Applied Information Technology And Computer Science Vol. 2 No. 2 (2021) 1696-1708

AITCS

Homepage: http://publisher.uthm.edu.my/periodicals/index.php/aitcs
e-ISSN :2773-5141

Facial Recognition for Smart Attendance Management System Using Local Binary Patterns Histograms

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DOI: https://doi.org/10.30880/aitcs.2021.02.02.110
Received 04 August 2021; Accepted 04 October 2021; Available online 30 November 2021

Abstract: Automatic face recognition (AFR) technologies have achieved numerous advancements in the changing world. Smart Attendance using Real-Time Face Recognition is a real-world solution which comes with day-to-day activities of handling student attendance system. In the previous system using QR code which is not easy and intuitive. Students need to take out their phones, open their QR code reader, and scan the code in front of them. The entire process can be time consuming which is frustrating. The purpose of this project is to build a smart web-based attendance system which is based on face recognition using OpenCV's Local Binary Patterns Histograms. The major steps in this system are detecting the faces and recognizing them. After these, the comparison of detected faces can be done by crosschecking with the database of student's faces. The System prototyping is used as the methodology for developing the proposed system. After that, the student attendance record will be saved in the database and the student can see their attendance percentage by logging in the system and lecturer can edit & update if its required. This smart system will be an effective way to maintain the attendance and records of students and the issue of fake attendance and proxies can be solved.

Keywords: Smart Attendance System, Face Recognition, Local Binary Patterns Histograms.

1. Introduction

Attendance is an evidence of a person's presence. It is currently found almost everywhere such as institution, organizations, hospital, etc. It is so important nowadays in educational institutions like Universiti Tun Hussein Onn Malaysia (UTHM) because student who have attendance below 80 percent will be unable to proceed for the final examination. From early days until now, mostly attendances in institution are still manually recorded by lecturers calling out the names of students one by one. This seems to be wasting time especially when the number of students is huge magnetic card is relatively common way to take attendance, but magnetic care is fragile and easily lost. Some institution used Quick Response code-based attendance system which is not easy and time consuming. QR code

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scanning functionalities are often sensitive to light and focus. In order to avoid this issue, a smart attendance system based on face recognition is introduced. According to Yongqiang [1], the human face is a unique representation of individual identity. Thus, face recognition is defined as a biometric method in which identification of an individual is performed by comparing real-time capture image with stored images in the database of that person. Face recognition system is prevalent due to its simplicity and awesome performance. For instance, airport protection systems and Federal Bureau of Investigation use face recognition for criminal investigations by tracking suspects, missing children, and drug activities [2]. Apart from that, Facebook which is a popular social networking website implement face recognition to allow the users to tag their friends in the photo for entertainment purposes [3]. Traditional method of attendance marking is a tedious task in many schools and colleges. Some institution using QR code which is not easy and intuitive. Students need to get out their phones, open their QR code reader, and scan the code in front of them. QR code scanning functionalities are often sensitive to light and focus. Because of the close shot required by such scanners, some smartphones fail to produce good results or require the students to point to the code in a special manner. The entire process can be long and frustrating. Therefore, many institutes started deploying many other techniques for recording attendance like use of Radio Frequency Identification (RFID), iris recognition, fingerprint recognition, and so on. However, these systems cause a long queue of students in the beginning of class which consume more time and they are intrusive in nature [4].

Therefore, current study is carried to build an attendance system which is based on face recognition using OpenCV's LBPH algorithm. Here face of an individual will be considered for marking FSKTM, UTHM students' attendance. So, it will be easy to use, security of database, accurate, time saving. The proposed system will include automatic management of the check in of student's attendance function. This system will be governed by the lecturers and thus covers only student study within FSKTM. The system will be maintained daily by the administrator or lecturer, and they can add, modify, and delete data on the database of the student. The lecturers under FSKTM register their identification to treat it as unique identification for login to the system. Student also can login to the system using their name and password to see their attendance according to date. The main concern will be the functions of system that identifies the student, recording check in of each lecture he or she has attended. The remainder of this paper is organized in sections: 2- investigate the literature of attendance management system, 3- justify the system designing with different characteristics, 4- discusses the implementation steps of proposed research and 5- verify and conclude the proposed research.

