Applied Information Technology And Computer Science Vol. 2 No. 2 (2021) 1590-1604

AITCS

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

A Development of an Attendance System based on Facial Recognition Approach

Lo Zhan Preston, Nureize Arbaiy*

Faculty of Computer Science and Information Technology,
Universiti Tun Hussein Onn Malaysia, Parit Raja, 86400, MALAYSIA.

DOI: https://doi.org/10.30880/aitcs.2021.02.02.103
Received 09 July 2021; Accepted 23 September 2021; Available online 30 November 2021

Abstract: In line with the rapid development of technology, methods of recording and storing data such as staff attendance and working hours are very important and need to be improved so that analysis and related work processes can be done more efficiently. Small and medium -sized companies, most of them still use punch card systems or electronic systems to keep records of employee attendance for employment purposes. However, existing systems cannot perform payroll calculations automatically, cannot generate warning letters to employees immediately, and cannot record data simultaneously. All of these difficulties will render the process of managing attendance records and employee salaries ineffective.Thus, a presence system using face recognition was developed to overcome the stated problems. The Administrators and users of the respective systems are the managers and employees of the company. The prototype model is used as a software development guide. This system includes fivemain modules namely user login & registration, face recognition, data management, data analysis, notifications and reporting. The Local Binary Pattern History (LBPH) algorithm is implemented into the system to handle the face recognition process. The Python, PHP, SQL programming languages and MySQL database are used to produce this system. The result of this project is a fully automated attendance system that will conduct attendance checks on all employees on each working day. The system developed is also expected to be able to perform salary calculations at the end of each month, can produce a reminder letter when necessary, can record many attendances at one time, and data will be taken in real time.

Keywords: Attendance System, Facial Recognition, Local Binary Pattern Histogram, Prototyping

1. Introduction

Attendance system can be of various types, from muster roll to mechanized system to biometric system. For a general company, the most used attendance system is manual punch card system [1]. This system requires manual input from the employees, and manual checking process from the company manager [2]. Generally, an Administrator must distribute a punch card to employees at the beginning of every month. Then, the employees are responsible to perform card punching for every working day.

*Corresponding author: *nureize@uthm.edu.my*

Next, an Administrator is responsible to gather, verify, and calculate all data recorded on punch cards at the end of every month. Lastly, the Administrator is then able to pay employees' wages based on the attendance report. This process repeats every month.

The existing punched card system may be very practical, but it has few limitations. For instance, the existing system does not automate an employee's attendance. Each employee is required to provide input manually [1]. Next, the existing system does prevent attendance fraud, but it doesn't prevent loss of card. If an employee happened to lose his or her card, all data recorded on the card will be lost, recovering such lost data is an impossibility. Finally, the existing system does not automatically calculate attendance percentage. Without the ability to calculate attendance percentage, an Administrator can't calculate an employee's wages without prior attendance percentage calculation. In other words, an Administrator has multiple works prior to be done in order to pay employee salaries, such works are verifying attendance on the card, calculate attendance percentage based on the card, calculate wages, and finally pay wages.

Hence, the facial recognition technique will be adopted into general supermarket company attendance system that utilizes manual punch card system. The case study for the project is Chau Sui Teck (Mawar) Sdn. Bhd. The goal in this project is to develop an attendance system using facial recognition with Local Binary Pattern History (LBPH) [3] algorithm. It is hoped to improve the existing punch card system into a fully automated attendance system for Chau Sui Teck workers. In this system, a camera function is utilized to detect for human faces. The camera will only recognize the face registered and stored in the system database, i.e., in this case the face of the employee. When the corresponding employee face is detected by the match in the database, the system will record the employee presence. Attendance will be recorded automatically without the need for input from employees. Then, the system should also calculate employees' attendance and wages automatically at the end of the month. This process eliminates manual calculation and attendance verifying work. Providing a better less time-consuming process, prevent attendance fraud, and data loss protection.

This article is organized into sixsections. The first segment explains the context of the project. The second section clarifies the analysis of literature. In the third part, the methodology is explained. The study and design of the system is illustrated in the fourth section. Section 5 explains system implementation and testing. In the last segment, Conclusion.

2 Related Work

The study in this project focuses on the process of recording employee attendance. The study was conducted at Chau Sui Teck (Mawar) Sdn. Bhd., which is a retail business company located at Taman Mawar, Sandakan, Sabah. The company to date has around 40 workers. The company is currently utilizing manual punch card system [1]. Punch cards should usually be issued by supervisors to all workers at the beginning of each month [4]. Then according to their working shift, each employee must punch their card. Next, if this is not the end of the month, then the procedure will end, otherwise the Administrator will collect all employees' hostage cards and conduct verification of attendance on all cards. The accounting department then takes over after verification, to determine the salary of each employee. The final payment report will then be issued, and the payment report will be verified by the Administrator. Eventually, all workers would be paying wages.

