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Smart Face Attendance System Using Deep Face Integration for BCB Berhad Kluang

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Abstract

An attendance system is a method used to record and monitor individual presences. BCB Berhad is a property development company which has been using a traditional punch card system for 20 years but faces several challenges including human error, time consuming hours calculation and buddy punching. Smart Face Attendance System Using Deep Face Integration is designed to meet specific requirements of BCB Berhad target clients. This system deploys face recognition use DeepFace library that includes Python integrated with PHP in Visual Studio Code. Object-Oriented approach is used to develop the system including analysis, design, implementation, testing and maintenance phases. The web-based attendance system was created using advanced facial recognition technology with security features and improving the accuracy of the attendance records for daily operations. The project is designed for all users to provide a smarter and secure solution uniquely to serve BCB Berhad's requirements.

1. Introduction

BCB Berhad which is a property developer based in Kluang, Johor has played a significant role in the town's development through various residential and commercial projects. With a workforce of around 30 to 40 employees across four departments, the company currently relies on a manual punch card system to track employee attendance. These traditional methods require employees to punch in and out using physical cards. In addition, Human Resources department must manually tally each employee's work hours for payroll processing. However, there are several key challenges encountered in this current system such as human error, time consuming in calculating work hours and buddy punching. The challenge for human error is employees forget to punch in or out and make mistakes in pressing the wrong button. Next, the key challenges are time consuming for Human Resource department because of manual collect physical card and calculating total hours of each employee. This process will slow down overall attendance management and potential risk of calculation errors. Moreover, buddy punching is the biggest challenge since the system lacks identity verification that helps employees to punch in or out for others. The implementation of Smart Face Attendance System using Deep Face Integration is proposed to overcome the current system challenges in BCB Berhad and improve overall accuracy of attendance system.

The objectives of the system are to design a Smart Face Attendance System using Deep Face Integration, develop it as a web-based application, and evaluate its functionality with the target users which is employees of BCB Berhad. This system uses facial recognition technology to automatically capture and verify user attendance in real-time. Real-time data processing can minimize Human Resources workload without manual data entry by improving automatic calculation work hours and minimizing data entry errors. By integrating DeepFace library with python, the system achieves a balance between speed and accuracy to ensure a reliable performance under

different challenge conditions. Moreover, the Smart Face Attendance System involves three users in the company such as Admin, Manager and Employee. The proposed system for the administrator includes several features such as registering users, capturing facial image for enrollment, generating attendance reports, editing user profile and performance analysis. For managers the system allows viewing of their specific department while for employees they can view their daily performance. Additionally, both can view their history of manual login attendance and view their personal profile. Moreover, advanced technology not only improves the company operational but also promotes accountability and fairness among all users.

The following sections provide a detailed explanation of comparison the attendance system. In Section 2 literature reviews present existing attendance system. Furthermore, the methodology used to develop the proposed system is explained in Section 3, while Section 4 focuses on the analysis and design of the system. Moreover, Section 5 presents the implementations and testing results. Lastly, Section 6 concludes the paper with future work and recommendation.

2. Literature Review

In this section, the study on the Smart Face Attendance System using Deep Face Integration reviews research on web-based attendance systems, face recognition methods, and security measures. It compares existing systems to identify ways to improve efficiency and accuracy.

2.1 Attendance System

An attendance system is used to record and track individuals' presence in workplaces, schools, or institutions by capturing clock-in and clock-out data. These systems can operate either manually or automatically. Automated systems use digital technology to track attendance in real-time to reduce errors and minimize manual process. It also can integrate with payroll systems to calculate salary, manage leave and generate report.

A manual attendance system is a traditional method where attendance is recorded using paper-based registers, logbooks, or spreadsheets. Attendance is marked by a designated person or by individuals themselves. This method is simple, cost-effective and does not require advanced technology and relying only on basic tools like paper and pen. As a result, the data can be accessed quickly without need of electronic devices.

A web-based attendance system is an online platform for managing attendance through the internet. It is accessible via web browsers like Chrome, Safari, or Edge on computers and mobile devices. These systems use protocols like HTTP or HTTPS to secure communication between web servers and users. In addition, it uses open-source technologies such as HTML, CSS, and JavaScript to develop a web-based system. This allows real-time updates and remote access to attendance records from anywhere.

2.1.1 QR Code Based Attendance System

A QR code short for Quick Response Code is invented in 1994 by Masahiro Hara, chief engineer at Denso Wave, a subsidiary of Toyota [1]. QR codes were initially used as a two-dimensional bar code to store various types of data such as website links, account details, phone numbers, or coupons. Additionally, QR code system has gained popularity due to its fast readability and higher storage capacity consisting of black modules (square dots) arranged in a square grid on a white background [2]. Furthermore, there are two types of QR codes such as static and dynamic. Static QR codes are fixed and cannot be changed once generated, while dynamic QR codes store a shortened URL or reference to a location where the actual data is hosted allowing for updates.

Furthermore, QR code-based attendance systems are now widely used in many organizations. It allows employees or members to scan their unique QR codes by using a smartphone or scanner to record attendance. The system automatically updates and stores the attendance data to make the process efficient and convenient for both users and administrators.

2.1.2 Smart Card Based Attendance System

A smart card is a physical card with an embedded microprocessor or memory chip used to authenticate users and grant access to systems by connecting to a card reader either through direct contact or short-range wireless technologies like NFC [3]. Each smart card has a unique ID that differentiates it on the network which is passed to the reader to confirm the user's identity whenever they access the system [4]. Smart cards also can store valuable data that cannot easily erase or modify the data, unlike magnetic stripe cards can directly process data without requiring remote connection [3]. Smart cards are lightweight and easy to carry, making them convenient for everyday use. Examples include credit cards, SIM cards, access control cards, and smart health cards. In many organizations, smart cards are used to track attendance by recording clock-in and clock-out times in real time. Employees scan their cards to gain access, and the system automatically tracks their hours once their ID is recognized. In conclusion, smart cards allow for faster verification attendance and time saving.

2.1.3 Facial Recognition Attendance System

Face recognition uses computer vision and image processing to identify and authenticate individuals based on unique facial features. The process involves three main steps such as face detection, feature extraction, and classification. The design of face recognition process is shown in Fig. 1. In face detection, algorithms like Haar cascades, deep learning models or other detection techniques are to identify and locate faces in images or video. Next, feature extraction identifies unique facial landmarks such as eye distance, nose shape and mouth position using techniques like Histogram of Oriented Gradients (HOG), Local Binary Patterns (LBP) and DeepFace library to create a "faceprint". Lastly, classification compares the extracted features to a database of known faces for verifying or identifying the person using algorithms like Euclidean distance measurements or deep learning-based classifiers.

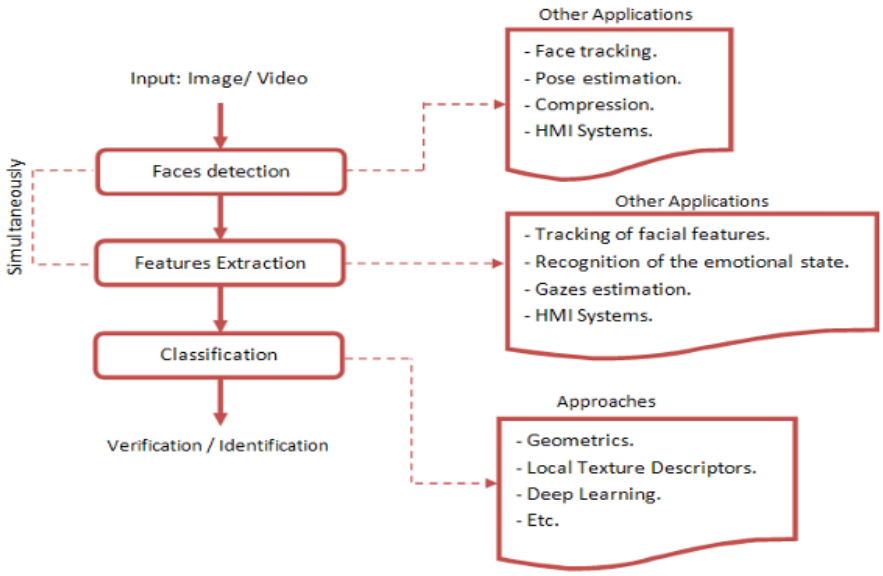

Fig. 1 *Facial Recognition Process Design [5]*

Face recognition is commonly used in attendance systems where cameras capture individuals' faces for identity verification. The face-recognition technique identifies a person's identity by evaluating the input feature vector of a face photograph against a large range of feature vectors in a data collection and typically developed in the Python environment [6]. It is touchless and relying on unique facial features for secure and efficient real-time logging. Many devices support facial recognition features, for instance, Apple introduced Face ID in 2017 for quick and secure phone unlocking [7]. Face recognition offers ease and superior convenience compared to other biometrics.

2.2 Facial Recognition Method

Face recognition methods is a technique and technologies used to identify or verify a person's identity by analyzing and comparing facial features from an image or video frame. The goal of face recognition is to accurately detect and recognize human faces either for identification or verification.

2.2.1 Histogram of Oriented Gradients (HOG)

The Histogram of Oriented Gradients (HOG) is a feature descriptor technique in computer vision and image processing that detects objects by analyzing their shape through the distribution of gradient orientations and constructing histograms based on gradient magnitude and direction in localized regions [8]. The method captures the geometry of buildings by dividing the image into 4×4 blocks of 8×8 pixel cells, where each pixel votes for a fixed gradient orientation bin based on its gradient magnitude [9]. The gradient of each pixel is calculated using the differences intensity values in horizontal and vertical directions and the gradients capture the edge information in the image. This approach ensures that a pixel contributes not only to its corresponding orientation bin but also to adjacent bins, with weighted votes based on its gradient orientation such as a 45-degree gradient casts 0.5 votes each for the 35–45 and 45–55 degree bins [9]. After that, the normalized histograms from all blocks are concatenated into a single feature vector that represents the image. HOG is effective for tasks like face detection as it can handle variations in lighting, pose, and facial expressions. It is often paired with classifiers like Support Vector Machines (SVMs) to identify faces quickly and accurately. This technique is valued for its ability to capture edge information and perform efficiently in real-time applications.

2.2.2 Local Binary Patterns (LBP)

Local Binary Patterns (LBP) is an efficient texture analysis method that labels image pixels by comparing their intensity to neighbouring pixels, encoding the results as binary numbers and is valued for its robustness to monitoring gray-scale variations in real-world applications [10]. The LBP process begins by converting the image to grayscale to simplify calculations. The face image is divided into small regions, such as 3x3 or 7x7 grids. Each pixel in these regions is compared to its surrounding pixels, and a binary value is assigned (1 if the neighbor's intensity is greater or equal to the center pixel, otherwise 0).