2. Literature Review

2.1 Student attendance

According to Corbulid learners dictionary Attendance is the fact that someone is present at an event or go regularly to an institution, or the attendance at an event is the number of people who are present at it. Furthermore, if someone is in attendance of a place or event, they are present. Empirical evidence has shown that there is a significant correlation between students' attendances and their academic performances [5]. There was also a claim stated that the students who have poor attendance records will generally link to poor retention [6]. This is also agreed by Mazza and Dimitrova where they both claimed that the students' attendances to the course may indicate their behaviors towards the subject where it can be used to judge their tendency and commitment to the course [7].While the move towards the digital era is being accelerated every hour, biometrics technologies have begun to affect people's daily life more and more. Biometrics technologies verify identity through characteristics such as fingerprints, faces, irises, retinal patterns, palm prints, voice, hand-written signatures, and so on. These techniques, which use physical data, are receiving attention as a personal authentication method that is more convenient than conventional methods such as a password or ID cards. The biometric personal authentication uses data taken from measurements. Such data is unique to the individual and remains so throughout one's life. [8]It is important to identify the correct tools to use in commercial and

scientific studies. Barcode readers, Radio Frequency Identification (RFID) system, Bluetooth and NFC are just a few of the examples of such tools [9]. However, they were expensive when first introduced and therefore they had limited use. Nowadays, these technologies become cheaper, and they can be used in various applications, such as, identification, counting, tracking, or positioning. Barcodes and their readers are greatly used in markets to identify the sales objects.

2.2 Web base student attendance

Web based system is a set of functions, logic, the method as a standard exchange of data between applications or systems that can be accessed remotely by various devices with different programming languages, architectures, or platforms. Web services must be stateless so that they can be read and located multi-platform [10]. The structure of the web service can be built using Simple Object Access Protocol (SOAP) or Representational State Transfer (REST), while the function is represented in the form of text, JSON or XML format. Web based student attendance system is an innovative way to monitor and track the attendance of students. Web based system has replaced the previous paper-based premises of attendance system. The new system can now handle large number of attendees and events over large networks. Web based attendance system is easy to use and yet very powerful attendance management system that has a firm grip over schools, laboratories, committees, offices, business organizations etc. networks. Web based attendance system is easy to use and yet very powerful attendance system that has a firm grip over schools, laboratories, committees, offices, business organizations because the system can be accessed from anywhere around the globe. Web based attendance systems ensure accurate time records and minimize the inevitable and costly errors with manual data entry. Web based attendance management systems to suit your needs based on the nature of work and policies. There are systems available which can be integrated with any third-party attendance hardware (swipe, biometric), and which can capture GPS-based attendance with mobile applications. Also customized attendance policies as per organizational needs with time tracking and attendance monitoring systems. Hence, provide individual configurations for each attendance shift, with options to define attendance cycles, mark-in/out rules, leave deductions, and optional holidays.

2.3 Existing Systems versus the Proposed System

Table1shows a precise summery of the comparison between the three existing system and proposed system, namely Attendance System Using NFC Technology with Embedded Camera on Mobile Device, Fingerprint Based Attendance System Using Microcontroller and Lab view, RFID Based Student Attendance System and the proposed system which is a Smart Attendance Management System Based on Facial Recognition. Among all the system compared, the three existing system is not web based except the proposed system where student and lecturer can access the system anytime and anywhere if they have internet connection. Efficiency of taking attendance in NFC based attendance system and fingerprint-based attendance system is high. On the other hand, face recognition-based attendance system the efficiency will be very high. In NFC and RFID based attendance system spoofing is possible. But in fingerprint and face recognition-based attendance system spoofing is impossible because every person has unique face and fingerprint structure. Lastly, the overall performance of the proposed system is higher than the three-existing system.

Table 1: Comparison between existing systems with proposed system

System Features	Attendance System Using NFC Technology with Embedded Camera on Mobile Device	Fingerprint Based Attendance System Using Microcontroller and Lab view	RFID Based Student Attendance System	Smart Attendance Management System Based on Facial Recognition
Web based	This system is not web based system	This system is not web based system	This system is not web based system	This system is web-based system
Efficiency	High	High	Medium	Very high
Spoofing or impersonation	Possible	Impossible	possible	Impossible
Graph and report	Does not produce a graph but produce a report.	Does not produce a graph but produce a report.	Does not produce a graph but produce a report.	Does not produce a graph but produce a report

3. Methodology

Methodology chosen for this system is System prototyping which consist of four phases, planning phase, analysis phase, design phase, and implementation phase respectively. All the four phases are repeated in a cycle until the system is fully developed. Figure 1 shows the model of System Prototyping.

