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Course: Computer Science

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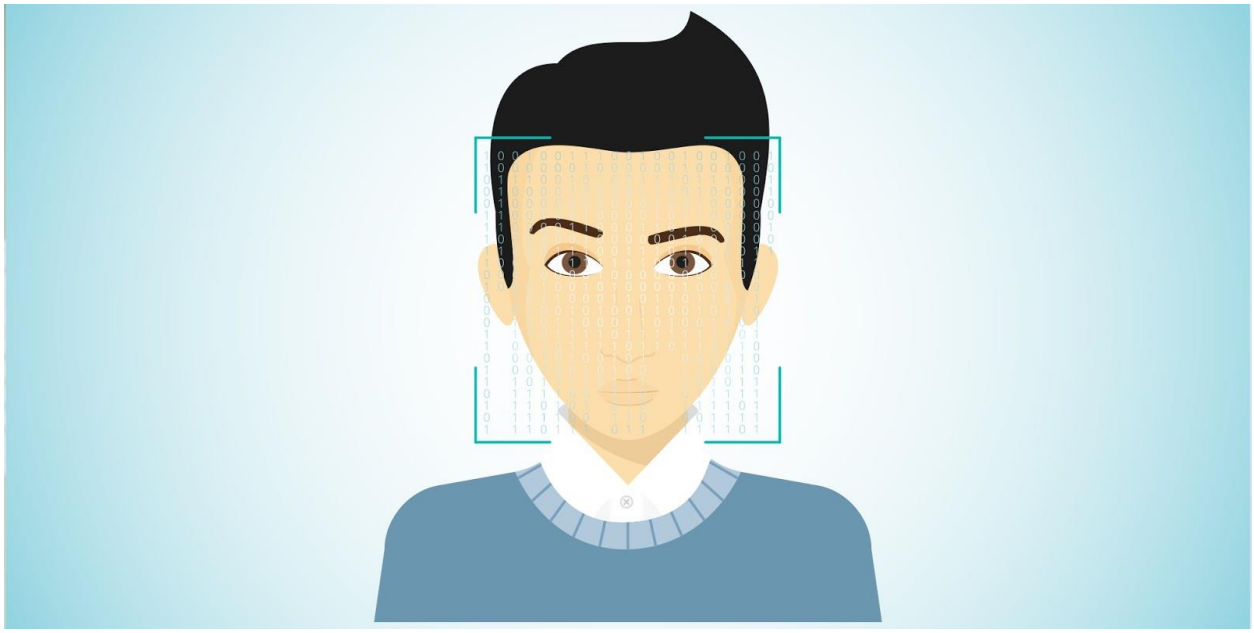
Project Title: Facial recognition system to automatically record attendance of Coventry University Students.



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Submitted in partial fulfilment of the requirements for the Degree of Bachelor of Computer Science

Academic Year: 2017/18

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Abstract

Face is an important part of a person, it is used to identify and differentiate identities of two or more individuals in real world. Different parts of the body have been exploited over the recent years, to ensure that only the legitimate individual has access to their respective accounts both in real world and in virtual. Different methods have been created, one being Biometrics, which consists identifiers such as Fingerprint, Palm veins, DNA, Palm print and Face recognition etc. Similarly, this project seeks to use one distinctive identifier of Biometrics, Face Recognition.

The project has created a working Automated Facial Recognition System for Coventry University and its students. With the use Open CV library through programming language, Microsoft Visual Studio C#, OpenCV consists of Voila and Jones machine learning algorithms for face detection and extraction, which is stored in built T-SQL Database built inside Microsoft Visual Studio. Object classifier called Eigen Object Detector, is used to match the faces detected with camera against the one stored in the SQL Database. The system is programmed fully with Microsoft Visual Studio 2017.

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

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

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Table of figures

Additional Materials on the Accompanying

Example of partial code are in the report because full code is of a large quantity and not possible to fit in the report, therefore the full code is available at:

Project's GitHub URL: https://github.com/AsisRai/Facial-Recognition-System-to-Automatically-record-attendance-of-Coventry-University-Students

Acknowledgements

I would like to take this opportunity to express my appreciation and deep regards to my supervisor Dr Dianabasi Nkantah, for his help and support throughout the project.

I would like to extend my thanks to the students of Coventry University, who agreed to participate in development of this project and also agreed to evaluate the system. I am very grateful to them as without them, this project would not have been possible to complete.

Finally, I'd like to thank my family, for their support and encouragement throughout my study.

1 Introduction

1.1 Project background

Being a student in Coventry University for 3 years, it has been difficult to record attendance. In first year, it was mainly paper-based attendance system. Second Year, a new card-based system was implemented which was slow at time and very buggy, in that event, paper-based attendance was used. Even after a year, the card-based system is still very slow at times, where it takes more than 4-5 seconds to record attendance.

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

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

1.2 Problem Statement / Motivation

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

1.3 Project Aim and Objectives

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

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

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

The objectives of the project are:

- Critically review the Literature Review
- Select appropriate software development life cycle methodology

- Analyse and Determine the requirements for the Automated Facial Recognition Attendance System
- Produce designs for the Automated Facial Recognition Attendance System
- Develop and Implement the Automated Facial Recognition Attendance System
- Test and Evaluate the Automated Facial Recognition Attendance System
- Determine possible future improvements/suggestions for the Automated Facial Recognition Attendance System

1.4 Overview of This Report

The report structure is shown below:

Section	Details
1. Introduction	Project background, Problem Statement, Project Aim & Objectives and Report Structure are discussed in this section.
2. Literature Review	Research on different types of attendance systems and their comparison, A Brief History of Semi-automate and Automated Attendance Systems using face recognition techniques, Face Recognition Steps & Techniques are all investigated and considered for requirements. Algorithms, Programming language and database selection is discussed and selected in this chapter as well.
3. Analysis & Requirements	This chapter discusses requirements gathering techniques, functional and non-functional requirements
4. Methodology	Methodologies have been investigated and chosen with justification.
5. Design	This chapter contains Interface design and Database design
6. Implementation	This chapter shows implementation of the system using Evolutionary prototype method, evaluated with requirements.
7. Testing	This chapter explains the test plan performed on the system to ensure the reliability and stability of the system. User Acceptance is also included here.
8. Evaluation	This chapter evaluates against functional and non-functional requirements. The project management and methodology are also evaluated.
9. Conclusion	This chapter has the summary of the entire project, summarising the aims and objectives of the project and suggesting future works.

2 Literature Review/Theory

2.1 Introduction

In this age of fast scientific and technological advancements, numerous inventions and innovations have been introduced to save time, manpower and economy and to increase the comfort level in people's lives. Managing student attendance is necessary and a vital task in all educational institutes for analyzing students' performance. Every educational institutes such as Coventry University, has its own procedure relating to this matter. Some take attendance by hand, utilizing the old paper or document-based approach and some have embraced automated methods for taking attendance. Automated Attendance System is an improvement in the field of computerization and has replaced conventional attendance taking methods in educational institutes. Conventional methods take a lot of time to take manual attendance of students, much more effort when the strength of students is in hundreds.

Mechanization of manual attendance system has proved much advantageous in terms of saving time and more secure. Students have little chance to fool the system, such as peers faking attendance for each other. Mechanized Attendance Systems are usually categorized into bio-metric based, smart card-based and web-based systems. Bio-metric methods are used mostly, for attendance systems. Each biometric framework comprises of enrolment process, in which characteristics of an individual are accumulated in databases for storage. After storing the features, identification and verification processes take place. It has played a vital role in improving the quality of education in institutes and students.

In this literature review, different types of automated attendance systems are explained and critically evaluated. More research is applied with the best approach to find out the steps and approaches used by that method and how the system is implemented in computers. Overall, the review has been divided as three parts. First section deals with different types of automated management systems to find, if Face Recognition system is the most efficient. The second section puts light on a brief history of semi-automated and automated attendance management systems. The third section explains different types of facial recognition techniques and the procedures in the attendance management system to find out what kind of algorithms are used, and procedures are used. Based on these findings, research on a programing language, database and algorithms are performed.

2.2 Different types of attendance management system and their comparison

While advancement towards the computerized period is made each hour, biometrics innovations have started to influence individuals' day to day life to an ever-increasing extent. Biometrics advances check personality through attributes, for example, fingerprints, faces, irises, retinal examples, palm prints, voice, written by hand marks, etc. These procedures, which utilize physical information, are getting consideration as an individual verification strategy that is more helpful than traditional techniques, for example, a secret key or ID cards. The biometric individual validation utilizes information taken from measurements. Such information is novel to the individual and remains so for the duration of one's life.

Biometrics is the programmed recognition of a man, using perceiving qualities. These days, in the mechanized verification process, numerous biometric procedures are being used in different markets. Biometric advancements empower programmed individual acknowledgement in the light of behavioral or physiological attributes. Different biometric techniques have been presented in the image below.

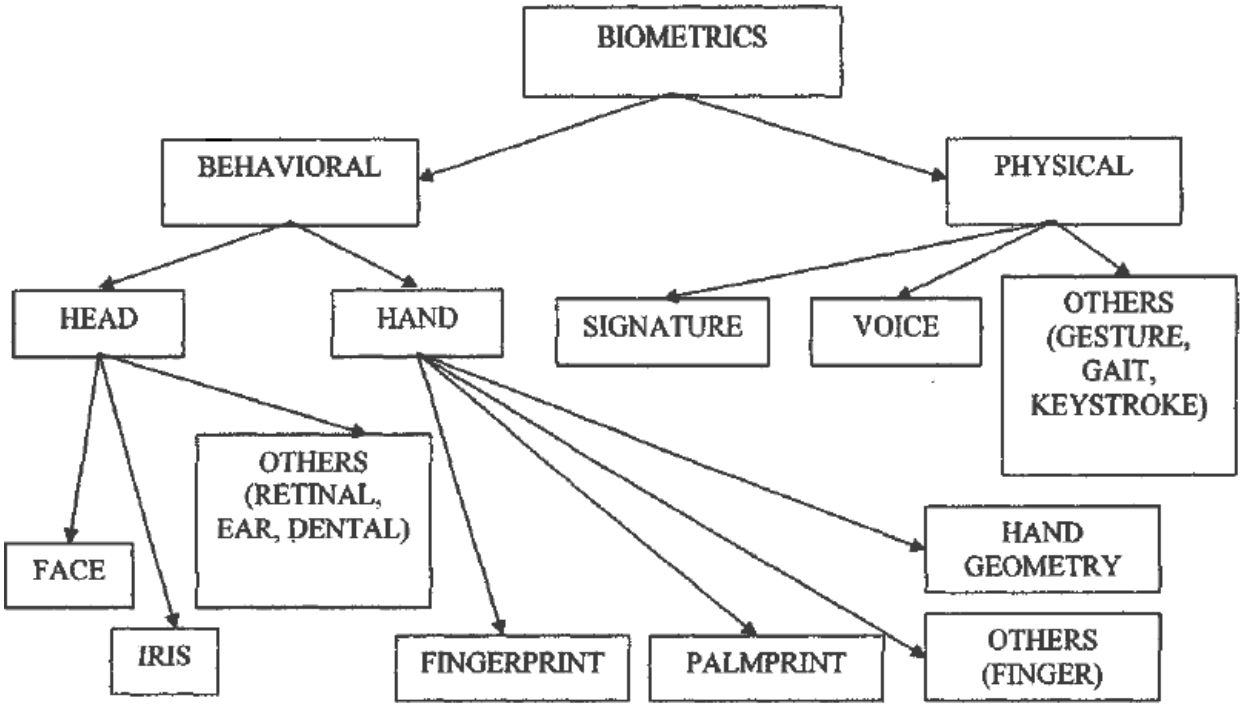

Figure 1 - Types of Biometric Techniques, (Unnati A. Patel, 2014)

Without a programmed time and attendance system, organizations lose profitability, overpay workers, and wind up occupied by the manual undertakings of time and participation. Following are some types of modern attendance management system.

2.2.1 Computerized Based Attendance Systems

In 2008, Nucleus Research proposed the utilization of a modernized attendance framework, which can minimize human contribution, human information entry error and tedious work. This framework would build efficiency, decreased finance blunder, and lessened finance expansion, diminish extra time, the evacuation of heritage frameworks, elimination of paper expenses, and which can give every one of the reports on request. However, this system has a serious drawback. Personnel need to take participation physically, only these records must be introduced into the computerized framework. So, there is still a chance of human error while entering data. The participation enlistment is finished by clicking a checkbox beside the name of the students that are attending the class, and after that, an enlist button is clicked to stamp their attendance

Another similar program was proposed. However, for this situation, the students should enlist separately utilizing a client-server attachment program from their respective device (M. Mattam, 2012). Although the attendance of the students is saved easily, both the projects need a lot of time and there could be strong chances of human error.

2.2.2 Fingerprint Recognition Based Attendance System

(Basheer, 2012), invented a fingerprint device that is being used in fingerprint attendance administration. Students' attendance is marked when they place their fingers on the fingerprint device.

The system consists of:

- A handheld gadget which was developed and controlled by the microcontroller. Its components include Real Time Clock RTC, Graphic Liquid Crystal Display GLCD, finger module, buttons, Memory etc.
- Host PC with GUI application for dealing with participation, the application is utilized to exchange students' information to the appliance. The participation details can be achieved through USB interface and lastly store into the database (Basheer, 2012)

The main problem with this system, is that the students have to stand in a long queue for marking their attendance via fingerprint device. The system is also faulty and could run out of order if there is an interference with device.

In 2012, (R, 2012) presented a system that took fingerprint as an input, used novel fingerprint reconstruction algorithm then further processed fingerprints for attendance management system. The procedure includes Pre-preparing, Minutiae Extraction, Reconstruction, Fingerprint identification, Report development. But still, the problem of long queues and long waiting was not solved.

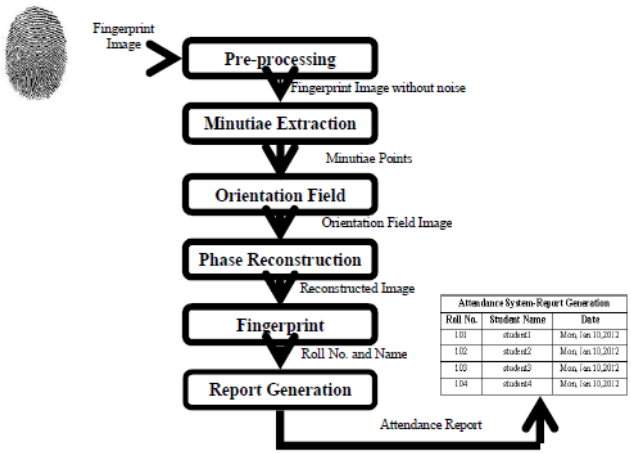

Figure 2 : System Architecture, (R, 2012)

In 2013, another framework was proposed for student attendance utilizing unique finger impression. In this framework, verification is finished utilizing extraction of minutiae method and the framework robotizes the entire procedure of taking participation. For taking attendance, one fingerprint template is compared with all fingerprint patterns stored in the databases. Although this system was better, yet it also had additional time issues because comparing of the fingerprint with all the patterns in the database is a very time-consuming process. (Unnati A. Patel, 2014)

Time-consuing problem was solved by another system, by the partition of databases while comparing the fingerprint with the stored templates in databases (Neha Verma, 2013). But still, the problem had the faults as students had to wait in queues for their attendance and fingerprint identification.

2.2.3 Bluetooth Based Attendance System

In 2013, a new attendance system based on Bluetooth technology was proposed. In this method, the instructor used his mobile phone to take students' attendance (Vishal Bhalla, 2013).The attendance software is installed in lecturer's cell phone, this facilitates to understudy's cell phone by means of Bluetooth connection and through the exchange of the pupils' cell phone Media Access Control (MAC) addresses to the lecturer's cell phone, this way the attendance of the students can be checked.

Serious issues are present in this attendance systems. This system requires the use of mobiles. Not everystudent has a acces to a mobile phone, some students are way wonger to have one. Students may also give their mobile to their friends for attendance marking while not attending the institue. This means that presence of student's mobile is important rather than the presence of students.

2.2.4 NFC Technology Based Attendance System

NFC technology is a modern era technology that has been solving many daily life problems. Close Field Communication (NFC) is a model of connection that is short-ranged and utilizes magnetic forces of attraction and its field acceptance to implement communication between electronic devices when they're touched together, or brought near to each other (Strommer, 2009).

Attendance Management System based on NFC technology and fingerprint technology has been implemented in a multi-user situation. In this procedure, the lecturer uses fingerprint and Bluetooth address of the NFC enabled phone of the student to identify them and mark their attendance. A desktop application receives ID's of NFC tags and related data from the user's phone and further analyze the data to authenticate their presence. But chances of survival of this system are not too bright in the future because this methodology also requires the presence of user's mobile phone and not the students to mark their attendance.

2.2.5 Iris Based Attendance System

The iris-based system was proposed by the Seifedine Kadry and Mohamad Smaili in 2010 (Unnati A. Patel, 2014). The iris acknowledgement process starts with picture capturing. Picture securing is a procedure which manages the catching of pictures of the iris with the assistance of a digital camera.

It is desirable to secure pictures of the iris with adequate resolution and sharpness to help acknowledgement. It is basic to have great complexity inside the iris design with no diversion in the picture. The Daugman arrangement of iris acknowledgement is broadly utilized, which catches pictures with iris distance across ordinarily, vicinity of 100 and 200 pixels from a separation of 46 cm utilizing a 330-mm lens (Prashik S. Bhagat, 2015).

The process is followed by localization of iris and template matching (Unnati A. Patel, 2014). It is an acknowledgement towards perceiving a man by the investigation of the arbitrary pattern of iris. Iris scan utilizes the unique characteristics of iris in the human eye to authenticate a person. The pigmented or shaded circles are dark coloured and blue normally which is only the iris region of the eye. This procedure happens only in two seconds, which gives the details of the iris that are accumulated for future confirmation. This strategy is thought to be one of the protected, fastest and most precise biometric advances. This is also being used in attendance management system.

Since it is a relatively new technology, it is very costly. Iris is a very small part of the eye, so the student must be placed near to the camera for correct authentication. The reflection of lashes, glasses and contact lenses cannot make an iris-based system to correctly analyze a person. Also, the long queue issue of students is not solved in this methodology.

2.2.6 Mobile oriented Attendance System

A framework was attempted to be implemented which defeats the impediments of the other approaches by taking the participation through instructor's cell phones. Doing similar work with a cell phone would save assets as well as empowers the clients to get simple and intuitive access to the attendance records of the students. This system is practised just on S60 Symbian stage. Therefore, all Symbian based cell phones are practicable by this framework. The disadvantage of the framework is an instructor must have S60 Symbian stage and again, human association for participation tracking must be there.

The student data tracking structure was created in Android OS to oversee students' participation on mobile (Opoku, 2017). This framework enables instructors to take attendance, alter attendance, see students who are absent, send essential archives in pdf formats. For example, exam time table, question bank etc. Furthermore, Educators can advise understudies about the occasions that institute could organize. The framework is not dependent on mobiles, it be introduced on any device which has android OS. The issue of the framework is that it is only created on for the Android OS, so it cannot be installed on iOS and other portable OS'. In addition, it is exceptionally tedious for lecturers, to mark attendance on mobile phone. This would be very time consuming taking a long time to take attendance, giving less time for the important stage which is to accommodate to the actual lecture and learning objectives for the students.

2.2.7 RFID oriented Attendance System

An innovation that could solve the attendance issues and even accomplish more is RFID innovation. RFID is a computerized recognition and information compilation innovation, that guarantees more precise and convenient information entry. RFID became popular because of its minimal investment and advances in other figuring fields that opened more application zones.

RFID consolidates radio recurrence and microchip innovations to make a savvy framework that can be utilized to distinguish, screen, secure and does objects stock (OT Arulogun, 2013). At their most straightforward, RFID systems use small chips called ―tags that contain and transfer some bit of recognizing data to an RFID reader, a gadget that in turn can form an alliance with PCs (Dawes, 2004).

A framework established on RFID innovation can send SMS and email alerts to guardians/gatekeepers of students consequently. Student must enrol at the entryway by touching RFID gadget with their RFID tag and send the information to BISAM server stored inside institutes. The server will process the participation information and send a notiftifaction such as, SMS text, to the guardians of the missing student, in the event when students go missing, through BISAM SMS portal server.

