Middle East Technical University Northern Cyprus Campus
Computer Engineering Program

CNG491 Computer Engineering Design I

Iris Analyzer

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Chapter 1

Introduction

1.1 Motivation

Iris recognition can be used for verifying owner identity (biometric data) and demographic data of the identified person (soft biometric data). Verification(1-to-1 comparison) is the process where the biometrics information of an individual is compared with biometrics on the record[4] while identificaton(1-to-many comparison) is used to discover the origin of certain biometrics to prove or disprove the association of that information with a certain person/individual. [4] Research and studies have been done on gender prediction[1], age prediction[2] and biometric technology[3] using iris analysis using image processing and machine learning techniques.

The main motivation for this project is to improve the prediction part by using deep learning technique instead of image processing classification and tree algorithms as used in the research projects. This will improve the output data accuracy.

1.2 Aims and Objectives

The main aim of this project is to acquire identification and their demographic information by analyzing their eyes (iris). The objectives are:

1. Get eye data from a database.
2. Pre-processing where the eye image will be segmented using image segmentation techniques.
3. Use deep learning to retrieve the identity and demographic data

1.3 Methodology

The project will be done in two parts: image processing part and machine learning part. The image processing part will be achieved using the following methods:

1. Acquiring the eye image from the BioSecure Multimodal Database (BMDB). The BioSecure Multimodal Database is a database containing eye images collected in a standard office environment using the LG Iris Access EOU3000 system.

2. Pre-processing: The chosen eye image will be segmented using image processing segmentation algorithms. This process will localise the iris region and detect the sclera and pupil boundaries.

The deep learning part will use the method explained below:

1. The segmented eye images in the database shall be divided into training and testing sets.

   The training set: is used to discover the predictive relationship by using a model. The model can learn the behavior and tweak itself. The model is built based on the data it discovers in the training dataset.

   Testing set: Once the model is built, the test dataset is used to get the accuracy of the hypothesis.

2. The system shall use deep learning algorithms to train the input images using the training set, and to predict the output based on the model using the testing set.

Chapter 2

Requirements

2.1 Stakeholders

1. System administrator
2. Application users

2.2 Functional System Requirements

1. The user shall be able to choose eye images as inputs.

    1. The system shall display eye images as input to the screen.
    2. The system shall mark all the eyes images selected by the user as wanted input.
    3. The system shall move copies of the chosen eye inputs to the next stage (processing stage).

2. The user shall be able to choose the expected output (identification and demographic output).

    1. The system shall read checkbox input of either or both identification and demographic data.
    2. The system shall display a confirmation message for the selected output.
    3. The system shall use the chosen input to process the data after the output confirmation from the user.

3. The system administrator shall be able to add eye images in the database.

    1. The system shall display an authentication message to the administrator.
    2. The system shall give the administrator access to the database if the pin is correct.
    3. The system display an error message if the pin entered is correct.
    4. The system shall display a add confirmation message to the system administrator.
    5. The system shall send the added images to the database.

   6. The system shall display an added image successfully message to the system administrator.

4. The system administrator shall be able to delete eye images in the database.
   1. The system shall display an authentication message to the administrator.
   2. The system shall give the administrator access to the database if the pin is correct.
   3. The system display an error message if the pin entered is correct.
   4. The system shall display a delete confirmation message to the system administrator.
   5. The system shall discard the selected image from the database.
   6. The system shall display a deleted image successful message to the system administrator.

5. The system administrator shall be able to create a model to be used in deep learning section.
   1. The system shall display an authentication message to the administrator.
   2. The system shall give the administrator access to the database if the pin is correct.
   3. The system display an error message if the pin entered is correct.
   4. The system administrator shall divide the eye images in the database into 2 parts: training and testing set.
   5. The system shall save the 2 sets in the database.
   6. The system shall use the training set for modelling and the testing set for prediction using deep leaning algorithms.

2.3 Non-functional System Requirements

1. The system shall be available to users 24hrs a day.
   1. The system shall check every 2hrs (system troubleshoot) that all parts are functioning properly.
   2. The system shall send a notification to the system administrator about any errors that occurred.

2. The system shall work on Windows, Linux and Mac operating system.
   1. The system shall run on all devices with Windows 7 and above, all Linux and Mac devices.
   2. The system shall display an error message if the device is incompatible.

3. The system shall be built using python programming language.

    1. The system shall be coded using python programming language.

4. Only the system administrator shall have access to the database.
    1. The system shall display a 4-digit access pin to the user.
    2. The system shall give access to the database if the pin is correct.
    3. The system shall display a wrong pin message to the administrator or user.
5. The system interface input response time should not be more than 1 second to users.
    1. The system shall shall detect keyed and clicked inputs at a response time of 50ms.
6. The system shall handle only one user at a time.
    1. The system interface shall take input from one person at a time.