Moreover, histogram is created from these binary values for each region, representing the local texture features of the image. This histogram is then turned into a feature vector. In face recognition, the feature vector is compared with those in a database using similarity measures like Euclidean or Chi-square distance. The face with the highest similarity score is identified. LBP is efficient, robust to lighting changes, and captures local features of the face, making it useful in controlled settings with consistent lighting and pose.

2.2.3 DeepFace

DeepFace is a lightweight Python framework for face recognition and facial attribute analysis including age, gender, emotion and race and bulit on Keras and TensorFlow [11]. DeepFace integrates advanced models like VGG-Face, FaceNet, OpenFace, Facebook DeepFace, DeepID, ArcFace and Dlib using OpenCV for image input and Matplotlib for visualization. It supports features like face verification, face recognition, facial attribute analysis and real time face analysis. In addition, Labeled Faces in the Wild (LFW) dataset benchmark have achieved an accuracy of 97.35% (±0.25%) while human-level performance at 97.53% [12]. This highlights DeepFace as one of the most advanced facial recognition technologies globally but sometimes outperforming humans in face recognition tasks.

Fig. 2 shows the end-to-end pipeline of a DeepFace recognition system. The process begins with submitting a facial image which is undergoes with face detection and face alignment to standardize the position for consistent recognition. In the second stage, anti-spoofing mechanism checks whether the aligned face from a live source or a spoofed input. If the aligned face from live source, it will process to the final stage which is Deep Face Recognition. In this final stage, it includes face processing, feature extraction and face matching. The system handles both one-to-many (single face compared with multiple face in database) and many-to-one (multiple faces are analyzed if it belongs to same person). Next, feature extraction is performed using deep learning models that transform facial images into numerical vectors using Euclidean or Angular Distance. Lastly, face matching compares these vectors against stored identities using techniques like Threshold Comparison, Metric Learning, Sparse Representation Classification (SRC) and Identification.

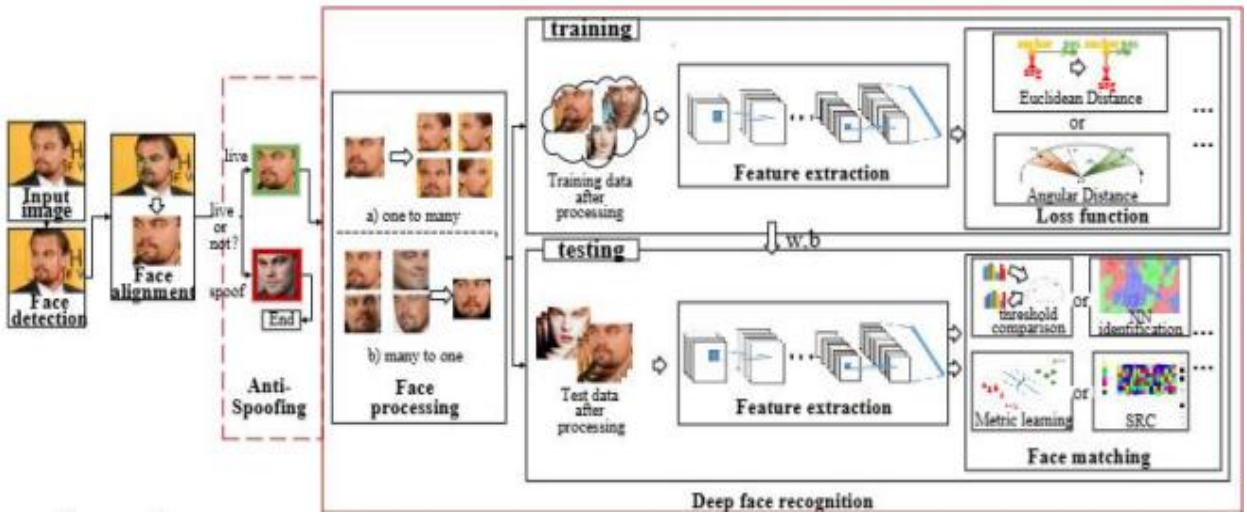

Fig. 2 *End-to-End Pipeline DeepFace Face Recognition [13]*

2.3 Existing System

An existing attendance system refers to the methods that a company or organization currently use to record and manage the attendance of its employees and members.

2.3.1 Manual Punch Card Attendance System

Manual punch card attendance system is a traditional method used to track employee attendance where employee use physical cards to record their time stamps. This physical card is designed with rows for date and columns for clock in and clock out time along with employee details such as name, ID and department. Employees need to insert their punch card into the machine and press the correct button "IN" for clock in and "OUT" for clock out. The machine will stamp with the current date and time on the punch card. At the end of the month, HR department will collect all the employee punch cards to calculate total working hours and prepare attendance reports. However, this process required manual data collection and calculation of each employee's working hours then recorded into Excel sheets for future references. Finally, manual punch card attendance system is simple to use, requires minimal training to use and can operate without need for internet or digital systems.

2.3.2 Clockify

Clockify is a time-tracking and attendance management design to make it easy for individuals and teams to log work hours and generate reports without complications as shown in Fig. 3. Users can streamline processes such as collecting time sheets, tracking attendance, analyzing time usage and calculating payroll. Additionally, Clockify enables users to track work hours and track paid time off (PTO) to measure time spent on various activities. Next, Clockify allows users to manually log their hours by starting and stopping a timer then it will record to the dashboard for overview of team activities in real-time. This feature helps to track the recent activities and gain a visual representation of the team's workweek. Other than that, Clockify has ability to generate reports that allow users to export data in formats such as PDF, Excel or CSV. Finally, the system offers better visibility and management of work patterns.

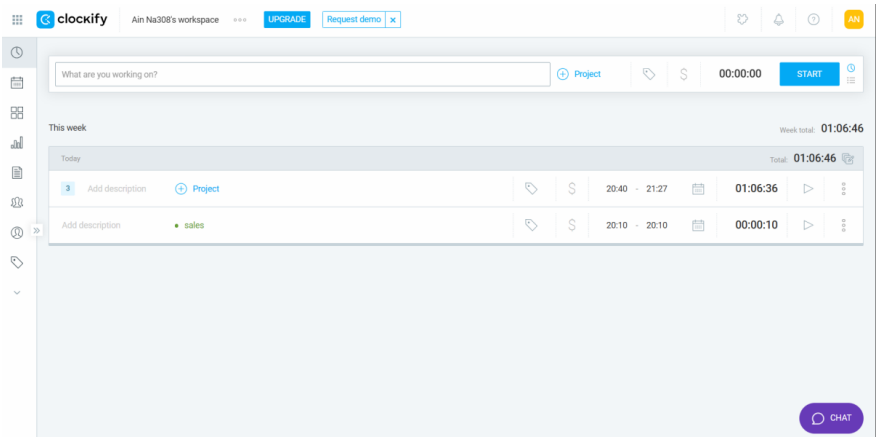

Fig. 3 *Clockify Interface*

2.3.3 Lystloc

Lystloc is a mobile and web-based application that manages field workforce using real-time location-based features as shown in Fig. 4. It is designed to support employees working outside the office such as sales teams, service technicians or delivery staff. Lystloc also helps companies monitor and streamline their operations through a range of productivity-boosting tools. One of its key features is real-time location tracking, which provides managers with a live view of the locations and movements during work hours. Additionally, Lystloc allows employees to mark their attendance directly from their current work location using single-touch authentication to eliminate the need for physical registers or trips to the office. The app also features Geofence attendance, which uses technologies such as GPS (Global Positioning System), RFID (Radio Frequency Identification), Wi-Fi, cellular data, or a combination of these to determine the location of a tracked device [14]. Moreover, Lystloc uses a registered number and sends an OTP for login while unregistered users receive an error message. Lastly, Lystloc offers flexibility for employees' work outstations and ensures quick adoption without the need for extensive training.

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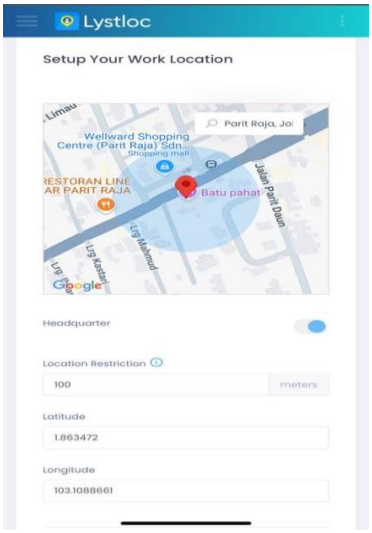
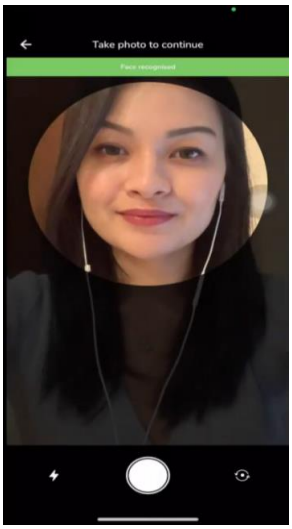


Fig. 4 *Lysloc Interface*

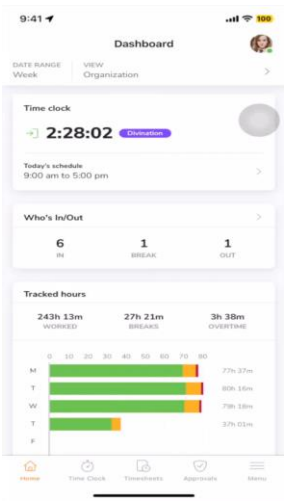
2.3.4 Jibble

Jibble is a cloud-based time tracking and attendance management that securely stores all data in the cloud to allow users access anytime and anywhere as shown in Fig. 5. Moreover, Jibble provide real-time employee tracking for managers with up-to-date information on employee time stamp and location. Employee can clock in using facial recognition in Fig. 5(a) and GPS location with all the data will automatically timestamp. Additionally, Jibble also allows users to view daily schedule and track hours spent on activity and projects as shown in Fig. 5(b).

Furthermore, administrator can monitor all employees' status and authorized locations directly from the dashboard. Additionally, admin can track an employee route in real-time after clocking in and tracing their movements and location throughout the workday. Jibble includes key features for time-off management where administrator can review and make decisions to approve or reject employee leave requests. Lastly, admin can generate reports to track time spent on task and activities by each team member. The reports also include payroll calculation to help the company manage the attendance records efficiently.



(a)



(b)

Fig. 5 *Jibble Interface (a)Facial Recognition; (b) User Dashboard*

2.4 Comparison of Existing System

Table 1 presents a table of comparison of four different types of attendance systems such as Manual Punch Card Attendance System, Clockify, Lystloc and Jibble This comparison aims to identify areas for improvement and address the shortcomings of current systems. There are five features that need to identify each of the existing systems such as biometric, GPS features, real-time tracking, two-factor authentication and report.