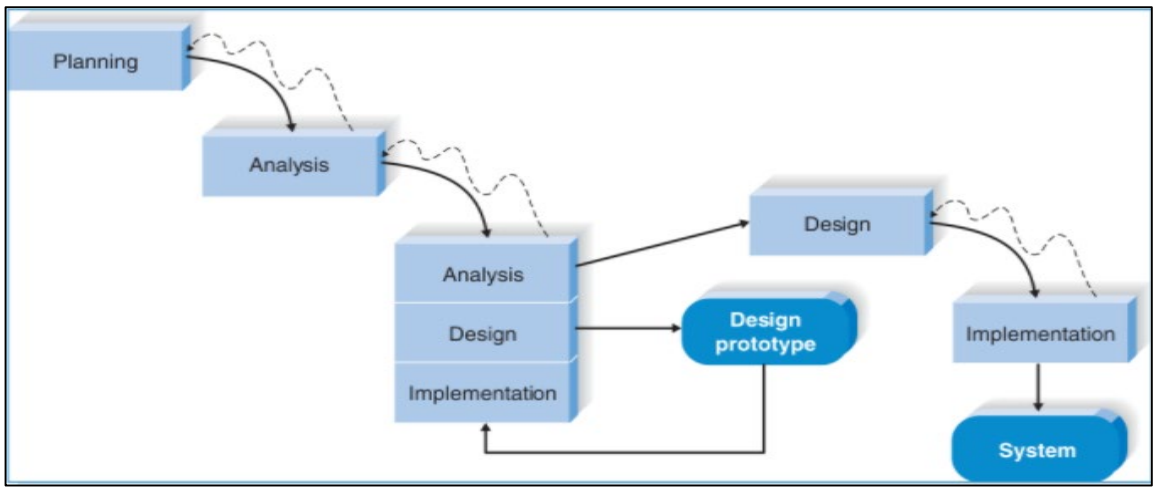


Figure 1: Model of System Prototyping [11]

3.1 Planning Phase

A systematic planning was also being conducted in order to ensure the activities that carry out during developing the project will be systematic manner. Thus, a Gantt chart was developed as a guideline for the task that must be carried out. Gantt chart was designed to ensure that the system. will develop smoothly. Each activity is assigned a time and each of this activity should be completed in time given time.

3.2 Analysis Phase

Structured approach (System Analysis and Design) was used in this project. Data Flow Diagram (DFD) and Entity Relationship Diagram (ERD) of smart attendance system for FSKTM will be created in this phase. Data flow diagramming is a technique that diagrams the business processes and the data that pass among them. An entity relationship diagram (ERD) is a picture which shows the information that is created, stored, and used by a business system[11].

3.3 Design Phase

The system architecture was implemented by analyzing the data and process models that have been determined in the analysis phase. Sketches system was initiated in the early stages of design. Interface design and database of the system can be illustrated more clearly in the modeling entity relationship diagram (ERD) and flowchart. Data Flow Diagram (DFD) is generated so that the system can be developed to fulfill the scope and objectives that have been set in the planning phase. Furthermore, the database of the system was designed carefully so that it is compatible with the input and output designed in the system interface. This database is developed according to suitability and requirements of the system. In this project, MySQL will be used in designing the database. The system interface design and database design will be used as a guideline when implements the prototype.

3.4 Implementation Phase

In this phase, the source code will be made to allow the proposed system can be tested by users of the system. Among the activities involved in this stage are to test the database, programming, module testing and system testing. The database will be tested by ensuring that data can be accessed from the database. Whereas, testing of the program was conducted to ensure that the program built without any problems. Module testing is done to test the functionality of each module. The system testing is needed because it involves the users of the system.

A smart attendance system will be implemented by using programming language which is hypertext Preprocessor (PHP). When the prototype is done, it will be evaluated by user. If the system does not meet the requirements of users and needs to be repaired, process improvements will be made.

4. System Analysis and Implementation

In this section will discuss about System Architecture, Context Diagram (CD), Data Flow Diagram (DFD) and Entity Relationship Diagram (ERD) that relates to propose system. Moreover, there are some sub-topics will be highlighted like dataset creation, face detection, user interface, and functional testing.

4.1 System Architecture

The system architecture of the smart attendance management system is a 2-tier architecture. This is because the web application has a user interface that runs on a client with a data layer that gets stored on the server. The two-tier software framework that was adopted in this work is XAMPP server and deliver a windows friendly platform for PHP, Apache web server and MySQL.