2.4 Domain Requirements

1. The eye images in the database should be negatives (black and white) so as to used in the pre-processing and prediction part.
2. The system administrator should seperate the training and testing datasets. This is to prevent the model seeing the test dataset and giving the exact results. (The model gives impartial results because it hasn't seen the test dataset)

2.5 Assumptions and Justifications

1. The eye images used are not captured in real time but are taken from a database. These is due to the following reasons:

1. It needs special cameras and scanners.
2. The eye is sensitive to flashes and they might be damaged.
3. Ethic and privacy concerns, because users may not be sure of their safety of their images.

Chapter 3

System Modelling

3.1 Structured Use Case Diagram

The use case diagram shows how the relationship between the user and different use cases. The user can insert an image for the prediction but he has to set an output option first. Prediction model is then called to process the user input. The system administrator is entitled to manage the system. The system administrator can modify the processing model of the system later on. However, the user will be notified by the new modification.

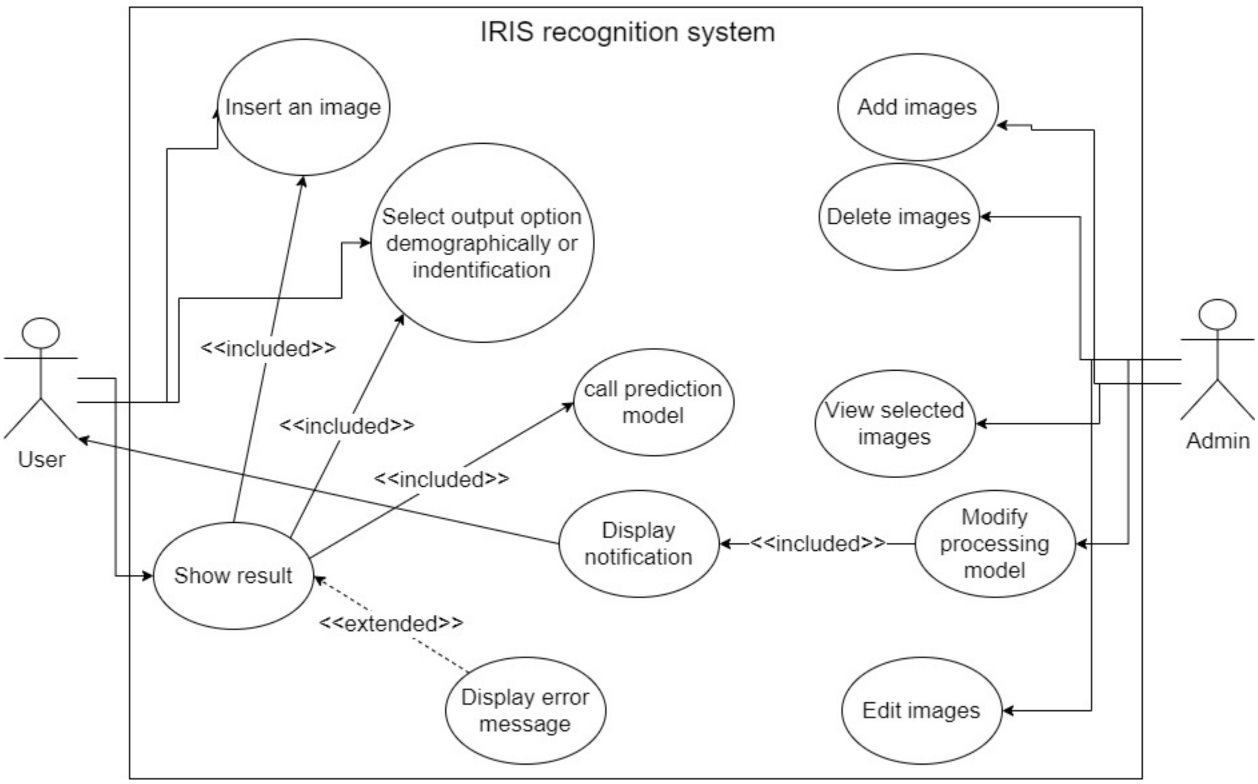

Figure 3.1: Structured Use Case Diagram for Iris Analyzer System

3.2 Sequence Diagram of Major User Cases

The system shall require authentication from the system administrator and give access to the system and Database. The System administrator shall choose training and testing sets from the images in the database. The sets will be used as a model to train the user inputs using deep learning algorithms and test them to get the output data.