Organization and company in this era utilize manual punch card system and fingerprint biometric attendance system for their mass group of employees. Both systems only allow one attendance record at a time. For company that uses punch card system, at the end of every month, the Administrator has to gather mass punch card from the employees and perform several tasks before wages can be paid. Such tasks are verifying attendance, calculate attendance percentage, calculate wage rate, and finally calculate final total wages. The existing system does not perform mathematic calculation. Without a

system's aid in calculating mathematics, manual calculation could prone to calculation errors, difficult to generate accurate report, and does not trigger warning letter for problematic employee automatically.

Therefore, an automated attendance system is needed to overcome the problems that occur in the existing process, where the new system is able to capture employees' attendance quickly and accurately using face recognition algorithms. In addition, automated data processing is also required to support data management, data processing, and report generation. Hence, the face recognition system with the Local Binary Pattern History (LBPH) algorithm will be optimized as a solution to create a new attendance method. Recently, there have been many in-app attendances systems that have been developed to facilitate the recording of attendance for staff, students, or any participant in system information [5] – [10].

2.1 Haar Cascade Classifier

Haar Cascade is a technique for machine to detect object in an image and in video. In order to detect faces, Haar Feature is used. Figure 1 shows the Haar Feature originally developed by Viola and Jones [11]. Figure 2 shows a face is detected using Haar Feature. Haar Feature works by computing the sum of white areas and the sum of dark areas. Then, the differences between the sums will be calculated. The value will be used to determine whether a face is present in an image.

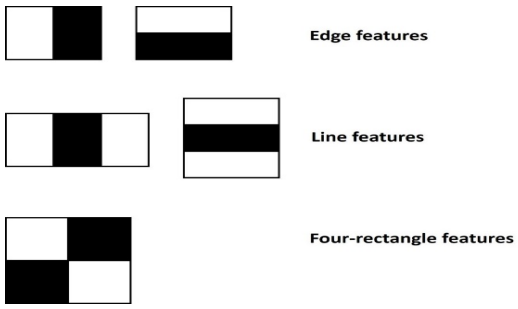

Figure 1: Haar Features

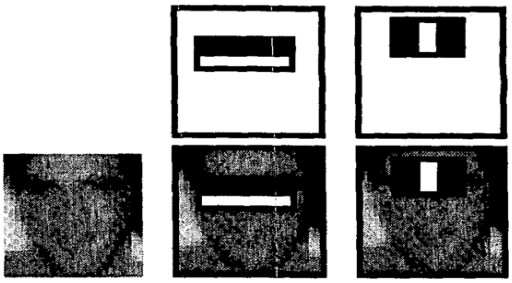

Figure 2: Face detection using Haar Feature [8]

2.2 Local Binary Pattern Histogram

Local Binary Pattern Histogram was originally designed for descripting texture [3] [12].LBP has the ability to identify identical twins [13]. This is because LBP can describe the micro patterns of the face very well.

Local Binary Pattern (LBP) algorithm is described in the following:

i. The image will first be converted into grayscale image, this is because greyscale only have 1 channel instead of 3 channels (RGB Channels).
ii. The image will then be divided into $N \times N$ of grid. The number of grids to be divided depends on the size of the image.
iii. 3×3 grid will be taken starting from top-left position of image. Each pixel in the grid will have their respective greyscale value ranged from 0 to 255.
iv. The center value will act as threshold value, the 7 neighbor values will be comparing with the threshold value. For values that is lower than the threshold value, 0 will be assigned to that cell, otherwise 1 will be assigned.
v. Starting from top-left position and in a close-wise manner, an 8-bit binary value will be generated. Later, the binary value will be converted into decimal value, which is 98. The decimal value indicates the greyscale value ranged from 0 to 255.
vi. The converted decimal value will then be assigned to the center cell.

vii. The A new greyscale value is assigned onto the image, a new shade of grey color will be generated.
viii. The image has been converted into new shade of grey colors.
ix. Next, the new shade of grey image will be further divided into grids.
x. A histogram will be constructed on each grid. The height of grid is based on the value of the color. i.e., darker pixels will be having higher histogram height.
xi. By using the constructed histogram, the captured face image and processed face image will be compared to calculate similarity rate.

This method of calculation does not require complex mathematical computation; thus, formulas does not exist in this method. Figure 3 illustrates the process of Local Binary Pattern.