Table 1 *Comparison of Existing System*

System/ Feature	Manual Punch Card Attendance System	Clockify [15]	Lystloc	Jibble [16]	Proposed System
Biometric	No	No	No	Yes (Facial Recognition)	Yes (Facial Recognition)
GPS Features	No	No	Yes	Yes	Yes
Real Time Tracking	No	Yes	Yes	Yes	Yes
Report	No	Yes	Yes	Yes	Yes
Two-Factor Authentication	No	No	No	No	Yes

Table 1 display that only Jibble and the proposed Smart Face Attendance System have implemented biometric features such as facial recognition to record user attendance. In contrast, the manual punch card system, Clockify, and Lystloc do not offer any form of biometric verification. Regarding GPS feature only Lystloc, Jibble, and the proposed system support this feature. Lystloc and Jibble use GPS for location verification, while the proposed system allows facial recognition only through a web interface accessible within the workplace. On the other hand, the manual punch card system and Clockify do not require or utilize GPS tracking. In terms of real-time attendance tracking, all the existing digital systems such as Clockify, Lystloc, Jibble, and the proposed system provide real-time functionality to allow administrators to monitor attendance records. However, the manual punch card system lacks this feature as it requires end-of-month manual processing.Lastly, two-factor authentication (2FA) is implemented only in the proposed system requires both password and One-Time Password (OTP) to enhance login security.

3. Related Work

This section discusses the methodology used to develop the system. A project methodology is a structured approach to system development and consists of interconnected phases. This project follows the Object-Oriented Development Model, which includes analysis, design, implementation, testing, and maintenance. Each phase ensures the systematic development and completion of the proposed system. The phrases are explained briefly in this section.

3.1 Object-Oriented Software Development Model

Object-Oriented Software Development (OOSD) is a structured approach to software engineering that revolves around the principles of Object-Oriented Programming (OOP) [17]. It models real-world entities as objects, combining data (attributes) and behavior (methods) to create modular, reusable and scalable systems. OOSD follows several phases, as shown in Fig. 6 to ensure a well-structured system that meets user requirements.

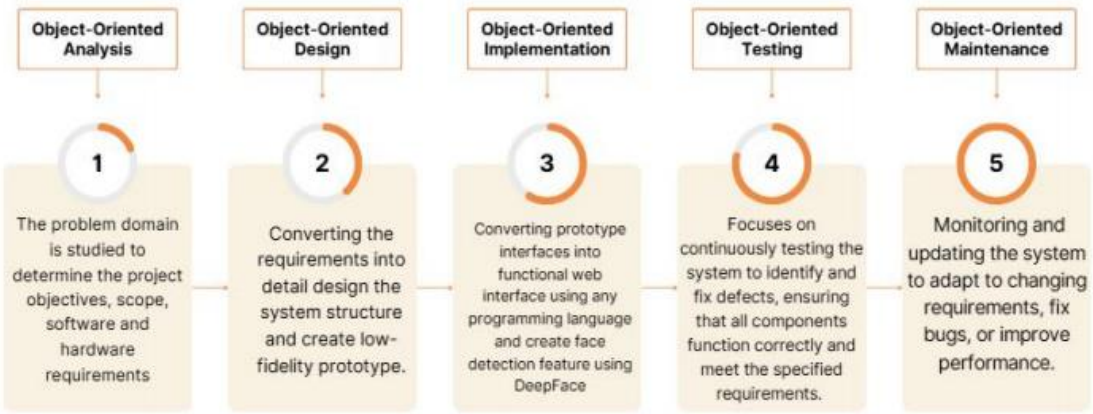


Fig. 6 *Object-Oriented Software Development (OOSD) Phases*

Fig. 6 shows the object-oriented process begins with the analysis phase, which focuses on understanding the system's requirements by gathering information from stakeholders and identifying problems with the current system. The second phase is the design phase, where the requirements are translated into detailed

designs that define the system's structure and interactions. The third phase is implementation, where the designs are converted into code using Visual Studio Code. Next is the testing phase, which ensures the system meets functionality, performance, security, and user experience requirements. Finally, the maintenance phase involves monitoring and maintaining the system to ensure it operates smoothly, including fixing bugs, optimizing performance, and adding new features while ensuring it continues to meet user requirements.

4. Analysis and Design

This section covers the analysis and design of the Smart Face Attendance System using Deep Face Integration for BCB Berhad Kluang. It includes detailed requirement analysis, outlining functional and non-functional, hardware and software, and user requirements. Unified Modeling Language (UML) diagrams are used to analyze the system as it follows an Object-Oriented approach. Additionally, interface designs for each module are presented to guide the system's development.

4.1 Requirements Analysis

Requirement analysis is an essential step in software development to ensure project success. It identifies and manages functional and non-functional requirements through collaboration with stakeholders and users. The goal is to align the system with user needs, organizational goals, and technical capabilities. Gathering detailed information early ensures a high-quality system that meets objectives and user expectations.

4.1.1 Functional and Non-Functional Requirements

Functional requirements are specific what a system must do to meet user needs describe the features, actions and processes essential for achieving its objectives. They ensure that all necessary functionalities are included, guiding the development of the proposed Smart Face Attendance System using Deep Face Integration. The system includes eight key modules, each with specific functions outlined in Table 2.

Table 2 *Functionality Requirements*

Module		Function
Login	i.	The system requires users to log in before accessing its feature
	ii.	First time login users are required to change their default password
	iii.	Admin must verify identity using a One-Time Password (OTP)
Registration	i.	The system collects employee information and facial image data
	i.	The system stores face image data for attendance tracking
Admin	i.	The system allows admin to register, edit or deactivate user profiles
	ii.	Admin can view all registered users
	iii.	Admin can activate or deactivate both user account and department
	iv.	Admin allows to assign public holiday in calendar
Face Recognition	i.	The system must scan and match real-time facial data
	ii.	The system should display the match facial data with employee ID
Reporting & Analytic	i.	Admin can generate detail attendance reports
	ii.	Admin can view real-time daily attendance records by all user
Manual Login Attendance	i.	Users can choose manual login if face detection fails
	ii.	Admin can approve or reject manual login requests
	iii.	The system must allow user to view their history manual login attendance
User	i.	User can view their attendance records
	ii.	The system must allow user to change their password
	iii.	Users can view their personal information and update their profile picture
Manager	i.	Manager can view daily attendance records for their departments

Non-functional requirements define the quality attributes and constraints that ensure the system performs efficiently, operates reliably under specified conditions and enhances user experience. These requirements, outlined in Table 3, are to make sure the system maintains functionality and user satisfaction.

Table 3 *Non-Functionality Requirements*

Aspect		Description
Security	i.	Only authorized users can access the system with two-factor authentication
	ii.	All user password must securely be encrypted in the system
	iii.	The system must automatically log out users after inactivity
Performance	i.	The system must verify employee facial data for clock in and clock out in a short amount of time
	ii.	The system must maintain accuracy in face recognition under varying lighting conditions
Usability	i.	The system interface must be user-friendly and easy to train
Scalability	i.	The system must handle large volumes of attendance records
Operational	i.	The system should be able to generate attendance reports
Integrity	i.	The system must securely store employees records properly and ensure the data uncorrupted and easily readable

4.2 System Analysis

System analysis is the process of studying and evaluating an organization's infrastructure, workflows, and data systems to improve performance and meet specific goals. Fig. 7 shows the developed system architecture, its workflow and how the system operates. The system includes both administrative and all of the employee functionalities. During the registration process, admin is responsible for managing user data by registering each employee's facial image and store it in web-based database, while employees provide their facial data and the system uses DeepFace to detect faces in real time. Then, the system compares the real time facial data with store registration data to verify identity. All attendance records are automatically stored in the database, and the system automatically generates attendance reports for admin monitoring and analysis.

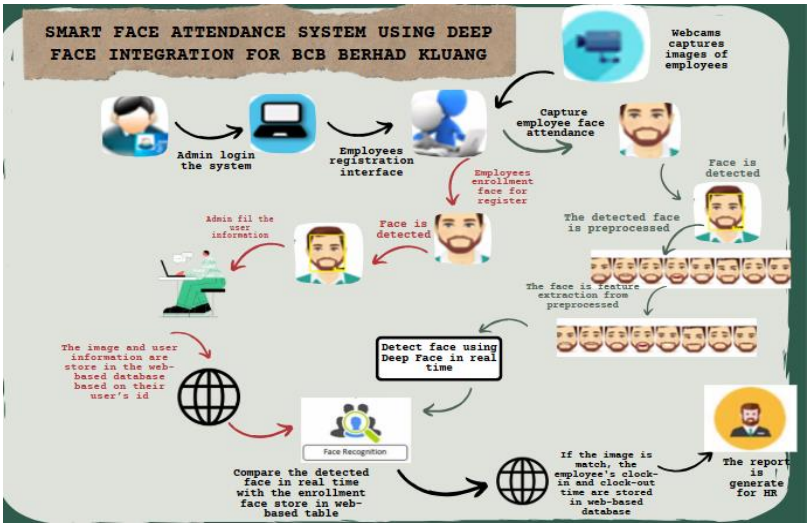


Fig. 7 *Proposed System Architecture*

4.2.1 Use Case Diagram

A use case diagram is a type of Unified Modeling Language (UML) that represents the functional requirements of a system. Fig. 8 shows the Smart Face Attendance System illustrating interactions between its actors inincludingdmin, Employees and Manager. The Admin is responsible for managing the system such as register each employee, verify employee, face enrollment of new user, face recognition for attendance records, view all employee attendance records, manage system setting and generate attendance reports. Next, the system will verify the employees facial data and able to access the system to view their individual attendance records. Similarly, the system verifies the Manager facial data and grant access the system to view attendance data for their department.