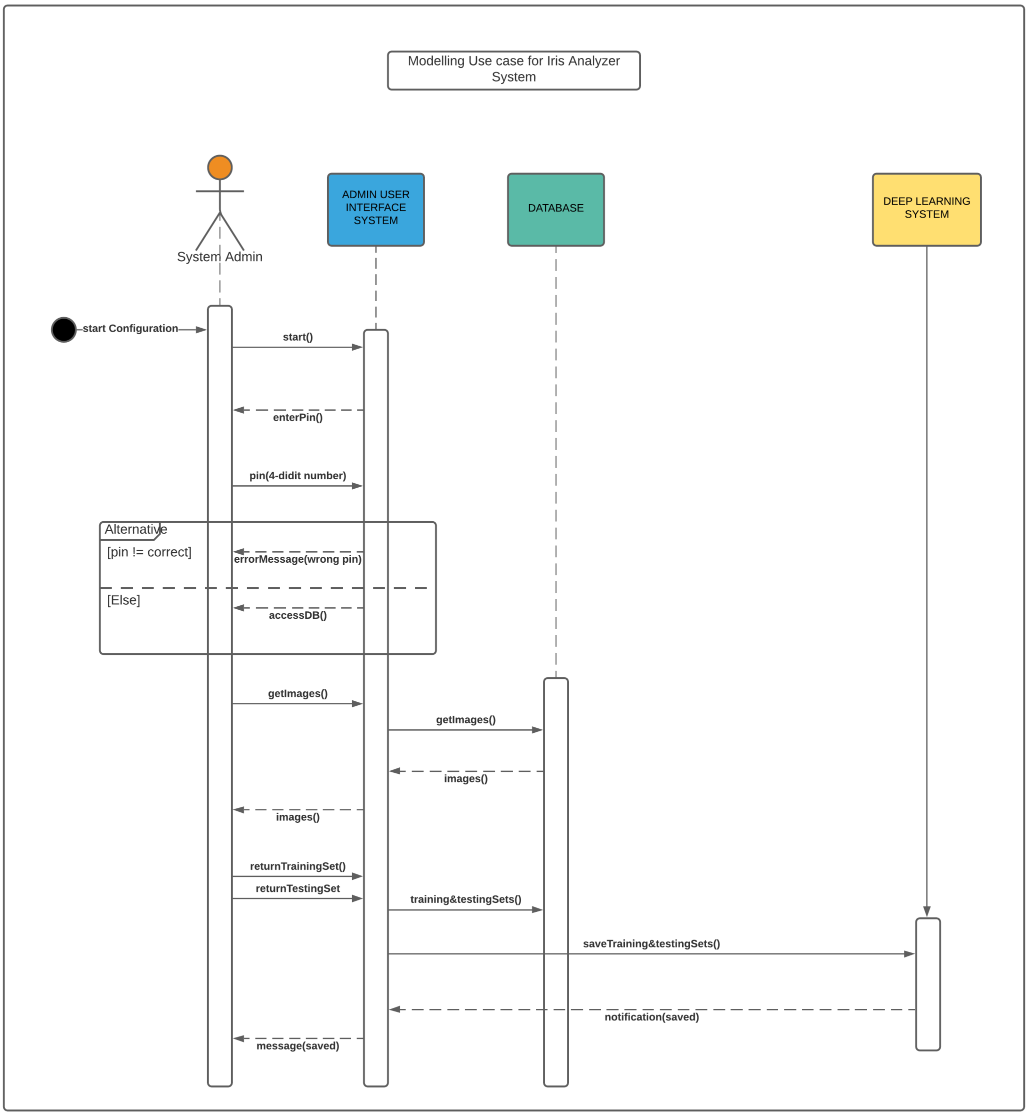

Figure 3.2: Modelling Image Use Case Sequence Diagram

3.3 Context Model

The context model shows the external and actors on the applications environment which are the Users, system administrator and Database.