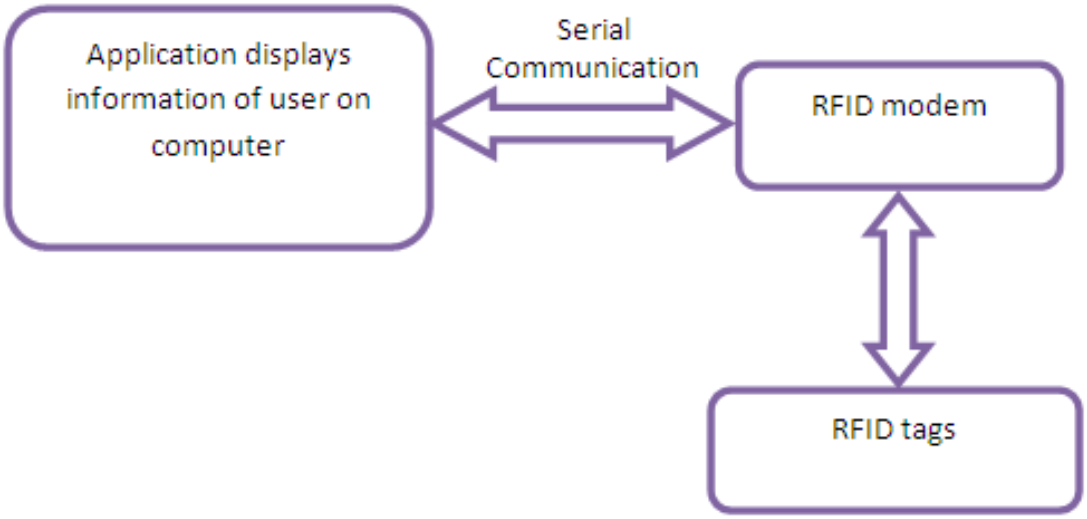

Figure 3 - System Functioning, (Choudhary, 2011)

RFID pursuer is devised with a microcontroller, transceiver chip, control supply module, serial correspondence LCD, IC, USB interface, and so on as segments. At the point when a staff part touches the pursuer with their card, the information is sent to PC manager application which will approve the information and concentrate data like staff ID and admittance time into the database (W. N. Liu, 2010)

A system is made with the theory discussed above by (Choudhary, 2011). RFID terminal read the student ID, date and time. The data is stored on online servers. Although this system is much better than the previous systems explained, it has a drawback, it does not contain verification algorithm, so proxy can easy be marked and students do not necessarily need to take the class, therefore giving false/unreliable attendance of students.

2.2.8 Face Recognition Oriented Attendance System

In this procedure, attendance is taken by making use of one of the most efficient bio-metric technique i.e. face recognition. In most of the situations in educational institutes, the students sit at a distance from the lecturers.

A technique was introduced which facilities student attendance from their seats (BEHARA, 2013). The model is developed with Open CV library which consists of machine learning algorithms. One of which contains, Voila and Jones algorithm. It is the best-suggested algorithm for face detection. It has Linear stretch contrast enhancement further processes the image and finally using PCA/LDA algorithms, the image is recognized. After the procedure is completed, the students ’attendance is marked along with date and time.

Further advancements include a CCTV camera which is placed on the entrance of the room, which instantly captures the pictures of students and after processing, compare it with facial templates in the databases (MuthuKalyani., 2013).
It has two basic purposes. First to take attendance of the students and to recognize the people who are unknown i.e. strangers. A 3D technology has also been introduced for better face recognition at different angles.

Looking at all the systems available for attendance management system, face recognition is the ideal to use because it's more effective than other systems available. It saves students from standing in long queues, this valuable time as student can go to the classroom and they will be marked, this allows the students to continue to focus on the session that they are in without having to worry about not being marked in because of forgotten card or forgetting to sign in. This always allows the lecturer to start their content as soon as the students arrive in the classroom, which allows the lecturers more time to deliver the learning objectives to the students effectively.

2.3 A Brief History of Semi-automate and Automated Attendance Systems using face recognition techniques

Facial recognition techniques were first practically used in 1960's using semi-automated systems (Kar, 2012). It used ear, eye, nose and mouth's features. To locate major features, dots were drawn on the images. In the early 1970's Goldstein, Harmon and Lesk arranged 21 subjective markers, for example, hair shading and lip thickness. The measurements were taken by hands. Fisher and Elschlager measured different face areas and located them on a global impression. But still, these features were not enough to recognize and personify a face (M.A. Fischler, 1973). Another approach is the Connectionist approach, which tries to group the human face utilizing a blend of both scopes of signals and an arrangement of distinguishing markers. This is typically executed utilizing 2-dimensional pattern acknowledgement and neural net standards. In the 2000's, many scientists used the eigenface approach for facial recognition. Kirby and Sirovich introduced this method at Brown University in 1988. The strategy works by dissecting face pictures and processing eigenface which are faces made of eigenvectors. The examination of eigenface is used to distinguish the presence of a face and its personality. Turk and Pentland also introduced a system in which recognition consisted of five steps process (Y. Cui et al, 1992).

2.4 Face Recognition Steps & Techniques

Usually, two steps are included in facial recognition. At first, detection occurs and then compared with the databases for verification happens (Kar, 2012)Face as a biometric feature was less reliable due to variations in illumination conditions, poses, and expressions. 3D facial recognition methods resolved the reliability issues like pose change and lighting. With the advancement of technology, different techniques improved the situation and face became a more secure biometric feature as compared to other characteristics e.g fingerprint etc. Following image explains different facial recognition techniques:

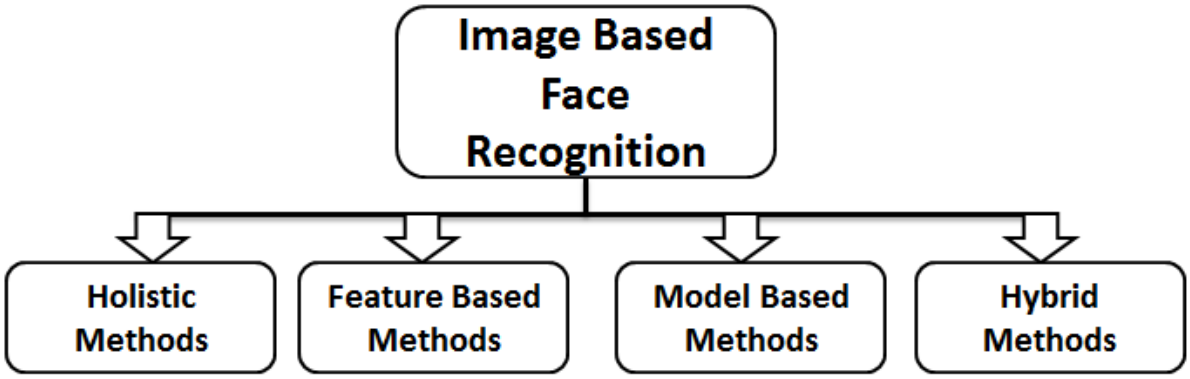

Figure 4 - Types of face recognition systems, (Qureshi, 2015)

2.4.1 Holistic Approach

In this approach, the entire face is considered as a solitary feature for identification and acknowledgement. It analyzes the similarities of the entire face, overlooking individual highlights like eyes, mouth, nose etc. These schemes are portrayed into two sections as appeared in the figure (Qureshi, 2015).

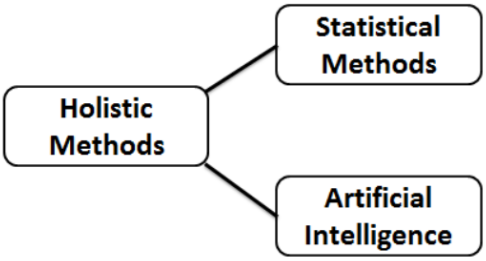

Figure 5 - Types of Holistic methods

2.4.1.1 Statistical Method

The face picture density is computed, density set qualities are compared with the values of database pictures. This calculation is extremely costly and specifically enduring under the standard holes pathways, for example, orientation of face scaling and lightings. To adapt to the issue of measurements, it has been recommended that numerous different diagrams, utilizing approaches to lessen the size and measurably remain ahead of the most evident dimensions before recognition performance. Some of them are as per the following, Sirovich and Kirby were first to get the advantage of PCA monetarily for representing face pictures. They depict facial pictures. They demonstrated that in specific PCA can viably represent time, Eigen pictures coordinate space and that every region can modernize with just little photographs, claim accumulation and suitable desires with every Eigen picture. Turk and Pentland enhanced the performance of the system and explained “Multiple Observer” to solve the problems in pose changes. Hashtag technique is another technique used for rapid face recognition (Moghaddam, 1994).

2.3.1.2 Artificial Intelligence Technique

Manmade brainpower technique with devices, for example, neural systems, consequently perceives the characteristics of learning procedures. Samaria and Harter connected one-dimensional HMM and observed 87% exactness rate on ORL database (F. S. Samaria, 1994) Sharif M and his co-researchers delivered a survey on HMM, Eigenface, geometric based and format coordinating methodology. Nefian and Hayes III using the same database observed 98% correct face recognition and claimed it to be better than that of Samaria (Muhammad Sharif, 2012).

2.4.2 Feature Based Technique

Inverse to the holistic approach, features based approach consider every individual element of the face: eyes, nose, mouth, mole, ears and match the similarities between the pictures. Another approach in face recognition encompasses, recognition with methods for hexagonal feature location. The approach takes a shot at the bases of edge location for face location and recognition utilizing the hexagonal facial feature (Muhammad Sharif, 2012). Heuristic parameters centre around the nose segment of the collected pictures followed by grey scale changes and change of intensity. Another research work in which the face acknowledgement is finished by the assistance of edge data refined by the assistance of diminished sample size. The shading highlight in case of HSV shading space of the pictures of the facial segment is considered. The skin areas are recognized utilizing the shade and immersion characteristics. Skin highlight of the face is utilized as a part of piece approach, this examination system utilizes the procedures like piece approach and the RGB shading space. Gabor filter is used to extract the features.

2.4.3 Technique based on Models

Model-based feature acknowledgement is another approach. The 3D facial model can be procured utilizing both dynamic and inactive means (W. Zhao, 2000). The extensively utilized active 3D picture procurement technique is infrared information, which ventures laser beam onto an object and records its appearance coming about best and exact 3D model's recognition (Athinodoros S. Georghiades, 2001). Stereo Imaging is the procedure for the securing of the 3D show, in which at least two cameras at the same time are catching a scene from various points. Clear data is procured utilizing different data from various angles. 3D to 2D confronting acknowledgement that the technique is displayed, utilizing SRC and CCA for acknowledgement, outcome demonstrating a better performance with low computational cost (Huang D., 2010). Another model "Partner Predict" (AP) was presented abolish to posture, light and impression variations. AP technique adequately dealt with the individual variations (Yin Q., 2011). A discriminative model was presented to reduce age heterogeneity issues in confront acknowledgement, utilizing scale-invariant feature transform (SIFT) and multi-scale neighborhood binary patterns for restricted descriptors and presented multi-features discriminant analysis (MFDA) algorithm to compare down the local descriptors, outcomes were facial acknowledgement development in the influence of ageing (Wong Y., 2011).

2.4.4 Hybrid Approach

Hybrid methodologies are considered as the best techniques for face recognition. The advanced hybrid methods for face acknowledgement is Eigen-based facial acknowledgement. Face acknowledgement by methods for utilizing the nose tip is the principal trait of facial extraction

stage. At that point, a crossover 3D display is utilized for the acknowledgement reason (Sharif M. et al., 2011). An exploration work is done on the face acknowledgement with the assistance of the Gabor filter approach and the normalization method. With the blend of holistic and feature-based, a hybrid technique was proposed utilizing Markov Random Field, in which facial pictures were partitioned into patches. The IDs were distributed and analyzed utilizing BP calculation (Huang R., Pavlovic V. and Metaxas D. N., 2004). Spreeuwers L. introduced presented a much efficient face recognition technique in his research paper in 2011 which utilized premise directions of nose tip, its incline and combination of various area classifier with the 3D confront classifier. Outcomes indicate 99% identification and 94.6% correct verification (Huang D., Ouji K., Ardabilian M., Wang Y. and Chen L., 2011). It proposed LSP descriptor to solve light and posture varieties problems. Advance SRC was connected to extricate 3D depth data. Shading picture utilized and the idea of tensor discriminant color space (TDCS), was presented in 2D quick Face acknowledgement approach in view of wavelet networks was proposed (Zaied M., 2011). Insensitive to noise and resolution invariant-based method was also presented (Y, 2011). Utilizing the sub-pattern procedure, another innovative face acknowledgement technique Sp-Tensor was introduced (Wang S.-J. et al., 2013). The recorded results of the Sp-Tensor were proved better than that of Tensor Face.

Many techniques have been researched and practised for facial recognition, but hybrid technologies have been proved best to date and most researched. These facial recognition techniques are applied and used in different biometric systems used for taking attendance of students in classrooms.

2.4.4.1 Enlistment & Interpretation of Hybrid techniques into Biometric Systems

The first phase of each biometric framework is the enrolment of people who are utilizing data and their biometric included as layouts (Lijuan Duan et al, 2002). The process includes image capture, enhancements and then extraction of the features. The framework comprises a camera that catches the pictures of the classroom and sends it to the picture improvement module. After that, the processes of detection and recognition take place and then students' presence is marked on the database server.

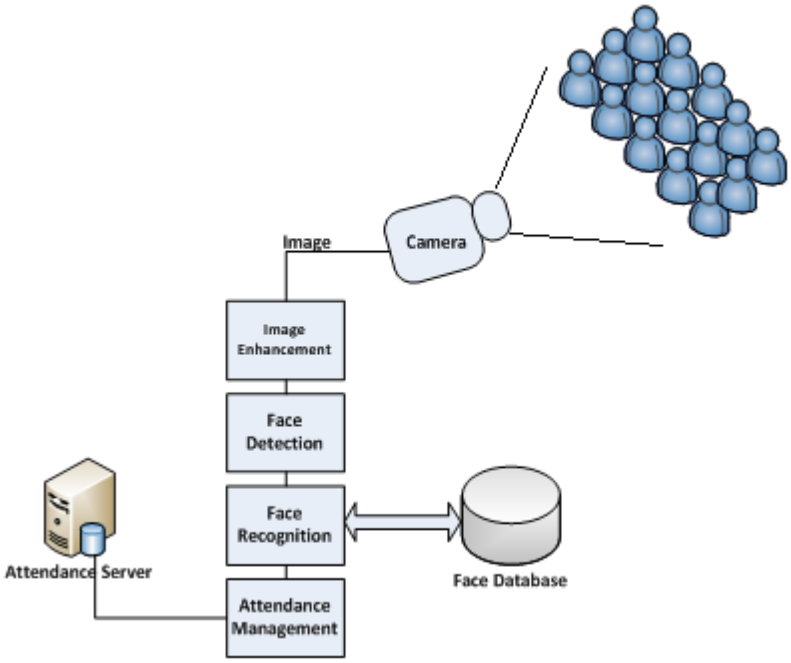

Figure 6 - Experimental arrangement, (Naveed K. Baloch et al., 2012)

During enlistment of the face, pictures of individual understudies are stockpiled in the Face database. Each image is then recognized from the input picture and the algorithm analyses them one by one. This methodology utilizes a protocol for taking attendance. A timetable module is connected to the framework which consequently gets the subject, class, date and time. Instructors come into the class and simply press a button to begin the participation procedure. The system then naturally gets the participation without even the expectations of pupils and instructor. This is very economical as a lot of time is saved, ensuring high security because no one can mark attendance of any other absent student, making the system fool proof. Attendance is saved in the databases and servers and can be used when required e.g. for examinations, administration and for report purposes. Images are continuously clicked to check the presence of students during the entire time of the lectures. This prevents students from leaving the class earlier. Skin classification technique is also used to avoid false detection. This technique increases the accuracy of facial recognition and minimizes the rate of false detection. The setup usually consists of two different databases. In the first database, images are stored while the second database comprises of the information related to the teachers, students and the other administrative data (S. Chintalapati and M.V. Raghunadh, 2013).

2.4.4.1.1 Procedures

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

1. Obtaining the images
2. Detection of face
3. Turbulence removal/pre-processing
4. Development of the databases
5. Face recognition and analysis
6. Attendance

The following image depicts different steps in automated attendance management system (Shireesha Chintalapati, M.V. Raghunadh, 2013).

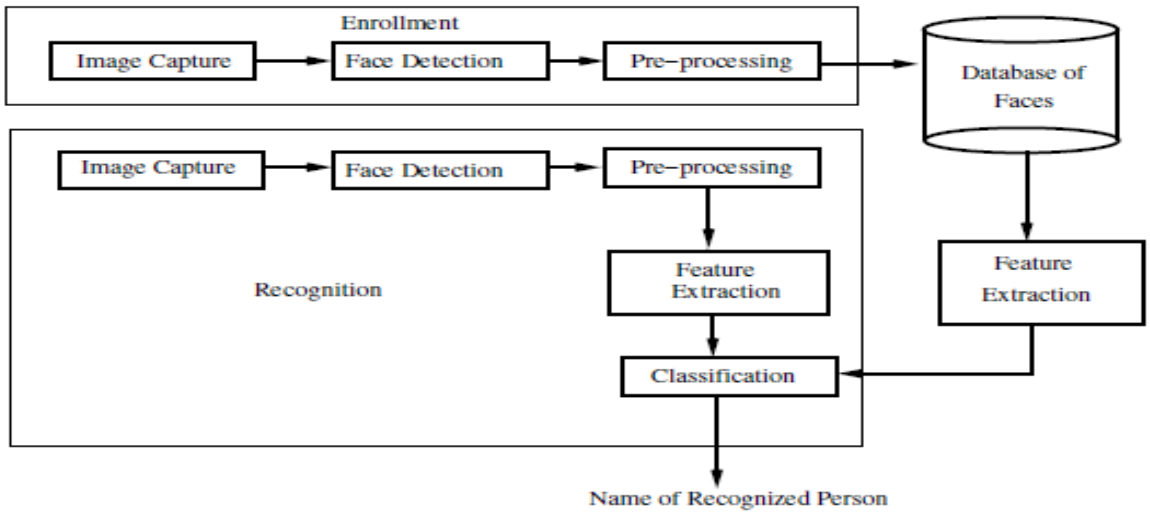

Figure 7 - System Architecture

2.4.1.1.1 Obtaining the images

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

2.4.1.1.2 Detection of Faces

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

2.4.1.1.3 Pre-processing

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

2.4.1.1.4 Database Development

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

2.4.1.1.5 Face Recognition & Analysis

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

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

Figure 8 - Comparison of different holistic algorithms, (Shireesha Chintalapati, M.V. Raghunadh, 2013).

Principal Component Analysis (PCA) was the first algorithm that was introduced to represent faces closely. In PCA the face pictures are expressed utilizing eigenfaces and their relating projections along each eigenface. Rather than utilizing all the dimensions of a picture, just important measurements are considered to represent the picture. Scientifically a picture utilizing PCA is expressed as:

$$x= WY + \mu$$

In this equation, x represents face vector, W is feature vector, Y represents a vector of eigenfaces and μ symbolizes the average face vector. These projections (feature vectors) are then utilized as classification includes in face acknowledgement. Later FisherâĂŹs Linear Discriminant Analysis (LDA) was proposed, in which the proportion of between-class dissipate, and inside-class scramble amplifies. PCA does not consider the discriminative data in the information though LDA stores the discriminative data in the information. LDA does not work effectively in poor conditions of light. Nearby Binary Pattern Histogram (LBPH) is as of late proposed algorithm for face highlight extraction. In this technique, LBP picture is portioned into local areas and the histogram of each is extricated and are connected to create a face descriptor. The precision of a system actualized utilizing PCA and LDA are influenced by the size of the database which isn't the situation in LBP. PCA is utilized for characters extraction and Support Vector Machine (SVM) is utilized for the classification. SVM is as of late proposed algorithm which is a compelling example grouping algorithm. For design acknowledgement SVM finds the ideal partition of nearest focus points in the training set. This partition should be possible straightly or non-linearly.

Face recognition consists of two procedures, extraction followed by classification. The previously mentioned highlight extractors joined with classifiers are thought about in different true situations, for example, lighting conditions, Unintentional facial component changes

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

2.4.1.1.6 Attendance

In biometric framework, the names are refreshed into an exceed expectations sheet. Towards the end of the class an arrangement to declare the names of all understudies who are available in the class is additionally included (Raghu, 2012).

