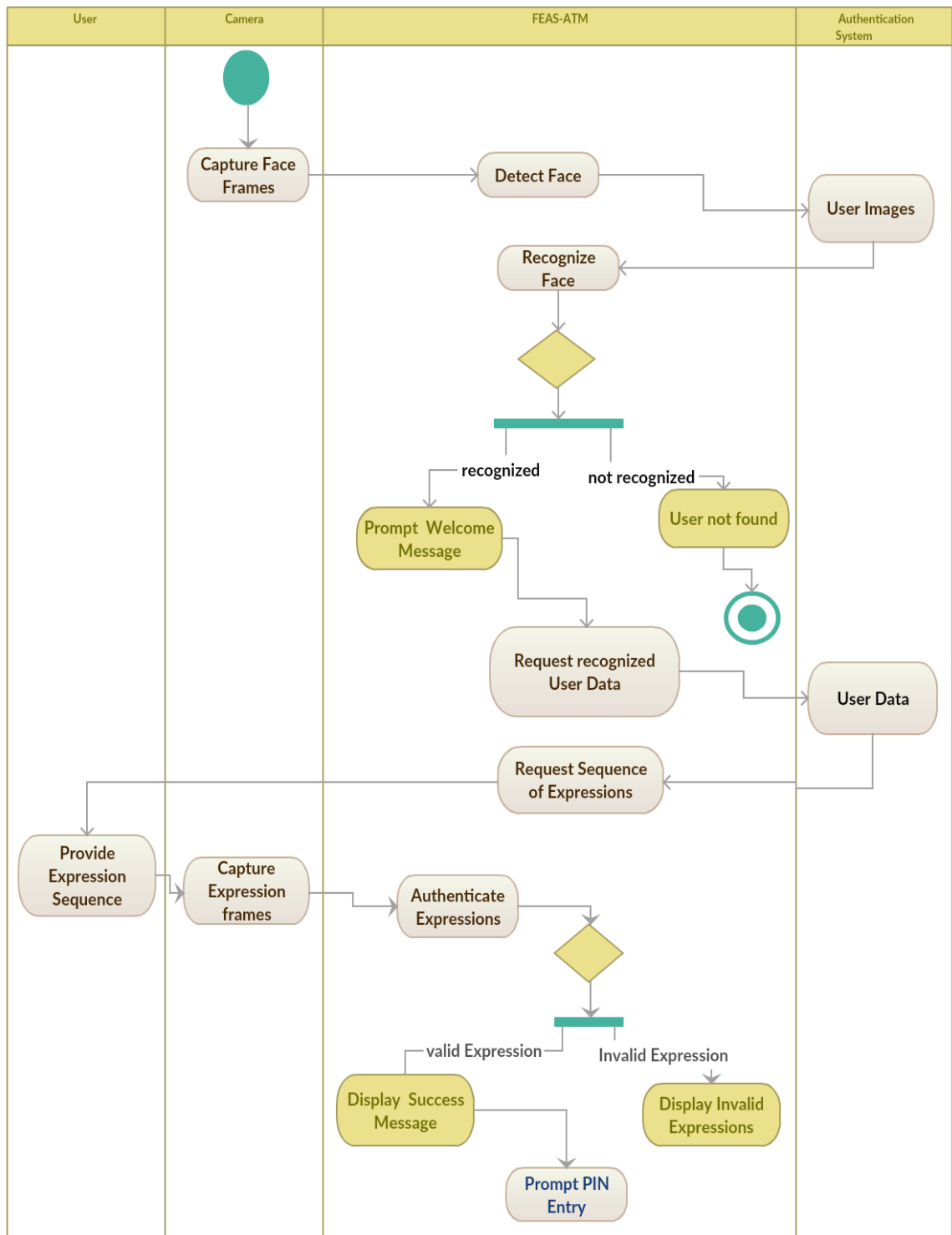


Figure 3. 15 FEAS-ATM Activity Diagram

3.7 Non-Functional Requirements

Checking the fact that the system must perform as what every user expects. So in every action-response of the system, there are no immediate delays.

3.7.1 Performance Requirements

PR-1: Camera will generate image frames at 30fps.

PR-2: Action and response of system will be in less than 2 seconds. Actions include Detecting face, Recognition of face, Expression authentication.

3.7.2 Accuracy Requirement

AR-1: If Face detection is correct up to 85 % then system will mark the user as authorized.

AR-2: System will consider correct expression if it matches with stored expression up to 75%.

3.7.3 Security Requirements SER

SER-1: Security of any system is important. Hence all communication is being done on a secure channel.

SER-2: Bank database is also secure as it cannot be accessed by any unauthorized person.

SER-3: Our system will not allow unauthorized user to make transaction on a bank account.

SER-4: Triple authentication will be used in proposed solution, first the Face authentication, second Facial Expressions recognition of predefined expressions, and third PIN code verification.

SER-5: This product uses object oriented mechanisms to protect its data passage by using methods.

SER-6: In face tracking if user face is out of frames for 3 seconds system will reinitialize from face detection

SER-7: The user is able to send a silent alarm in response to a threat.

SER-8: *After three entries of wrong expression system will block the user.*

3.7.4 Reliability

AMBITION: Make system as reliable as possible.

SCALE: Number of “Show stopper” defects

METER: Measuring all classes of defects reported by customer during testing

MINIMUM: 5

TARGET: 3

OUTSTANDING: 0

3.7.5 Availability

AMBITION: Make system available for user.

SCALE: Hours

METER: Time

TARGET: 24/7

OUTSTANDING: 24/7

3.7.6 Usability

AMBITION: A layman would be able to understand the interface with ease.

SCALE: The probability in % that defined Users can successfully complete defined Tasks.

METER: Probability.

TARGET:

- {User=Novice} = 60%
- {User=Expert} = 80%

OUTSTANDING:

- {User=Novice} = 75%
- {User=Expert} = 90%

3.7.7 Flexibility

- The system is flexible and open to changes for future research.
- System code must be modular and independent to make interfacing and changing with other code easy.

3.7.8 Maintainability

- FEAS-ATM is maintainable however bank staff which will be maintaining this system should have complete understanding of system and latest technologies of the time so that maintenance process could be easy for them.

Chapter 4

Design Specifications

4.1 Introduction

This section contains the complete description of FEAS-ATM. It states the perspective of FEAS-ATM, how it's been implemented. UML Diagrams are drawn for user's understanding of the system.

The proposed product is advance version of ATM which replaces ATM card with the facial expression Authentication and makes ATM intelligent enough to recognize users and give them access to their accounts. ATM will communicate with the bank's Database to perform authentications.