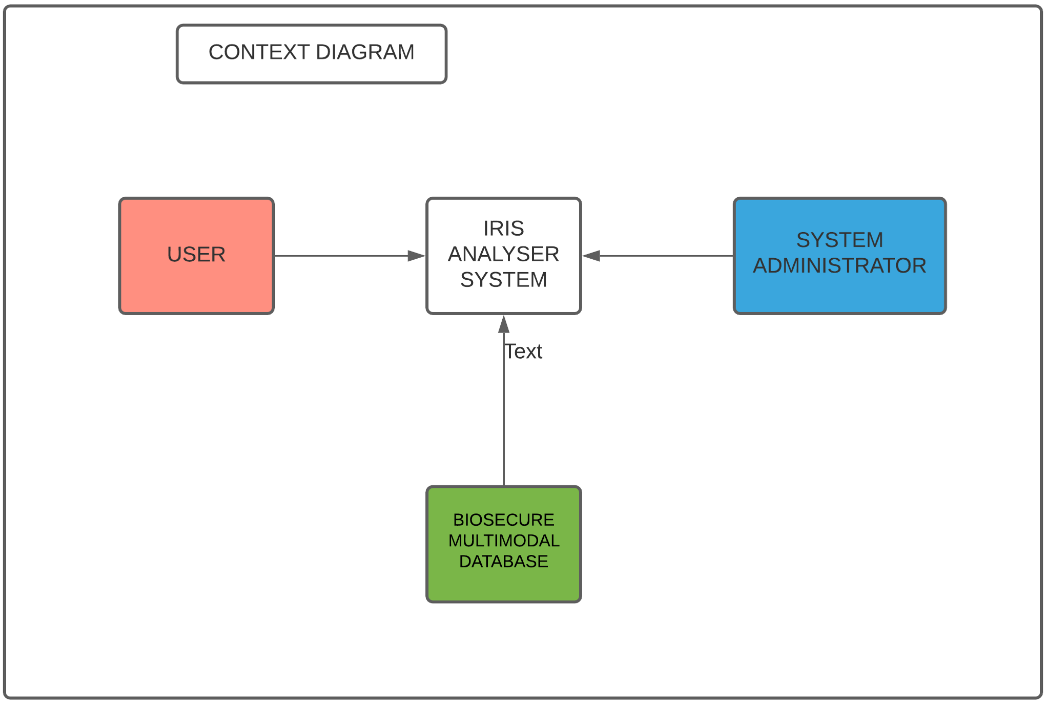

Figure 3.3: Context Model for the Iris Analyzer System

3.4 Architectural Model

This is a pipe and filter architecture diagram since the flow of the diagram is very straight forward. We have a data-set in which some parts of it get segmented, to build the model. After that, the user can insert an image or set of images. These pictures will be first filtered by modelling and segmented, then passed to the prediction for the final result.

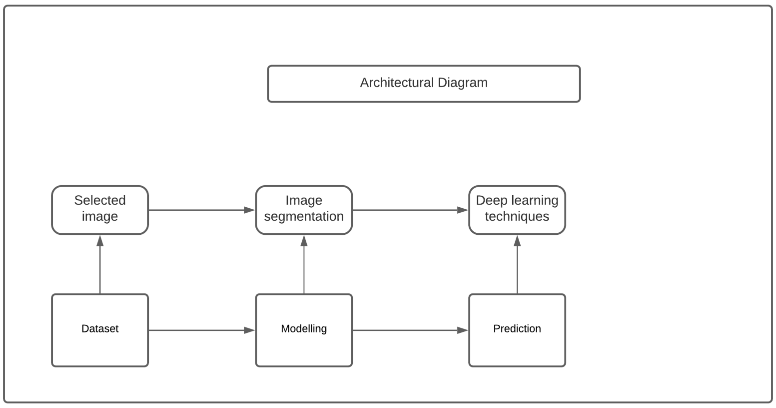

Figure 3.4: Architectural Model for the Iris Analyzer System

3.5 Process Model

The process model diagram shows the procedure to get the output from the inputted data. The user shall choose and image and the expected output wanted. The image shall be segmented and prediction done using deep learning methods to display the output.