2.5 Conclusion

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

2.6 Algorithms for Face Detection, Extraction and Matching

2.6.1 OpenCV Library

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

The OpenCV Library includes Viola and Jones, which from literature review, it is knows as one of the best algorithms for face detection and extraction algorithm. It also includes Eigen Object Detector which will be can be used to match the faces stored in the database against the face from camera.

2.7 Programming Language & Database

Programming language chosen to implement the algorithms is C#, which comes built in with Microsoft Visual Studio. tis is used as an integrated software development environment, used to develop computer programs for Microsoft Windows, as well as web sites, web applications and web services.

Reason for this choosing is that the component of Microsoft video Studio includes built-in tools include a forms designer for building GUI applications and Local Database built in. LocalDB is created specifically for developers. It is very easy to install and requires no management, yet it offers the same T-SQL language, programming surface and client-side providers as the regular SQL Server Express. In effect the developers that target SQL Server no longer have to install and manage a full instance of SQL Server Express on their laptops and other development machine. (Nixon, 2018)

3 Analysis & Requirements

3.1 Introduction

To determine the requirements for the project, the first step is to analyse the initial idea. Series of meetings were held with the supervisor, to determine the steps for the project and finalise the requirements. The initial idea of creating an Automated Facial Recognition Attendance system for Coventry University was proposed. This was done through a project proposal. The proposal was discussed and analysed to determine the requirements for the project. Due to the nature of the project and the data being used, it was advised to carry out, Risk Management Analysis and Ethical Analysis.

3.2 Analysis

3.2.1 Meetings

To analyse the requirements for the project, series of meetings were held between myself and the supervisor. From the meetings, several ideas were suggested, by the supervisor for myself to consider further details. The final outcome of the project was to be an Automated Attendance system using Facial Recognition techniques, therefore the supervisor suggested to look into Image Processing and Machine learning algorithms to process the images and detection of faces in real-time, Databases which are appropriate for the storage and generation of data by the application and suitable programming languages which were able to handle connections to be chosen database and it's dataset, algorithms which could handle the machine learning algorithms., either to be coded or imported. This can be found in Appendix I.

The result of these meetings, lead to an initial proposal for the project. The proposal stated an application was to be created that would be able to take Attendance of Coventry University students, automatically with Facial Recognition system.

3.2.2 Proposal Analysis

To determine the requirements, the initial project proposal was analysed. This helped produced a series of Functional and Non-Functional requirements. The requirements were determined using FURPS – Functional, Usability, Reliability, Performance and Security. FURPS is a model for classifying software quality attributes. The requirements were partially implied in the proposal but since both Functional & Non-Functional requirements are necessary for the application to be successful, it was advised to look into it further.

After the completion of the system, a questionnaire is handed out to a range of students who participated in creation of the system, to gather their feedback and update the system based on the suggestions. This will also help to know if the system is the right implemented solution to the problem identified.

3.2.3 Research

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

3.3 Requirements Summary

3.3.1 Functional Requirements

Looking at all the research results, the functional requirements for the were determined. These are the requirements that deal directly with the functionality of the application. The functionality requirements can be seen in Table 1: Functional Requirements.

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

Table 1 : Functional Requirements

3.3.2 Non-Functional Requirements

The Non-Functional requirements do no directly deal with the functionality of the system. The Non-Functional requirements can be seen in Table 2: Non-Functional Requirements.

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

NF4	**The application must handle the events of all forms**	High

Table 2 : Non-Functional Requirements

3.3.3 Ethics

Since the system deals with sensitive data of Coventry University students, there needs to be ethical considerations that had to be made. The initial ethical concern was that since it is not ethical to capture live pictures of students without their consent, it was decided only a handful of participants would volunteer to participate in creation of the system, to test the system and to review the system. Therefore, a participant leaflet was created so that, the students who volunteer to participate in the project know exactly what data will be stored of them and they have every right to reject or change their mind if they wish to.

This participant leaflet can be found in Appendix C – Participant Leaflet. To give their consent of holding their data and promise of deletion of their sensitive data, Participant consent form was created, this can be found in Appendix D – Participant Consent Form. A short review of short description of ethical consideration was submitted to Coventry Ethics board, this can be found in Appendix B – Ethics Approval.

4 Methodology

4.1 Introduction

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

4.2 Life Cycles

4.2.1 Waterfall Model

The Waterfall model is where the progress of the software development flows downwards like a waterfall from task to task. There are six stages in this lifecycle. (Powell-Morse, 2018)

- Requirements – This is the first phase, where the potential requirements are collected, analyzed and written down, this will help in the future development of the project. The results are typically written down in a Requirement document.
- Analysis – This is the second stage, and, in this stage, the system is analyzed to know what kind of models and business logic is appropriate for the project.
- Design - This third stage covers technical design requirements, to create a design specification to cover the implementation of the business layer.
- Coding - This is the stage where the actual source code is written to meet the requirements of implanting all models, business logic layers and service integrations.
- Testing – In this stage, the system is tested to discover and report issues, so that they can be solved. If any issues found, then the coding stage is visited again to fix the issue in the code.
- Maintenance/Operations – Only when the testing stage is fully completed, the system is then ready to be deployed. This stage is the stage of deployment of the system and maintaining the system so that it can be up-to-date and functional.

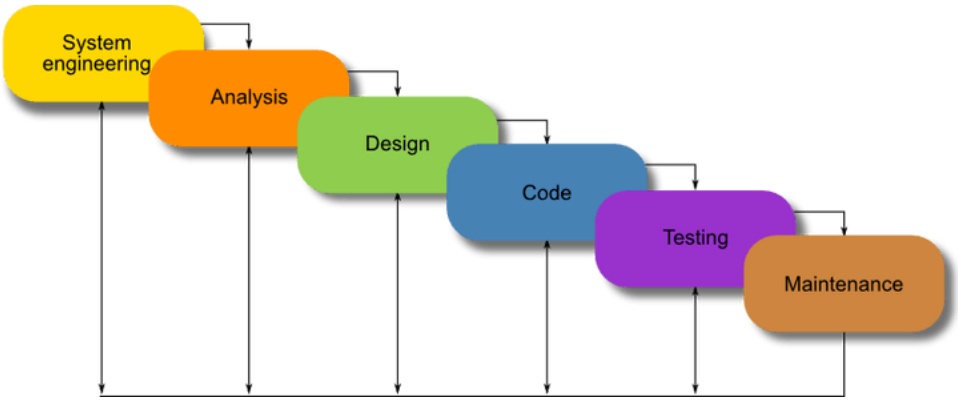

Figure 9 - Waterfall Model

The advantages waterfall model to the project:

- The waterfall model maintains the project to be detailed with robust scope and design structure because of the early planning stages which are detailed documented. This means that the project will rely heavily in core planning and documentation.

- The waterfall model forces projects to be heavily disciplined with design and structure, which includes detailed design procedures from design layer, all the way to implementation.
- The waterfall allows early design changes, by gathering specification at early stages and changes can be made well early in the life-cycle because coding and implementation only takes places after the requirements specification is finalized. This could the project a lot of time.

The disadvantages of Waterfall Model to the project:

- The Waterfall Model ignores feedbacks in mid-stages because flowing downwards from task to task. The feedbacks are also provided during the design development cycle and changes are requested during the design stage, then the project has to take a step back to make the changes, this can be costly and time-consuming for the project.
- The Waterfall Model's testing is done quite late in the life cycle. This means that design issues or code issues could be discovered very late in the life cycle because testing is only done after the coding stage is finished. This will be time-consuming and costly for the project.

4.2.2 Prototype Model

In Prototype Model, a throw-away prototype is built with potentially few features included to closely understand the requirements. The prototype is not the complete system because many of the features are not built in the prototype, it is simply a prototype of what the final system will look like so that the client/user can get close feel of the system before the final system is even built. (CERTIFICATION, 2018)

Figure 10 - Prototype Model

Advantages of Prototype Model to the project:

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

identified, as feedbacks from both supervisors and students will be regularly inputted in very prototype developed.

Disadvantages of Prototype Model to the project:

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

There are many more variations of Prototyping Model:

- Throwaway prototyping, this is prototype is developed and thrown away rather than being used as a model for the final system. This is to show the user/client, what the requirements would look like in the final system before it is implemented so that the user/client can approve or reject the prototype.
- Evolutionary Prototyping is where a robust prototyping is developed, and other prototypes are built upon that robust prototype as each requirement is fed by the user/client and implemented upon understanding.
- Incremental Prototyping is where separate prototypes are built and tested with the user/client to match the requirements, eventually at the end all prototypes are added together to create the final system.

4.2.3 Incremental Model

Incremental Model makes use of parts from the Waterfall Model & Prototype Model.
Incremental Model works in iterations. For example, in each iteration, a piece is incrementally designed, implemented and tested, when that iteration piece is satisfied, second iteration follows of other pieces fulfil the requirements and the final system. Demonstrated in Figure 11 – How Incremental Model Works.

Figure 11 - How Incremental Model Works

Advantages of Prototype Model to the project:

- Generate a working software in each iteration which means the modules of the system can be split into different iterations, such as Database creation, Face Recognition and Detection module and Interface. This could give greater flexible as the Harder ones can be iterated first, than the easier ones as they can be done in a short amount of time and finally at the end joined together.
- Testing is done in each piece that is incremented, therefore faults can be identified sooner than later in the cycle, this leaves fewer changes to be made between different iterations of the system. This will make it easier to test and debug, compared to other

two life cycles, as few changes are made in each increment leaving less iterations for the life cycle, saving time.

Disadvantages of Prototype Model to the project are problems with the system architecture as changes to the system are added which were not foreseen in the earlier increments. This model therefore requires detailed planning, design and a clear definition of the system before breaking down parts of the system to be incremented.

4.2.4 Justification of Chosen Lifecycle

The chosen lifecycle methodology to be followed by the system was Prototype Model. This methodology was chosen because it allows to work on different aspects of the system requirements separately, this allows to get feedbacks on different prototypes very quickly and allows changes to be made, so that the final system matches with the requirements specified. Furthermore, it also helps to see that the project schedule, Gantt chart (See Appendix A), is accurate and achievable.

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

5 Project Management

Project management is the art of planning, then executing on it.
Expectations needs to be managed, anticipate avoidable problems, and troubleshoot the ones that are not foreseen. (Atlassian, 2018). Project management has several principles that could help development of the project.

5.1 Milestones

milestone is a special event that requires special attention. Milestones can add significant value to project scheduling. They help projects accurately determine whether or not the project is on schedule. (KATCHEROVSKI, 2018). Milestones are not achieved if the project is not going according to plan and falling behind schedule, this means the pre-define milestones goals are not being achieved.

Milestone principle works by creating a parent task, containing all other sub-tasks, which are required to complete a certain objective. Like in the project, Literature review is to be completed before February, which is a milestone as shown in Appendix A.

5.2 Measurability

One of the most challenging aspects of a project is measuring the objectives. If the objective cannot be measured, it needs to be rewritten so that it can be measured and tracked for successful completion. The only way to do this is to make sure qualitative and quantitative components are set.

Qualitative measurements measure a project based on quality standards, quality indicators, or quality characteristics. Each of these can be prioritized and broken down into different segments, such as improvement needed for the project with acceptance testing with the students, the feedback can be used to improve the system further to match the quality standards.

Quantitative measurements measure the project based on numerical indicators. Two indicators are process time, and development progress in the project, Gantt chart is used as an indicator to see the broken-down tasks and their completion time, shown in Appendix A. (Mathis, 2018)

5.3 Risk Management

Risk management is a process that allows individual risk events and overall risk to be understood and managed proactively, optimising success by minimising threats and maximising opportunities. (Management), 2018). Therefore, the risks are identified, managed and optimised in the Table below. It deals with all the potential risks that could arise during the project, their probability, impact, effect of the impact and potential solution.

No.	Risk	Probability	Impact	Effect of Impact	Solution
1.	Poor capture of full requirements	Medium	High	Failing to meet the minimum requirements and make the wrong artifact	Focus on the requirements early on the project and ensure that

					the requirements are validated with the supervisor
2.	Changes of requirements	Low	High	It will need changes in the design and schedule	Make sure that the requirements are regularly discussed with supervisor
3.	Poor Planning	Medium	High	Miss deadlines because other projects and coursework would add the workload	Plan every part of the project by ensuring that requirements are always met and not changed as often
4.	Coding Issue	High	High	Takes time to debug, needs research to solve the issue	Look online or Ask supervisor for help, who can direct to the right department, who can help
5.	Loss of Work because of Hardware failure	High	High	Unable to deliver the system	Project is started with GitHub and regularly committed
6.	Software Failure	Low	Low	Delay work as everything needs to be re-installed	Update software regularly
7.	System full of bugs	Low	High	Can cause delay in completion of the system as the bugs needs to be debugged	Crate an extensive test plan
8.	Design not meeting the requirements	Medium	Low	System won't do, what it was supposed to	Test the design against the requirements
9.	Poor user	Medium	Low	Students might dislike the	Test the

	Interface			system and give negative reviews	prototype with students, improve interface based on the feedback received

5.4 Time Management

Time is very congested in Final year, as more there are more coursework, exam and lectures. A Gantt chart is provided planned and provided in Appendix A.1 for the overview of the project. As for Time Management, daily schedule is created to follow, therefore time is not wasted.

	Monday	Tuesday	Wednesday	Thursday	Friday
9.am	Dissertation	380CT Lecture		380CT Work	Dissertation
10.am	Dissertation	380CT Lecture	Dissertation	Dissertation	Dissertation
11.am	Dissertation	380CT Lecture	Dissertation	Dissertation	Dissertation
12.pm	Dissertation	Dissertation	380CT Work	Dissertation	380CT Work
1.pm	380CT Lab	Dissertation	380CT Work	Dissertation	300COM Lecture
2.pm	380CT Lab	Dissertation	Dissertation		380CT Work
3.pm	380CT Work	380CT Work	Dissertation	380CT Work	380CT Work
4.pm					

Figure 12 -Daily Schedule to follow

5.5 Legal, Ethical, Professional and Social Issues

Legal Issues relate to intellectual property which is made of four parts: Patents for inventions, Trademark for brand identity, Design for product appearance and Copyright for materials. (Yong, 2018). There shouldn't be any legal issues as the work produced is of novelty.

Ethical Issues relates to code of Ethics that must be followed. To make sure that the project met the ethical requirements of Coventry University, Ethics form was filled and submitted to Coventry University Ethics Department. The application was reviewed and accepted successfully, means the project will not impose any un-ethical issues. Certificate of Ethics approval, is found in Appendix B.

The professional and social issues is regards to the system acceptance questionnaire. The questionnaire is distributed with Participant Information leaflet found in Appendix C, which gives information on what the project is about and what they are participating in. Students are also provided with a consent form, to state that they have the right to opt-out anytime they want, if they wish, without any reason, this form can be found in Appendix D.

6 Design

6.1 Main Screen

This is the first screen the user will see, upon starting the system. Although there was no requirement for how the interface of the 'Main screen' should look like. The requirement of other interfaces was to be easy to understand and use, this can be seen in section 3.3.2. As seen in the figure 12, The interface of the system that Home Screen, is not constrained with heavy use of images or colours and it is clear to see and understand as the buttons are labelled to make it easier to understand where the button navigates to.

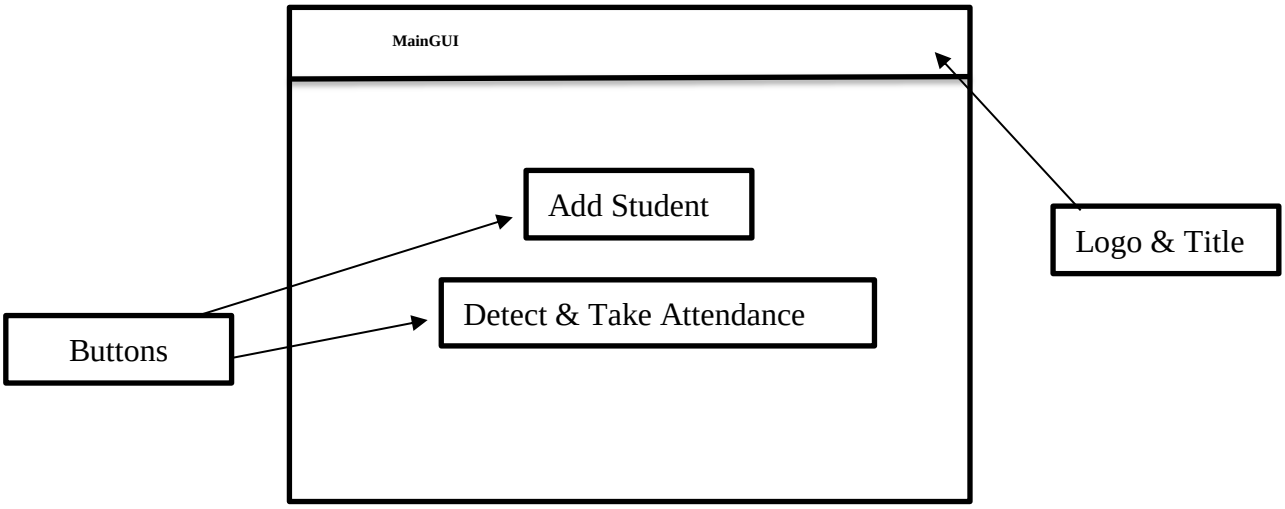

Figure 13 - Main Screen

- Button 'Add Student', closes the Main screen and takes to the screen where the faces of the student can be opened.
- Button 'Detect & Take Attendance', closes the Main screen and takes to the screen where, a real-time face video is matched up against the faces stored in the database, therefore taking the attendance of the person who is matched against the database data.
- Logo and Title goes to the top.

6.2 Adding Faces to Database

This is the screen, where new faces data can be entered, captured and stored. User will see this screen, upon clicking 'Add Student' button, through 'Main Screen'. The requirement stated that the interface to enable face capture needs to be easy to understand and use in section 3.3.2. As seen in the figure 13, The interface of the system that Adds Students into the database, is not constrained with heavy use of images or colours and it is clear to see and understand as the buttons are labelled to make it easier to understand where the button navigates to. Although, first time it looks complicated but to make it ease, as labels are added to aid as an instruction.