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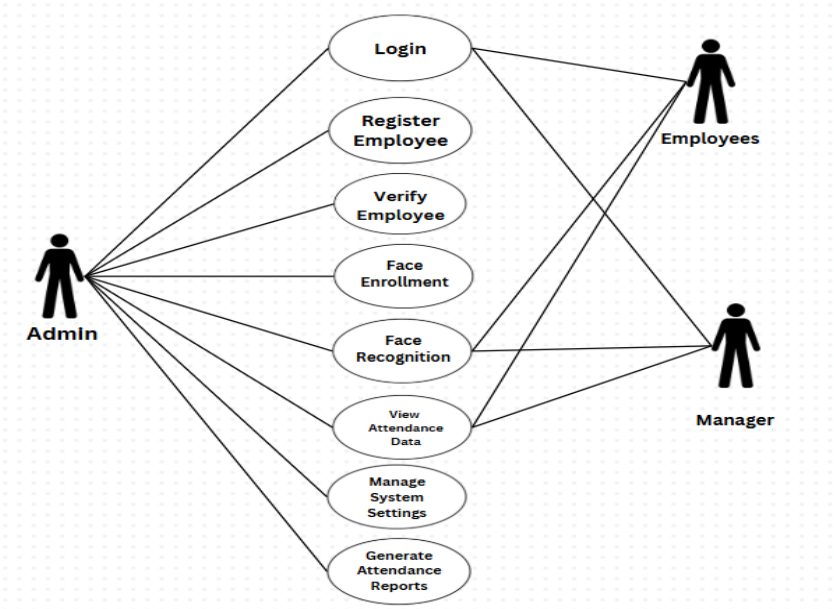


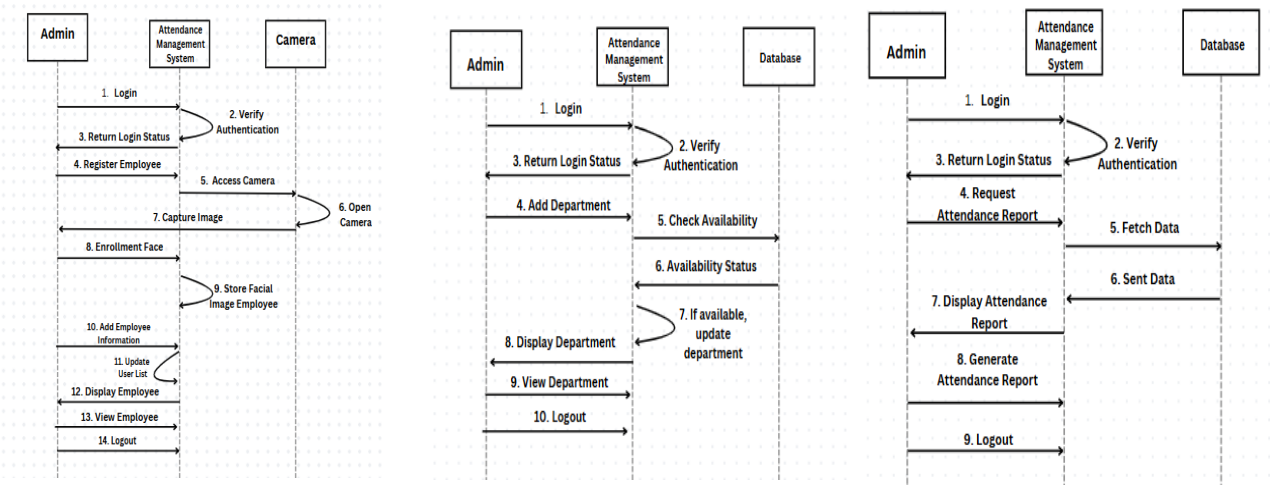
Fig. 8 *Use Case Diagram*

4.2.2 Sequence Diagram

A sequence diagram illustrates the flow of interactions between system components during runtime to visualize how a system operates. Fig. 9. show the sequence diagram for admin module. Firstly, as shown in Fig. 9(a), the process begins with the admin login into the system and captures image of the employee's face for the enrollment process. The captured image is stored in a web-based database with user's information. Once the information is saved, the system updates the user list and displays the registered employees on the admin page.

Secondly, the sequence diagram in Fig. 9(b) shows the process of the admin managing the system settings. In this process, the admin can manage departments by adding new departments. The admin must log in to the system first before adding a new department. The system then checks the availability of the department to avoid duplication, which could cause confusion in the system. If the process is successful, the new department will be displayed on the admin page.

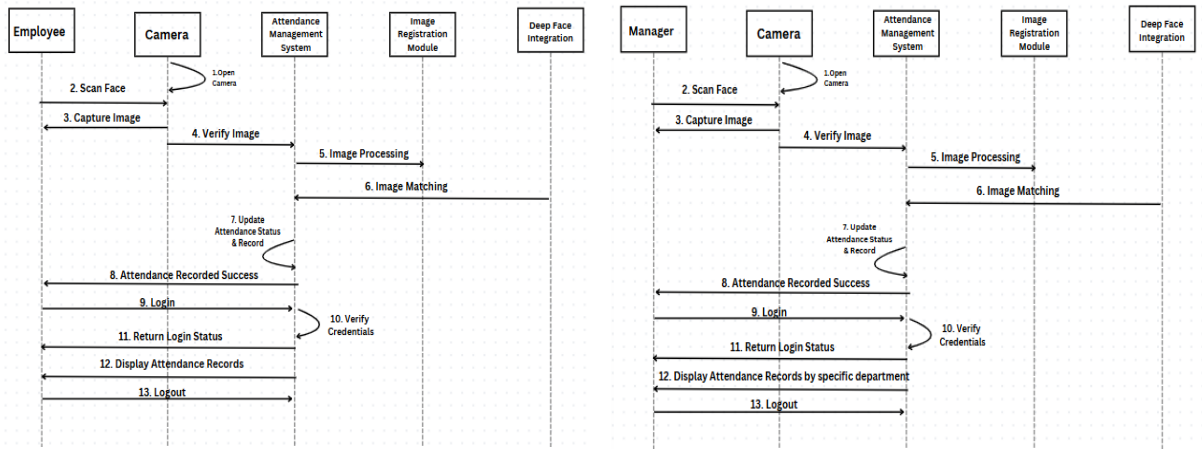
Lastly, the sequence diagram for admin module shows in Fig. 9(c) is the process of report generation allowing the admin to generate a report of all employees based on their real-time attendance records. The process begins with the admin login into the system and requesting the attendance records. The system then retrieves the data from the database and sends it to the system. The system processes the data, generates the report, and displays it to the admin.



(a) (b) (c)

Fig. 9 *Admin Sequence Diagram (a) Register User Process; (b) Register Department Process; (c)Generate Report Process*

Next, the sequence diagram in Fig. 10 display the attendance process for both employees and manager. In Fig. 10(a) shows that employees are required to scan their faces using the camera to record their attendance. The system then verifies and matches the scanned image with the registration image to confirm the employee's identity. Once verified, the attendance record is updated on the web-based table. In contrast, Fig. 10(b) shows the sequences diagram for manager which follow same process as employee. However, manager have been granted access to view attendance records data specific to their department.



(a) (b)

Fig. 10 *Sequence Diagram (a)Employee Sequence Diagram; (b) Manager Sequence Diagram*

Finally, Fig 11 shows a sequence diagram for manual login attendance feature for user when the system fails to detect their faces. The system allows user to capture an image and enter their employee ID to submit a manual login attendance request to the admin. The admin will then review the submitted image and determine whether to approve or reject the request. If the image matches a registered employee, the admin approves and the attendance is recorded others will be rejected.

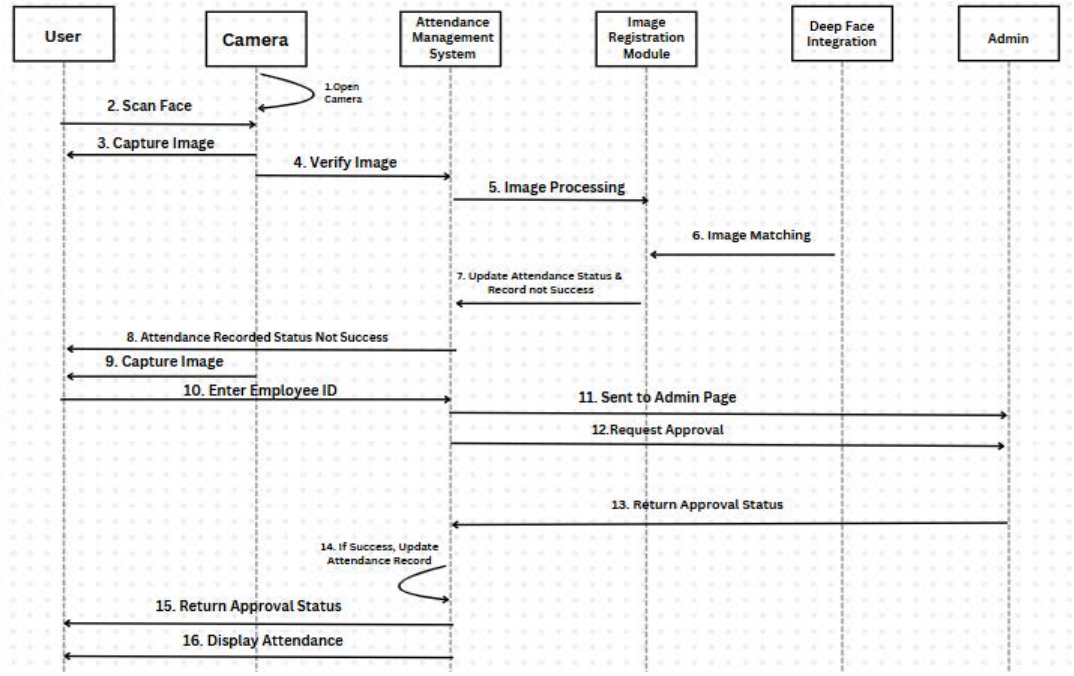


Fig. 11 *User Manual Login Attendance Sequence Diagram*

4.2.3 Class Diagram

The class diagram in Fig. 12 shows eight main classes such as Users, Department, Role, Daily Summary, Public Holiday, Face Recognition, Annual Leave and Manual Login. It defines system structure, where Users handle registration, Department and Role support Role Based Access Control (RBAC), Face Recognition manages attendance, Daily Summary records daily attendance, Public Holiday and Annual Leave prevent from incorrect data, and Manual Login handles failed face scans that need admin approval.