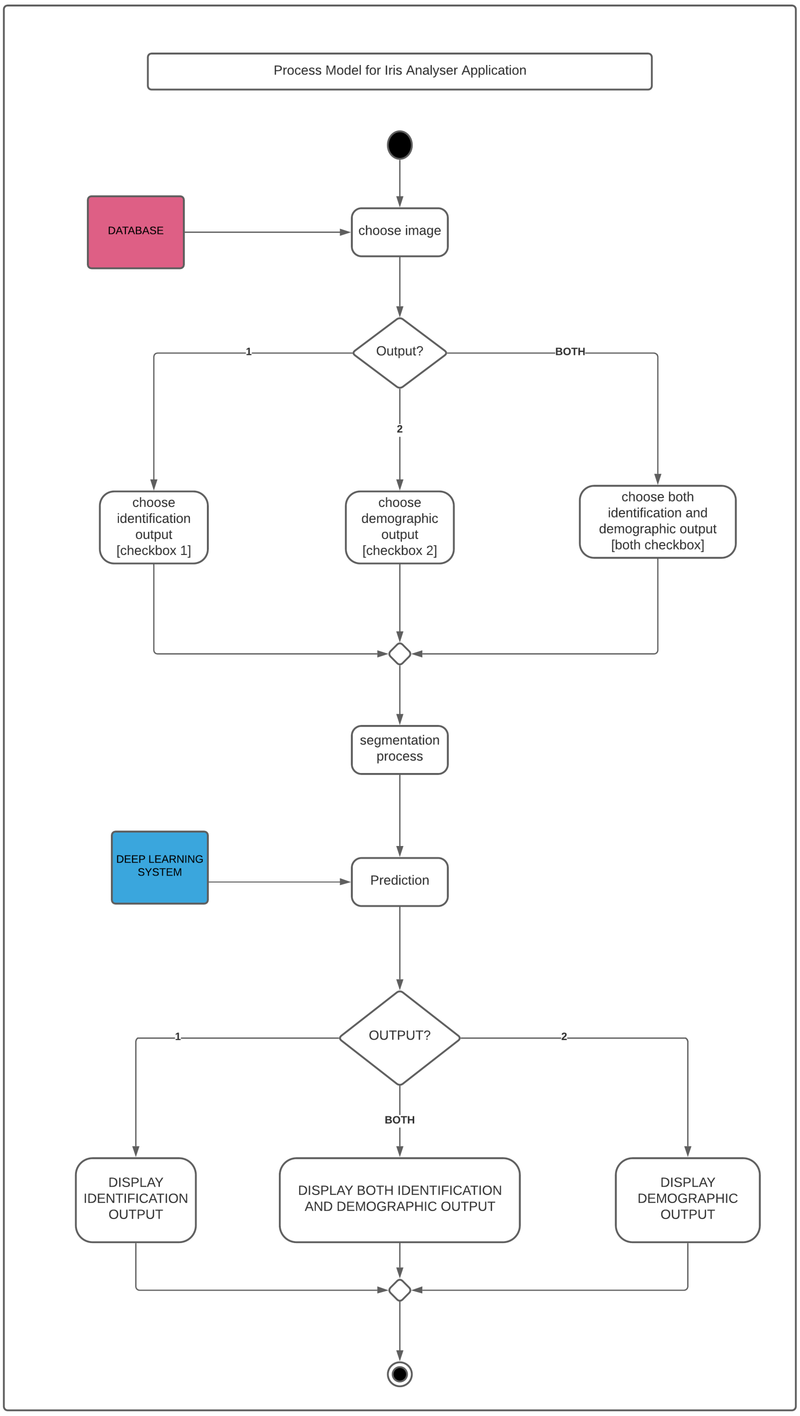

Figure 3.5: Process Model for the Iris Analyzer System

Chapter 4

(Graphical) User Interface

Below is a very early iteration of how the graphical user interface of the Iris Analyser application will look like. The interface is in early stages of design and is subject to many changes across the upcoming sprints.

4.1 Main Page GUI

The user will be given an option either to open the system administrator section or User section.

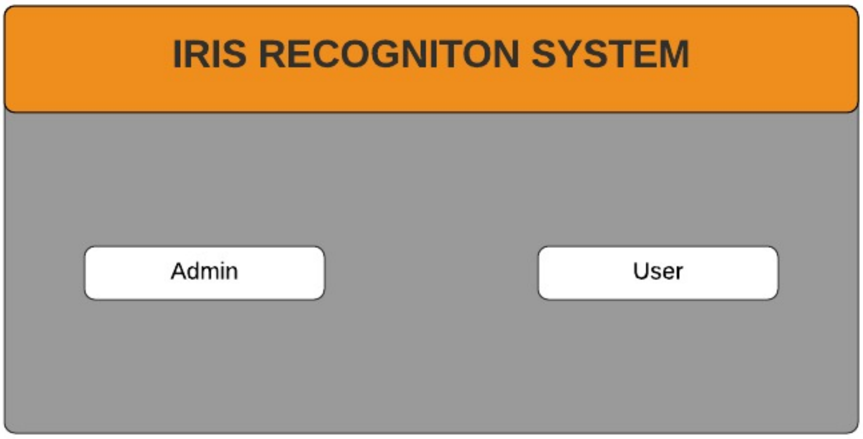

Figure 4.1: Graphical User Interface Main page view

4.2 User GUI

The User Interface works as follows; After the appearance of the interface below, the user must first click on "Choose eye image" in order to choose an eye image of their choice from the Iris Analyzer eye image database. If the user presses any other option before doing so an appropriate error message will be prompted. The user shall choose either the identification or demographic output or both. After having chosen an eye image, output and confirming, the user must press the "Start Configuration" button and will be immediately presented with the identification and demographic result in the "Identification output" and "Demographic output" boxes respectively.