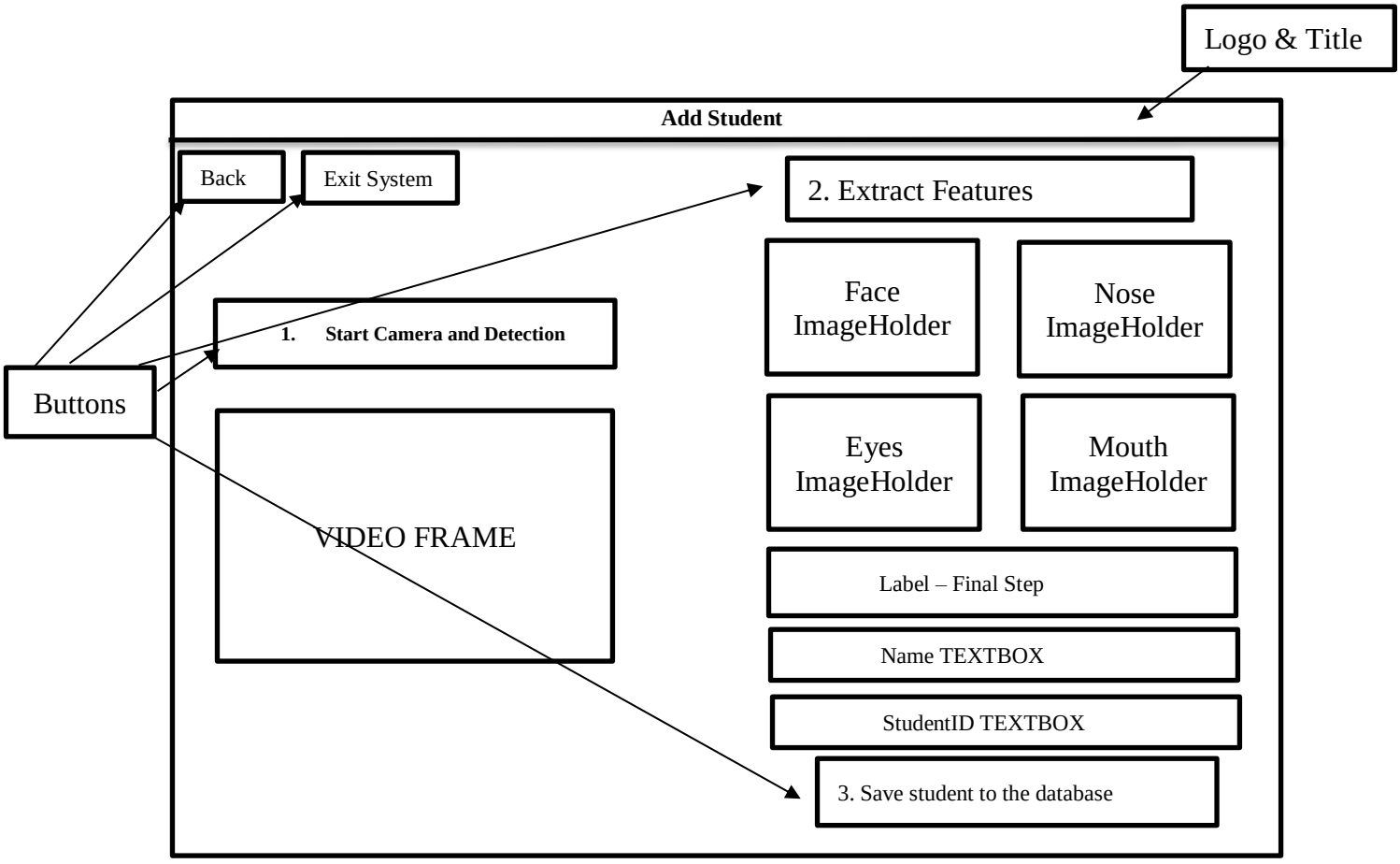

Figure 14 - Add Student

- Button 'Back', takes to the Main Screen.
- Button 'Exit System', closes the program.
- Button '1. Start Camera and Detection', It is the first step that must be followed. Clicking the button enables the 'default' or first camera that is installed inside the computer to open, then the real-time video is displayed in the 'VIDEO FRAME'.
- Button '2. Extract Features', when clicked takes pictures of the facial features detected by Viola and Jones algorithm. Facial features Face, Nose, Eyes and Mouth is detected the algorithm in the 'VIDEO FRAME', when satisfied with the detection, '2. Extract Button' can be clicked and the facial features captured will be display in their respective Image Holders.
- Button '3. Save student to the database', This button when clicked, saves the data gathered, all the features extracted, student 'Name' entered in textbox and 'StudentID' entered in textbox, to the main database.

6.3 Real-Time Face Detection & Attendance

This is the screen, where the faces stored in the database gets matched against the real-time video face, coming from the camera. User will see this screen, upon clicking 'Detect & Take Attendance' button, through 'Main Screen'. The requirement stated that the interface to enable face detection needs to be easy to understand and use, in sectionn 3.3.2. As seen in the figure 14, The interface of the system that detects face and matches against the database, is not constrained with heavy use of images or colours and it is clear to see and understand as the buttons are labelled to make it easier to understand where the button navigates to. Although, first time it looks complicated but to make it ease labels are added to aid as an instruction.

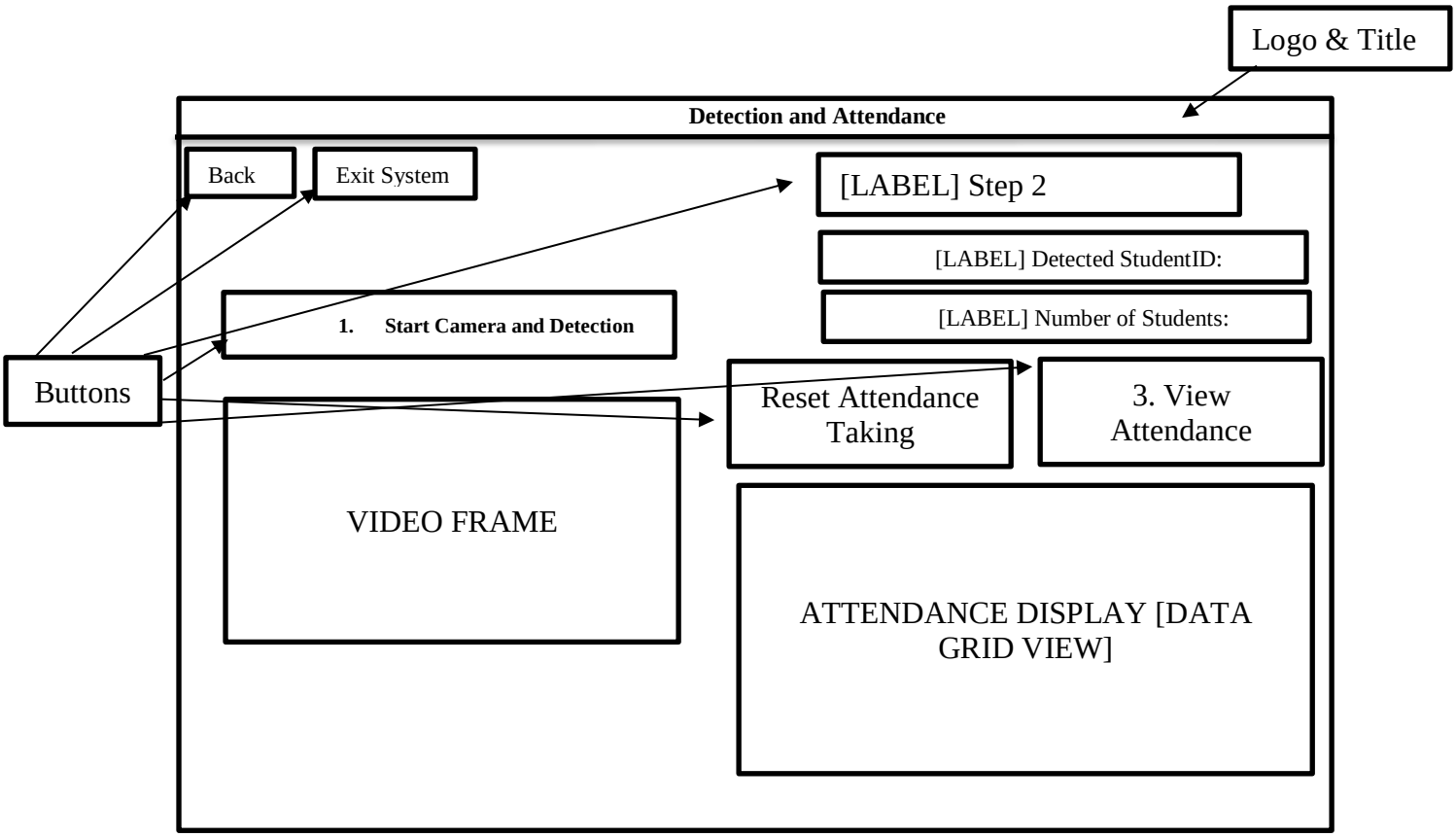

Figure 15 - Detection and Attendance

- Button ‘Back’, takes to the Main Screen
- Button ‘Exit System’, closes the program.
- Button ‘1. Start Camera and Detection’, It is the first step that must be followed. Clicking the button enables the ‘default’ or first camera that is installed inside the camera to open, then the real-time video is displayed in the ‘VIDEO FRAME’. After this, the EigenObjectRecognizer algorithm is enabled, which takes the images stored in the database and matches with the real-time video coming from the ‘VIDEO FRAME’, through the camera. When there is a match, the attendance of the person in the video frame, is automatically recorded and saved into database, with the time and date when the attendance was recorded.
- Button ‘Reset Attendance’, will reset the stored data, this is because once the person is recorded and stored in the database. It will not be recorded again, therefore, clicking this button will reset the data and the same person will be detected again and stored again with the new time and data stamp. This button is mainly for testing purposes.
- Button ‘View Attendance’, will show attendance record that is stored in the database. As the student are detected and recorded, it is instantly saved into the database. When this button is clicked, this data is displayed into the ‘Attendance Display’ Data Grid.
- Label ‘Detected StudentID’, this label displays the StudentID that is matched with the face in the video frame. It doesn’t display the StudentID, if the student is not matched or out of frame.
- Label ‘Number of Students’, this label displays the number of that is detected in the frame, it doesn’t display the number if the student is not matched or out of frame.

6.4 Database Design

A database is needed for the system to store the information of students extracted facial features, StudentName and StudentID. The database consists of two tables, which are **attendance_Table** and **student_Table** Both table consists of their own attributes.

The attendance_Table consists of attributes:

- Attendance_ID – Primary Key of the table, which holds the unique ID for attendance by auto-incremented number.
- Student_Name: Foreign Key to Student_Name, as when the Student_ID is detected, student name is pulled from the student_Table to be saved into attendance_Table.
- Student_ID: Foreign Key to Student_ID, as when the Student_ID is detected, student ID is pulled from the student_Table to be saved into attendance_Table.
- Date_Time – Date and Time Datatype, when a new attendance is recorded, data and time is allocated automatically for the new attendance record.

The student_Table consists of attributes:

- Record_ID - Primary Key of the table, which holds the unique ID for attendance by auto-incremented number.
- Student_Name – Stored names of the students
- Student_ID – Stored student id of the students
- Extracted_features – Facial features pictures stored of the students

7 Implementation

7.1 Development Tools

The Automated Facial Recognition attendance system is developed during this phase. It includes graphical user interface, programming language C# built in Visual Studio 2017 and the database of the system. See justification in section 2.7.

CV library – Algorithms – Voila and Jones algorithms and Eigen Object Detector algorithm. See justification in section 2.6.

The chosen approach is Evolutionary Prototyping method as discussed in Section 4. Therefore, the development includes producing the first robust prototype, if it matches the requirements, other prototypes are added into it.

7.2 First Prototype

This section covers requirements, design, implementation and evaluation of the first prototype for the system. The aim of this first prototype is to setup all the foundation such as creating the interfaces, without the code, which is added in the second prototype, as well as collecting pictures and creating buttons that is going to be used as part of navigation, suggested in design section.

7.2.1 Requirements

The requirements were for followed from the requirements gathered in section 3 and from design section 5.

- The interface to enable face capture needs to be easy to understand and use
- The interface to enable face detection needs to be easy to understand and use
- The interface to display attendance which are taken automatically, will be easy to understand and use
- Buttons to be created for navigation and labelled
- Other labels added

7.2.2 Implementation

7.2.2.1 Main Screen without code

The Main screen in Figure 15 was created as part of the first robust prototype, following the design guide in section 5.1. This is a windows form created in Microsoft Visual Studio. Although there was no requirement for how the interface of the ‘Main screen’ should look like. The requirement of other interfaces was to be easy to understand and use, this can be seen in section 3.3.2. As seen in the figure 15, The interface of the system that Home Screen, is not constrained with heavy use of images or colours and it is clear to see and understand as the buttons are labelled to make it easier to understand where the button navigates to.

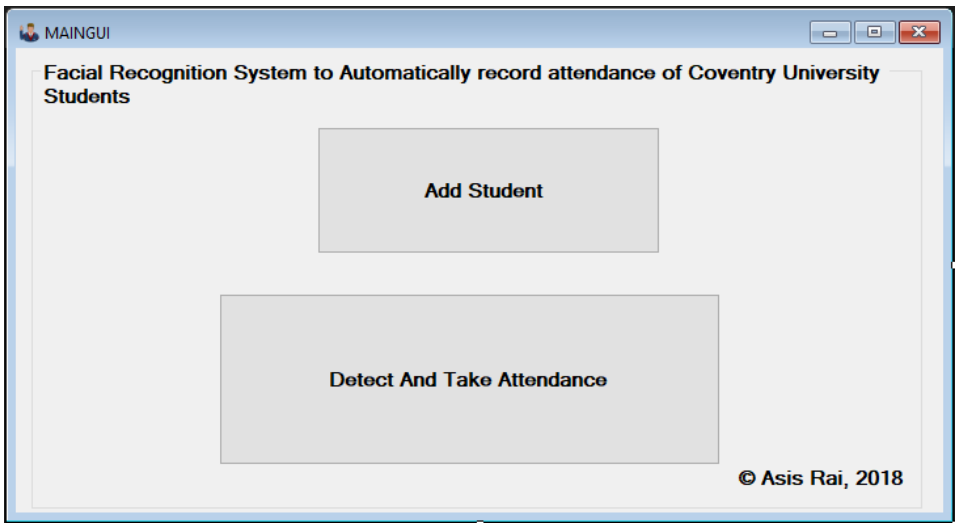

Figure 16 - Main Screen without Code

7.2.2.2 Add Student Screen without Code

The requirement stated that the interface to enable face capture needs to be easy to understand and use in section 3.3.2. As seen in the figure 16, The interface of the system is not constrained with heavy use of images or colours and it is clear to see and understand as the buttons are labelled to make it easier to understand where the button navigates to. Although, first time it looks complicated but to make it ease, as labels are added to aid as an instruction.

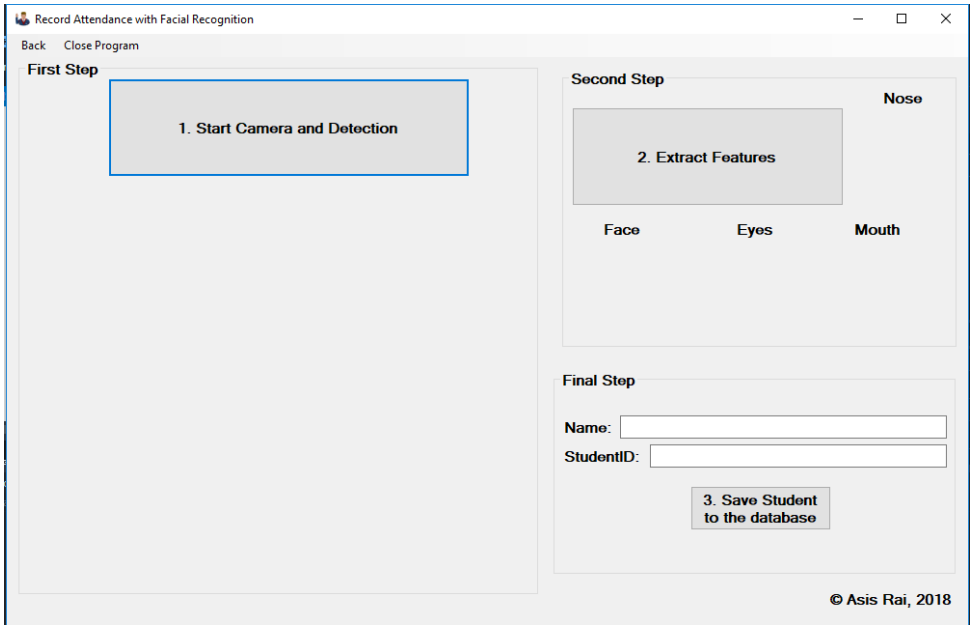

Figure 17 - Add Student Screen without Code

7.2.2.3 Detect and Attendance Screen without Code

The requirement stated that the interface to enable face detection needs to be easy to understand and use, in sectionn 3.3.2. As seen in the figure 17, The interface is not constrained with heavy use of images or colours and it is clear to see and understand as the buttons are labelled to make it easier to understand where the button navigates to. Although, first time it looks complicated but to make it ease labels are added to aid as an instruction.

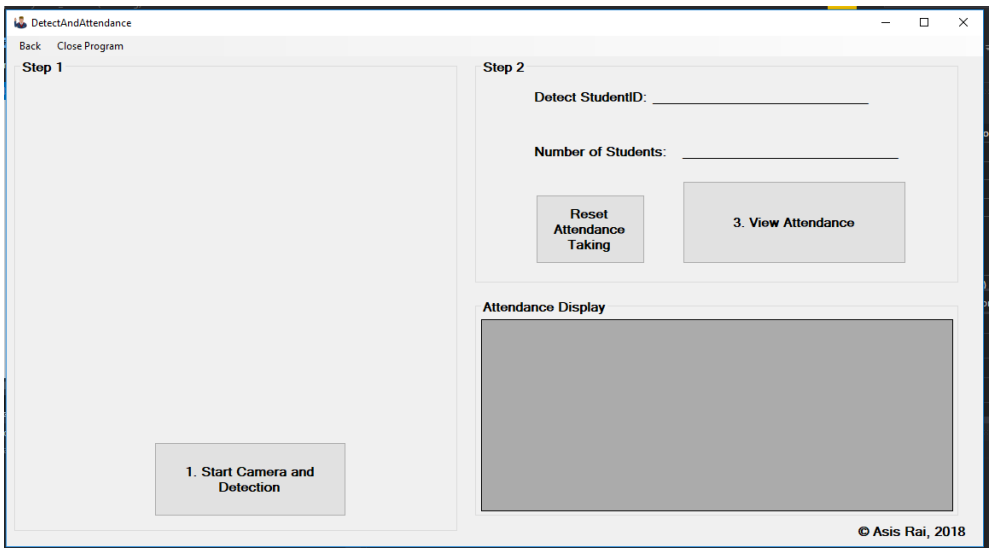

Figure 18 - Detect and Attendance Screen without Code

7.2.2.4 Evaluation

All requirements in first prototype are met. In first prototype all the front end requirement are met, following second prototype will implement the database tables and their attributes.

7.3 Second Prototype

7.3.1 Database Implementation

The Database used is called SQL Database, which comes in built with Microsoft Visual Studio. The requirement suggested of two tables, which are **attendance_Table** and **student_Table**, this can be seen in Figure 18. Both table consists of their own attributes as seen in Figure 19 for attendance_Table and Figure 20 for student_Table.