4.2 System Architecture

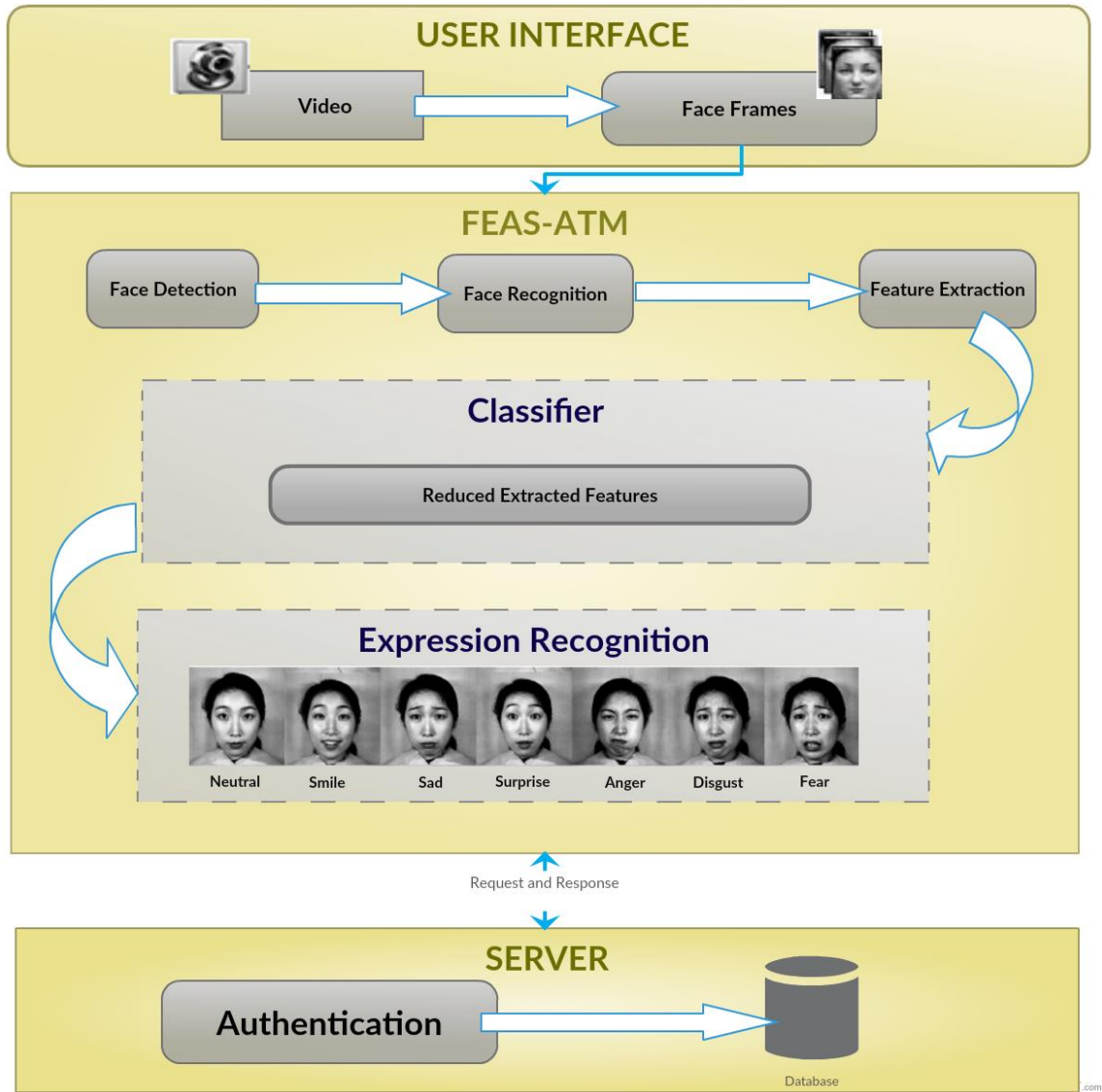


Figure 4. 1 Architecture diagram of FEAS-ATM

4.2.1 Three Tier Architecture

The architecture of our product is based on 'Three Tier Architecture'. Proposed architecture contains presentation layer, business layer and database layer. Client can only interact with interface for recognition purpose. Whereas face expression recognition and

authentication is performed in logic layer and database is stored in another local desktop/server.

Three tiers or layers are:

- Presentation Layer (User Interface)
- Business Logic Layer (FEAS-ATM Layer)
- Data Layer (Data Access Layer)

4.2.1.1 Presentation Layer (User Interface)

In our FEA-ATM system, people concerned with the presentation layer are ATM user and admin. User interacts with ATM to perform transactions with secure login and admin enters all the records regarding users and pictures through the interface provided. They are unaware of how the logics are implemented and where the data is being stored.

4.2.1.2 Business Logic Layer (FEAS_ATM Layer)

Logic has been implemented in Visual Studio with embedded libraries of EMGU CV, Accord, Viola and Jones object detection framework. This middle layer controls the functionality that is being performed on the user interface. User is only able to perform the actions which are implemented in the logic layer of the application.

4.2.1.3 Data Layer (Data Access Layer)

Database has been saved in Amazon web services (AWS) from where the data/information is retrieved and stored. Data is kept independent by this method, irrespective of the logic and user interface this stored data can be used using appropriate queries.

There are several benefits of using n-tier architecture for our software.

- **Scalability**

This architecture allows the distribution of application components across multiple servers which make it more scalable than 2 tier architectures.

- **Availability**

As layers are independent of each other, even if one layer gets crashed or disturbed the other two layers would still be working fine.

- **Performance**

Using this architecture one can easily migrate from one graphical environment to another. Modifications can be incorporated in the presentation layer without having to disturb the remaining two layers.

4.3 Design Methodology DM

This system consists of two phases, one Data Gathering, second User Login.

DM 1: In data gathering phase password of users are stored in Bank database. A secret password consist of sequence of expressions is assigned to each user. There are seven universal expressions (i.e. Happy, Sad, Angry, Fear, Disgust, Surprise, and Neutral) which are gathered and stored in database against every single user of FEAS-ATM. So whenever user wants to access his/her account the authentication process is performed on given expression sequence password.

DM 2: In second phase, “User login” camera captures stream of continues video in which FEAS-ATM detects the face of user by applying face detection technique Viola–Jones object detection framework on input face frames of video from HD camera. These face

frames are then used to recognize user by extracting features with the help of local binary pattern algorithm(LBP) these features are then given to principle component analysis algorithm (PCA) to recognize the user and match frames with the previously stored dataset in database. After user face recognition, FEAS-ATM asks user to give sequence of expression password one by one in random manner to authenticate user in real time environment (to get conformation about user if he/she is real, clown, masked person, or image). This phase implements Discrete Cosine Transformation (DCT) technique for feature extraction of expressions and embedded accord library of k-nearest neighbors (KNN) algorithm for expression classification (i.e. happy, Sad, angry etc.). Furthermore FEAS-ATM will request for PIN from user to login successfully into account and perform transactions.