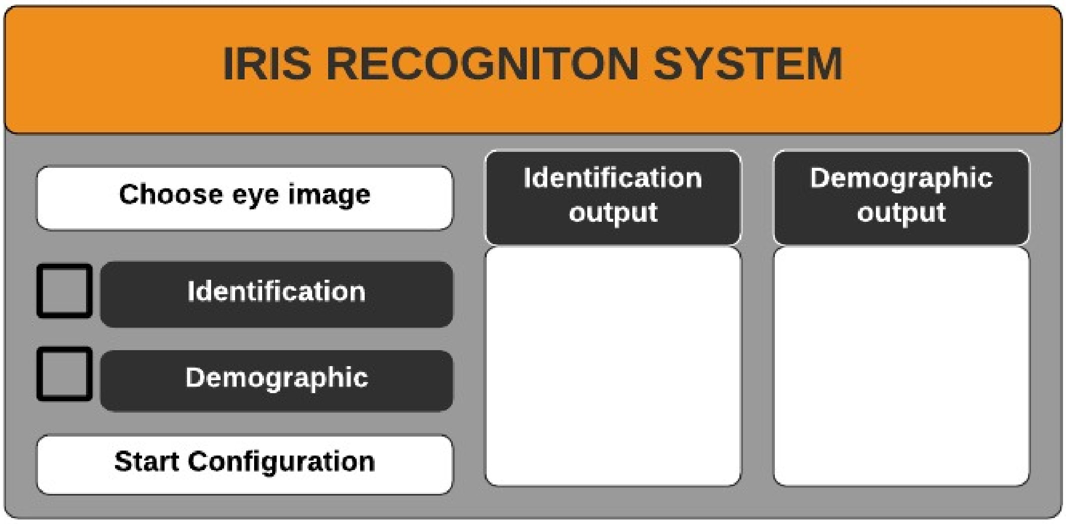

Figure 4.2: Graphical User Interface User view

4.3 System Administrator GUI

The system administrator interface works as follows; After the appearance of the interface below, the system admin shall be prompted to enter a 4-digit pin. The system shall move on to the next interface if pin is correct and if its wrong display an error message. In the next interface the system admin can add and delete images from the database.