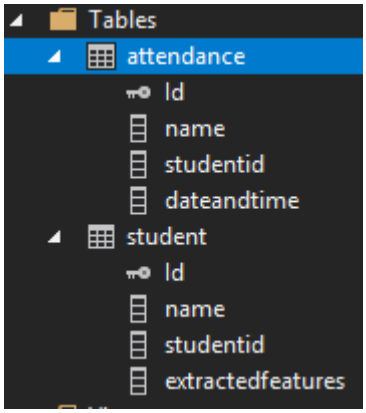

Figure 19 - Database Tables

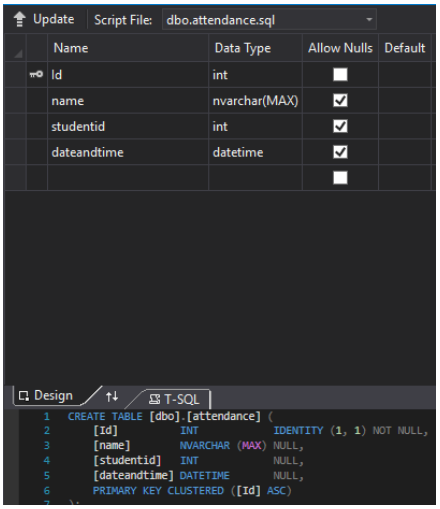

Figure 20 - attendance_Table Attributes

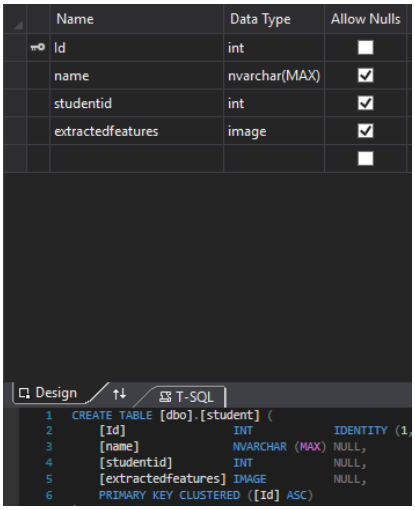

Figure 21 - student_Table attributes

7.4 Third Prototype

7.4.1 Code Implementation & Linking to database

7.4.1.1 Main Screen buttons

Code for Button ‘Add Student’ is added which closes the Main screen and takes to the screen where the faces of the student can be opened. Code for Button ‘Detect & Take Attendance’ which closes the Main screen and takes to the screen where, a real-time face video is matched up

against the faces stored in the database, therefore taking the attendance of the person who is matched against the database data.

```
private void button2_Click(object sender, EventArgs e) //Add student button
{
    AddStudent add = new AddStudent();
    add.Show();
    this.Hide();
}

private void button1_Click(object sender, EventArgs e) //Detect and Attendance button
{
    DetectAndAttendance detect = new DetectAndAttendance();
    detect.Show();
    this.Hide();
}
```

Figure 22- Code to Main Screen buttons

7.4.1.2 Add Student Screen buttons

7.4.1.2.1 Start Camera and Detection button

- Button '1. Start Camera and Detection', It is the first step that must be followed. Clicking the button enables the 'default' or first camera that is installed inside the computer, seen in Figure 22 & 23, calls the frame grabber module, which utilities Voila and Jones's facial features detection algorithms, seen in Figure 23. Example of code working seen in Figure 24.

```
private void button1_Click_1(object sender, EventArgs e) //start camera button
{
    grabber = new Capture(); //when click camera wil be opened
    // 1.initializing the grabber event
    grabber.QueryFrame();
    // 2.Now to capture the video
    Application.Idle += new EventHandler(FrameGrabber); //if the application is idel and the camera is on then call the frame grabber event
    // 3.initializing frame grabber
}
```

Figure 23 – Partial Code which Starts Camera

```
void FrameGrabber(object sender, EventArgs e) //Frame grabber event
{
    //initialize current frame with query grabber which is catching the frame
    currentFrame = grabber.QueryFrame().Resize(501, 407, Emgu.CV.CvEnum.INTER.CV_INTER_CUBIC); //resizing the frame with cubic frame
    //currentFrame2 = grabber.QueryFrame().Resize(400, 300, Emgu.CV.CvEnum.INTER.CV_INTER_CUBIC);

    //1. Converting image frame to gray scale (image processing)
    gray = currentFrame.Convert<Gray, Byte>();
    //gray2 = currentFrame.Convert<Gray, Byte>();

    //2. Detecting face by using Haar Classifier
    MCvAvgComp[][] facesDetected = gray.DetectHaarCascade(face, 1.2, 1, Emgu.CV.CvEnum.HAAR_DETECTION_TYPE.DO_CANNY_PRUNING, new Size(20, 20));
    MCvAvgComp[][] eyesDetected = gray.DetectHaarCascade(eyes, 1.2, 5, Emgu.CV.CvEnum.HAAR_DETECTION_TYPE.DO_CANNY_PRUNING, new Size(20, 20));
    MCvAvgComp[][] mouthDetected = gray.DetectHaarCascade(mouth, 1.2, 10, Emgu.CV.CvEnum.HAAR_DETECTION_TYPE.DO_CANNY_PRUNING, new Size(50, 50));
    MCvAvgComp[][] noseDetected = gray.DetectHaarCascade(nose, 1.2, 5, Emgu.CV.CvEnum.HAAR_DETECTION_TYPE.DO_CANNY_PRUNING, new Size(20, 20));
    //face is name of the haar cascade, giving sizes to the cascade, applying canny pruning on haar classifier

    //3. Checking each frame of image processed by the classifer through ImageBox (video is processed as image frames for face detection), then detect face
    foreach (MCvAvgComp f in facesDetected[0])
    {
        //a. If face is detected then increment t into 1 = True
        t = t + 1;
        //b. Copy detected face in a frame name as result (gray.result)
        result = currentFrame.Copy(f.rect).Convert<Gray, byte>().Resize(100, 100, Emgu.CV.CvEnum.INTER.CV_INTER_CUBIC);
        //resize copied frame and make it as cubic
        //view the result (detected image, face), convert current frame to grey scale

        //c. Drawing traingle around on detected image (face)
        currentFrame.Draw(f.rect, new Bgr(Color.Red), 2);
    }
```

Figure 24 – Partial code which Detect Facial Features

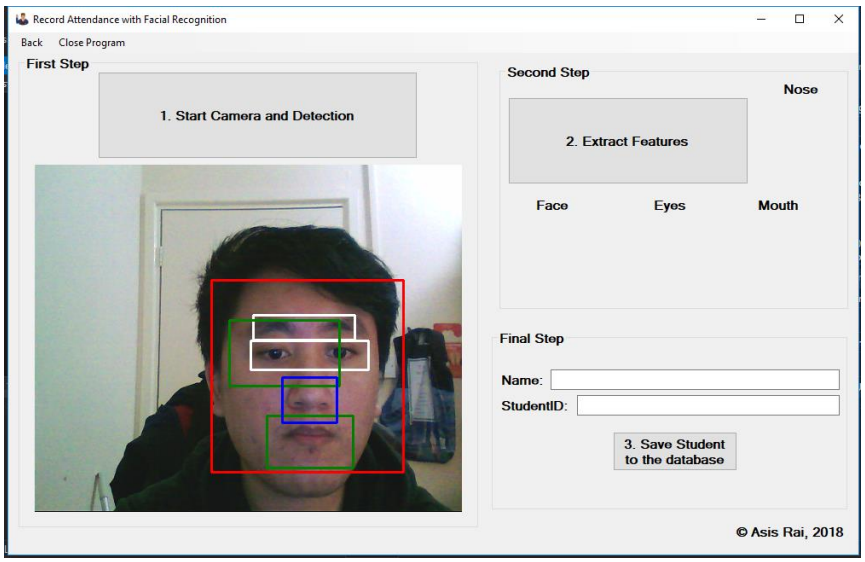

Figure 25 - Program running when 'Start Camera and Detection' button clicked

7.4.1.2.2 Extract Features Button

- Button ‘2. Extract Features’, seen in Figure 25, when clicked takes pictures of the facial features detected by Viola and Jones algorithm. Facial features Face, Nose, Eyes and Mouth is detected the algorithm in the ‘VIDEO FRAME’, when satisfied with the detection, ‘2. Extract Button’ can be clicked and the facial features captured will be display in their respective Image Holders. Demonstrated with an example in Figure 26.
-

```
private void button2_Click_1(object sender, EventArgs e) //extract features button
{
    //a. Resizing detected faces to grey scale images
    TrainedFace = result.Resize(100, 100, Emgu.CV.CvEnum.INTER.CV_INTER_CUBIC);
    TrainedEyes = result2.Resize(100, 100, Emgu.CV.CvEnum.INTER.CV_INTER_CUBIC);
    TrainedMouth = result3.Resize(100, 100, Emgu.CV.CvEnum.INTER.CV_INTER_CUBIC);
    TrainedNose = result4.Resize(100, 100, Emgu.CV.CvEnum.INTER.CV_INTER_CUBIC);
    //b. Image box to show the detected faces
    imageBox2.Image = TrainedFace;
    imageBox3.Image = TrainedEyes;
    imageBox4.Image = TrainedMouth;
    imageBox5.Image = TrainedNose;
}
```

Figure 26- Partial Code Which Extracts feature from Video Frame

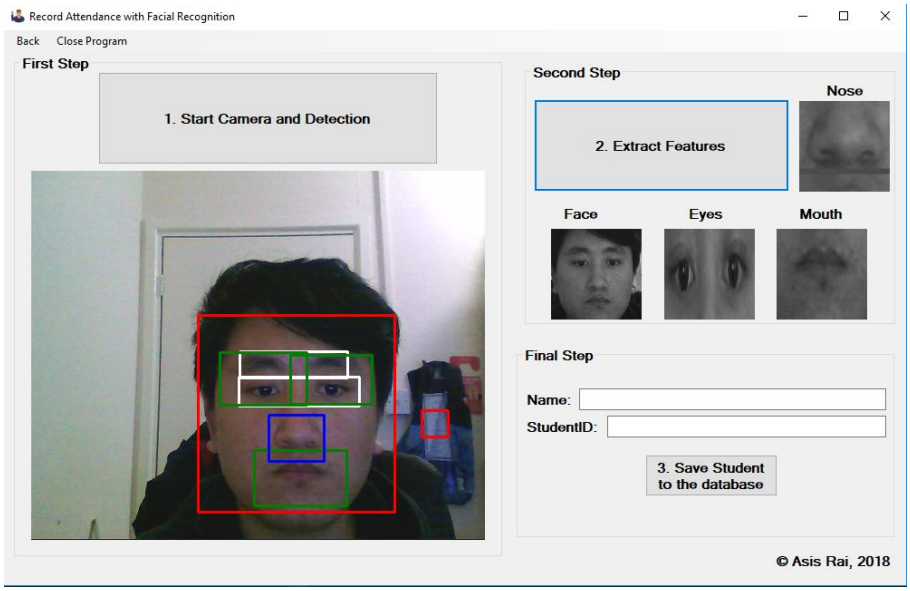

Figure 27 - Example of Code extraction facial features after detection

7.4.1.2.3 Save student to the database button

Button '3. Save student to the database', This button when clicked, runs two functions, as seen in Figure 27.

```
private void button3_Click_1(object sender, EventArgs e) //save face button
{
    extractfeatures(); //saves extracted features
    addtodatabase(); //adds everything to the database
}
```

Figure 28 - Code of Save Student button

All the data set from the form is saved into the database with addtodase (); function, seen in figure 28.

```
private void addtodatabase() //adds to database
{
    using (SqlConnection Connection = new SqlConnection(@"Data Source=(LocalDB)\MSSQLLocalDB;AttachDbFilename=C:\Users\Trust\Documents\GitHub\Facial-Recognition-System-to-Autom
    {
        if (textBox1.Text == String.Empty || textBox2.Text == String.Empty)
        {
            MessageBox.Show("Error, Student details must be entered", "Value Error", MessageBoxButtons.OK, MessageBoxIcon.Error);
        }

        else
        {
            try
            {
                Connection.Open();
                SqlCommand cmd = new SqlCommand(@"INSERT INTO student ([name], [studentid]) VALUES (@studentname, @idstudent);", Connection);
                cmd.Parameters.AddWithValue("@studentname", textBox1.Text);
                cmd.Parameters.AddWithValue("@idstudent", textBox2.Text);
                int i = cmd.ExecuteNonQuery();
                Connection.Close();
```

Figure 29 – Partial Code to gather the facial features extracted

All the Facial features extracted earlier by other functions are gathered and ready to be saved into the database, see in figure 29, this is saved by the addtodase (); function.

```
public void extractfeatures()
{
    ContTrain = ContTrain + 1;

    //detected faces will be saved into a folder with the name of the person
    //setting commands
    detectedImages.Add(TrainedFace);
    detectedImages2.Add(TrainedEyes);
    detectedImages3.Add(TrainedMouth);
    detectedImages4.Add(TrainedNose);

    labels.Add(textBox2.Text);
    //write name of the detected person into list
    File.WriteAllText(Application.StartupPath + "/TrainedFaces/TrainedNames.txt", detectedImages.ToArray().Length.ToString() + "%");
    File.WriteAllText(Application.StartupPath + "/TrainedFaces/TrainedNames.txt", detectedImages2.ToArray().Length.ToString() + "%");
    File.WriteAllText(Application.StartupPath + "/TrainedFaces/TrainedNames.txt", detectedImages3.ToArray().Length.ToString() + "%");
    File.WriteAllText(Application.StartupPath + "/TrainedFaces/TrainedNames.txt", detectedImages4.ToArray().Length.ToString() + "%");

    //write to files
    for (int i = 1; i < detectedImages.ToArray().Length + 1; i++)
    {
        //save faces to folder with name face(i) i being the name/number of the face detected
        detectedImages.ToArray()[i - 1].Save(Application.StartupPath + "/TrainedFaces/face" + i + ".bmp");
        //Saves name to text file
        File.AppendAllText(Application.StartupPath + "/TrainedFaces/TrainedNames.txt", labels.ToArray()[i - 1] + "%");
    }
```

Figure 30 – Partial code to save everything to the database

Confirmation is given when the data is successfully saved into the database. Example seen in Figure 30.

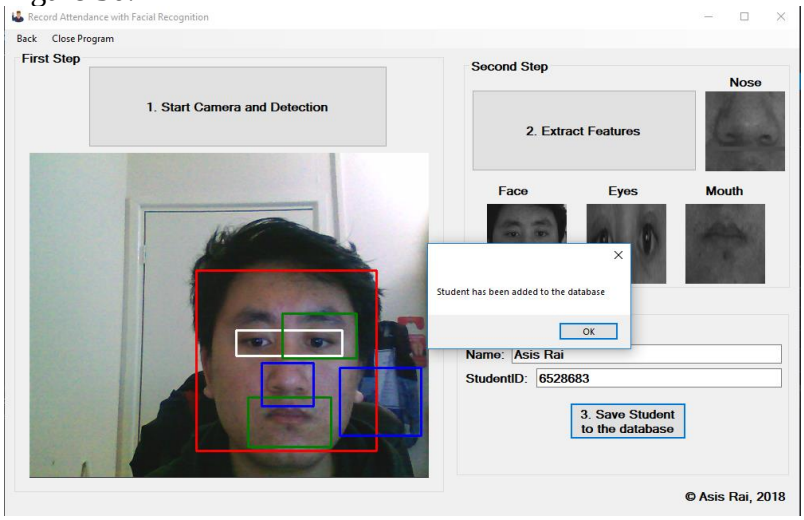

Figure 31 - Confirmation of Dataset saved

7.4.1.3 Face Detection & Attendance Screen

7.4.1.3.1 Start Camera and Detection button

- Button '1. Start Camera and Detection', It is the first step that must be followed. Clicking the button enables the 'default' or first camera that is installed inside the computer, seen in Figure 22 & 23, calls the frame grabber module, using EigenObjectRecognizer algorithm to be matched the faces stored in database seen in Figure 33, against the real-time video feed face, 31. As the student's attendance is already recorded in the database, only it's StudentID is shown, identifying the student, seen in Figure 31.

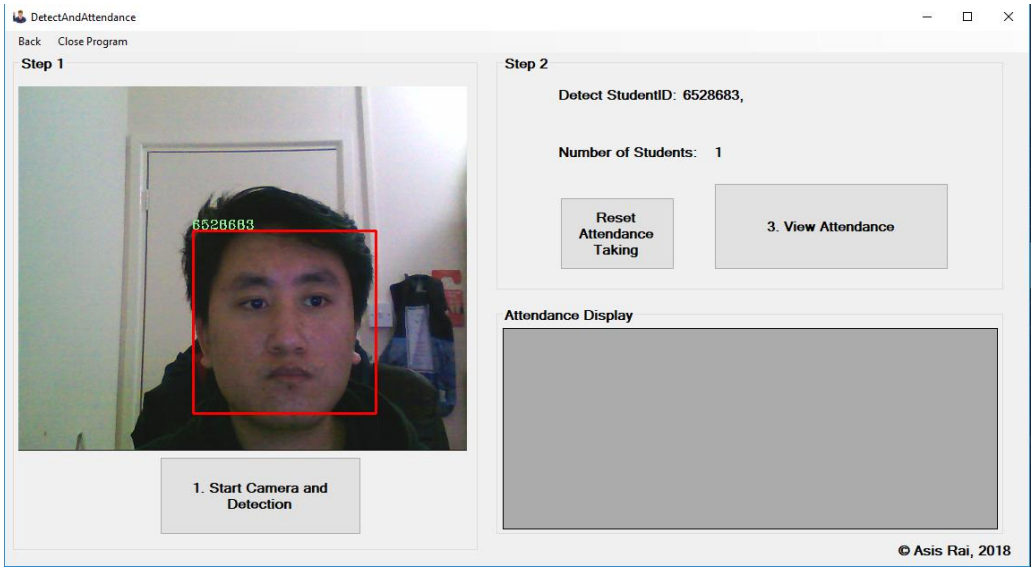

Figure 32 - Student's Attendance already recorded

In other instances, such as if the student's attendance was not recorded, the student's attendance is recorded as soon as the face is detected in the video frame. This is given with a confirmation with a dialog box pop up. Example is demonstrated in Figure 32.

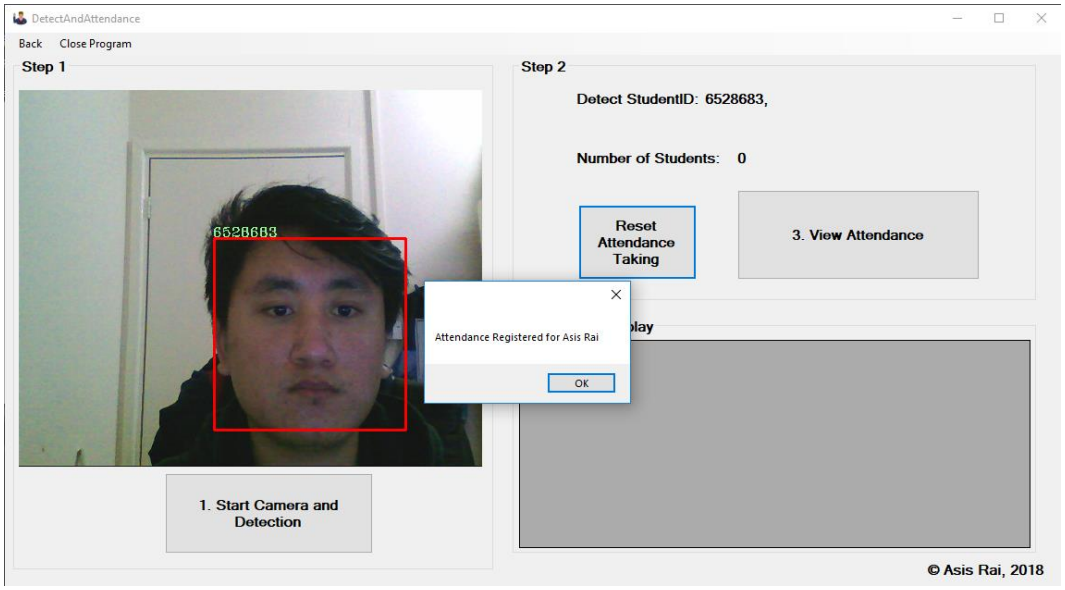

Figure 33 - First time attendance is recorded

```
//Action for each element detected
foreach (MCvAvgComp f in facesDetected[0])
{
    t = t + 1;
    result = currentFrame.Copy(f.rect).Convert<Gray, byte>().Resize(100, 100, Emgu.CV.CvEnum.INTER.CV_INTER_CUBIC);
    //draw the face detected in the 0th (gray) channel with blue color
    currentFrame.Draw(f.rect, new Bgr(Color.Red), 2);
    //initialize result,t and gray if (trainingImages.ToArray().Length != 0)
    {
        //term criteria against each image to find a match with it, perform different iterations
        MCvTermCriteria termCrit = new MCvTermCriteria(ContTrain, 0.001);
        //call class by creating object and pass parameters
        EigenObjectRecognizer recognizer = new EigenObjectRecognizer(
            trainingImages.ToArray(),
            labels.ToArray(),
            5000,
            ref termCrit);
        //next step is to name find for recognize face
        name = recognizer.Recognize(result);
        //now show recognized person name so
        currentFrame.Draw(name, ref font, new Point(f.rect.X - 2, f.rect.Y - 2), new Bgr(Color.LightGreen));//initalize font for the name captured

    }

    if (!FacesAlreadyDetected.Contains(name))
    {
        SaveToDatabase(name, DateTime.Now);
        FacesAlreadyDetected.Add(name);
    }
```

Figure 34 - Partial Code for Matching facial features against the one stored in database

7.4.1.3.2 View Attendance Button

Button 'View Attendance', will show attendance record that is stored in the database. As the student are detected and recorded, it is instantly saved into the database. When this button is clicked, this data is displayed into the 'Attendance Display' Data Grid. Code to pull the dataset from database is seen in figure 34. Code working is demonstrated in figure 35.

```
private void button3_Click(object sender, EventArgs e)
{
    con = new SqlConnection(@"Data Source=(LocalDB)\MSSQLLocalDB;AttachDbFilename=C:\Users\Trust\Documents\GitHub\Facial-Recognition-System-to-Automatically-record-att
    SqlDataAdapter checkup = new SqlDataAdapter("SELECT * FROM attendance", con); //this will get all marked attendance from the database
    DataTable sd = new DataTable();

    checkup.Fill(sd);
    dataGridView1.DataSource = sd;

    DataTable sd1 = new DataTable();
    sd1 = sd.DefaultView.ToTable(true, "name", "studentid", "dateandtime");

    dataGridView1.DataSource = sd1;
}
```

Figure 35 - Code to pull dataset of Attendance

Attendance Display

	name	studentid	dateandtime
▶	Asis Rai	6528683	15/05/2018 17:49
	Asis Rai	6528683	15/05/2018 17:58
*			

Figure 36 - When View Attendance Button is clicked

7.5 How algorithms are implemented and Initialised

The OpenCV library is downloaded from their main website and installed. Once installed Viola and Jones algorithms are imported into the solution. The imported algorithms are for face – HAAR Cascade frontal face, Nose -HAAR Cascade Nose, Mouth – HAAR Cascade Mouth and HAAR Cascade, see Figure 36. These cascades are now ready to be linked to the Add student form. From the Add student form, each cascade is defined and assigned with a variable, so that they are initialized called when the 'Start Camera' button is pressed, see Figure 36. When the camera video is sent to the 'Frame Grabber', The cascades are applied inside the frame grabber as well with their respective cascade names, see Figure 38.