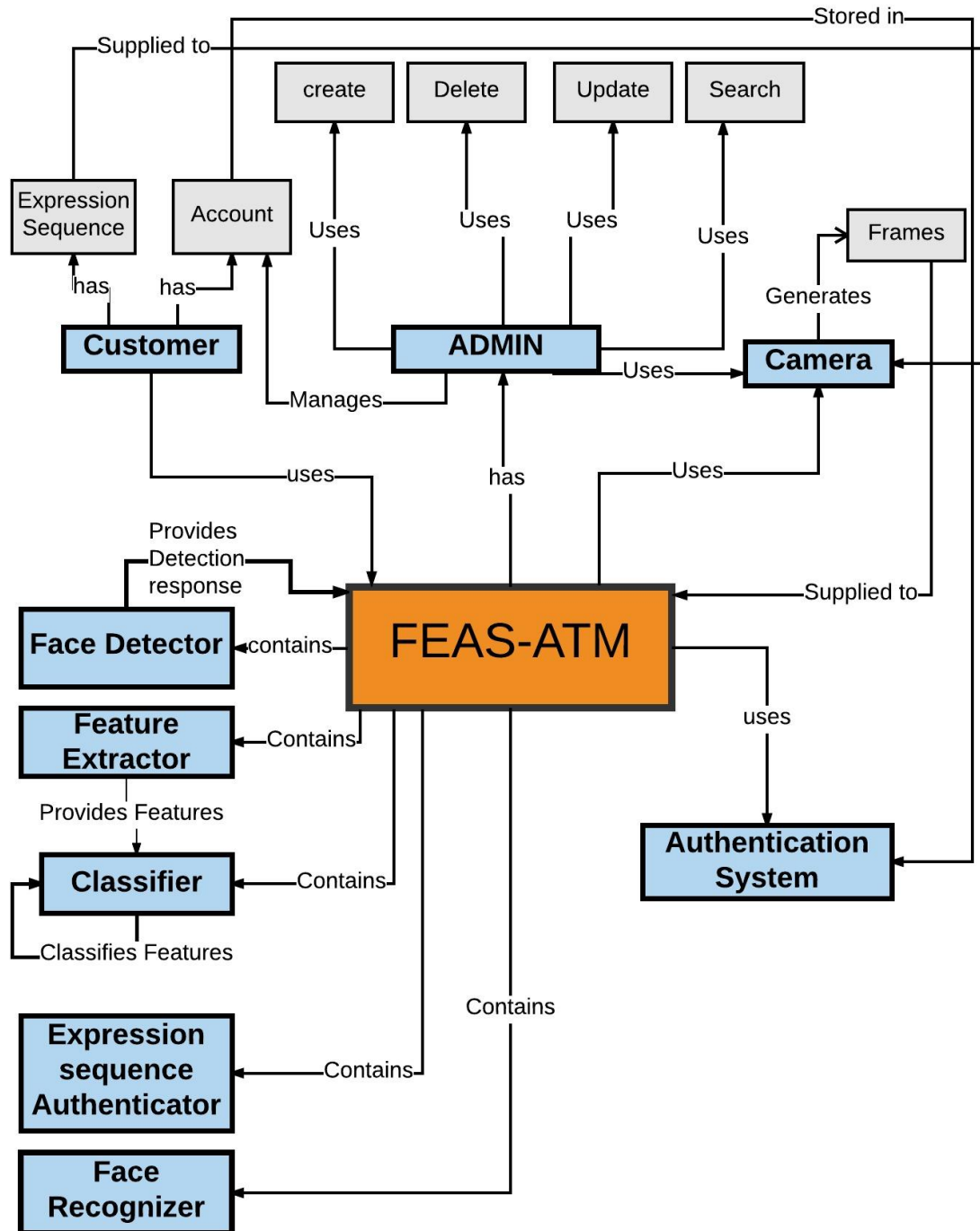


Figure 4. 2 Conceptual Model of FEAS-ATM

4.4 High Level Design

The High level design will present all of the design aspects and define them in detail, describes the hardware and software design, design and implementation constraints along with assumption and dependencies.

4.4.1 Hardware

FEAS-ATM will be made up of

- **Display:** to control the user interface and various aspects of transaction
- **Camera:** to detect and recognize the user by giving frames to system
- **PIN Pad:** similar in layout to a Touch tone or Calculator keypad, often manufactured as part of a secure enclosure.
- **Secure crypto processor:** generally within a secure enclosure.
- **Touchscreen:** used to select the various aspects of the transaction
- **Illumination sources:** light

4.4.2 Software

FEAS-ATM is developed using windows 10 under MS.NET Framework 4.5.1 and MATLAB as desktop application, code language C# using Visual Studio.

Software being developed is embedded on Typical platforms used in ATM development include Microsoft operating systems (such as Windows XP, Windows 10, Windows 8.1, Windows 8, Windows 7 Service Pack 1, Windows Server 2016, Windows Server 2012, Windows Server 2008 R2, Service Pack 1).

Data is maintained in database of bank. ATM and bank database is connected through Authentication System.

4.4.3 Design and Implementation Constraints DIC

The challenge in developing the FEAS-ATM includes:

IC-1: The choice of platform for developing product. The developer should code in .NET framework and MATLAB in parallel.

IC-2: During facial expression authentication and PIN authentication only 3 attempts will be provided to each user to authenticate him/her-self.

IC3: Authentication will only be done on the frontal face.

IC-4: Each user must have account in ATM to use the FEAS-ATM. Those who don't have an account in ATM will not be recognized by the system during face detection.

IC-5: If user goes through any kind of physical face transformation i.e. face surgery, glasses, beard, hijab, heavy makeup etc. he/she can't have access to account until or unless user update's these transformation in bank database.

IC-6: User should have to be present for using FEAS-ATM no one can replace him/her to perform transactions.

IC-7: Product should be developed with-in 6 months.

DC-1: Object oriented approach will be used to develop system

DC-2: Datasets will be stored in bank database

DC-3: The application should be a desktop Application developed under Windows Forms Application.

DC-4: Make context, flowchart, architecture, use-case and system sequence diagram to get clear understanding of product.

4.4.4 Assumptions and Dependencies AS & DP

AS-1: Final product will always be used on ATM

AS-2: FEAS-ATM is assistive technology can be used by people with disabilities

AS-3: User has prior knowledge of ATM system

AS-4: Project will be done by May 30th, 2017.

AS-5: Data will be made secured by using cryptographic techniques

AS-6: FER and authentication will be done in milliseconds

DP-1: Use of high definition camera will give high accuracy

DP-2: ATM should have good illumination or light source to have accurate recognition

DP-3: The ATM hardware is being handled as a separate project and will be available in time for the installation phase

4.5 Data Design

Detailed data model of database is produced, which contains all physical and logical design choices and physical storage perimeters which are needed to generate design in data definition languages, which is then used to create a database. A fully attributed data model contains attributes for each entity. The term database design describes the design of an overall database of system.

Database schemas along with their attributes are described in the table below

Table 4. 1 User Table

| | Column Name | Data Type | Length | Allows Nulls |
|----|--------------------|------------------|---------------|---------------------|
| PK | UserID | Integer | 10 | |
| | Name | Char | 255 | |
| | AccNo | Varchar | 19 | |
| | ProfilePic | Blob | | N |
| | ExpAttributes | Varchar | 255 | N |
| | Exp1 | Char | 10 | N |
| | Exp2 | Char | 10 | N |
| | Exp3 | Char | 10 | N |

Table 4. 2 Picture table

| | Column Name | Data Type | Length | Allows Null |
|----|-------------|-----------|--------|-------------|
| PK | PicID | Integer | 10 | |
| | Picture | Blob | | N |
| FK | UserID | Integer | 10 | |
| | ExpType | Char | 10 | N |