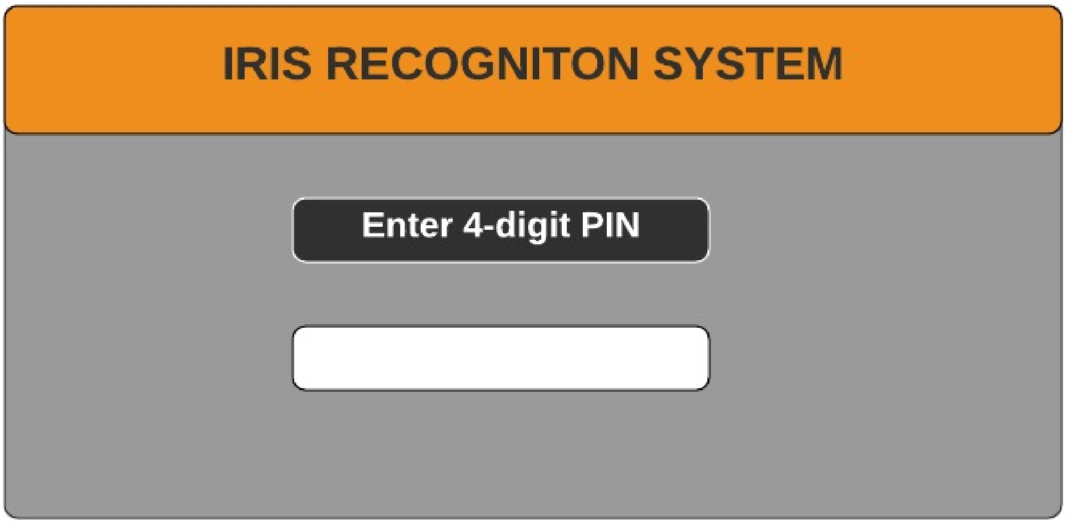

Figure 4.3: Graphical User Interface Authentication view

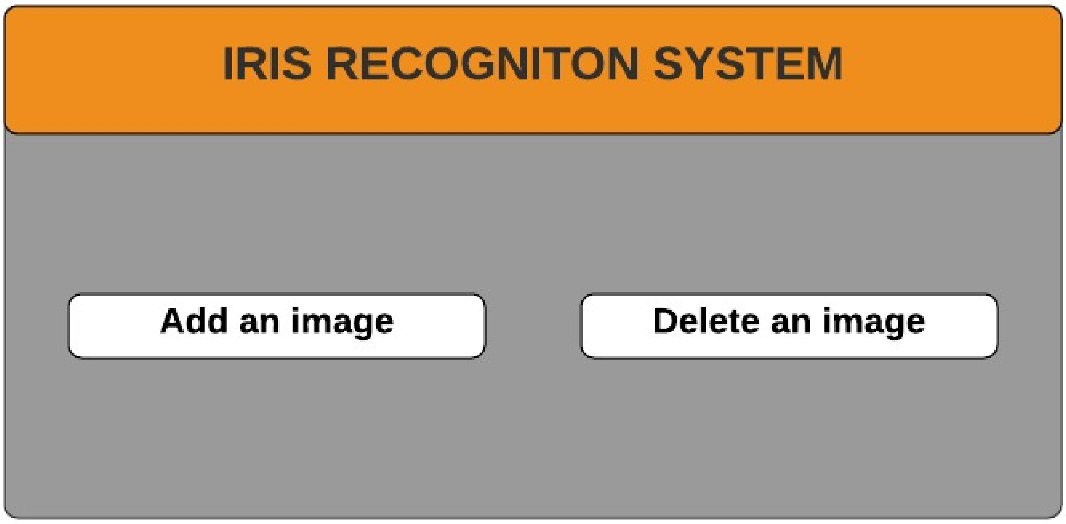

Figure 4.4: Graphical User Interface User database add/delete image view

Chapter 5

Agile Development with Scrum

5.1 Sprint Backlog

Table 5.1 shows the list of tasks completed so far and the time spent on each one. It also includes the priority level for each task. During the first sprint since we did not have many tasks to complete, the group was not divided in any particular way. Meaning that all 4 members worked on the Research for both Image processing techniques as well as Deep learning basics. As for the literature review, each member worked on their own papers and wrote a separate review.

We did not have official Scrum roles for the team since we are a small group who is well accustomed to each other, however after unanimous decision we elected Evans Kimathi as our Scrum Master, in order to keep the group on track and ensure that all team members are working on their parts correctly and in a timely manner.

Table 5.1: Sprint Backlog table

	Sprint Backlog Tasks	**Priority (High, Med or Low)**	**Time Spent (Hours)**
1	Research (Image Processing techniques)	L	6
2	Write a Literature Review	L	3
3	Research (Deep Learning basics)	L	7
4	Write a Project Report (1)	M	10
Sprint 1 Gather enough information regarding deep learning in Iris Recognition studies			

5.2 Sprint Burndown Chart

Table 5.2 shows the remaining time of the tasks of the first sprint over the past 4 weeks against a general sprint guideline.

Table 5.2: Sprint Burndown table

Task #	Sprint Backlog Tasks	Week 1	Week 2	Week 3	Week 4
	Guideline	**26**	**13**	**6**	**0**
	Remaining Values	**26**	**21**	**7**	**0**
1	Research (Image Processing techniques)	6	0	0	0
2	Write a Literature Review	3	3	0	0
3	Research (Deep Learning basics)	7	7	2	0
4	Write a Project Report (1)	10	10	5	0

Figure 5.1 shows the graphical format of the above Sprint Burndown chart with the red line indicating the guideline to follow, and the green line representing the group progress on the hours spent and remaining on the tasks.

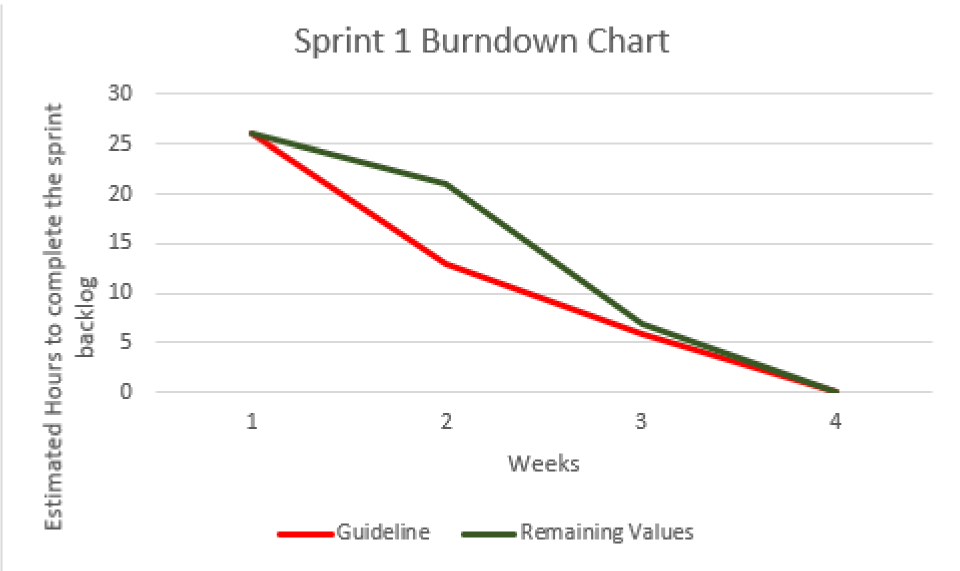

Figure 5.1: Sprint Backlog graph

5.3 Sprint Review

In order to determine if the current sprint (sprint 1) has been successful and has met its goal we need to have a look at the table of information provided above. Although, at first glance it may be assumed that the sprint was unsuccessful since the estimated hours of work remaining is not zero, however, this is not the case. This sprint has been a short one and is the first sprint in the agile development process, therefore, there have not been detailed nor quantitative tasks to complete in this short time period and hence, being behind by a few hours is no reason for worry.