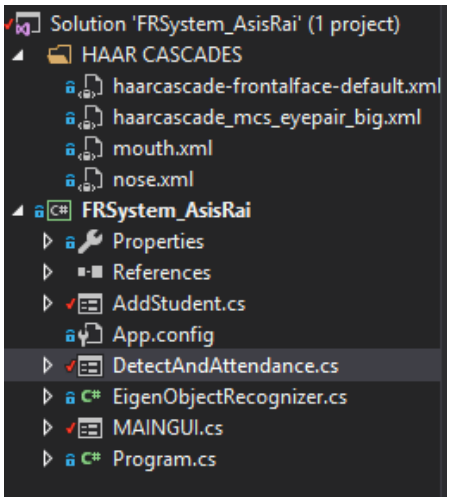

Figure 38 - All imported algorithms

```
//loading haarcascade file by file name and assining to haarcascade variable
//Load haarcascades for face detection
face = new HaarCascade("haarcascade-frontalface-default.xml");
//Load haarcascades for eye detection
eyes = new HaarCascade("haarcascade_mcs_eyepair_big.xml");
//Load haarcascades for mouth detection
mouth = new HaarCascade("mouth.xml");
//Load haarcascades for nose detection
nose = new HaarCascade("nose.xml");
```

Figure 37 - Cascades assigned to variables

```
void FrameGrabber(object sender, EventArgs e) //Frame grabber event
{
    //initialize current frame with query grabber which is catching the frame
    currentFrame = grabber.QueryFrame().Resize(501, 407, Emgu.CV.CvEnum.INTER.CV_INTER_CUBIC); //resizing the frame with cubic frame
    //currentFrame2 = grabber.QueryFrame().Resize(400, 300, Emgu.CV.CvEnum.INTER.CV_INTER_CUBIC);

    //1. Converting image frame to gray scale (image processing)
    gray = currentFrame.Convert<Gray, Byte>();
    //gray2 = currentFrame.Convert<Gray, Byte>();

    //2. Detecting face by using Haar Classifier
    MCvAvgComp[][] facesDetected = gray.DetectHaarCascade(face, 1.2, 1, Emgu.CV.CvEnum.HAAR_DETECTION_TYPE.DO_CANNY_PRUNING, new Size(20, 20));
    MCvAvgComp[][] eyesDetected = gray.DetectHaarCascade(eyes, 1.2, 5, Emgu.CV.CvEnum.HAAR_DETECTION_TYPE.DO_CANNY_PRUNING, new Size(20, 20));
    MCvAvgComp[][] mouthDetected = gray.DetectHaarCascade(mouth, 1.2, 10, Emgu.CV.CvEnum.HAAR_DETECTION_TYPE.DO_CANNY_PRUNING, new Size(50, 50));
    MCvAvgComp[][] noseDetected = gray.DetectHaarCascade(nose, 1.2, 5, Emgu.CV.CvEnum.HAAR_DETECTION_TYPE.DO_CANNY_PRUNING, new Size(20, 20));
    //face is name of the haar cascade, giving sizes to the cascade, applying canny pruning on haar classifier

    //3. Checking each frame of image processed by the classifer through ImageBox (video is processed as image frames for face detection), then detect face
    foreach (MCvAvgComp f in facesDetected[0])
    {
        //a. If face is detected then increment t into 1 = True
        t = t + 1;
        //b. Copy detected face in a frame name as result (gray.result)
        result = currentFrame.Copy(f.rect).Convert<Gray, byte>().Resize(100, 100, Emgu.CV.CvEnum.INTER.CV_INTER_CUBIC);
        //resize copied frame and make it as cubic
        //view the result (detected image, face), convert current frame to grey scale

        //c. Drawing traingle around on detected image (face)
        currentFrame.Draw(f.rect, new Bgr(Color.Red), 2);

    }
```

Figure 39 – All HAAR Cascades inside the video frame

7.6 Database

Data is stored into the database by using SQL commands. It becomes evident where the SQL commands are used in the code as it is easy to commands, starting with '@Data Source'. Example can be seen in Figure 39.

```
con = new SqlConnection(@"Data Source=(LocalDB)\MSSQLLocalDB;AttachDbFilename=C:\Users\Trust\Documents\GitHub\Facial-Recognition-System-to-Automatically-record-att
SqlDataAdapter checkup = new SqlDataAdapter("SELECT * FROM attendance", con); //this will get all marked attendance from the database
DataTable sd = new DataTable();
```

Figure 40 - Example of SQL Commands

7.7 Evaluation

All design requirements are met with the final prototype, fully functioning and stable. The system will go through a series of testing in the next chapter to ensure that the system is reliable, complete and is consistent.

8 Testing

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

8.1 Testing Results

Test ID	Test Description	Expected Result	Outcome
T1	Home screen	Both buttons are linked to their respective forms correctly.	PASS
T2	Camera Initialization	When 1. Start Camera and Detection button clicked in Add student form, video is displayed in Video Frame.	PASS
T3	Facial Features Detection	When 1. Start Camera and Detection button clicked in Add student form, Facial features are correctly detected in Video Frame.	PASS
T4	Extracting Features	When Extract Features button click in Add student form, all features are successfully extracted and displayed in their respective Image Boxes.	PASS
T5	Saving to Database	When Save student to the database button is clicked in Add student form, a dialog box is given with a confirmation of the data saved to the database.	PASS
T6	Back Button	When back button is clicked in Add Student Form, the form is closed successfully, and Main Screen Form is opened.	PASS
T7	Close Program Button	When Close Program button is clicked in Add Student Form, the program is closed.	PASS
T8	Back Button 2	When back button is clicked DetectAndAttendance form, the form is closed successfully, and Main Screen Form is opened.	PASS
T9	Close Program Button 2	When Close Program button is clicked in DetectAndAttendance form, the program is closed.	PASS
T10	Face Detection and Automatic Attendance	When 1. Start Camera and Detection button is pressed in DetectAndAttendance Form, Face is identified with StudentID and a confirmation message is pop up with a dialog box.	PASS
T11	StudentID	The detected Student ID's matching the student's face is displayed next to Detected StudentID label.	PASS
T12	Number of Students	Number of faces detected in the video	PASS

		frame, should appear next to the Number of Students label.	
T13	Reset Attendance Taking	Reset Attendance Button should reset the attendance, detect the same face again and record attendance.	PASS
T14	View Attendance Button	When this button is clicked, all the recorded attendance is pulled from the database and displayed in data grid view.	PASS
T15	Detecting Multiple faces	When multiple faces detected in the same video frame, both faces stored in the database. The system should record attendance of both faces.	PASS
T16	First Face stored, second not stored in the database	When both faces stepped in front of camera, only first face's attendance should be recorded	PASS

Table 3 - Test plans and results

8.2 Acceptance Testing

After implementation and personal testing. Acceptance Testing was performed with Coventry University students who volunteered to participate in the project and gave their consent to use and store their data for this project. The students were simply asked to sit in front of the computer and see their attendance marked automatically, after they were registered and stored in the system's database. After that a questionnaire was given them to fill out and give their feedbacks on the Automated Facial Recognition Attendance System, in Appendix E. The overall feedbacks are shows below:

- **Interface**: Overall feedbacks on the interface were mostly positive, which indicates that the system easy to see and use, as people commented that the design of the system was simple, and the labels helped to see which procedure must be followed first.
- **Functionalities**: The feedbacks were positive for functionalities, most students commented that they liked the ease just sitting down and their attendance recorded.
- **General comments**: The feedbacks indicate that the show could be more effective at recording attendance than the current card-based system, if implemented right.
- **Future Suggestions**: General suggestions include, better cameras should be used, and the system could replace the current card-based system in the future.

8.3 Evaluation of Results

The overall testing performed on the system has met the expected result. The system seems to be stable and reliable as the system did not crash throughout tests. The feedbacks of acceptance testing were very positive, in section 7.2. Therefore, the system is now ready for evaluation against the functional, non-functional requirements and design requirements.

9 Evaluation

After the testing stage, the whole project is evaluated to find out how successful it has been. In this chapter the system is evaluated against the functional and non-fictional requirements to find out if the system is fit for purpose.

9.1 Evaluation against Requirements

9.1.1 Functional Requirements

The following table shows the evaluation against the functional requirements. The screenshots are provided in Appendix G, they are evidence to prove that the project achieved the functional requirements.

ID	Requirement	Outcome	Appendix Reference
F1	**The system must make use of a database schema**	Achieved	G.1
F2	**The system much get algorithms from OpenCV library**	Achieved	G.2
F3	**The system must have use a Programming language which can import database and OpenCV library**	Achieved	G.3
F4	**The camera must be compatible with the system**	Achieved	G.4
F6	**The system must detect faces to extraction and storage of faces**	Achieved	G.5
F7	**The system must detect faces to detect and take attendance**	Achieved	G.6
F8	**The system must show record of attendance taken**	Achieved	G.7

Table 4 - Evaluation against Functional Requirements

9.1.2 Non-Functional Requirements

The following table shows evaluation against the non-functional requirements and determine whether the system has achieved the non-functional requirements.

ID	Requirement	Outcome
NF1	**The interface to enable face capture needs to be easy to understand and use**	Achieved through acceptance testing, students feedback confirmed it
NF2	**The interface to enable face detection needs to be easy to understand and use**	Achieved through acceptance testing, students feedback confirmed it
NF3	**The system needs to be easy to use and run**	Achieved through acceptance testing, students feedback confirmed it
NF4	**The interface to display attendance which are taken automatically, will be easy to understand and use**	Achieved through acceptance testing, students feedback confirmed it
NF4	**The application must handle the events of all forms**	Achieved, Refer to Appendix G.4, G.5, G.6 and G.7

Table 5 - Evaluation against Non-Functional Requirements

9.1.3 Evaluation against Project Management & Methodology

9.1.3.1 Project Management, Project Schedule, Risk Assessment & Quality Management

The project management researched and discussed in section 5, helped the project to be completed on time. The initial Gantt chart is shown in Appendix A.1. After meetings with supervisors, meeting evidence can be seen in Appendix I, it was suggested that Gantt chart needed to be changed and more information needed to be added such as presentation, with that feedback the Gantt chart was changed into much more detailed and realistic goal time, this can be seen in Appendix A.2. Project management principles helped set milestones in the new Gantt chart. Every phase of milestones in Gantt chart must be completed. The daily time is utilized in Time Management section 5.4 in order to meet the milestones of the Gantt chart and Project Schedule. Risk management is also thought-out in section 5.3, with log of potential issues that could arise during the project development. One issue arose that was predicted in risks analysis, which was coding issue in the system development stage, where some of the components did not respond to the code. Solution offered in Risk analysis was followed and looked online for help, the solution helped to solve the problem, as the code was missing few references in Microsoft Visual Studio.

9.1.3.2 Methodology

The chosen lifecycle methodology for developing the artefact was Evolutionary variation of Prototype Model and this methodology helped a lot during the development of the artefact. The methodology mostly helped during the implementation of the system. First robust prototype was produced following the methodology, then the prototype was shown to the supervisor which allowed to bring in feedback and make changes, instantly. Other prototypes were added on top of the initial prototype, meaning it allowed to implement coding at a second stage when the forms design was made, this allowed to code faster to the forms and stay on time with the Gantt chart project schedule. The methodology ultimately, allowed to get acceptance feedback on the final prototype, which helped to know that created system is a solution that is fit for the problem identified, based on the positive feedback from acceptance feedback questionnaire, which can be found in Appendix H.

10 Conclusions

10.1 Achievements

10.1.1 Project Aims

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

- **Record attendance without the use of student cards, through their face**
  This aim is met as the project is successfully implemented, tested and evaluated in chapter 7,8 and 9 respectively.
- **Record Multiple attendance at the same time**
  This aim is met as the project is successfully implemented, tested and evaluated in chapter 7,8 and 9 respectively.

10.1.2 Project Objectives

This section evaluates the aims and objectives set in introduction section.

- **Critically review the Literature Review**
  Different types of automated attendance systems are explained and critically evaluated. More research is applied with the best approach to find out the steps and approaches used by that method and how the system is implemented in computers. Additional Research applied is done to find out if Face Recognition technique is really better than the others. Brief history of semi-automated and automated attendance management systems is done and different types of facial recognition techniques and the procedures in the attendance management system to find out what kind of algorithms are used, and procedures are used. This is all done in Chapter 2. Based on these findings, research on a programing language, database and algorithms are performed in section 2.6 and 2.7
- **Select appropriate software development life cycle methodology**
  Several software development cycles are critically reviewed in methodology Chapter 4, The chosen methodology is a variation of Prototype Model, Evolutionary Prototype Model. This methodology is well suited to the development life cycle of the project as it provides prototypes and feedbacks.
- **Analyse and Determine the requirements for the Automated Facial Recognition Attendance System**
  Research and Meetings are two techniques used to determine the functional and non-functional requirements for the system, in chapter 1.3.
- **Produce designs for the Automated Facial Recognition Attendance System**
  Interface Design of the whole system, Database design and functionalities design are produced based on the requirements in chapter 6
- **Develop and Implement the Automated Facial Recognition Attendance System**
  An Automated Facial Recognition Attendance System has been developed through producing and combining prototypes.
- **Test and Evaluate the Automated Facial Recognition Attendance System**
  The system is tested alone and also tested with the students of Coventry University. The system is tested with students for user acceptance testing feedback. The requirements are also evaluated based on the system

- **Determine possible future improvements/suggestions for the Automated Facial Recognition Attendance System**
  Some improvements are suggested by the students of Coventry University from User acceptance testing, which can be found in Appendix H.2. The recommendations are also discussed in Section 10.2.

10.2 Recommendations for Future Work

The Automated Facial Recognition Attendance System is ready for release. However, there are still some improvements to be made. More features and functions could be added to the system.

The feedbacks received from the acceptance testing, found in Appendix H.2. were very positive, however they did point out that the system could be even better with additional features and functionalities. More functionalities could be added such as opening doors, when faces are detected and matched of the correct classroom's. This could open new doors for further enhancement.

Moreover, If the Automated Facial Recognition Attendance System was extended more and implemented as the actual attendance recording method in Coventry University, it could be huge for the students and a next leap of advancement towards the modern technology. The data could be stored in their central server, so the data will be safe.

Lastly the mythology suggested for future approaches, Agile methodology would probably be the one to look for. It is used by most of the software development companies are it incorporates different flexible techniques such as SCRUM. However, for a small individual project such as this, the previously chosen and discussed methodology would be better, as prototypes generated faster and it is quicker to get feedbacks and correct them.

10.3 Summary

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

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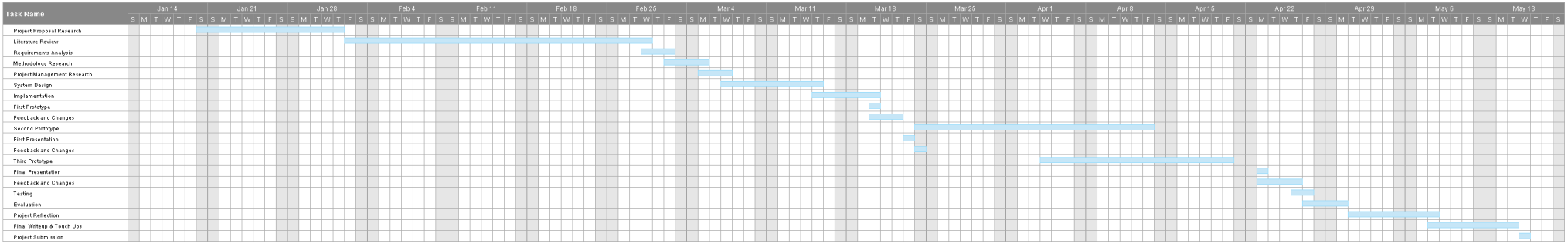
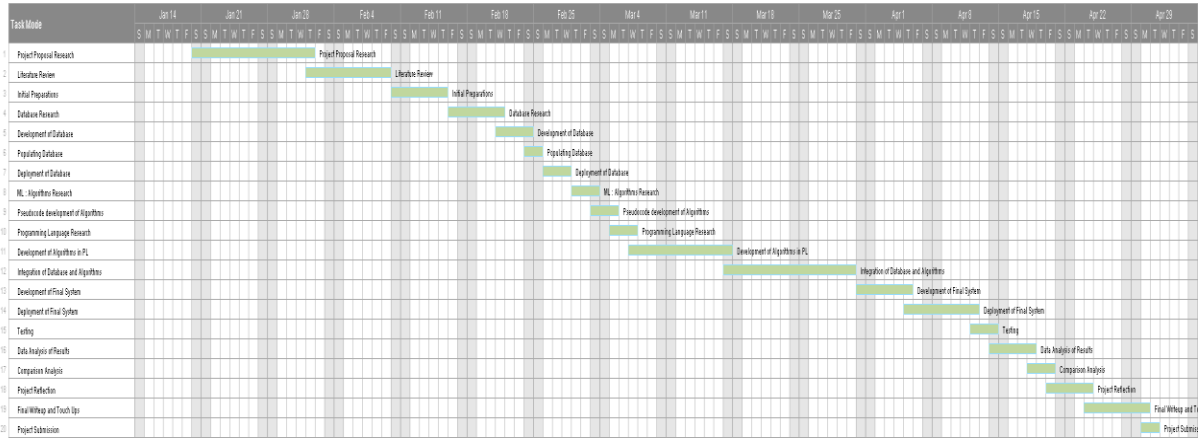
Appendix A – Gantt Chart

A.1 Finalized Version Gantt Chart



A.2 Initial Gantt Chart



Appendix B – Ethics Approval Certificate

Certificate of Ethical Approval

Applicant:

Asis Rai

Project Title:

Facial recognition system to automatically record attendance of Coventry University Students

This is to certify that the above named applicant has completed the Coventry University Ethical Approval process and their project has been confirmed and approved as Medium Risk

Date of approval:

05 March 2018

Project Reference Number:

P68181

Appendix C – Participant Leaflet

Title of the proposed study	Facial recognition system to automatically record attendance of Coventry University Students.

Description of the proposed study

Face is an important part of a person, it is used to identify and differentiate identities of two or more individuals in real world. Different parts of the body has been exploited over the recent years, to ensure that only the legitimate individual has access to their respective accounts both in real world and in virtual. Different methods have been created, one being Biometrics, which consists identifiers such as Fingerprint, Palm veins, DNA, Palm print and Face recognition etc. Similarly, This project seeks to use one distinctive identifier of Biometrics, Face Recognition. The project aims to combine Face Recognition with image processing techniques and Machine learning algorithms to be deployed as an Automated Attendance System for Coventry University. The Automated Attendance System should be able to help Coventry Students to make it easier for them to record their attendance by not having to be dependent with Card-systems, as Student cards are often lost and paid to replace. This means they cannot prove their identity and record attendance instantly. The cardsystem is also at fault often with inaccurate attendance recordings, as it can be tricked or cheated when individuals are able to record attendance for others, or crash of the system, paper-based system have to be used in this event. This makes more time consuming for students and makes it harder for them to focus on the session. This project's objectives is to find out if facial recognition system is better at recording attendance than Card-based system/paper based system for Coventry University and it's students by implementing a Facial Recognition System.