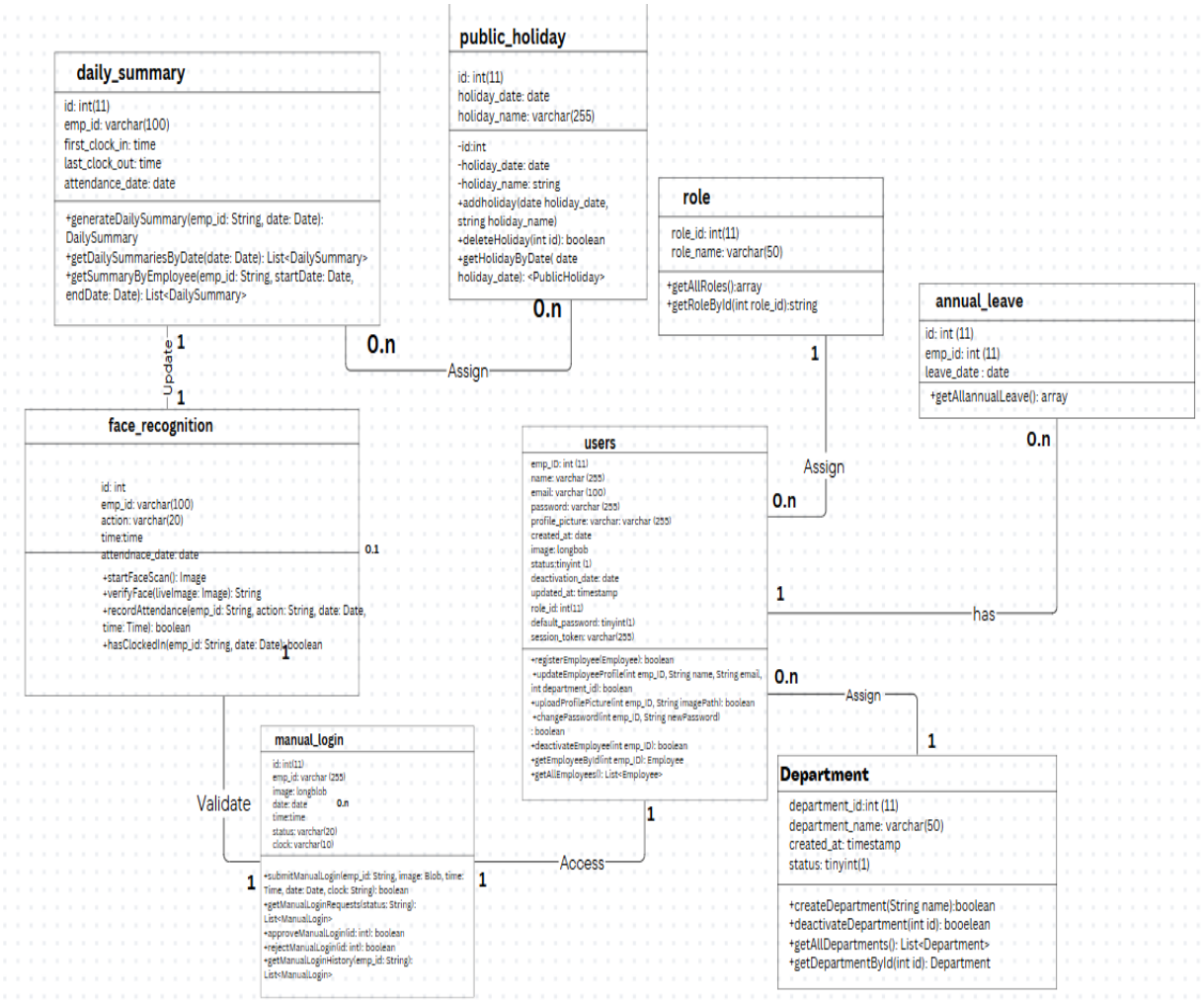


Fig. 12 *User Manual Login Attendance Sequence Diagram*

4.2.4 Activity Diagram

An activity diagram illustrates the flow of activities in a system or process, including workflows, processes, or actions. For the Smart Face Attendance System, there are three activity diagrams such as admin, employee and manager process. In Fig. 13 display the admin activity diagram where admin login into the system by entering their email and password. If the system verifies, one-time password (OTP) is required for second authentication. After successful login, the admin can access the system by selecting the desired functionality.

The next activity diagram represents the process for employees in Fig. 14. Employees are required to scan their faces when they arrive at and leave work. The system verifies the scanned face by matching it with the stored data and updates the data in the attendance report if the match is success. In addition, if the system fails to be matching, a manual login button is provided and allows employee to capture their face, enter employee ID and submit a request for approval. Moreover, employees can log in to the system to view their daily performance, manual login attendance history and personal information

The last activity diagram is for manager process as shown on Fig. 15. The process for the manager is a similar process to employees. The key of difference is that manager can view the attendance summary of all employees within their department including the total number of present and absent employees.

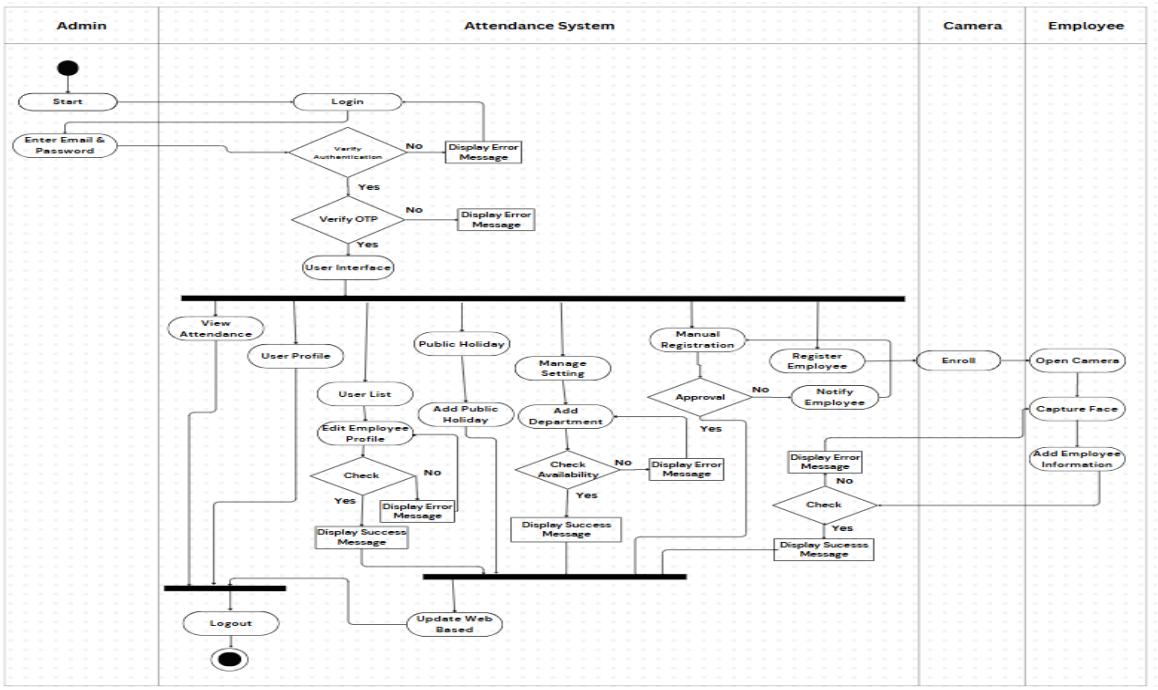


Fig. 13 *Activity Diagram for Admin Process*

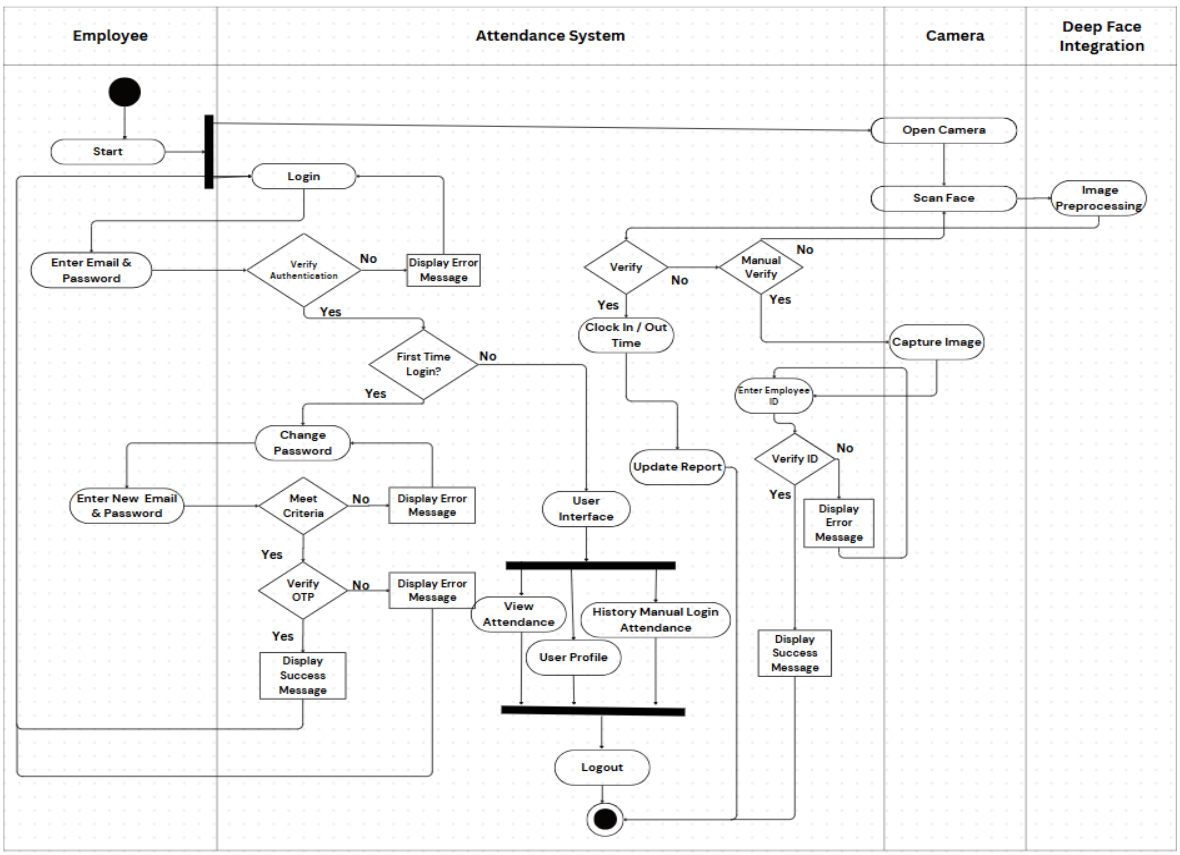


Fig. 14 *Activity Diagram for Employee Process*

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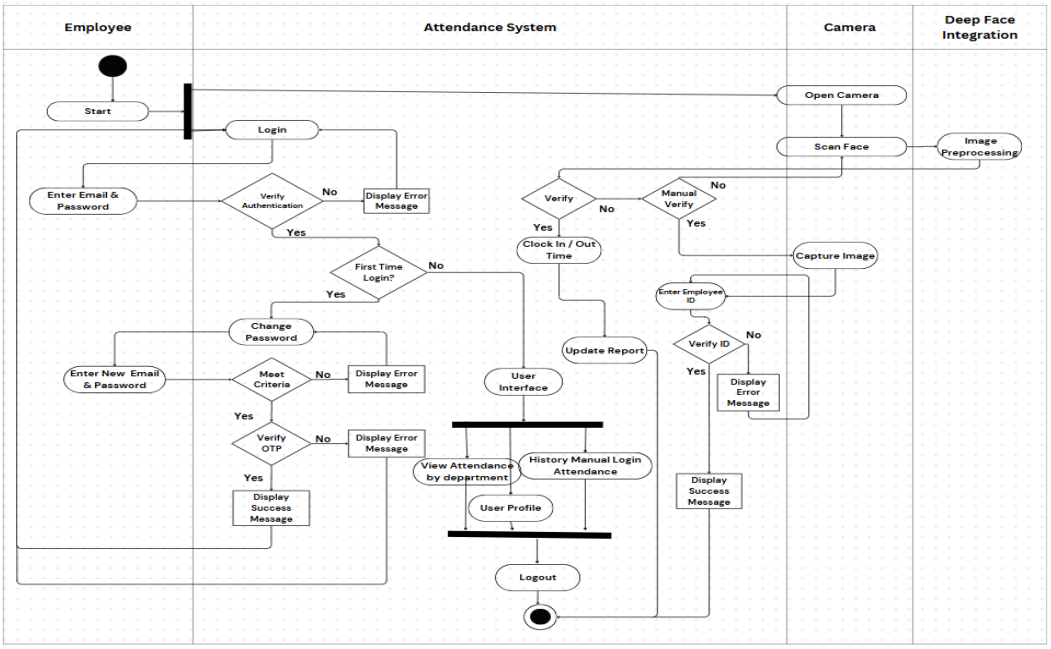