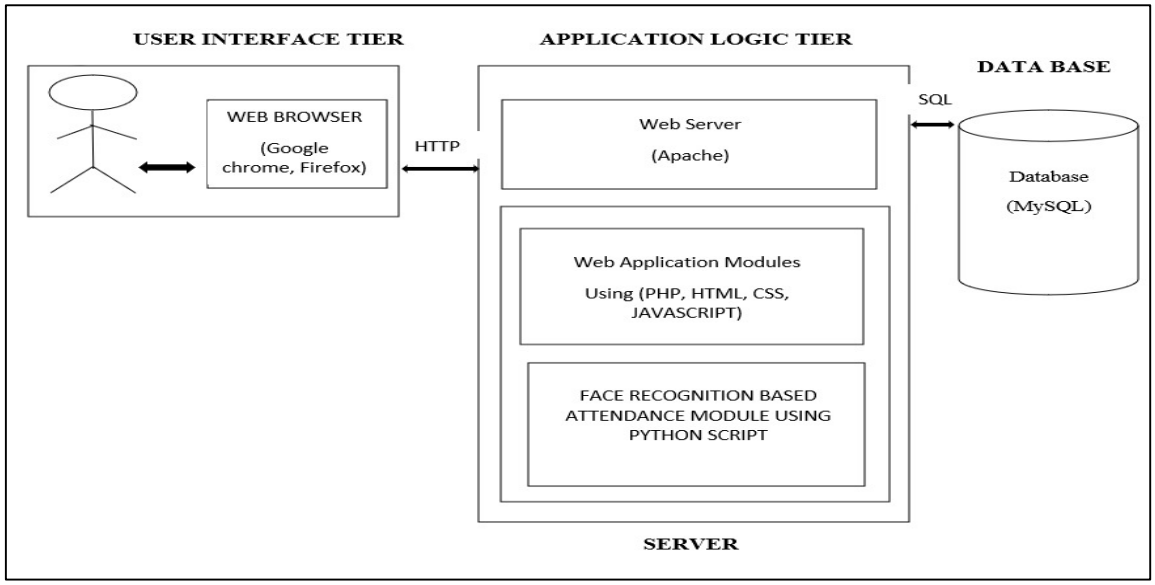


Figure 2: Two-tier architecture of the smart attendance management system

4.2 Context Diagram

Context diagram, data flow diagram (DFD), and entity relationship diagram (ERD) will be explained in this section. In context diagram there will be two entities involved that are student and lecturer. Figure 3 shows the context diagram for smart attendance system based on face recognition using PCA.

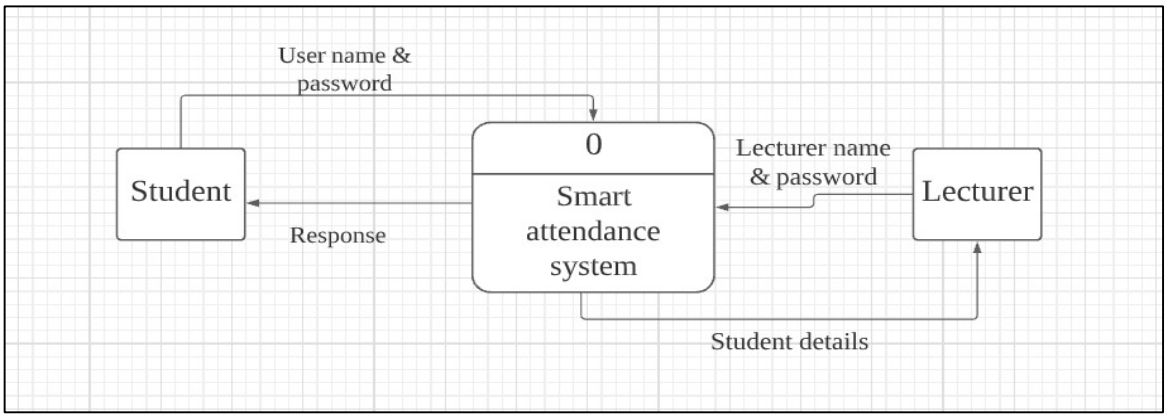


Figure 3: Context diagram

4.3 Data Flow Diagram

Data flow diagram (DFD) level one is the extended version of context diagram that includes with processes in the proposed system. The smart attendance system has five processes. Figure 4 shows the data flow diagram for smart attendance system. The diagram is shown in Appendix A.

4.4 Entity Relationship Diagram

Entity relationship diagram (ERD) shows the relationship between entities and attributes. ERD is a drawing form of database before implementation in database server. Figure 3 shows the entity relationship diagram for smart attendance system. The diagram is shown in Appendix B.

4.5 Dataset Creation

Images of students are captured using a web cam. Multiple images of single student will be acquired with varied gestures and angles. These images undergo pre-processing. The images are cropped to obtain the Region of Interest (ROI) which will be further used in recognition process. Figure 3 shows the sample of the photos took as a dataset.