Problems and issues during this sprint have been prevalent during this sprint. The graphical data may show that progress line is close to the guideline, however, there have been problems in this period. The first problem we encountered as a team was a result of poor communication between the group members and the supervisor. The weekly meetings left many topics and questions regarding the project itself unclear as the team as a whole did not have a clear vision on the goal of the project and its steps.However, after setting up an extra semi-daily group meeting, constant clarifications were being made and project started to take shape nicely.

5.4 Sprint Retrospective

In retrospect, the sprint so far has been a success on paper, but has place for improvement. With time, the sprint will take shape as more tasks are added and with the project steps becoming clarified and the direction in which the team will move on with the project is finalized.

In order to further improve the sprint, we are planning to incorporate our supervisor more strongly in the agile development process. In addition to this, more improvements can be made by updating the sprint backlog and sprint burndown chart more consistently and by showing it in the weekly meetings as well as semi-daily meetings.

Chapter 6

Estimation

6.1 Input

Each input in GUI is 1 functional point in which some are complex, simple and average.

Measurement Parameter	**Count (value >= 0)**	**Weighting Factor**
Number of User Input	7	Average
Number of User Outputs	2	Complex
Number of User Inquiries	1	Complex
Number of Files	2	Complex
Number of External Interfaces	0	Simple

6.2 Complexity Adjustment Table

Item	Complexity Adjustment Questions	Scale
1	Does the system require reliable backup and recovery?	**5**
2	Are data communications required?	**5**
3	Are there distributed processing functions?	**1**
4	Is performance critical?	**5**
5	Will the system run in an existing, heavily utilized operational environment?	**5**
6	Does the system require on-line data entry?	**2**
7	Does the on-line data entry require the input transaction to be built over multiple screens or operations?	**1**
8	Are the master files updated on-line?	**1**
9	Are the inputs, outputs, files or inquiries complex?	**5**
10	Is the internal processing complex?	**5**
11	Is the code to be designed reusable?	**4**
12	Are conversion and installation included in the design?	**4**
13	Is the system designed for multiple installations in different organizations?	**3**
14	Is the application designed to facilitate change and ease of use by the user?	**4**

Result	
Project Function Points	89.6999999

6.3 Line of Code

To calculate the number of code lines we chose Python as the language to use and had a unit size of 67 which we multiplied by ATFP. This is the average unit size for both.

Python 100

Loc = 67 * 89.7 = 6009.9

6.4 Estimate the Efforts

6.4.1 Constructive Cost Model COCOM0 Basic

Development mode: organic.

a=2.4, b=1.05, c=0.38

Number of thousand delivered source instructions= (KDSI) = ATFP* Language unit size/1000 = 6009.9/1000=6.0090

Effort in staff months =effort in man-moths=MM=a*KDSIb = 2.4*(6.0090^1.05) = 15.77

The development time=TDEV=2.5*MM^c = 2.5(15.77^0.38) = 6.99 $approx.7months$

6.4.2 jones's first -order effort estimation methods

We are building a shrink-wrap kind of software in an average organization.

Rough schedule estimation = ATFP$^e xp$ = $90^{\cdot}042$ = 6.61 7$months.$

6.4.3 Schedule rule of thumb

Schedule in months = 4.76 5 months

Chapter 7

References

1. M. Fairhurst, M. Erbilek and M. C. D. C. Abreu, "Exploring Gender Prediction from Iris Biometrics", International Conference of the Biometrics Special Interest Group (BIOSIG), pp. 1-11, 9-11 September, 2015, Darmstadt, Germany.

2. M. Da Costa-Abreu, M. Fairhurst, M. Erbilek, "Age predictive biometrics: predicting age from iris characteristics", Iris and Periocular Biometric Recognition, IET, Chap. 10, pp. 213- 234, 2017.

3. R. P. Wildes, "Iris recognition: an emerging biometric technology," in Proceedings of the IEEE, vol. 85, no. 9, pp. 1348-1363, Sept. 1997, doi: 10.1109/5.628669.

4. Bhattacharyya D., Das P., Bandyopadhyay S.K., Kim T. (2009) Feature Extraction for IRIS Recognition. In: Kim H., Kim T., Kiumi A. (eds) Advances in Security Technology. SecTech 2008. Communications in Computer and Information Science, vol 29. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-10240-0_3