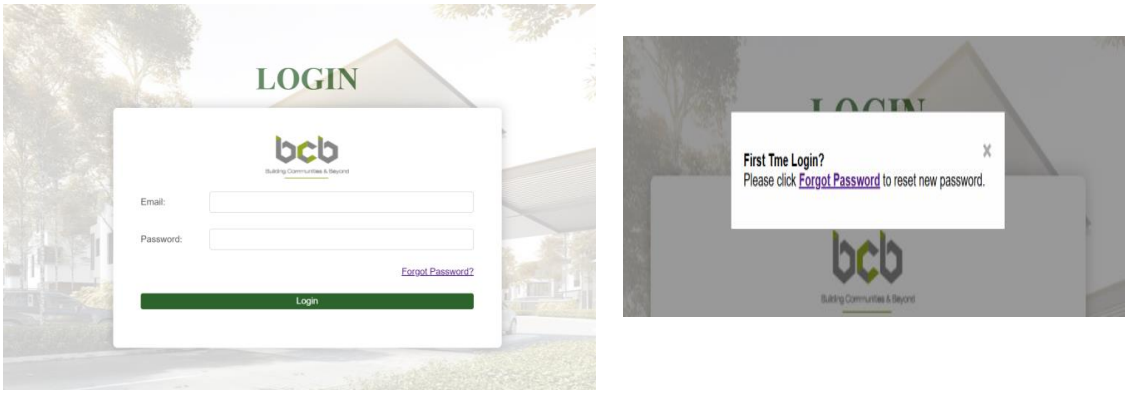
Fig. 15 *Activity Diagram for Manager Process*

4.3 Interface Design

Interface design is the process of planning like buttons, menus, and forms to make it easy to use. A visually attractive design can influence the user's mood and make the system more enjoyable to use. By how users interact with a system by defining its layout, structure, and appearance. It includes key element creating an interface that balances usability with visual appeal, the system can effectively capture user interest and improve satisfaction.

4.3.1 Login Module

Fig. 16 displays the login interface for all users' roles, including administrators, managers, and employees. Next, login page for all the user to enter email and password in Fig. 16(a). Moreover, for first time user who want to login, the system requires them to verify their email and change their default password before gaining full access as shown in Fig. 16(b).

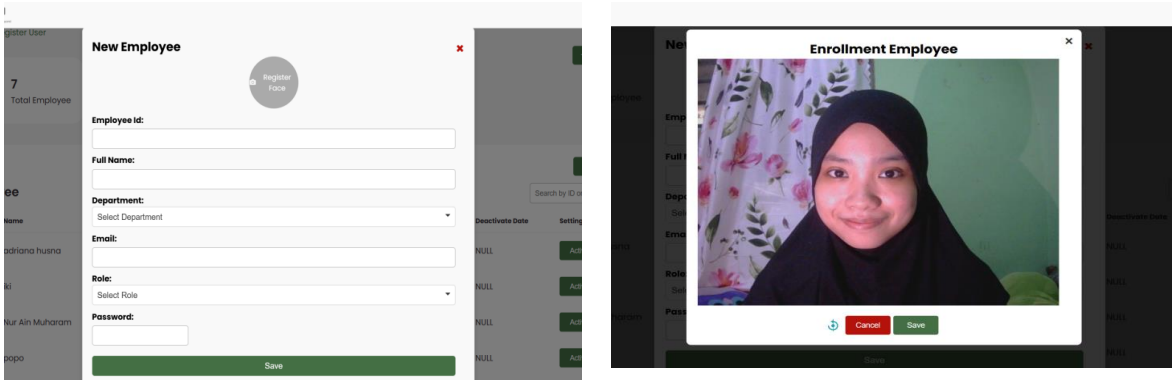


(a) (b)

Fig. 16 *Login Module (a) Login Page; (b) First Time Login Page*

4.3.2 Registration Module

Fig. 17 shows the interface for admin to register a new user into the system. This feature allows admin to register new user which include features such as capturing a facial image, entering the employee id, full name, select department, email, role and default password as shown in Fig. 17(a). Furthermore, the interface for capturing facial image in the system shown in Fig. 17(b) allows the admin to recapture or save the captured image.

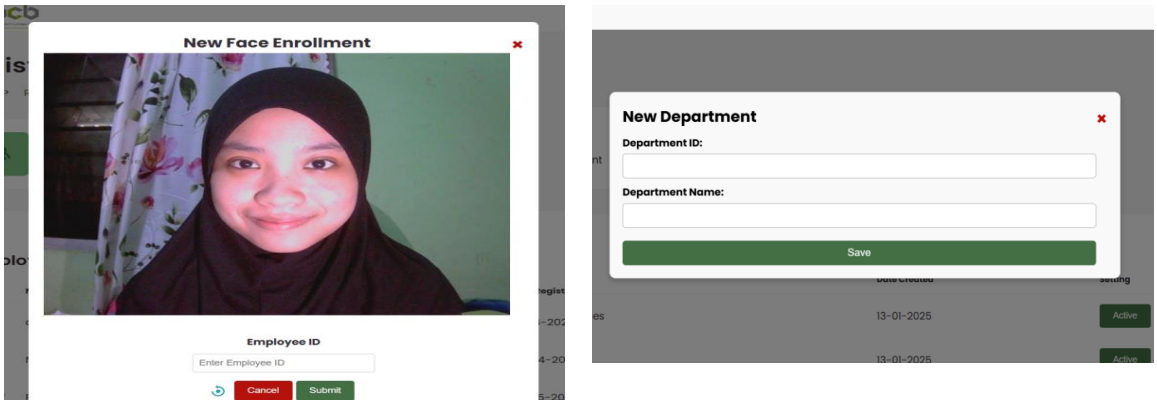


(a) (b)

Fig. 17 *Registration Module (a) Registration Page; (b) Enrollment User Page*

4.3.3 Admin Module

Fig. 18 shows that in admin module for Smart Face Attendance System. Admin has ability to update new facial image by entering valid employee ID and store in the database shown in Fig. 18(a). Additionally, admin have feature to manage department by adding or deactivating the department show in Fig. 18(b). Moreover, admin have ability handle manual login attendance request by selecting whether "Clock In" or "Clock Out" and choose to approve or reject the request as shown in Fig. 19.



(a) **(b)**

Fig. 18 *Admin Module (a) Edit Employee Page; (b) Manage Department Page*

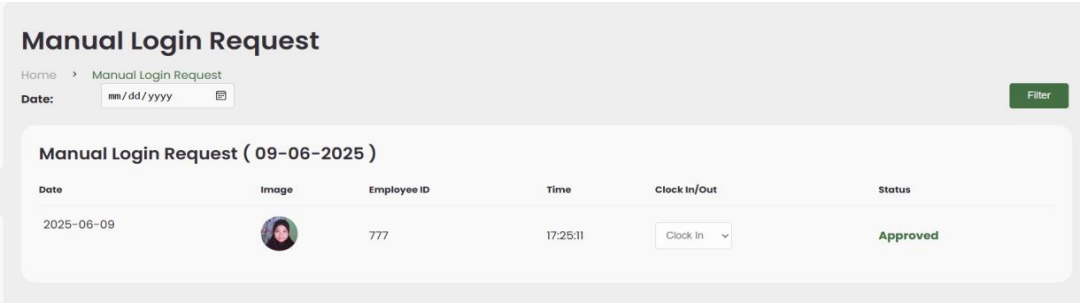


Fig. 19 *Manual Login Request Page*

4.3.4 Face Recognition Module

Fig. 20 displays the face recognition homepage which is in Fig. 20(a) shows the matched employee ID after successful facial recognition. The system uses the DeepFace library to compare the user's real-time facial image with the stored registration image. Additionally, the system restricts access if the user is not within the authorized location as shown in Fig. 20(b).

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(a)

(b)

Fig. 20 *FaceRecognition Module (a) Success Matches Result; (b) Face Recognition Code Segment*

4.3.5 Reporting and Analytic Module

The admin could generate reports for all employees by filtering a date range and selecting individual users, as shown in Fig. 21. The generated report displays the filtered results, including daily clock-in and clock-out times, total hours worked, and attendance status for the selected user.

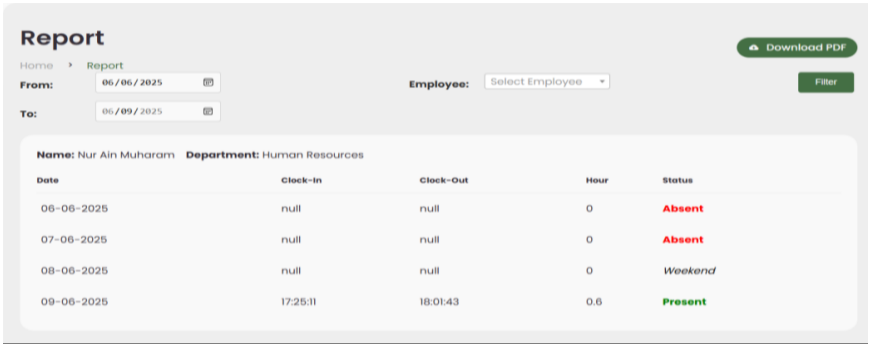
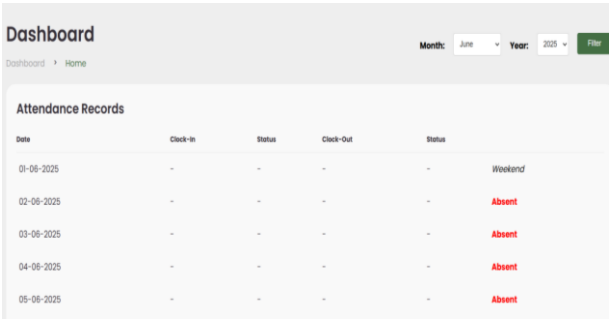


Fig. 21 *Generate Report Page*

4.3.6 User Module

Fig. 22 shows the user module for Smart Face Attendance System. The system in Fig. 22(a) shows the employee dashboard which displays attendance record for current month by default. In addition, employee can filter the table by month and year to view their previous attendance. Furthermore, employee can also view the status of their manual login attendance requests as shown in Fig. 22(b). This page allows employee more alert about their request's status or have been approved or rejected by the admin.