4.6 Data Model (ERD)

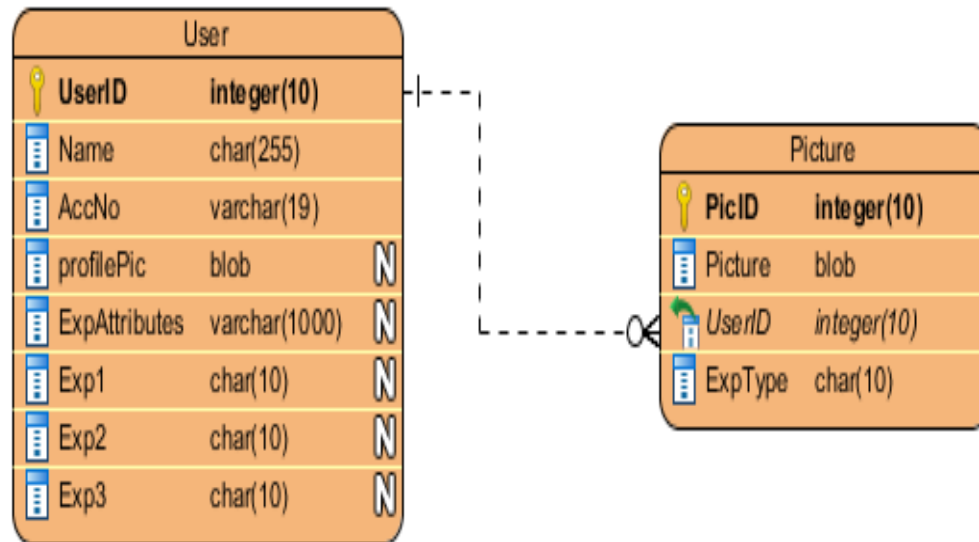


Figure 4. 3 : Entity Relationship Diagram

4.7 Detail Design

4.7.1 Scenario 1: FEAS-ATM

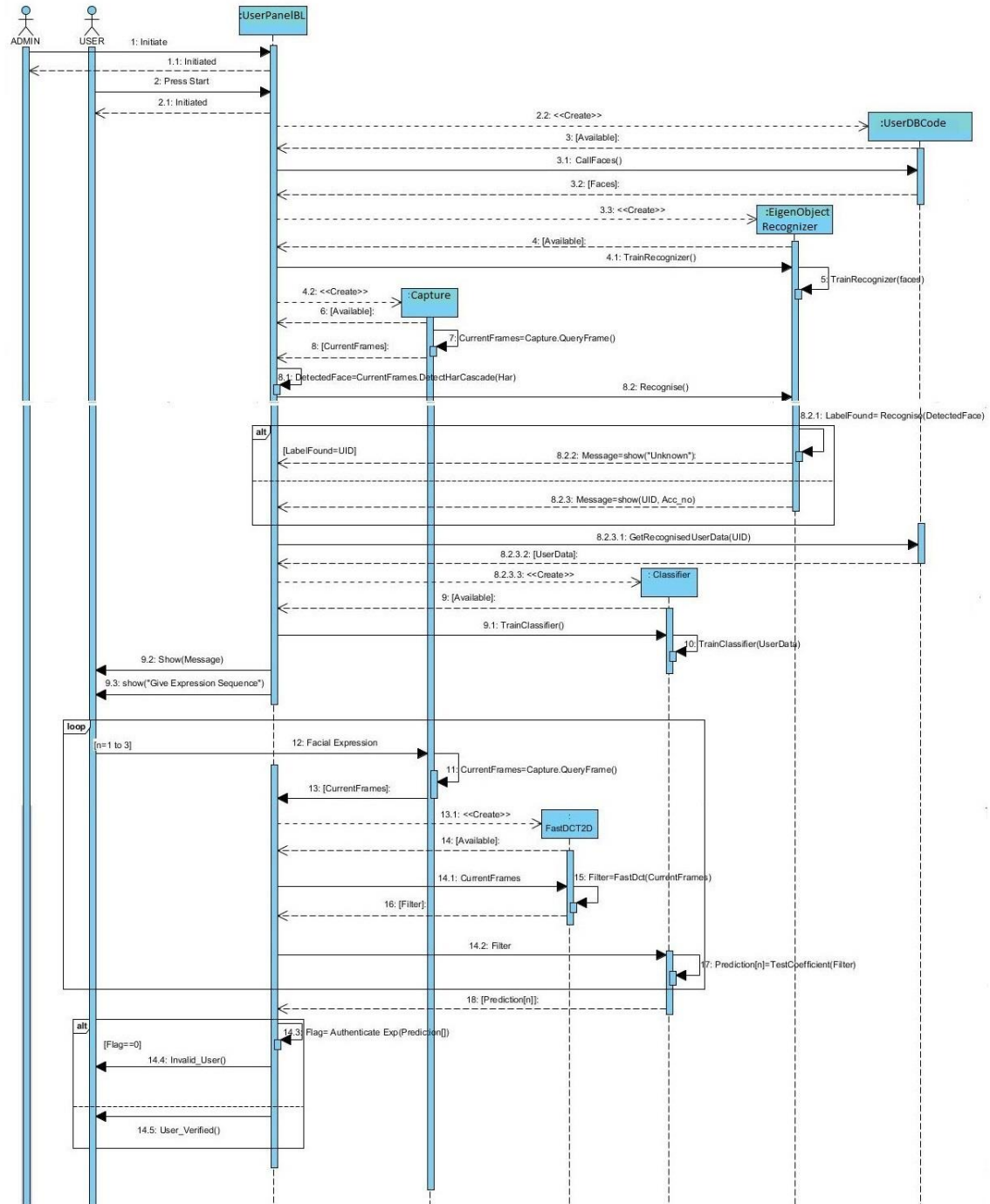


Figure 4. 4 Sequence diagram of FEAS-ATM

4.7.2 Scenario 2: Admin

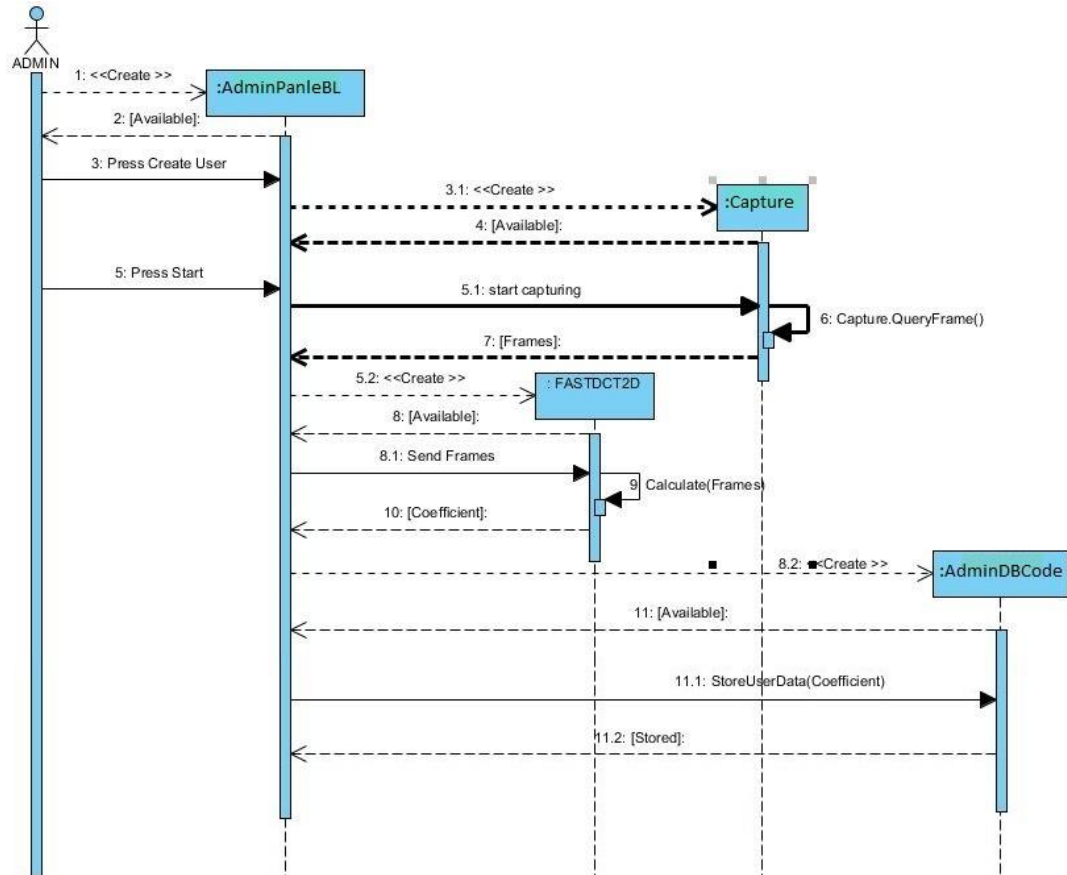


Figure 4. 5 sequence diagram of Admin panel

4.8 Package Diagram

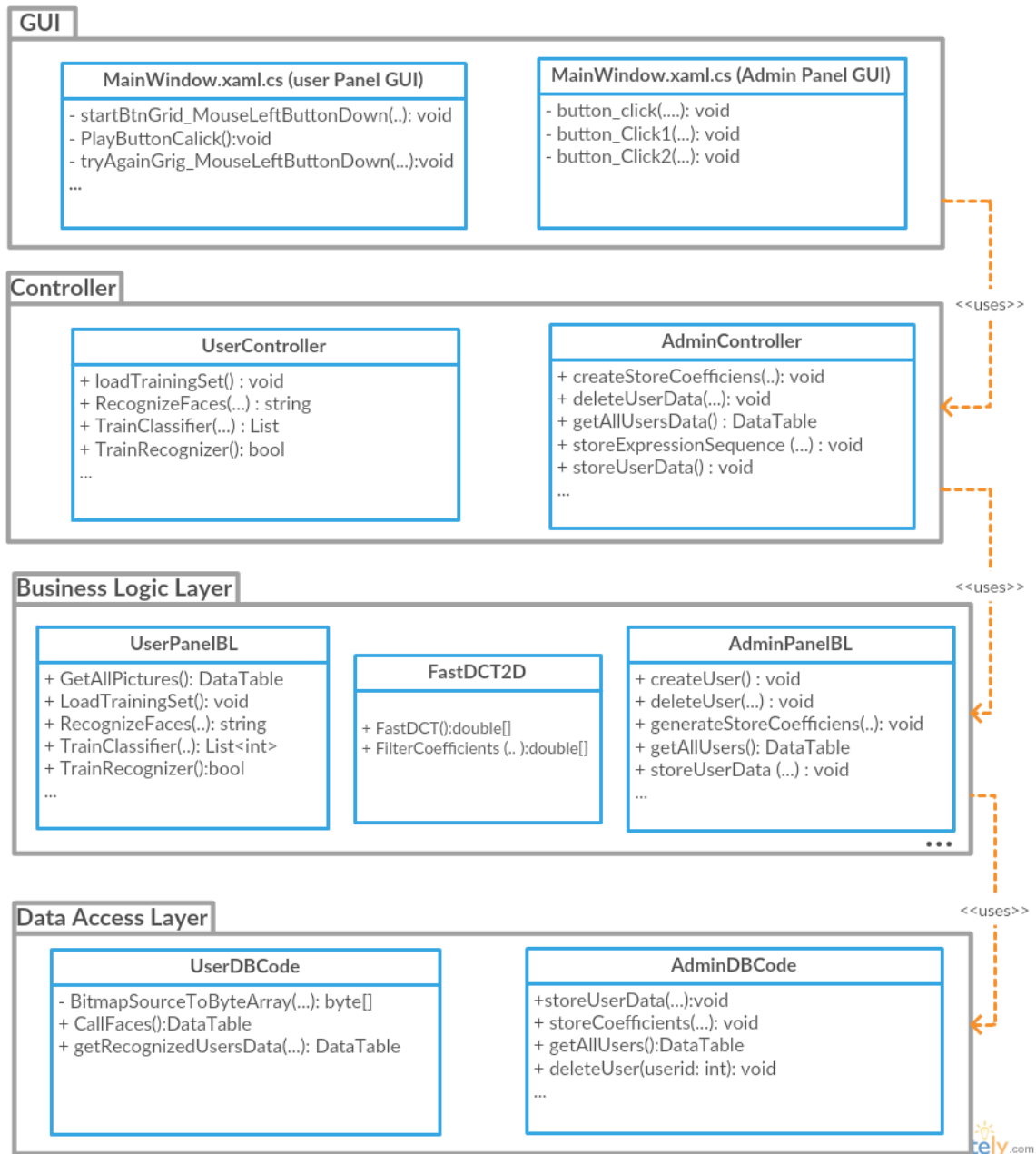


Figure 4. 6 Package Diagram

4.9 Class diagram

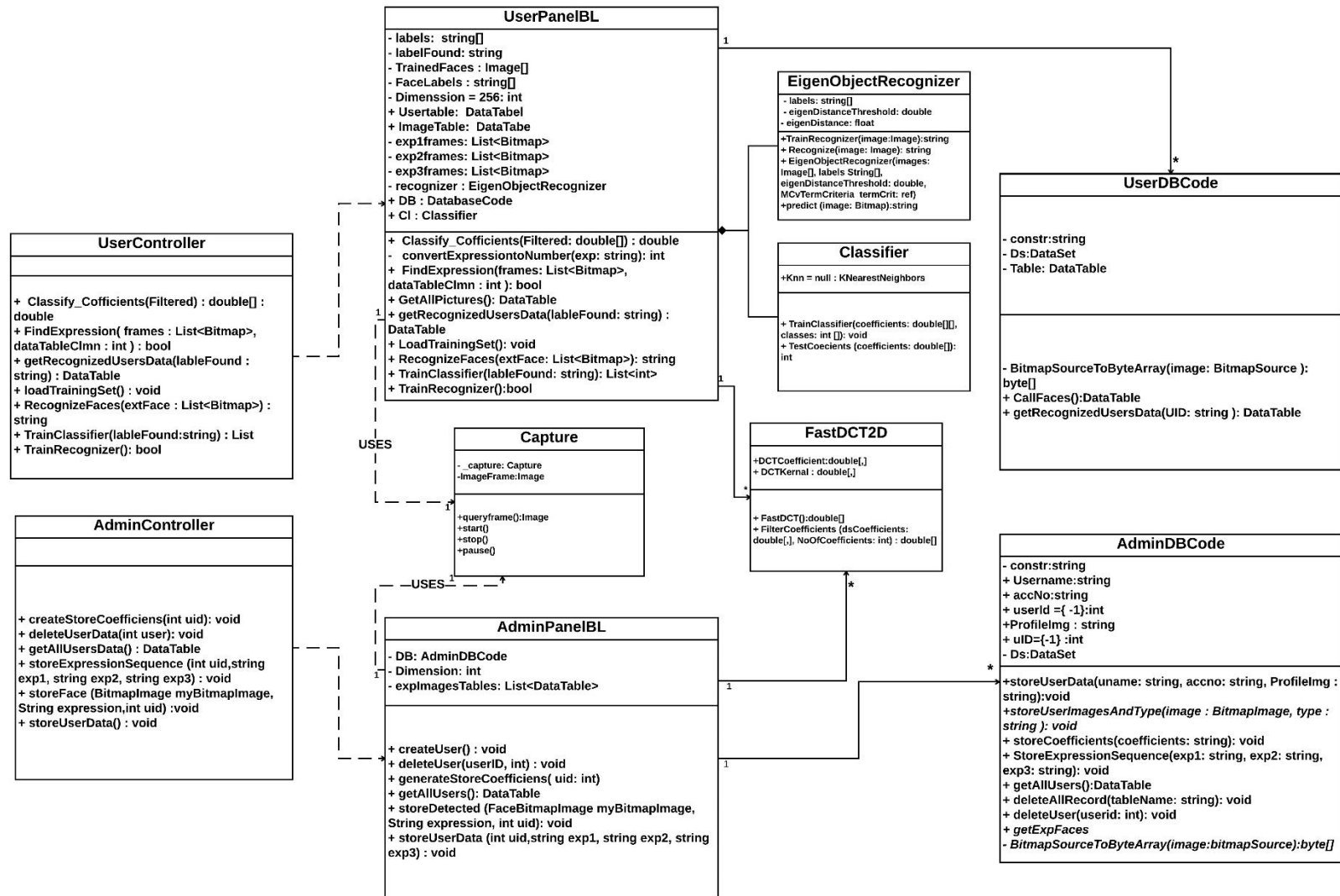


Figure 4. 7 Class diagram of FEAS-ATM

4.10 Deployment Diagram

The FEAS-ATM is expected to be deployed in an Automated Teller Machine. As our proposed software is a module of ATM which will be embedded in previous ATM software only card functionality will be replaced by facial expression recognition. ATMs are placed not only near or inside the premises of banks, but also in locations such as shopping centres/malls, grocery stores, gas stations and restaurants.