Invitation to participate

- You have been invited to participate in a study to find out if implementing a facial recognition to record attendance is better than using card/paper based system.
- Please Note that the participation is voluntary and if you were to participate, you have the right to withdraw at anytime, without an explanation.
- The participation is required to be a student of Coventry University.
- The participation includes taking several (face) pictures of the participant; the pictures will be stored in a secure database with the participant's profile.
- The participants profile will be used to match against the participant's live image/video at another time to automatically record their attendance.
- The participants will be asked to test the system upon completion and will be required to fill out a questionnaire to get feedback on the system created and its benefits to the participants.
- **Please ask the researcher if you need to seek further clarification**

Confidentiality/anonymity and data security	• The data stored is the participant's profile. No personal data should be stored. The participant will be given a fake name and only their image(s) will be stored into a secure database. • The researcher will delete the data stored after the completion of the project.
Results of the study	• The results of the study maybe shared with the participant if he/she wishes. • The results will be shared between the researcher and his supervisor.
Contact details	Researcher – Asis Rai, 3rd year student at Coventry University. Supervisor - Dianabasi Nkantah.

Appendix D – Participant Consent Form

Name of Researcher	Asis Rai
Title of Study	Facial recognition system to automatically record attendance of Coventry University Students
Name of Supervisor	Dianabasi Nkantah

Please read and complete this form carefully. If you are willing to participate in this study, ✓ or ✗ the appropriate responses and sign and data the declaration at the end. If you do not understand anything and would like more information, please ask.

* I have had the research satisfactorily explained to me in verbal and/or written from the researcher.	
* I understand that the research will involve taking a picture of my face only and will be used to store it in a secure database, which will be erased at the end of the project.	
* I understand that I have the right to withdraw from this study at any time without giving an explanation.	
* I understand that my picture will be shared with the researcher's supervisor to aid the study of the researcher.	
* I understand that my picture will be treated with strict confidence and will not be shared outside of this study.	
I freely give my consent to participate in this research study and have been given a copy of this form for my own information. Name:	
Date:	
Signature:	

Appendix E – Project Proposal

300/303COM Detailed Project Proposal

First Name:	Asis
Last Name:	Rai
Student Number:	6528683
Supervisor:	Dianabasi Nkantah

SECTION ONE: DEFINING YOUR RESEARCH PROJECT

1.1 Detailed research question

Help: Your detailed research question is the statement of a problem within the computing domain which you will address in your project. Refining the research question involves narrowing down an initial question until it is answerable using a primary research method(s) that you will conduct during the time of your project. The refined research question must not be so general that it is answerable with a yes or no answer. It must not be so broad that you would be unable to achieve a solution during your project. The key to this is BEING SPECIFIC: Narrow down the method or technology you will use, narrow down the group that the question refers to (localize a general question) If the project is still 'too big', can you think of a way to work on a part of the problem? Avoid using words that cannot be measured, by you, without a huge research budget e.g. 'effects on society', 'effects on business'. *Example:* The initial question "Does cloud computing effect business" needs narrowing down *(for a start the answer is yes)* What is meant by cloud computing? Or 'effect'? Or 'business', in this question? Refining this first question will involve narrowing it down to something you, personally, can measure. A refined version of this question might be: "Does implementing a cloud based voting system improve the speed of decision making in a small company in Coventry?" This refined question is implementable: You can now identify a small company to work with, document their current decision making processes, implement a cloud based voting system, compare decision making speeds over a limited time period (say 1 month) and evaluate your findings. *A small piece of genuinely new knowledge is produced.*

Does implementing facial recognition system, help Coventry University and its students, better at recording attendance than using a card-based/paper based system?

1.2 Keywords

Help: Include up to 6 keywords separated by a semi-colon; what keywords are appropriate to describe your project in an online database like Google Scholar? Keywords should include the general research area and the specific technologies you will be working with. *Example.* A project that proposes a novel way of visualising large amounts of twitter feed data may have the keywords: Data visualisation; twitter; hashtags; database design; graphics libraries. For further help, take a look at the ACM keywords list http://www.computer.org/portal/web/publications/acmtaxonomy

Facial recognition; machine learning algorithm; image processing; database; programming language; artificial intelligence; data processing; identification; Pattern Recognition

1.3 Project title

Help: The project title is a statement based on your detailed research question. For example, the research question *'to what extent does a mobile application reduce the number of errors made in class registers at Coventry University in comparison to current paper based registers'* may be stated in the project title: *"A Wi-Fi driven mobile application for large group registers using iBeacons".*

Facial recognition system to automatically record attendance of Coventry University Students.

1.4 Client, Audience and Motivation:

Help: Why is this project important? To whom is this project important? A research project must address a research question that generates a small piece of new knowledge. This new knowledge must be important to a named group or to a specific client (such as a company, an academic audience, policy makers, people with disabilities) to make it worthwhile carrying out. This is the ***motivation*** for your project. In this section you should address who will benefit from your findings and how they will benefit. Example: If you intend to demonstrate that a mobile application that automates class registers at Coventry University will be more efficient than paper based registers - the group who would be interested in knowing/applying these findings would be both academic and administrative staff at Coventry University and they would benefit by time saved and a reduction in their administrative workload. If you are making a business case for an organization explain how the organisation will benefit from your findings.

Client & Audience: Coventry University and its students.

Motivation: This project aims to help the students by making it easier for them to record their attendance, when students enter the classroom, a camera will scan their face and record their attendance in that specific lecture/lab session. This would save the students time because the current card system are queue based, which means that, for example, when there are 100-200 students in a single classroom, it will take a long time for each one to scan their student cards to record attendance. Paper-based system is used to record when the card-based system is at fault, this consumes more time for the session to start. It would also benefit the students when the students forget to bring or when they lose their students cards, this means they cannot record their attendance when they are in the session and they also have to pay for a replacement student card. This project aims to take the students mind off unnecessary things before a session and help them focus on the session, as soon as they enter the session. It also aims to improve incorrect attendance recordings, as card-base system and paper-based system can be falsely signed in for students that are not even in the session.

The project aims to help Coventry University by recording whereabouts of students, by tracking when a particular student enters and leaves sessions. This will help the university confirm that correct student is attending the session and follow-up on the students who are missing lots of sessions, correctly because some students do not bother to record their attendance with their students card even though they are attending the sessions and the staff of Coventry university have to do the chasing up to the students saving both students and staffs time, which can be indulged into other important matters.

1.5 Primary Research Plan

Help: This is the plan as to how you will go about answering your detailed research question - It must include a primary research method (an extended literature review is not an acceptable primary method). Think and plan logically. Primary methods may include experiments, applications or software demonstrators, process models, surveys, analysis of generated data ...

Example: In the class register example above "to what extent does a mobile application reduce the number of errors made in class registers at Coventry University in comparison to current paper based registers" - the research plan may involve: 1) Collecting and analysing paper based registers in a given class on five occasions. 2) Identifying the error rate average on these occasions 3) Designing and implementing a mobile application that automatically records attendance in class. 4) Deploying the application in the class on five occasions. 5) Identifying the error rate average of the mobile application on these occasions. 6) Comparison of data and summary of findings.

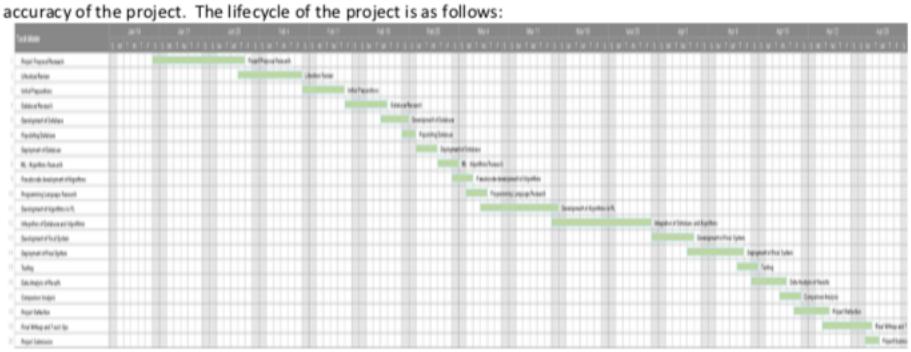
1. A database would be developed using an appropriate database system and a camera. The database would consist dataset of high-resolution pictures of 30-40 students, taking by the camera. Their details, such as their session's information, personal information etc. This is to get the student faces into the database to match up against the live image processing through machine learning algorithm later on, if it is matched then the student is automatically singed in as the student is supposed to be in the session. Size of 30-40 Students should be appropriate for the experiment, as this would give indication if the system would work in a larger environment and the amount of processing power that needs to be scaled in-order to match the system's demand in a larger environment. This method is non-intrusive, as only willing students will be photographed to be stored in the database.
2. Following the implementation of the database, a machine learning algorithms would be implemented using an appropriate programming language which will take the live video incoming from the camera, scan individual student faces in the classroom as image, by splitting the live video into image frames. The machine learning

algorithm will assign the obtain image frames into individual value of each student in the session.

3. Once developed, a new machine learning algorithm would be implemented get the individual processed images from the previous algorithm and extract facial features from the processed images: Eyes, Nose and Mouth. Extracting these features should give the algorithm a higher rate of accuracy as student's appearance can be changed overtime but their facial features are highly unlikely to change.
4. Following the completion of two machine-learning algorithms, a new algorithm would be developed to match the features extracted by the machine leaning algorithms against high-resolution images stored in the database. If the algorithm were successful and accurate on matching the correct students in the database, the algorithm would be extended to automatically sign-in matching students in the sessions. This experiment would be conducted in at least 3 sessions with the same students to ensure the datasets in the database are as accurate as possible.
5. After the completion of testing the system, data analysis would be conducted on the datasets stored in the database. This will help to produce a range of diagrams and comparison analysis in showing accuracy of the facial recognition system in detail.
6. A questionnaire would be designed to answer the research question. The questionnaire would be given to the 3-40 students who participated in the experiment and were in the sessions. The questionnaire would aim to answer on the ease and concentration boosted by the facial recognition system against paper-based/card-based system that are already implemented and used by the students. If it is believed that implementing facial recognition system helps Coventry University and its students better than using a card-based/paper based system to record attendance, the opinion and accuracy of the facial recognition system would be backed up with the evidence provided by the data analysis.
7. Finally, a critical review on the research methods used in the project will be started to measure the accuracy of the results obtained through the whole system and process, and what could be done to improve the process and the system in the future. This way the methods planned and used in this project and the research plan, will be justified.

Project Plan:

The project plan is visualized using Gantt Chart. Gantt Chart contains all the actions that are required to complete and predecessors, which must be completed throughout the project's Lifecycle. The Gantt chart's project plan could change depending on weekly/monthly meetings between supervisor, or if additional components are needed to increase the accuracy of the project. The lifecycle of the project is as follows:



This is the end of section one.

SECTION TWO: ABSTRACT AND LITERATURE REVIEW

2.1 Abstract

Help: An abstract is a short summary of a research project that enables other researchers to know if your report or research paper is relevant to them without reading the whole report. It is usually written retrospectively so that it can include findings and results. It is fully expected that you will rewrite your abstract when you come to write your final paper. For now, you should write an abstract of about 250 words that define the project described in section one. Before writing your abstract you MUST read some abstracts from conference or journal papers on *Google Scholar* or from

portal.acm.org (to understand their style) and then provide your own abstract that outlines what your question is and what you 'did' to answer it.

Face is an important part of a person, it is used to identify and differentiate identities of two or more individuals in real world. Different parts of the body has been exploited over the recent years, to ensure that only the legitimate individual has access to their respective accounts both in real world and in virtual. Different methods have been created, one being Biometrics, which consists identifiers such as Fingerprint, Palm veins, DNA, Palm print and Face recognition etc. Similarly, This project seeks to use one distinctive identifier of Biometrics, Face Recognition. The project aims to combine Face Recognition with image processing techniques and Machine learning algorithms to be deployed as an Automated Attendance System for Coventry University. The Automated Attendance System should be able to help Coventry Students to make it easier for them to record their attendance by not having to be dependent with Card-systems, as Student cards are often lost and paid to replace. This means they cannot prove their identity and record attendance instantly. The card-system is also at fault often with inaccurate attendance recordings, as it can be tricked or cheated when individuals are able to record attendance for others, or crash of the system, paper-based system have to be used in this event. This makes more time consuming for students and makes it harder for them to focus on the session. This project's objectives is to find out if facial recognition system is better at recording attendance than Card-based system/paper based system for Coventry University and it's students by implementing a Facial Recognition System and reviewing the system with the students.

2.2 Initial/Mini Literature Review (500 words – 750 words)

Help: A literature review is a select analysis of current existing research which is relevant to your topic, showing how it relates to your investigation. It explains and justifies how your investigation may help answer some of the questions or gaps in this area of research. A literature review is not a straightforward summary of everything you have read on the topic and it is not a chronological description of what was discovered in your field. Use your literature review to:

- compare and contrast different authors' views on an issue
- criticise aspects of methodology, note areas in which authors are in disagreement
- highlight exemplary studies
- highlight gaps in research
- show how your study relates to previous studies

1.

Title: Class Room Attendance System Using Facial Recognition System
Author: Abhishek Jha
Publisher: The International Journal of Mathematics, Science, Technology and Management
ISSN: 2319-8125 Vol.2 Issue 3
Description: The face is the identity of a person. The methods to exploit this physical feature have seen a great change since the advent of image processing techniques. The accurate recognition of a person is the sole aim of a face recognition system and this identification maybe used for further processing. Traditional face recognition systems employ methods to identify a face from the given input but the results are not usually accurate and precise as desired. The system described in this paper aims to deviate from such traditional systems and introduce a new approach to identify a student using a face recognition system i.e. the generation of a 3D Facial Model. This paper describes the working of the face recognition system that will be deployed as an Automated Attendance System in a classroom environment. (Jha, 2009)

Reason for Selection: This paper is key to understanding the basics steps of implementation of Facial Recognition system. This paper also provides different techniques that could be used to detect and extract the faces such as Colour based detection and Principle component Analysis. This research conducted in this paper provides better understanding of the steps, techniques and an appropriate system that the Automated Attendance System can be implemented upon.

2.

Title: Artificial Intelligence, A Modern Approach
Author: Stuart Russell, Peter Norvig
Subjects: Perception, Languages and Algorithms
Print ISBN 10 – 1292153962, **ISBN 13** – 9781292153964
Published: 2016
Language: English (Stuart Russell, 2016)

Reason for Selection: This book provides excellent research into Machine Learning Algorithms; It provides information on how the algorithms should be started and constructed, step-by-step. It also gives an insight to the previous works of early image processing techniques, which can be compared against recent image processing techniques. This should give a better insight into image processing techniques and Machine learning algorithms by providing computational and complex algorithms used by AI Agents, the flow and steps of algorithms will provide a clear structure for the Machine learning algorithm to be implemented in the Facial Recognition System and the mathematical parts of AI algorithms can be manipulated and implemented into a Machine learning algorithm.

3.

Title: Development of a Student Attendance Management System Using RFID and Face Recognition: A Review
Author: Unnati A. Patel; Assistant Professor, M.Sc. (IT) Department. Dr. Swaminarayan Priya; Professor & Head, MCA **Department**, ISTAR, V.V.Nagar, Gujarat, India ISTAR V.V.Nagar, Gujarat, India.
Publisher: International Journal of Advance Research in Computer Science and Management Studies
Published: 2014
ISSN: 232 7782
Description: Whole world and administrators of Educational institutions' in our country are concerned about regularity of Student attendance. Student's overall academic performance is affected by the student's present in his institute. Mainly there are two conventional methods for attendance taking and they are by calling student name or by taking student sign on paper. They both were more time consuming and inefficient. Hence, there is a requirement of computer-based student attendance management system, which will assist the faculty for maintaining attendance of presence. The paper reviews various computerized attendance management system. In this paper basic problem of student attendance management is defined which is traditionally taken manually by faculty. One alternative to make student attendance system automatic is provided by Computer Vision. In this paper we review the various computerized system, which is being developed by using different techniques. Based on this review a new approach for student attendance recording and management is proposed to be used for various colleges or academic institutes. (Unnati A. Patel, 2014)

Reason for Selection: This paper looks into more approaches to Biometrics Techniques, both behavioural and Physical. This paper helps to understand all the techniques that can be used and manipulated to increase the accuracy of the Facial Recognition system. This paper gives insight into all behavioural and physical systems that are researched thoroughly with components required for them to be implemented. This can be used to compare and contrast with the components required and the components that are already available. It also gives an insight to how far the machine learning algorithms can be written and how much processing power the algorithms would consume and additional equipment that may be integrated to increase the accuracy of the overall system.

2.3 Bibliography (key texts for your literature review)

Help: Please provide references, in correct Harvard style, for at least three key texts that have informed your literature review. If you are implementing an application, select texts which demonstrate how other researchers have tackled similar implementations? The references should be recent and sufficiently technical or academic. Your markers will be looking for you to identify technical reports, conference papers, journal papers, and recent text books. Avoid *Wikipedia* entries, newspaper reports that do not cite sources, and general or introductory texts.

THIS IS THE END OF SECTION TWO

DETAILED PROJECT PROPOSAL GRADING FORM

The grade sheets for marking the 300COM / 303COM Detailed project proposal are attached on the next page.

Grading Notes:

The proposal is marked out of 20 divided into 10 marks for the quality***, achievability and level of challenge demonstrated by the student's research question and proposed primary method*** **of solution generation** and 10 marks for the ***thoroughness of the proposa***l.

Modal grading: In awarding marks please consider the following modal template:

	Research question and primary research method in relation to learning outcomes	**Thoroughness of the proposal.**
>70%	A well-considered project proposal that fully satisfies the Learning outcomes for which there is a succinct and focused aim with an associated project A question or hypothesis that is well above norm for final-year undergraduate project level (approaching Masters level for >80%); The project involves improving or developing a complex programme, tool, application or the enhancement of a theory or methodology or their application in a new context. The project demonstrates a high degree of innovation and creativity	All fields completed demonstrating a clear blueprint for the research process and includes the necessary information with respect to the research question. Research methods are well-considered with clear reasoning for choice of those methods over others; A clear justification of the need for the project in relation to client or audience. Projects proposals involving 'business case' reports clearly identify the organisation involved and consider how the case will be evaluated. A sound grasp of the means of evidence by which the conduct and management of the project may be judged.
Threshold (40%)	A proposal that identifies an activity with some consideration of a broader context. A research question which lacks enough substance, context and scope to allow for depth of analysis, but which is marginally acceptable against a threshold for final year undergraduate projects; A primary method(s) which only just relates to the production of an appropriate solution to the research question.	Completion of sections is cursory or minimal with some cohesiveness and contextualisation. Sections demonstrate some understanding of the research process involved which loosely links with idea outlined (key question, method, audience); Research methods are discussed but demonstrate little consideration as to whether they are the most appropriate and lack refinement and further detail. Identification of some methods of evidence for conduct and management of the project but unclear thinking about planning for reflection or accounting for conduct.

Appendix F – Presentation Slide & Feedback

Coventry University | PG/UG Project Meeting Record | Faculty of Engineering & Computing

Face-To-Face Student/Supervisor Meeting Record

Project Title:	Facial Recognition System/Attendance System	**Photo:**	
Student Name:	Ass Rei	**Student ID:**	6528683
Supervisor:		**Student UID:**	
Supervisor UID:		**Department:**	
Course Code:		**Module Code:**	300COM / 303COM
Date Today:	23/04/2018	**Time:**	11:52

Current Progress and Issues:

(Include challenges encountered and actions taken to overcome them)

Challenges: finding wide programming languages, machine learning algorithms.

Progress: Managed to finish the program, with trial and error, picked C++ and visual studio to code the program as can use viola jones machine learning algorithms for facial features extraction and open faces algorithms for detection.

Agreed Key Action Points:

(Include dates of any deadlines)

Expand literature review => Management chapter, add 1 summary chapter on social / legal / ethical / professional issues, do critical evaluation on literature review, make a presentation PowerPoint for Appendix in main document.

* Risk analysis
* project plan.