(a)

(b)

Fig. 22 *User Module (a) Generate Report Page; (b) Manual Login History*

4.3.7 Manual Login Attendance Module

The manual login attendance system is displayed when the system fails to match the facial image data. In such cases, a button appears to allow the user to proceed with manual login which redirects to the page shown on Fig. 23. On this page, the user is required to manually capture their face and enter their employee ID. Once submitted, the request is sent to the admin for approval.

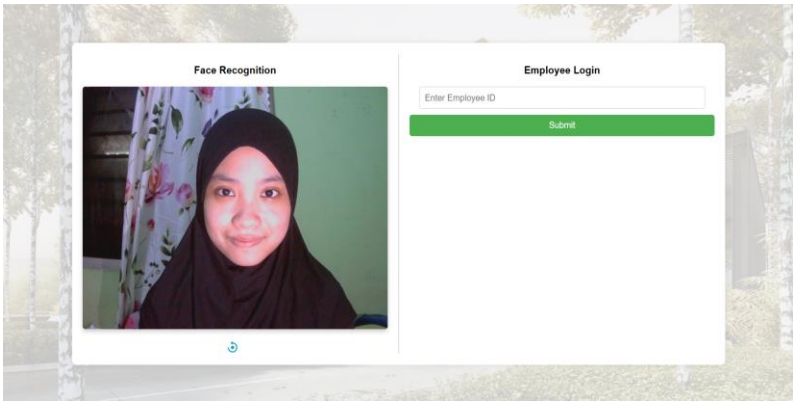


Fig. 23 *Manual Login Attendance Page*

4.3.8 Manager Module

Fig. 24 displays the manager's dashboard which allows manager to view and display attendance record specifically for employees within their own department. The system provides a feature that shows total number of employees present and absent for current day by default. In addition, the system includes date filtering that allows manager to view the previous attendance records data.

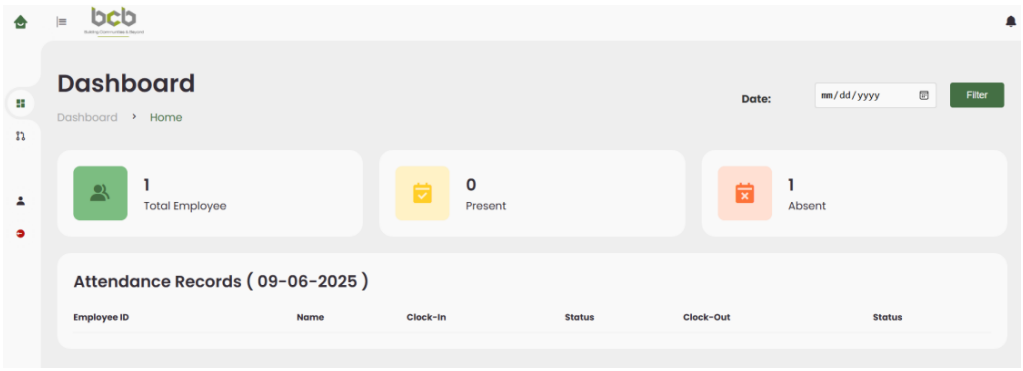


Fig. 24 *Manager Dashboard Page*

5. Implementation and Testing

Implementation is the stage where the planned system design is translated into an operational system through the actual development of source code. It involves executing the interface designs created in Section 4 and transforming them into a fully functional application.

5.1.1 Login Module

Fig. 25 displays the login code segment. In Fig. 25(a), a random token is generated after successful login. Fig. 25(b) implements a lockout mechanism where multiple incorrect login attempts require the user to wait 3 minutes before trying again. Fig. 25(c) the password is encrypted when user change password to enhance security.

```php
public function loginUserWithToken($email) {
    $query = "SELECT * FROM users WHERE email = ?";
    $stmt = $this->db->prepare($query);
    $stmt->bind_param("s", $email);
    $stmt->execute();
    $result = $stmt->get_result();

    if ($user = $result->fetch_assoc()) {
        $token = bin2hex(random_bytes(32));
```

(a)

```php
if ($_SESSION['login_attempts'] >= 3) {
    $elapsed = time() - $_SESSION['lockout_time'];
    if ($elapsed < 180) {
        $is_locked_out = true;
        $remaining_time = 180 - $elapsed;

        return [
            'is_locked_out' => $is_locked_out,
            'remaining_time' => $remaining_time,
            'error' => 'Too many login attempts. Try again later.'
```

(b)

```php
public function updatePasswordByEmpId($emp_id, $new_password) {
    $hash = password_hash($new_password, PASSWORD_ARGON2ID);
    $stmt = $this->db->prepare("UPDATE users SET password = ? WHERE emp_id = ?");
    return $stmt->execute([$hash, $emp_id]);
}
```

(c)

Fig. 25 *Login Code Segment (a) Generate Token; (b) Failure Attempt; (c)Encrypt Password*

5.1.2 Register Image Facial Data

Fig. 26 shows that the user's facial image is saved into directory and stored in the database. This configuration allows the system to retrieve and compare the stored image with real-time input during the facial recognition process and verify the user's identity.

```php
if (preg_match('/^data:image\/(\w+);base64,/', $profile_picture, $type)) {
    $data = substr($profile_picture, strpos($profile_picture, ',') + 1);
    $data = base64_decode($data);
    if ($data === false) {
        die('Base64 decode failed');
    }

    $sanitizedEmployeeId = preg_replace('/[^a-zA-Z0-9_-]/', '', $employeeId);
    $fileName = 'employee_picture/' . $sanitizedEmployeeId . '.png';

    if (!is_dir('employee_picture')) {
        mkdir('employee_picture', 0755, true);
    }

    if (file_put_contents($fileName, $data) === false) {
        die('Failed to save image to server');
    }
} else {
    die('Please capture user image for register!');
}
```

Fig. 26 *Store Image Data*

5.1.3 Face Recognition Module

Fig. 27 shows the code segment where DeepFace is used to perform the comparison. The process begins by enhancing the lighting of the captured image using histogram equalization to improve contrast under poor lighting conditions. Then, DeepFace compares the captured face with each enrolled image and if a match is found, the system returns the corresponding employee ID.

```python
def normalize_lighting(image):
    """Enhance image contrast and brightness to handle poor lighting."""
    ycrcb = cv2.cvtColor(image, cv2.COLOR_BGR2YCrCb)
    ycrcb[:, :, 0] = cv2.equalizeHist(ycrcb[:, :, 0])  # Equalize Y channel
    return cv2.cvtColor(ycrcb, cv2.COLOR_YCrCb2BGR)

def recognize_face(cropped_face, enrolled_faces):
    try:
        normalized_face = normalize_lighting(cropped_face)
        cropped_face_rgb = cv2.cvtColor(normalized_face, cv2.COLOR_BGR2RGB)
        resized_face = cv2.resize(cropped_face_rgb, (160, 160))  # For Facenet

        for emp_id, img_path in enrolled_faces.items():
            result = DeepFace.verify(
                resized_face,
                img_path,
                model_name="Facenet",
                enforce_detection=False
            )

            if result["verified"] and result["distance"] < 0.4:
                return emp_id

    except Exception as e:
        print(f"Error in face recognition: {e}")
```

Fig. 27 *Face Recognition Code Segment*

5.1.4 Location-Based Restriction

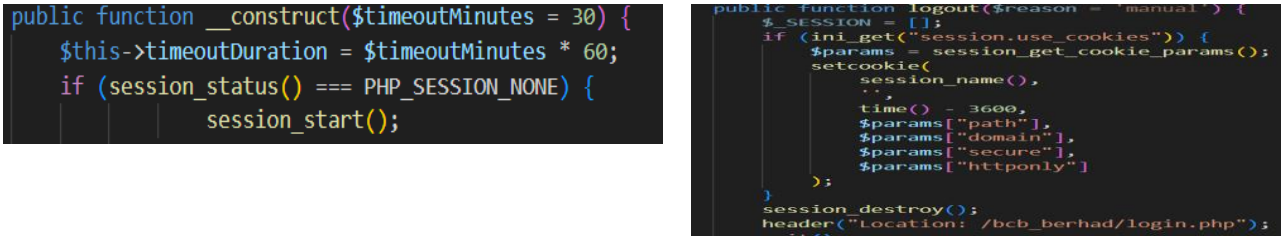
Fig. 28 display configuration with specific coordinates includes latitude and longitude of BCB Berhad's headquarters in Kluang, Johor. This location-based restriction ensures that user can only use the facial recognition feature on-site to prevent access to the web-based attendance system remotely.

```php
<?php
$data = json_decode(file_get_contents('php://input'), true);
$lat = $data['lat'];
$lon = $data['lon'];

$allowedLat = 2.0317;
$allowedLon = 103.3215;
$radiusKm = 0.5;

function getDistance($lat1, $lon1, $lat2, $lon2) {
    $earthRadius = 6371;
    $dLat = deg2rad($lat2 - $lat1);
    $dLon = deg2rad($lon2 - $lon1);
    $a = sin($dLat/2) * sin($dLat/2) +
         cos(deg2rad($lat1)) * cos(deg2rad($lat2)) *
         sin($dLon/2) * sin($dLon/2);
    $c = 2 * atan2(sqrt($a), sqrt(1-$a));
    return $earthRadius * $c;
}

$distance = getDistance($lat, $lon, $allowedLat, $allowedLon);
echo json_encode(["allowed" => $distance <= $radiusKm]);
?>
```

Fig. 28 *Coordinates of the BCB Berhad Kluang*

5.1.5 Timeout Session

Fig. 29 illustrates the code segment for session timeout. In Fig 29(a), the system is configured to automatically log out users after 30 minutes of inactivity. As shown in Fig 29(b) the system will destroy the session cookies after the system automatically logs out.



(a) (b)

Fig. 29 *Session Timeout (a) Set Timeout; (b) Cookies Destroy*

5.2 User Acceptance Testing

User Acceptance Testing (UAT) is a type of software testing that conducted by end users in a real-world by end users to meet their requirements and the function work as expected. UAT involves three types of users, such as Admin, Manager and Employee. For testing, I requested the admin at the company to test all user modules on behalf of the company to make sure the system functionalities meet the company requirement. The result of this testing is documented in Appendix A. Additionally, for manager and employee is conducted using google form, which is divided into 5 sections such as user information, functional testing, security testing, smart face attendance system and overall satisfaction.