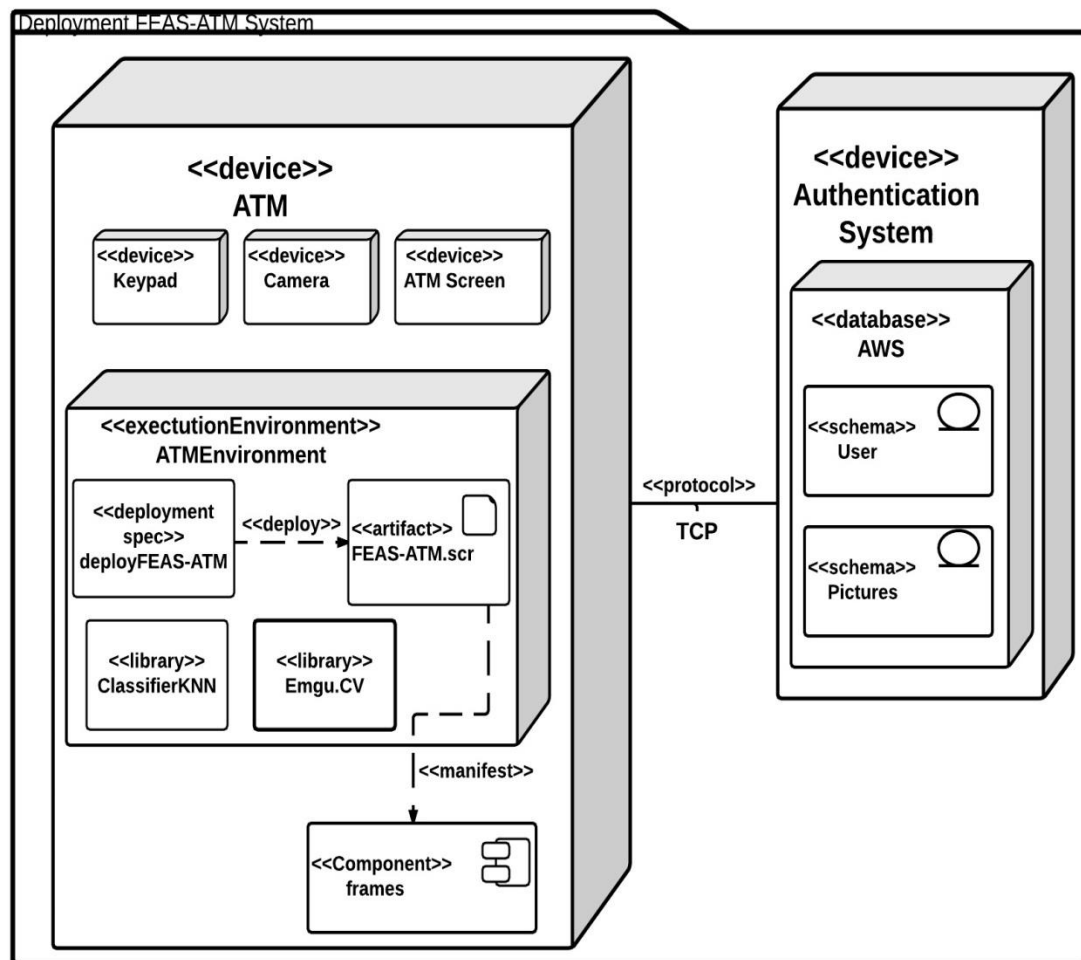


Figure 4. 8 Deployment diagram of FEAS-ATM

Chapter 5

Test Specifications

5.1 Introduction

The validation process will be done by testing each and every function by providing it with simple input and comparing it with the expected output. This is to be done to each and every function mentioned in the design section.

5.2 Test Cases

Table 5. 1 Scenario Table

| Scenario id | Description | Category |
|--------------|---|------------------------------|
| FEAS-ATM_001 | User will give frontal face to camera and camera generates face frames to FEAS-ATM where face detector will detect the face. | Face detection |
| FEAS-ATM_002 | Extracted face pictures or expressions save in database | Manage User Data |
| FEAS-ATM_003 | Detected face send to the recogniser for the face recognition | Face Recognition |
| FEAS-ATM_004 | Recognised face send to DCT for feature extraction | Feature Extraction |
| FEA-ATM_005 | Extracted features send to classifier to classify the facial expression | Classifier |
| FEAS-ATM_006 | User will give correct facial expression password which will match with the database to check whether the person is valid or not. | Expression Sequence Password |

5.2.1 Scenario id: FEAS-ATM_001

User give frontal face to camera and FEAS-ATM face detector will perform face detection.

| | |
|---|--|
| Test Case ID: TC_001 | Test Designed By: M Owais Janjua |
| Test Priority (Low/Medium/High): High | Test Designed Date: 07/05/2017 |
| Modula Name: Face Detection | Test Executed By: Rabia Akram |
| Test Title: Face detection | Test Execution Date: 09/05/2016 |
| Test Description: User will give frontal face to camera and it will generate face frames to FEAS-ATM where face detector will detect the face. | Pre-Condition: 1. Camera installed successfully 2. Voila jones working accurately |
| Cross Reference: FEAS-ATM_001 | Post-Condition: Face detected successfully |
| Purpose: Testing the face detection while user giving frontal face to camera | |

| Steps | Test Steps | Test Data | Expected Result | Actual Result | Status | Notes |
|-------|----------------------|---------------|-----------------|---------------|--------|-------|
| 1 | Just press the start | Frontal faces | Face detected | Face detected | Pass | |

5.2.2 Scenario id: FEAS-ATM_002

Save pictures or expressions in the database.

| | |
|--|---|
| Test Case ID: TC_002 | Test Designed By: M Owais Janjua |
| Test Priority (Low/Medium/High): High | Test Designed Date: 20/05/2016 |
| Module Name: Admin Panel | Test Executed By: Rabia Akram |
| Test Title: Manage user data | Test Execution Date: 21/05/2016 |
| Test Description: Save user pictures or expressions in the database | Pre-Condition: <ol style="list-style-type: none"> 1. Camera in working condition 2. Face detection done 3. Database exist |
| Cross Reference: FEAS-ATM_002 | Post-Condition: Pictures or expressions Saved in the database successfully |
| Purpose: Making database of users | |

| Steps | Test Steps | Test Data | Expected Result | Actual Result | Status | Notes |
|-------|-------------------------|-----------------------------------|-----------------|-----------------------|--------|-------|
| 1 | Press start | Frontal face | Face detection | Detected face | Pass | |
| 2 | Click on extract button | Pictures or expressions | Extracted | Extracted picture | Pass | |
| 3 | Click on save button | Extracted Pictures or expressions | Saved | Saved in the database | Pass | |

5.2.3 Scenario id: FEAS-ATM_003

Recognition of detected face

| | |
|--|--|
| Test Case ID: TC_003 | Test Designed By: M Owais Janjua |
| Test Priority (Low/Medium/High): High | Test Designed Date: 22/05/2016 |
| Module Name: Face Recognition | Test Executed By: Rabia Akram |
| Test Title: Face Recognition | Test Execution Date: 23/05/2016 |
| Test Description: Detected face will send to the recogniser where it will match the detected face with database pictures. | Pre-Condition: <ol style="list-style-type: none"> 1. Camera in working condition 2. Face detection done 3. Database exist 4. Pictures of user already saved in the database |
| Cross Reference: FEAS-ATM_004 and FEAS-ATM_005 | Post-Condition: Face recognised successfully |
| Purpose: To recognise the user through face recognition | |

| Steps | Test Steps | Test Data | Expected Result | Actual Result | Status | Notes |
|-------|-------------|--------------|-----------------------------------|------------------------------|--------|-------|
| 1 | Press start | Frontal face | Face detection + face recognition | Face recognised successfully | Pass | |

5.2.4 Scenario id: FEAS-ATM_004

Feature extraction of recognised face

| | |
|---|---|
| Test Case ID: TC_004 | Test Designed By: M Owais Janjua |
| Test Priority (Low/Medium/High): High | Test Designed Date: 24/05/2016 |
| Module Name: FASTDCT2D | Test Executed By: Rabia Akram |
| Test Title: Feature extraction | Test Execution Date: 25/05/2016 |
| Test Description: Feature extraction of recognised image | Pre-Condition: 1. Face detection done 2. Face recognised |
| Cross Reference: FEAS-ATM_004 | Post-Condition: Feature extracted successfully |
| Purpose: Extract features to send classifier for expression classification | |

| Step s | Test Steps | Test Data | Expected Result | Actual Result | Status | Notes |
|-----------|---------------|---------------------------------|--|--------------------------------|--------|-------|
| 1 | Press start | Frontal face + recognised image | Face detection + face recognition + Feature extraction | Feature extracted successfully | Pass | |

5.2.5 Scenario id: FEAS-ATM_005

Classification of facial expressions

| | |
|--|--|
| Test Case ID: TC_005 | Test Designed By: M Owais Janjua |
| Test Priority (Low/Medium/High): High | Test Designed Date: 25/05/2016 |
| Module Name: Classifier | Test Executed By: Rabia Akram |
| Test Title: Classification | Test Execution Date: 26/05/2016 |
| Test Description: Input the extracted feature to categorised facial expressions | Pre-Condition 1. Face detection done 2. Face recognised 3. Feature extraction done |
| Cross Reference: FEAS-ATM_005 | Post-Condition: Categorised expression |
| Purpose: Classification of facial expression | |

| Steps | Test Steps | Test Data | Expected Result | Actual Result | Status | Notes |
|-------|-------------|--------------|--|-------------------------|--------|-------|
| 1 | Press start | Frontal face | Face detection + face recognition done + feature extraction + classification | Categorised expressions | Pass | |

5.2.6 Scenario id: FEAS-ATM_006

Give expression sequence password

| | |
|---|--|
| Test Case ID: TC_006 | Test Designed By: M Owais Janjua |
| Test Priority (Low/Medium/High): High | Test Designed Date: 27/05/2016 |
| Module Name: Authenticate expression | Test Executed By: Rabia Akram |
| Test Title: Give expression sequence | Test Execution Date: 28/05/2016 |
| Test Description: User will give correct password of sequence expression | Pre-Condition: 1. Face detection done 2. Database exist 3. Recognised face |
| Cross Reference: FEAS-ATM_006 | Post-Condition: Verification of user done/ Valid user |
| Purpose: To check the user password sequence of expression working | |

| Steps | Test Steps | Test Data | Expected Result | Actual Result | Status | Notes |
|-------|--------------------------|----------------------|---|---|--------|-------|
| 1 | Press start | Frontal face | Face detected+ face recognised | Face detection + Face recognition done | Pass | |
| 2 | Give expression sequence | Expressions sequence | Extract features + Classify expression + password matched | Classification of facial expression done and password matched successfully. | pass | |

5.3 Test Design

We have adopted few of the best practices for software quality assurance and testing of this product; briefly described few practices are listed in subsequent sections.