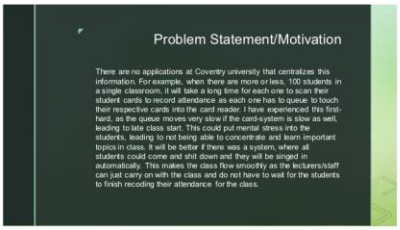
Date and Time of next meeting:	30/04/2018 11:30

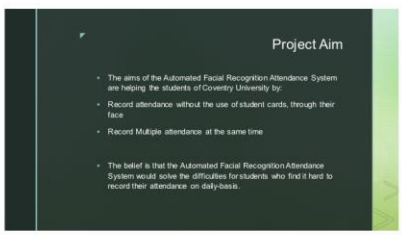
Signatures of those present:

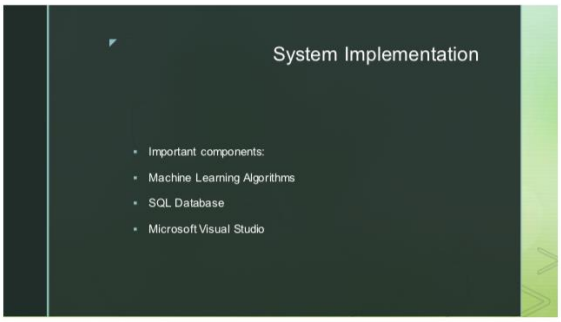
Supervisor:

Student:

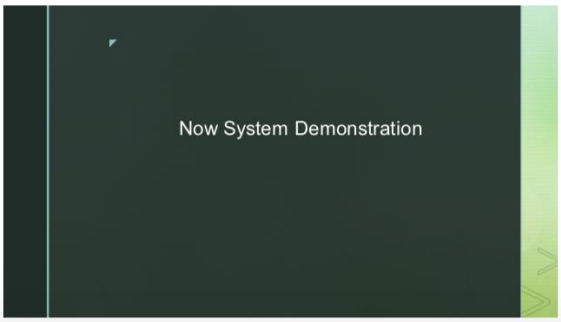
RJR/Oct2014/XTier4 | Page 1 of 1 | AAEEE/ug-pg-project-meeting-form-photo

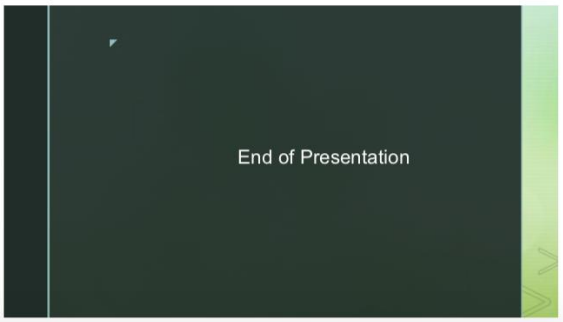





System Implementation
Important components:
Machine Learning Algorithms
SQL Database
Microsoft Visual Studio


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


Now System Demonstration


End of Presentation

Appendix G – Evidence of Achieving Functional Requirements

G.1. Database Schema

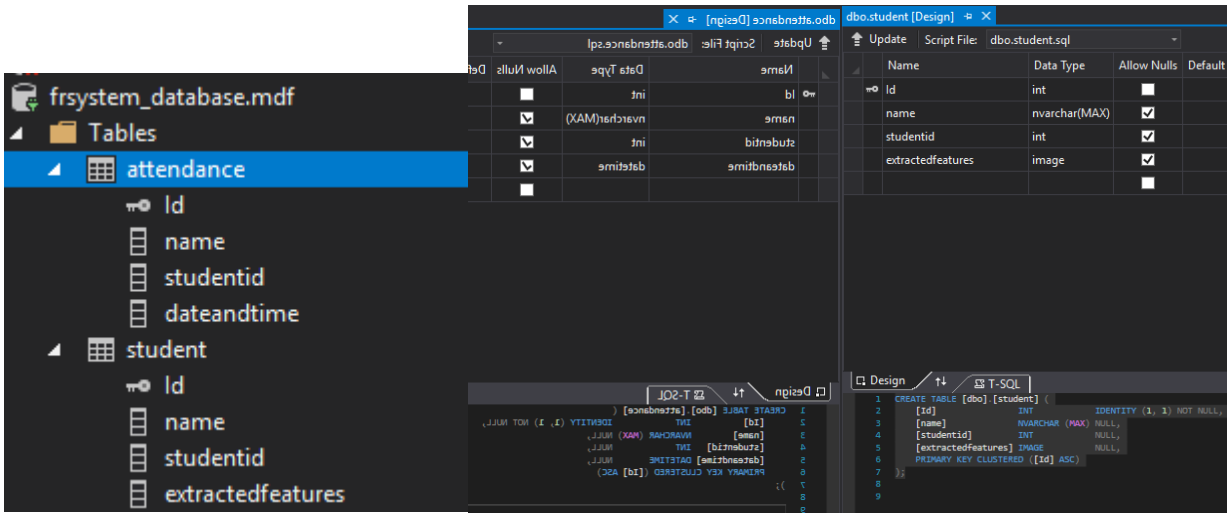


Figure 41- Evidence of Database Schema

G.2 Algorithms from OpenCV Library

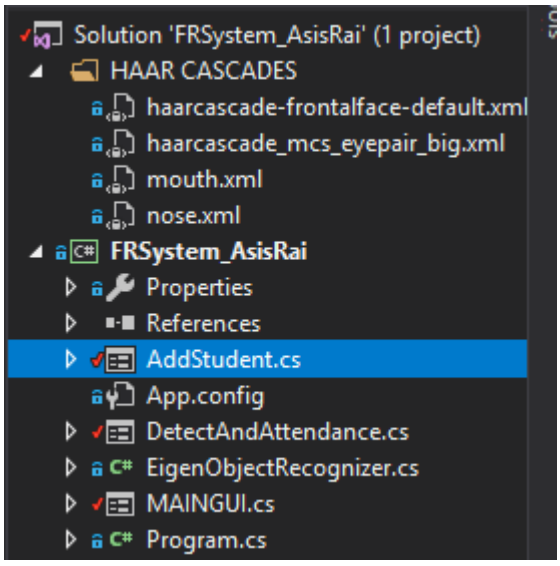


Figure 42 - Algorithms imported from OpenCV Library

G.3 Microsoft Visual Studio which integrates database and OpenCV library

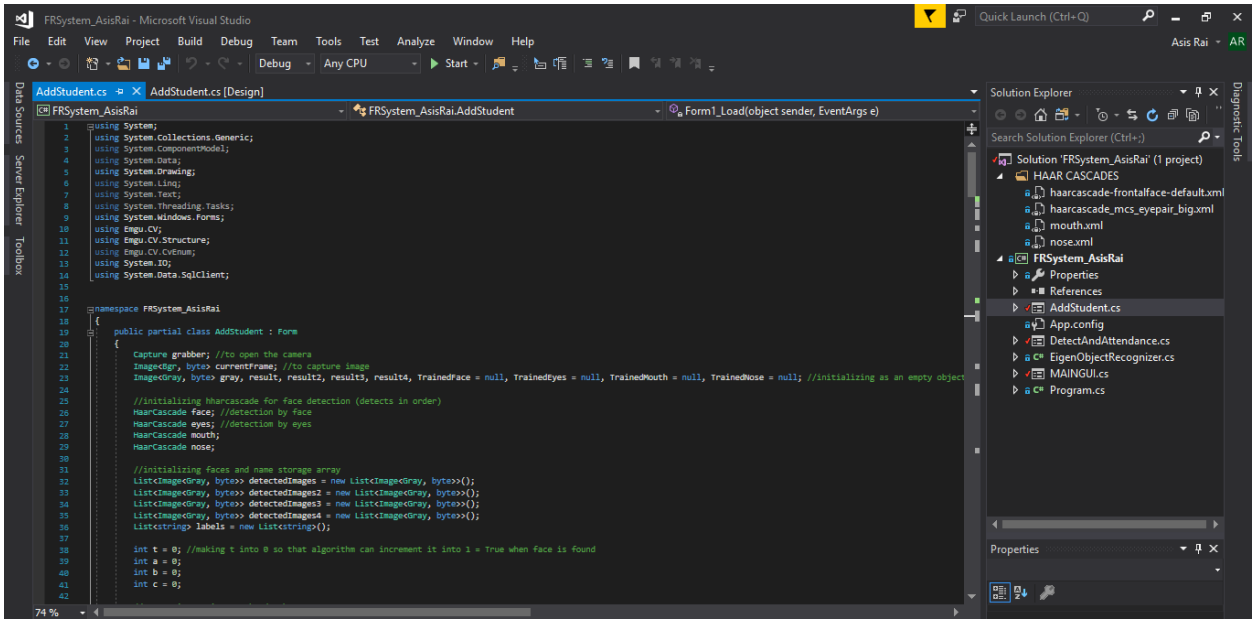


Figure 43 - Programming Language

G.4 Camera is compatible

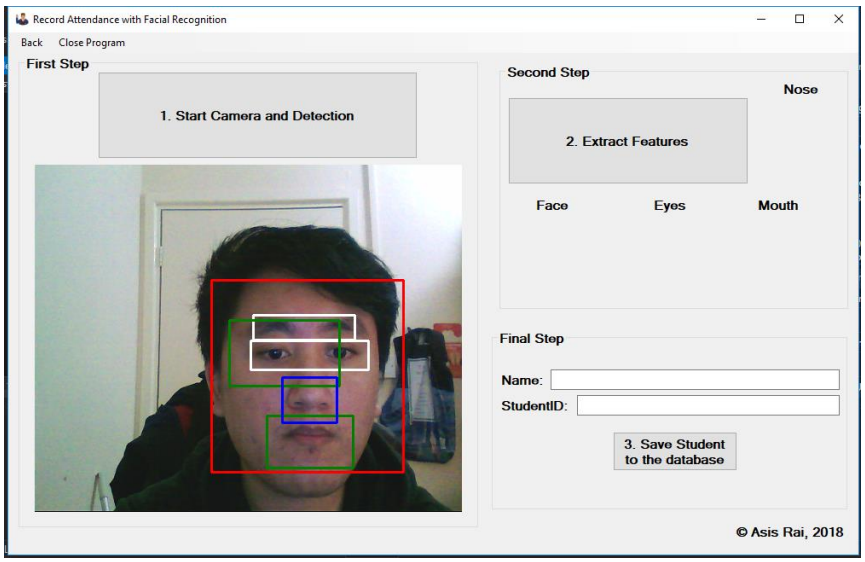


Figure 44 - Camera Compatible and Working

G.5 The system must detect faces to extraction and storage of faces

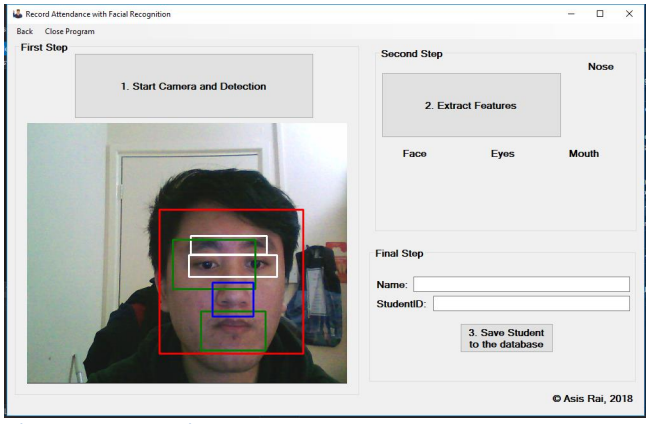


Figure 45 - Detection

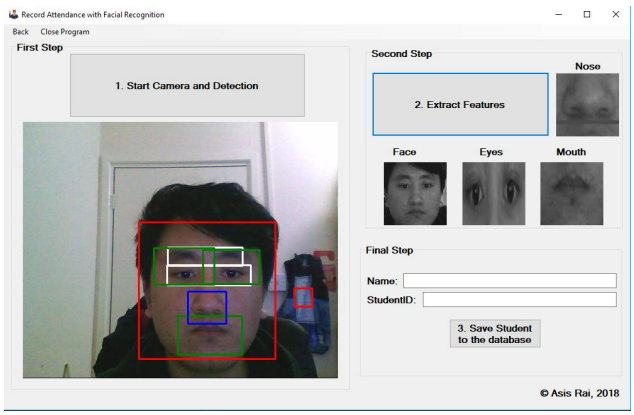


Figure 46 - Features Extraction

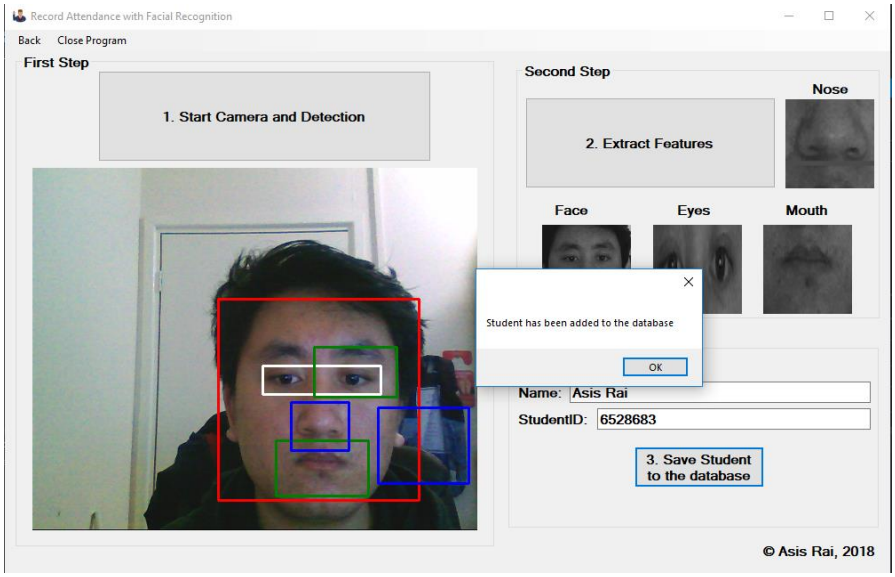


Figure 47 - All data stored in database

G.6 The system must detect faces to detect and take attendance

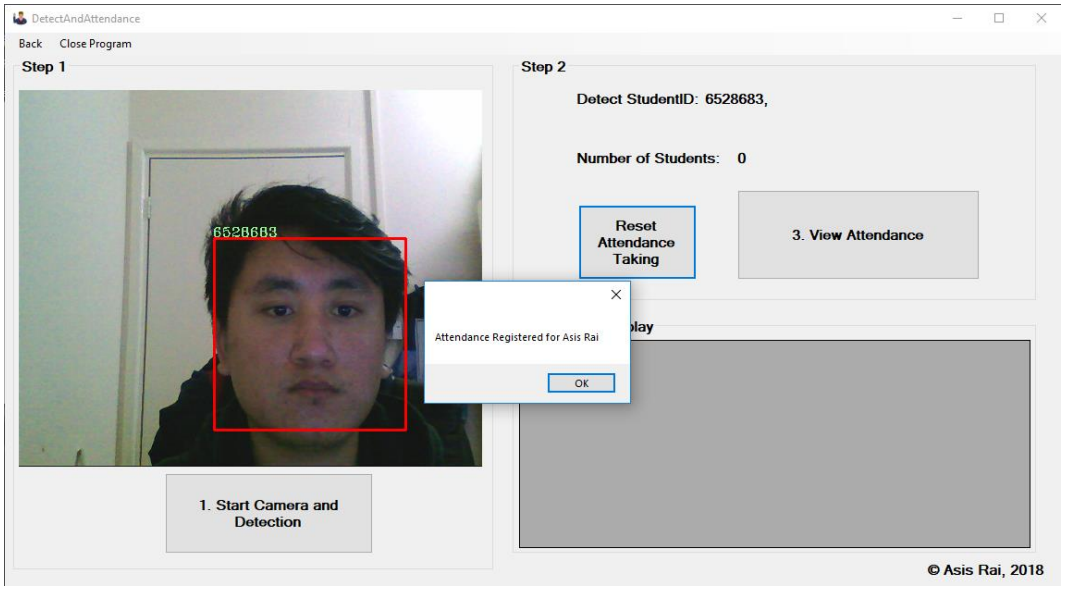


Figure 48 - Detection& Attendance Recorded

G.7 The system must show record of attendance taken

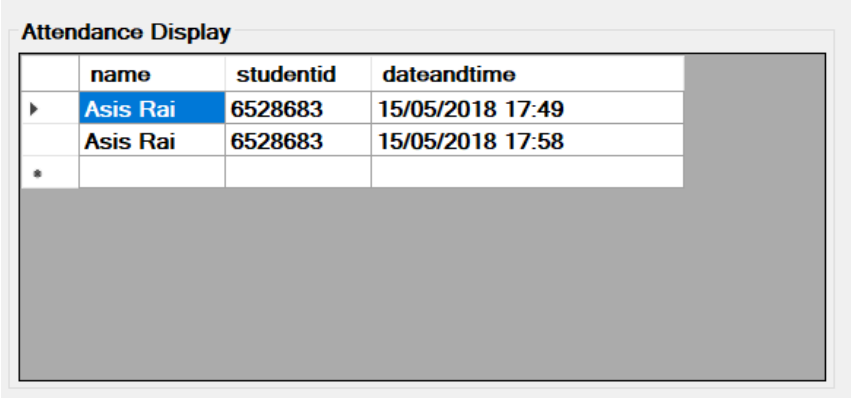


Figure 49 - Attendance Display

Appendix H – User Acceptance Testing

H.1 User Acceptance Form

Facial Recognition System to automatically record attendance of Coventry University Students

System Feedback Questionnaire

1. What is your name?

2. What is your age?

- 18-20
- 21-23
- 24-26
- 27 or over

3. Are you a student of Coventry University? If yes, please write your student ID.

4. What are your issues with the card/paper-based attendance system in Coventry University?

5. What did you think of the facial recognition system to automatically record your attendance using your face?

6. Do you think that the facial recognition system is more efficient than the card/paper-based system that is currently implemented? If so, please explain how it aids in your education and student life.

7. Does the new facial recognition system help you resolve the issues you were having with card/paper-based system? if so, please expand.

8. How do you think the facial recognition system helps the university, in-terms of false/inaccurate attendance of students?

pg. 1

9. Do you have any suggestions/improvements for the facial recognition system which automatically records attendance of Coventry University students?

H.2 User Accepting Testing Results

Student 1's Feedback:
4. Forget to sign in sometimes, forget to bring card sometimes as well
5. Very fast, so easy to sign in
6. Yes, I just had to sit down, and I was signed-in

7. Yes, I don’t have to bring my card with me
8. Friends cannot sign in each other
9. Could be expanded to automatically opening doors when face is detected

Student 2’s feedback:
4. Once sat down, cannot be asked to get up and sign in because of the long queue
5. Amazing system, brilliant idea to sign in students
6. Yes, I don’t have to wait in a queue in every 9am lectures
7. Yes, if It was in already at the university. I would just go and sit down and not worry not being signed in.
8. I do like the idea of other people not cheating
9. Yes, add it to the University already. This is an amazing way to signing in.

Student 3’s Feedback:
4.I forget to bring my card every day, I have been in university every day for a week, but I have not been signed in, not once.
5. Design looks simple and easy to use, it signed me in as soon as I stepped in front of the camera, in less than a second. Amazing!
6.Maybe, if it was being used at university at this moment, then it could have been easier to tell
7.Yes, even if I forget to bring my card I would still be signed in
8. what if they are twins?
9.why not ask the university to have a look at this and ask them if they want to use it?

These are the feedbacks, that stood out the most and gave meaning to the user acceptance testing results. 10 Feedbacks were collected in total however other feedbacks were similar to the feedbacks listed above, therefore they are not listed in this appendix.

Appendix I – Signed Meeting Records from Supervisor

303COM Record of supervisor meeting

Supervisor: D. Nkantah

Student: ASIS RAI

Date of meeting: 1/12/2017

Key topics Discussed:

AI -> Natural language, Image Processing, Medical Diagnosis, Classified, Prediction

Individual action points for next meeting (no more than 3):

* Think about topics discussed.

Record of individual actions completed + notes:

Date of next meeting: 12:15, Friday 8/12/2017

Supervisor signature: _____

303COM Record of supervisor meeting

Supervisor: DIANABASI NKANTAH

Student: Asis Rai

Date of meeting: 5/11/2017

Key topics Discussed:

Image Processing, Intergrated with AI

Individual action points for next meeting (no more than 3):

Look at image processing frameworks

Look at image processing databases

Record of individual actions completed + notes:

Ideas collected to be discussed.

Date of next meeting: 6/11/2017

Supervisor signature: _____

303 Com

~~305AEE/306AEE~~ Record of supervisor meeting

Supervisor: DIANABASI NKANTAH

Student: Asis Rai

Date of meeting: 21/2/2018

Key topics Discussed:

Literature review expansion.

Aims and objectives.

Individual action points for next meeting (no more than 3):

Layout of Report Chapter.

Introduction Chapter

Aims and objectives.

Record of individual actions completed + notes:

Project proposal.

Date of next meeting: 2/3/18 11:50 AM

Supervisor signature: DK.