Table 4 *Functionality Testing*

No	Question	Pass	Fail
i.	Are you able to login and logout the system	100%	
ii.	Are you able to change to a new password for the first time?	100%	
iii.	Are you able to view employees within specific departments?	100%	
iv.	Are you able to view your personal information?	100%	
v.	Are you able to view your status in manual login attendance history?	100%	
vi.	Are you able to upload or remove profile picture?	100%	
vii.	Are you able to view previous attendance records by filtering month and year?	100%	
viii.	Are you able to change to a new password?	100%	
ix.	Are you able to login with your new password?	100%	

Table 5 *Security Testing*

No	Question	Pass	Fail
i.	Does the system require strong password policies?	100%	
ii.	Were you able to receive One-Time Password (OTP) via your email?	100%	
iii.	Was the account locked after multiple failed login attempts?	100%	
iv.	Will the system automatically log out when the user inactivity for more than 30 minutes?	100%	

Table 6 *Smart face Attendance System Testing*

No	Question	Pass	Fail
i.	Did the system allow us to clock in or clock out multiple times?	100%	
ii.	Did the system show an error message if a user clicked 'Clock Out' before clocking in on the same day?	100%	
iii.	Was the system able to scan your face correctly and match it with the right employee ID?	100%	
iv.	Were you able to view your attendance records in dashboard after a successful face scan?	100%	
v.	Did the manual login button appear when the system failed to match the face?	100%	

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Table 7 *Overall Satisfaction*

No	Question	Pass	Fail
i.	Is the system easy to use?	100%	
ii.	Did you feel the system met your expectation?	100%	
iii.	How would you rate the system's overall performance?	100%	
iv.	How would you rate accuracy of the Smart Face Attendance System?	100%	

Based on the summary of the evaluation form for managers and employees, Table 4 shows that the Smart Face Attendance System is functional and can be used effectively by all users. Table 5 indicates that the system's security features meet user requirements and are well received. Furthermore, Table 6 demonstrates that the facial recognition component is accurate and reliable for scanning user faces. Lastly, Table 7 shows that the system meets user expectations and receives overall satisfaction from the respondents.

6. Conclusion

In conclusion, Smart Face Attendance System using Deep Face Integration is a web-based attendance system that integrates with facial recognition to automate employee attendance. It is also eliminating the problem that occurs from current system. The system successfully meets all functional and security requirements to ensure user data is protected and delivery accurately of the attendance tracking. It has been tested and accepted by all the user and aligns well with the operational needs of BCB Berhad. Overall, the system reduces administrative workload and improves organizational productivity. Although the system performs effectively, there is still improvement for future development. Finally, the system provides significant benefits to all users at BCB Berhad and enhances the company's overall attendance management process.

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Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

This journal requires that all authors take public responsibility for the content of the work submitted for review. The contributions of all authors must be described in the following manner:

The authors confirm contribution to the paper as follows: ***study conception and design:*** *N. A.Muharam, N. Abd Warif* ***data collection*** *N. A.Muharam, N. Abd Warif;* ***analysis and interpretation of results:*** *N. A.Muharam, N. Abd Warif* ***draft manuscript preparation:*** *N. A.Muharam, N. Abd Warif. All authors reviewed the results and approved the final version of the manuscript.*

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Appendix A: User Acceptance Testing

USER ACCEPTANCE TESTING (UAT)

SMART FACE ATTENDNACE SYSTEM USING DEEP FACE INTEGRATION

FOR BCB BERHAD KUJANG

Name : Ozura Sofrina Binti Iskandar

Date : 9 June 2025

No. Phone : 012-7044005

Organization :

User: Admin

No.	Module/Acceptance Criteria	Test Result		Remark (if any)
		Pass	Fail	
1.	**Login**			
(a)	I am able to log in using a valid email and password	✓		
(b)	I am able to view an appropriate error message when incorrect email or password is entered	✓		
(c)	I am able to verify a One-Time Password (OTP) sent to my registered email	✓		
(d)	I am able to view an error message when an incorrect OTP is entered	✓		
(e)	I am required to change my password upon first-time login	✓		
(f)	I am able to reset my password via email verification on the login page	✓		
(g)	I am able to log in successfully after changing to a new password	✓		
2.	**User Registration**			
(a)	I am able register new user information and successfully capture user facial image	✓		
(b)	I am able to view an error message if a duplicate employee ID or email address is used	✓		
(c)	I am able to view a list of registered users along with their registration dates after successful registration	✓		
(d)	I am able to view total number of active user	✓		
3.	**Department Management**			
(a)	I am able to add a new department by providing a unique department ID	✓		
(b)	I am able to view an error message if a duplicate department ID or name is used	✓		
(c)	I am able to view a list of departments with their creation dates after successful addition	✓		
(d)	I am able to view the total number of active departments	✓		
4.	**User Management**			
(a)	I am able to deactivate a user	✓		
(b)	I am able to deactivate a department	✓		
(c)	I am able to view the deactivation date for each deactivated user	✓		
(d)	I am able to edit a user's profile information	✓		
(e)	I am able to update a user's facial image using the same employee ID	✓		
5.	**User Profile**			
(a)	I am able to view my personal profile information	✓		
(b)	I am not allowed to edit my own profile details	✓		
(c)	I am able to upload and remove my profile picture	✓		
6.	**Password Management**			
(a)	I am able to view an error message if a weak password is entered	✓		
(b)	I am able to view an error message if the current password, new password, and confirmation password do not match.	✓		
(c)	I am able to successfully change my password using a strong password and a success message is displayed.	✓		
(d)	I am able to log in using the newly updated password	✓		
7.	**Face Recognition**			
(a)	I am able to clock in using my facial image matches my registered employee ID	✓		
(b)	I am able to clock out using my facial image matches my registered employee ID	✓		
(c)	I am able to click the clock in and clock out buttons multiple times	✓		
8.	**Manual Login Attendance**			
(a)	I am able to click manual login button if my face does not match	✓		
(b)	I am able to capture my picture and enter employee ID	✓		
(c)	I am able to view error message using invalid employee ID is entered	✓		
(d)	I am able to view success message upon successful submission of manual attendance request			
9.	**Manual Attendance Request**			
(a)	I am able to view manual login attendance requests submitted by users	✓		
(b)	I am able to receive notifications in the system and via email when a manual attendance request is submitted	✓		
(c)	I am able to choose whether to approve or reject each manual attendance request	✓		
(d)	I am able to view past manual attendance request records by filtering by date	✓		
10.	**Public Holiday**			
(a)	I am able to add new public holidays to the calendar	✓		
(b)	I am able to delete public holidays from the calendar	✓		
(c)	I am able to filter the calendar by month to view and manage holidays	✓		
11.	**Reporting and Analytic**			
(a)	I am able to view all employees' daily attendance performance on the dashboard	✓		
(b)	I am able to view the total number of employees, total present, and total absent figures on the dashboard	✓		
(c)	I am able to filter attendance records by date and department to view previous data	✓		
(d)	I am able to view previous attendance data for deactivated users in the dashboard	✓		
(e)	I am able to generate reports by filtering date ranges and individual employee data	✓		
(f)	I am able to export attendance reports into PDF format	✓		

User: Manager

No.	Module/Acceptance Criteria	Test Result		Remark (if any)
		Pass	Fail	
1.	**Face Recognition**			
(a)	I am able to clock in using my facial image matches my registered employee ID	✓		
(b)	I am able to clock out using my facial image matches my registered employee ID	✓		
(c)	I am able to click the clock in and clock out buttons multiple times	✓		
2.	**Manual Login Attendance**			
(a)	I am able to click manual login button if my face does not match	✓		
(b)	I am able to capture my picture and enter employee ID	✓		
(c)	I am able to view error message using invalid employee ID is entered	✓		
(d)	I am able to view success message upon successful submission of manual attendance request	✓		
3.	**Login**			
(a)	I am able to log in using a valid email and password	✓		
(b)	I am able to view an appropriate error message when incorrect email or password is entered	✓		
(c)	I am required to change my password upon first-time login	✓		
(d)	I am able to reset my password via email verification on the login page	✓		
4.	**Reporting and Analytic**			
(a)	I am able to view daily attendance performance for all department members	✓		
(b)	I am able to view the total number of department members such as total present and total absent counts	✓		
(c)	I am able to filter attendance records by date to view previous data	✓		
(d)	I am able to view previous attendance data for deactivated users	✓		
5.	**Manual Attendance History**			
(a)	I am able to view my manual login attendance history	✓		
(b)	I am able to receive notifications regarding my manual attendance requests	✓		
(c)	I am able to view past manual attendance history records by filtering by date	✓		
6.	**User Profile**			
(a)	I am able to view my personal profile information	✓		
(b)	I am not allowed to edit my own profile details	✓		
(c)	I am able to upload and remove my profile picture	✓		
7.	**Password Management**			
(a)	I am able to view an error message if a weak password is entered	✓		
(b)	I am able to view an error message if the current password, new password, and confirmation password do not match.	✓		
(c)	I am able to successfully change my password using a strong password and a success message is displayed.	✓		
(d)	I am able to log in using the newly updated password	✓		

User: Employee

No.	Module/Acceptance Criteria	Test Result		Remark (if any)
		Pass	Fail	
1.	**Face Recognition**			
(a)	I am able to clock in using my facial image matches my registered employee ID	✓		
(b)	I am able to clock out using my facial image matches my registered employee ID	✓		
(c)	I am able to click the clock in and clock out buttons multiple times	✓		
2.	**Manual Login Attendance**			
(a)	I am able to click manual login button if my face does not match	✓		
(b)	I am able to capture my picture and enter employee ID	✓		
(c)	I am able to view error message using invalid employee ID is entered	✓		
(d)	I am able to view success message upon successful submission of manual attendance request	✓		
3.	**Login**			
(a)	I am able to log in using a valid email and password	✓		
(b)	I am able to view an appropriate error message when incorrect email or password is entered	✓		
(c)	I am required to change my password upon first-time login	✓		
(d)	I am able to reset my password via email verification on the login page	✓		
4.	**Reporting and Analytic**			
(a)	I am able to view my daily attendance performance	✓		
(b)	I am able to filter attendance records by date to view previous data	✓		
(c)	I am able to view previous attendance data for deactivated users	✓		
5.	**Manual Attendance History**			
(a)	I am able to view my manual login attendance history	✓		
(b)	I am able to receive notifications regarding my manual attendance requests	✓		
(c)	I am able to view past manual attendance history records by filtering by date	✓		
6.	**User Profile**			
(a)	I am able to view my personal profile information	✓		
(b)	I am not allowed to edit my own profile details	✓		
(c)	I am able to upload and remove my profile picture	✓		
7.	**Password Management**			
(a)	I am able to view an error message if a weak password is entered	✓		
(b)	I am able to view an error message if the current password, new password, and confirmation password do not match.	✓		
(c)	I am able to successfully change my password using a strong password and a success message is displayed.	✓		
(d)	I am able to log in using the newly updated password	✓		

I am Ozura Sofrina Binti Iskandar hereby declare that the information provided is true and correct

Agreed by,

BCB BERHAD

Name: Ozura Sofrina Binti Iskandar

Position: Admin

Date: 9.6.2025

Fig A.1: *User Acceptance Testing For Admin*