Figure 4: Sample of photos took as a dataset.

4.6 Face Detection Algorithm

Student log into the system then press give attendance button then camera will open and detect their attendance and mark as present and stored in the database. Flowchart of the proposed face recognition algorithm is illustrated in Figure 5.Here, it will show how the LBPH algorithm works to recognize face by matching with dataset images.

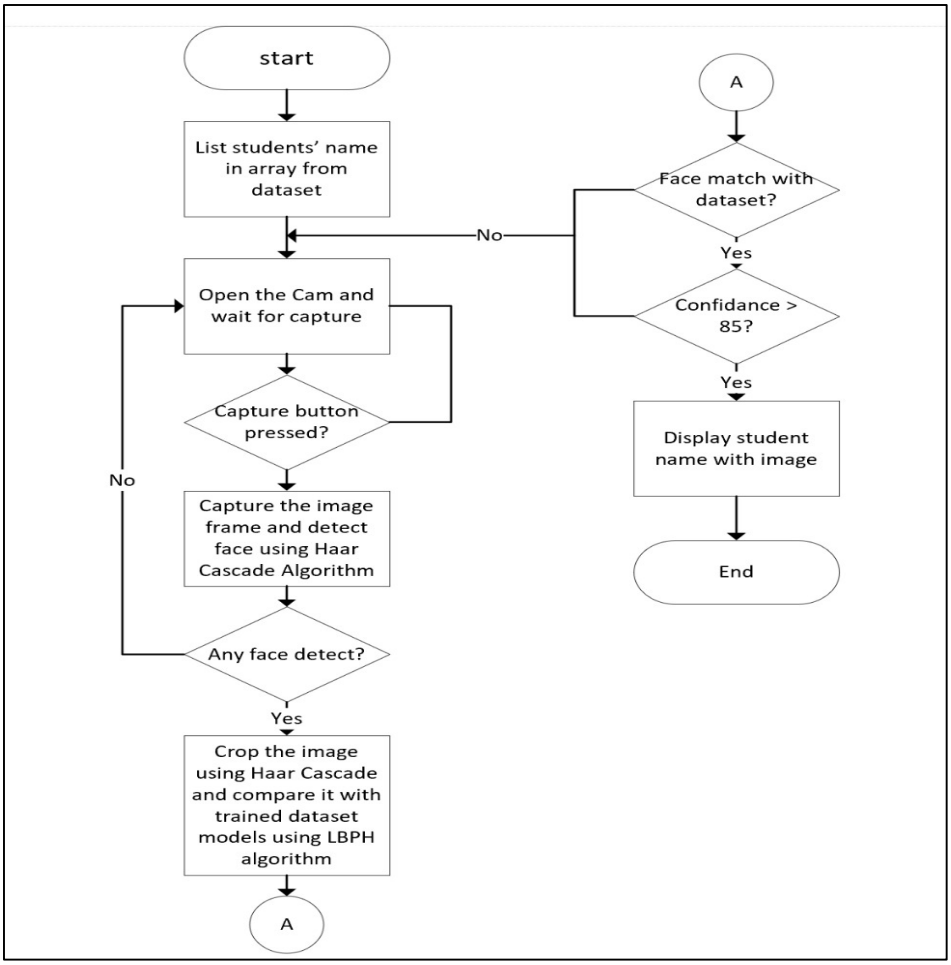


Figure 5: Proposed Face Recognition Algorithm

Result of the proposed algorithm on recognizing any face present in the dataset is shown in Appendix C.

4.7 Attendance Details

Student attendance will be captured after face is matched. Students can view their attendance in the interface shown in Appendix D. Lecturer can also view attendance details and update if its required. The interface is shown in Appendix E.

4.8 Activate Attendance Operation

Lecturer can select the course and active the attendance process. The interface will be shown in Appendix F.

4.9 Interface Design

Interface design is concentrates on looks, style, and designs of web pages. Interface design is created to show how the actual user interface will looks like. An interface should be easy and convenient to use. Figure 6 and Figure 7 shows the student interface design for registration and login page.