5.3.1 Verification

Verification was done after the completion of each phase i.e. after specify input, and database connection. All the functions were found to completely fulfil requirements that were under laid during the project approval.

5.3.2 Validation

Validation was done after the end of development process of each module. The modules are merged with less effort and system was integrated entirely to form the desired system.

5.3.3 Usability Testing

Usability testing was done after the logic of the system was completed and the interface was coming in the shape as was in the design document. The results turned out to be successful implementation of the user interface. The users were able to understand and recall the process easily and use the system with ease.

5.3.4 Unit Testing

All units (functions) were individually tested for any malicious errors. All the errors found were removed successfully and system unit came into operation, the units were tested rigorously.

5.3.5 System Testing

System was integrated and was tested as a whole, after the partial integrations were tested successfully. All the errors were identified and removed successfully.

5.3.6 Acceptance Testing

Acceptance testing was done with internal supervisors. The test was yielded successful when the outputs were matched and expected results were achieved.

5.4 Bug Report

5.4.1 Bug ID: 1

Test Case ID / Cross- Reference: FEAS-ATM _001

Purpose: To Test the face detection

Expected Result: Face detected

Actual Result: Not detected

Bug Description: Reference address of Haarcascade_frontalface_default.xml was wrong

Bug status: Resolved

Testing Status: Successful

Development Status: Successful

Author Name: Rabia Akram

Tester Name: M Owais

Severity: Medium

Priority: High

5.4.2 Bug ID: 2**Test Case ID / Cross- Reference:** FEAS-ATM_001**Purpose:** To Test Face detector**Expected Result:** Face detected and made rectangle on detected face**Actual Result:** No rectangle made on detected face**Bug Description:** Parameters in Draw rectangle function were wrong.**Bug status:** Resolved**Testing Status:** Successful**Development Status:** Successful**Author Name:** Rabia Akram**Tester Name:** M Owais**Severity:** High**Priority:** High

5.4.3 Bug ID: 3**Test Case ID / Cross- Reference:** FEAS-ATM-002**Purpose:** Save user pictures or data in database**Expected Result:** Pictures or expressions saved in database successfully**Actual Result:** Not saved**Bug Description:** Wrong Sql connection string**Bug status:** Resolved**Testing Status:** Successful**Development Status:** Successful**Author Name:** Rabia Akram**Tester Name:** M Owais**Severity:** medium**Priority:** High

5.4.4 Bug ID: 4**Test Case ID / Cross- Reference:** FEAS-ATM-003**Purpose:** Face recognition**Expected Result:** Recognized face**Actual Result:** Not recognized accurately**Bug Description:** Recognition results are in-accurate due to uncontrolled environment**Bug status:** Resolved**Testing Status:** Successful**Development Status:** Successful**Author Name:** Rabia Akram**Tester Name:** M Owais**Severity:** High**Priority:** High

5.4.5 Bug ID: 5**Test Case ID / Cross- Reference:** FEAS-ATM-004**Purpose:** Feature Extraction**Expected Result:** 15 sec / expression during feature extraction**Actual Result:** 1 minutes/ expression during feature extraction**Bug Description:** Time consumption due to load of feature extraction process**Bug status:** Resolved**Testing Status:** Successful**Development Status:** Successful**Author Name:** Rabia Akram**Tester Name:** M Owais**Severity:** High**Priority:** High

5.4.6 Bug ID: 6**Test Case ID / Cross- Reference:** FEAS-ATM-004**Purpose:** Retrieve sequence of expressions**Expected Result:** Get expressions sequence from database**Actual Result:** Unable to retrieve expression sequence**Bug Description:** Database column and query mismatched**Bug status:** Resolved**Testing Status:** Successful**Development Status:** Successful**Author Name:** Rabia Akram**Tester Name:** M Owais Janjua**Severity:** Medium**Priority:** High

Chapter 6

Project Meetings

Following are the records and agendas of our project meetings held during the entire project:

Meeting 1: Foundation University Rawalpindi Campus

Date: 7th October, 2016

Day: Friday

People in Meeting:

- Sajid Ali Khan
- Sohaib Shabbir Butt
- M Owais Ghafoor
- Rabia Akram
- Nouman Altaf

Agenda:

- Projects ideas discussion
- Introduction of final year project members
- Discussion about areas of interests

Outcomes:

- Articles suggested by Sajid Ali to study

- Figured out two areas of interest
- Recommended to check the feasibility of projects

Meeting 2: Foundation University Rawalpindi Campus

Date: 10th October, 2016

Day: Monday

People in Meeting:

- Sajid Ali Khan
- Sohaib Shabbir Butt
- M Owais Ghafoor
- Rabia Akram
- Nouman Altaf

Agenda:

- Present the summary of the articles
- Projects ideas discussion
- Brief overview of Sajid Ali Khan's work

Outcomes:

- Sajid Ali Khan recommended to study his research papers
- Directed to discuss ideas with other coordinators

Meeting 3: Foundation University Rawalpindi Campus

Date: 21nd October, 2016

Day: Friday

People in Meeting:

- Sajid Ali Khan
- Sohaib Shabbir Butt
- M Owais Ghafoor
- Rabia Akram
- Nouman Altaf

Agenda:

- Discuss remarks of other coordinators
- Present benchmarking to convince

Outcomes:

- First project suggested by Sajid Ali Khan

Meeting 4: Foundation University Rawalpindi Campus

Date: 3rd November, 2016

Day: Thursday

People in Meeting:

- Sajid Ali Khan

- Sohaib Shabbir Butt
- M Owais Ghafoor
- Rabia Akram
- Nouman Altaf

Agenda:

- Discuss the start of the project
- Present the researched work

Outcomes:

- Present use case diagram in next meeting
- Finalize the platform and coding language

Meeting 5: Foundation University Rawalpindi Campus

Date: 16th November, 2016

Day: Wednesday

People in Meeting:

- Sajid Ali Khan
- Sohaib Shabbir Butt
- M Owais Ghafoor
- Rabia Akram
- Nouman Altaf

Agenda:

- Present refined benchmarking
- Use Case diagram
- Discuss project in detail

Outcomes:

- Suggested to start writing software requirement specification document

Meeting 6: Foundation University Rawalpindi Campus

Date: 8th December, 2016

Day: Thursday

People in Meeting:

- Sajid Ali Khan
- Sohaib Shabbir Butt
- M Owais Ghafoor
- Rabia Akram
- Nouman Altaf

Agenda:

- Remarks on prepared software requirement specification document version 1.0

Outcomes:

- Make suggested amendments in the document

Meeting 7: Foundation University Rawalpindi Campus

Date: 16th December, 2016

Day: Friday

People in Meeting:

- Sajid Ali Khan
- Sohaib Shabbir Butt
- M Owais Ghafoor
- Rabia Akram
- Nouman Altaf

Agenda:

- Remarks on the software requirement specification document version 2.0

Outcomes:

- Announced final date for submission of final software requirement specification document
- Approved changes

Meeting 8: Foundation University Rawalpindi Campus

Date: 3rd January, 2017

Day: Tuesday

People in Meeting:

- Sajid Ali Khan
- Sohaib Shabbir Butt
- M Owais Ghafoor
- Rabia Akram
- Nouman Altaf

Agenda:

- Submission of software requirement specification document

Meeting 9: Foundation University Rawalpindi Campus

Date: 13th February, 2017

Day: Monday

People in Meeting:

- Sajid Ali Khan
- Sohaib Shabbir Butt
- M Owais Ghafoor
- Rabia Akram
- Nouman Altaf

Agenda:

- Project Launch
- Present framework for remarks

Outcomes:

- Improvements suggested framework

Meeting 10: Foundation University Rawalpindi Campus

Date: 24th February, 2017

Day: Friday

People in Meeting:

- Sajid Ali Khan
- Sohaib Shabbir Butt
- M Owais Ghafoor
- Rabia Akram
- Nouman Altaf

Agenda:

- First demonstration

Outcomes:

- Tasks hierarchy definition
- Complaints discussion
- Make class relationship diagram

Meeting 11: Foundation University Rawalpindi Campus

Date: 6th March, 2017

Day: Monday

People in Meeting:

- Sajid Ali Khan
- Sohaib Shabbir Butt
- M Owais Ghafoor
- Rabia Akram
- Nouman Altaf

Agenda:

- Allocation of next task
- Check the progress

Outcomes (Assigned Work):

- Draw refined ERD
- Start working on Front End (GUI)

Meeting 12: Foundation University Rawalpindi Campus

Date: 14th March, 2017

Day: Tuesday

People in Meeting:

- Sajid Ali Khan
- Sohaib Shabbir Butt
- M Owais Ghafoor
- Rabia Akram
- Nouman Altaf

Agenda:

- Allocation of next task
- Check the progress

Outcomes (Assigned Work):

- Create, Read, Update, Delete (CRUD) Functions

Meeting 13: Foundation University Rawalpindi Campus

Date: 27th March, 2017

Day: Monday

People in Meeting:

- Sajid Ali Khan
- Sohaib Shabbir Butt
- M Owais Ghafoor
- Rabia Akram
- Nouman Altaf

Agenda:

- Allocation of next task
- Check the progress

Outcomes (Assigned Work):

- Feature Extraction work
- Expression sequence password Authentication

Meeting 14: Foundation University Rawalpindi Campus

Date: 14th April, 2017

Day: Friday

People in Meeting:

- Sajid Ali Khan
- Sohaib Shabbir Butt
- M Owais Ghafoor
- Rabia Akram
- Nouman Altaf

Agenda:

- Allocation of next task
- Check the progress

Outcomes (Assigned Work):

- Search suitable algorithm for classification

Meeting 15: Foundation University Rawalpindi Campus**Date:** 28^h April, 2017**Day:** Friday**People in Meeting:**

- Sajid Ali Khan
- Sohaib Shabbir Butt
- M Owais Ghafoor
- Rabia Akram
- Nouman Altaf

Agenda:

- Allocation of next task
- Check the progress

Outcomes (Assigned Work):

- KNN algorithm
- Implement KNN algorithm
- Predict expressions using KNN algorithm

Meeting 16: Foundation University Rawalpindi Campus**Date:** 16^h May, 2017

Day: Tuesday

People in Meeting:

- Sajid Ali Khan
- Sohaib Shabbir Butt
- M Owais Ghafoor
- Rabia Akram
- Nouman Altaf

Agenda:

- Allocation of next task
- Check the progress

Outcomes (Assigned Work):

- Implement KNN algorithm

Meeting 17: Foundation University Rawalpindi Campus

Date: 22nd May, 2017

Day: Monday

People in Meeting:

- Sajid Ali Khan
- Sohaib Shabbir Butt
- M Owais Ghafoor
- Rabia Akram

- Nouman Altaf

Agenda:

- Allocation of next task
- Check the progress

Outcomes (Assigned Work):

- Test the Application
- Complete the Documentation

Meeting 18: Foundation University Rawalpindi Campus

Date: 5th June, 2017

Day: Monday

People in Meeting:

- Sajid Ali Khan
- Sohaib Shabbir Butt
- M Owais Ghafoor
- Rabia Akram
- Nouman Altaf

Agenda:

- Allocation of next task
- Check the progress

Outcomes:

- Demonstrate the Final Project

Chapter 7

Conclusion

7.1 Conclusion

By the end of the project we were able to develop a new frame work for ATM i.e. FEAS-ATM (Facial Expression Authentication system-ATM). FEAS-ATM is a type of framework which secures the ATM login by implementing the face recognition and expression authentication techniques. We used all of our energy to make it safe, simple and user-friendly for general public. Initially it was quite difficult but then by the grace of Almighty Allah project was completed successfully. The success of our prototype is demonstrated in the test results. During testing and implementation finding a bug and its fixture was totally new and healthy experience. One of the very important aspects of the project was how to document our project properly. We are great full to our prestigious institution for providing us an opportunity to work and support in form of honoured professors, coordinator and supervisor. We had a very good interaction with our supervisor. Our team gave best while implementing the FEAS-ATM. It was wonderful experience for each of us working in a group and we wish to work together again in future Insha'Allah.

7.2 Benefits

- FEAS-ATM supports all kind of users from educated to layman.
- System will remain available for user 24/7

- Replaced ATM card with facial expression authentication for providing secure and easy access to the user account.
- Maximum accuracy and reduce execution time of facial Expression recognition.

7.3 Limitations

The limitations of our system are as follow:

- Authentication will only be done on the frontal face.
- Each user must have account in ATM to use the FEAS-ATM. Those who don't have an account in ATM will not be recognized by the system during face detection.
- If user goes through any kind of physical face transformation i.e. face surgery, glasses, beard, hijab, heavy makeup etc. he/she can't have access to account until or unless user update's these transformation in bank database.
- User should have to be present for using FEAS-ATM no one can replace him/her to perform transactions.

7.4 Future Work

The main goal of this project was to implement facial expression authentication on ATM by replacing ATM card. FEAS-ATM is able to detect faces in low illumination. Future improvements could be to improve recognition rate, improve speed of authentication, illumination and authentication to be performed on non-frontal face.

GLOSSARY

Table 8.1 Glossary

| Reference | Definition |
|-------------|--|
| FEAS-ATM | FEAS-ATM's abbreviation is Facial Expression based Authentication system for an ATM. A software module integrated on ATM to make it more secure. |
| Algorithm | It is the basic procedures or rules used in estimations or other critical operation particularly by a computer. |
| Stakeholder | A person concerned with a specific system and involved it in any manner to run a business. |
| SRS | SRS's abbreviation is Software Requirement Specification is a document that provides description to software product that is to be developed. Includes functional and non-functional requirements of a system. |
| Database | It is the collection of data in form a rows, columns, classes and it is organized in this way to structure the data so that it can be managed, accessed and updated in multiple ways easily. |
| Encryption | It is a technique used to transform data in a way to make it secure. Once data is encrypted, needs key to access or special operations to perform for decryption. |
| User | Person who is using the system. |

| | |
|-------------------------|--|
| Effective | The extent to which goals are accomplished and the degree to which focused issues are unraveled. Effectiveness means “ding the right thing”. |
| Use-Cases | Relate sequence of interaction between a system and an external actor that results in accomplishing a task. These refer to major distinctions, not all interactions. |
| Software Infrastructure | The basic structure of a software. This segment acts like a middleware on what system is developed. |
| Functional Requirement | It defines what the system should do. Describes the observable behaviors the system will exhibit. Use Cases are elaborated into functional requirements. |
| KNN | K-nearest neighbor Is a classification algorithm used in our project. |
| Sequence Diagram | It is an interaction diagram that shows how and in what order objects interacts with each other. It deals in how information is shared between objects that carries the functionalities of scenario. |
| Literature Review | Literature review is a writing survey is an evaluative report of data found in the writing identified with your chose region of study. It ought to give a hypothetical base for the exploration and help you (the creator) decide nature of your research. The survey ought to depict, access and abridge your literature. |
| System, Product | The software we will develop. |

| | |
|-----------------------------|---|
| | |
| Non-Functional Requirements | These are contrasted by functional requirements that define functions. These improve the quality of system. Soft goals could be usability, performance, flexibility and security. |
| GUI | Stands for graphical user interface. It's an interface type that allows user to interact with system through icons and indicators. |
| PK | Primary key |
| FK | Foreign key |
| PCA | Principle component analysis algorithm for face recognition |
| LBP | Local binary pattern is a type of visual descriptor used for classification in computer vision. |
| KNN | K nearest neighbors is a method used for classification |
| AWS | Amazon Web Services is a subsidiary of Amazon.com that provides on-demand cloud computing platforms |

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