Figure 6: Registration Page

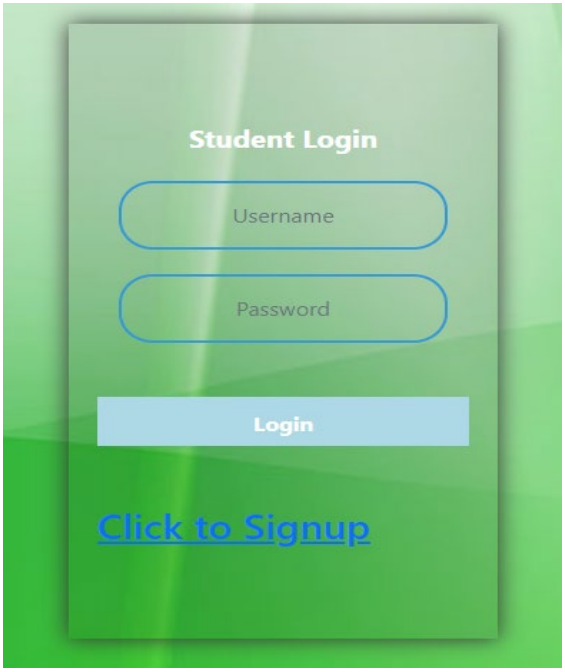


Figure 7: Login Page

4.10 Functional Testing

Functional testing is a type of black box testing which treats the system as “black box”, examining the system functionality without deal with the internal system implementation and is a specification-based testing [12]. The system testing was conducted during alpha phase by the developer based on requirements. Table 2 will show the functionality testing of Generate attendance and Give attendance functionality will be shown in table 3.

Table 2: System Functionality Testing of Generate Attendance

Test Cases	Software Requirement	Description	Output
TEST_100	**SRS_REQ_100**	**Generate Attendance**	**PASS/FAIL**
TEST_100_001	SRS_REQ_101	Lecturer can select courses	pass
TEST_100_002	SRS_REQ_101	Lecturer can activate the attendance taking process	pass
TEST_100_003	SRS_REQ_101	Lecturer can deactivate the attendance taking process	pass

Table 3: System Functionality Testing of Give Attendance

Test Cases	Software Requirement	Description	Output
TEST_200	**SRS_REQ_200**	**Give Attendance**	**PASS/FAIL**
TEST_200_001	SRS_REQ_201	Students click on the give attendance button	pass
TEST_200_002	SRS_REQ_201	Student can give attendance when lecturer activate the system	pass

5. Conclusion

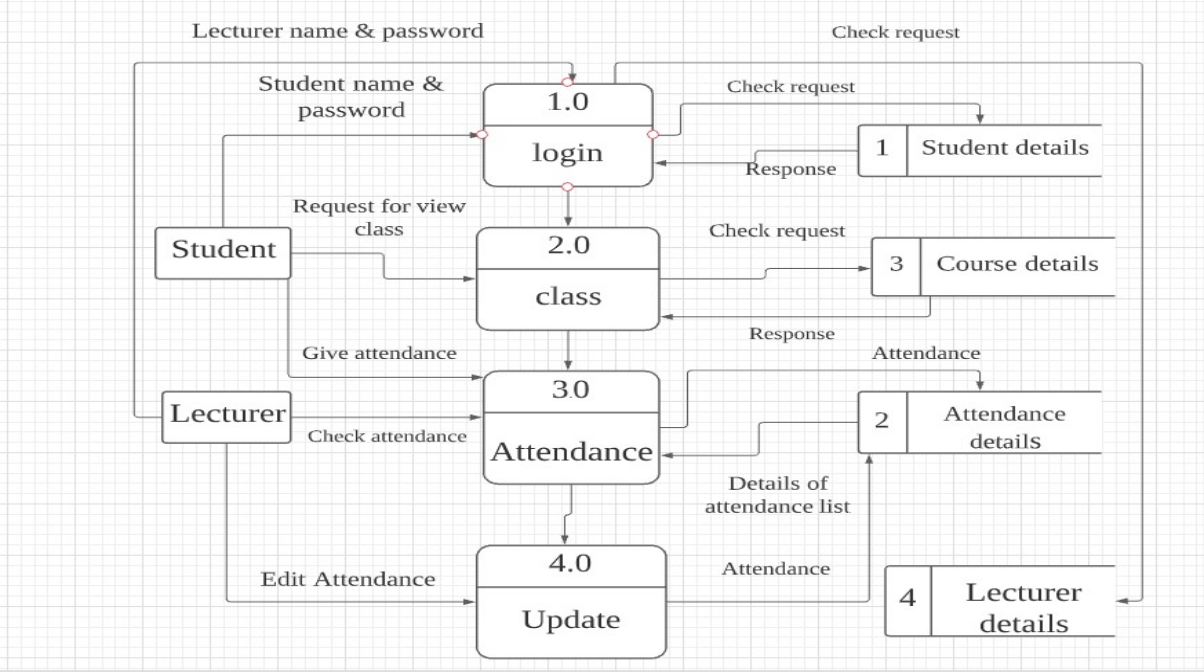
This system aims to build an effective class attendance system using face recognition techniques. The proposed system will be able to mark the attendance via name. It will detect faces via webcam and then recognize the faces. After recognition, it will record the recognized student's attendance and enter it into a database where the student can check their attendance and the lecturer can monitor and edit the attendance record.

Acknowledgement

The authors would like to thank the Faculty of Computer Science and Information Technology, Universiti Tun Hussein Onn Malaysia for its support and encouragement throughout the process of conducting this study.

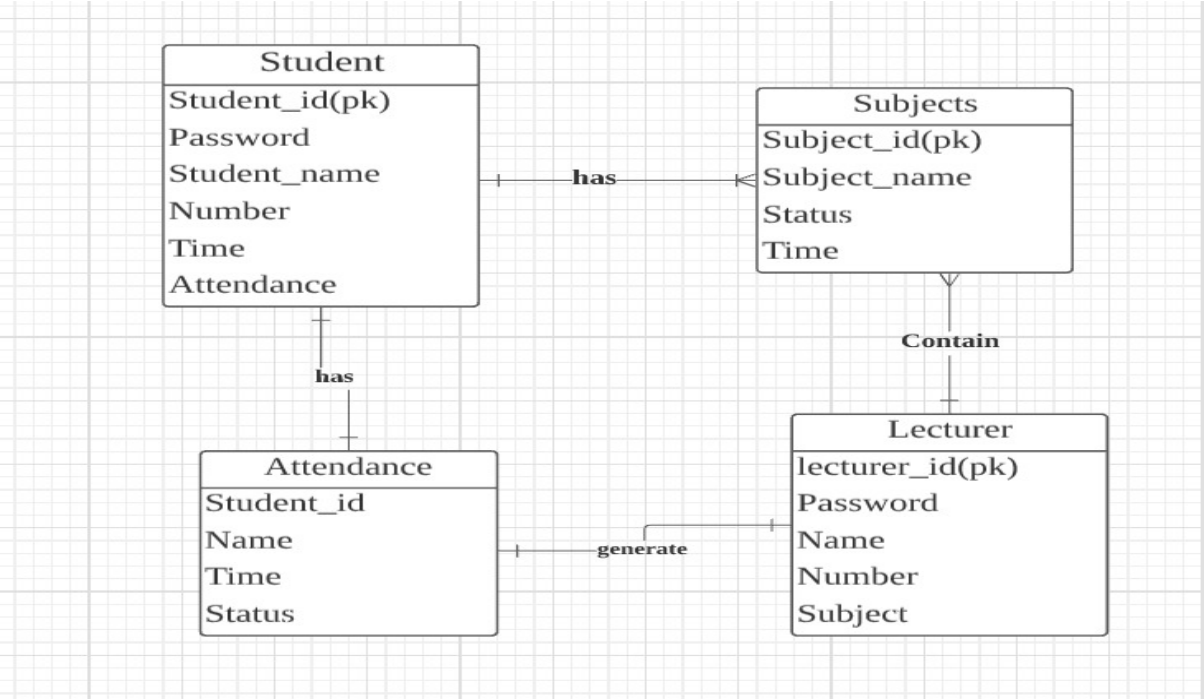
Appendix A

DATA FLOW DIAGRAM



Appendix B.

ENTITY RELATIONSHIP DIAGRAM

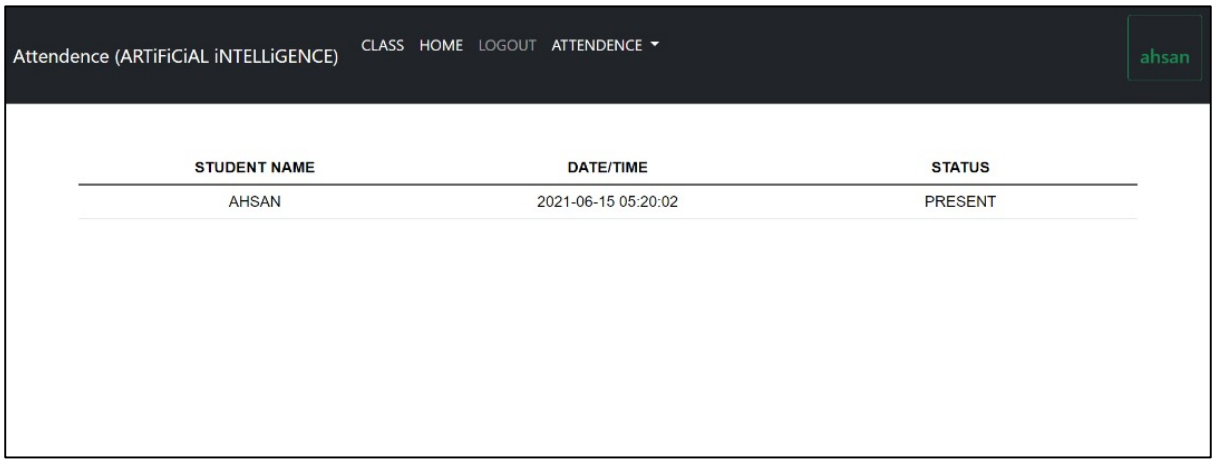


Appendix C

Face DetectionProcess

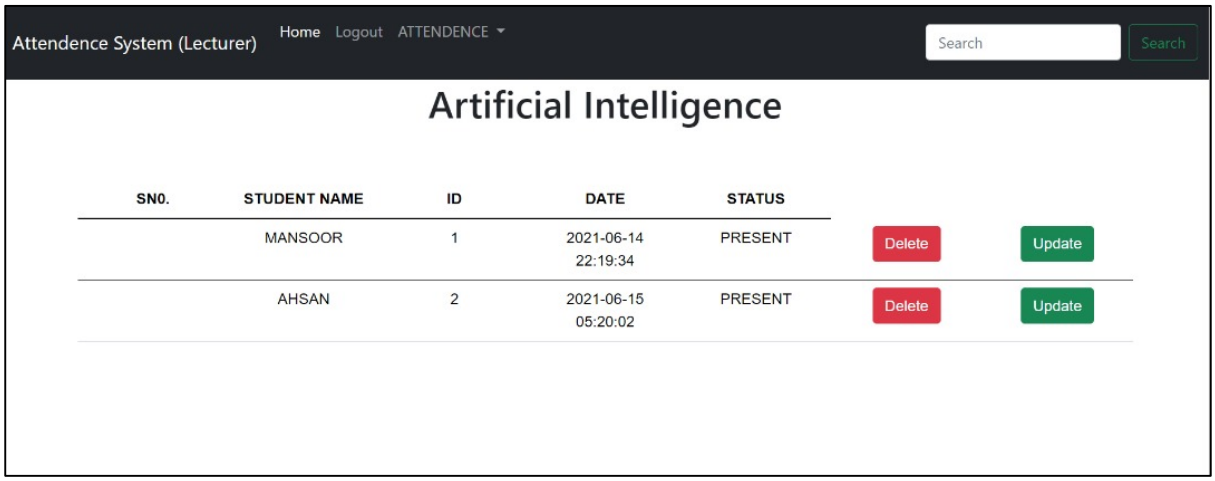
Appendix D

STUDENT ATTENDENCE VIEW INTERFACE



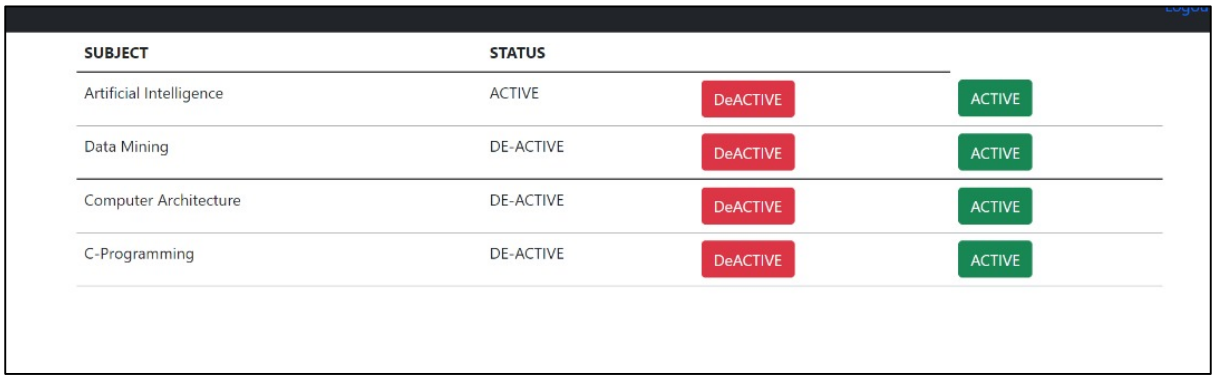
Appendix E

LECTURER ATTENDANCE VIEW INTERFACE



Appendix F

ACTIVATION ATTENDANCE PROCESS INTERFACE



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