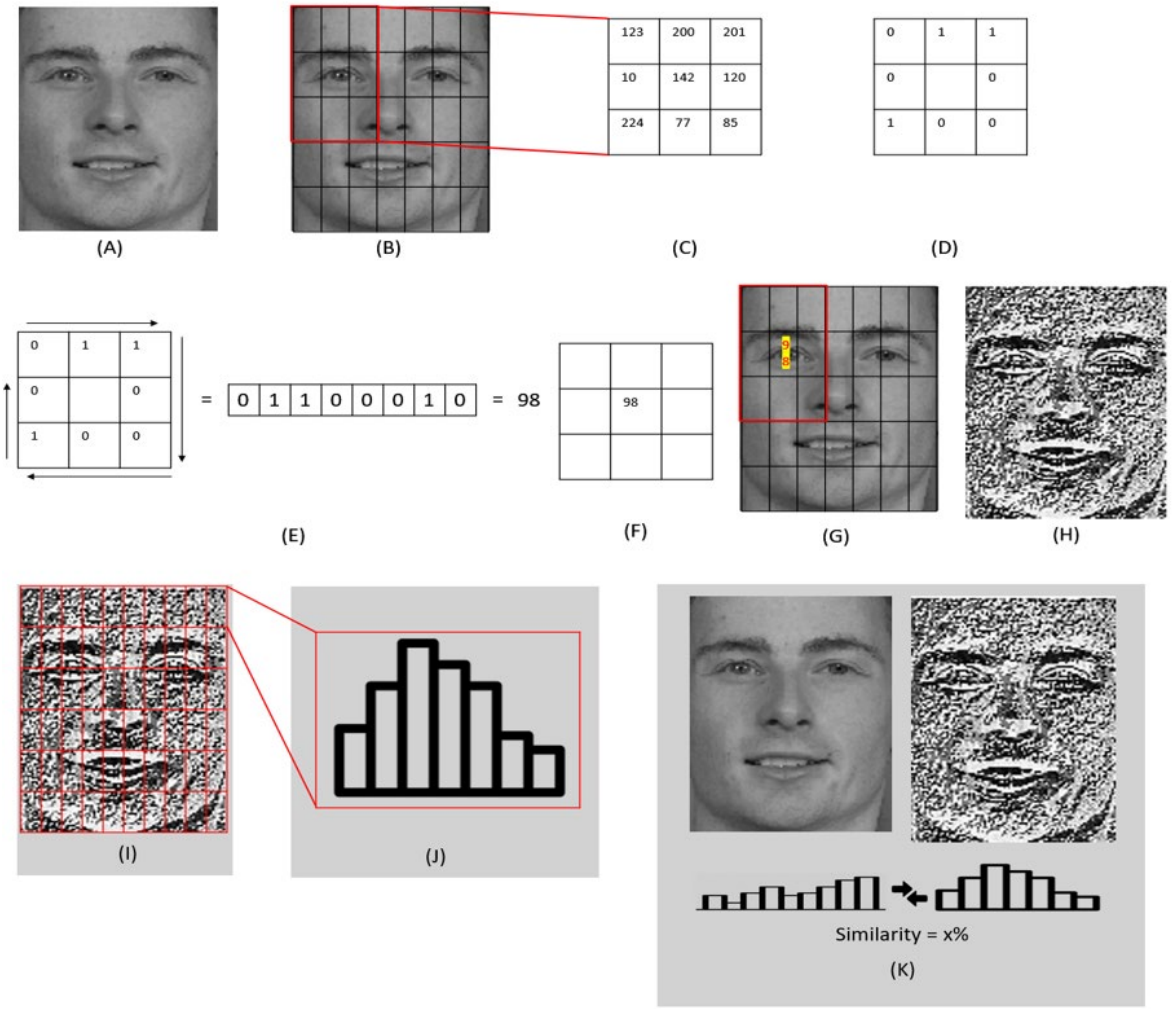

Figure 3: Local Binary Pattern Process

2.3 Comparison with the Existing Systems

The results of a comparison of the three (3) current systems to the proposed system are shown in Table 1. The three existing systems are *Adobe Character Animator Motion Capture*, *Facebook DeepFace*, and *iPhone Face ID*. Generally, motion capture in adobe character animator is a face tracking system, whereas DeepFace and Face ID are both facial recognition system. The five (5)

modules defined for the proposed system will be used to compare all 4 systems, which are user login and registration, face recognition algorithm, data management, data analysis and, finally, reporting and notification.

Table 1: System's Comparison

System / Features	Adobe Character Animator Motion Capture	Facebook DeepFace	iPhone Face ID	Face Recognition Attendance System
User Login & Registration	×	√ email and password	×	√ username and password
Face Recognition Algorithm	×	Neural Network	Neural Network	Local Binary Pattern
Data Management	√	√	√	√
Data Analysis	×	×	×	√
Reporting & Notification	×	√	√	√

3. Methodology

This segment discusses the prototyping models as well as the facial recognition technique.

3.1 Prototyping Model

The prototyping model is chosen to the fact that this model is the most suitable when system requirements are not clearly defined. Furthermore, the model is an iterative model which gives the developer the ability to go back to refining phase when the system does not meet user requirements. Table 2 shows each phase of prototyping method has its own tasks and output that need to produce during the entire project development.

Table 2: Software Development Activities and Respective Task

Phase	Task	Output
Requirement	Proposed the project Determine the project schedule, activities and output Conduct interview Gather Information	Project proposal Gantt chart List of requirements Requirement analysis
Design	Conduct requirement analysis o Determine the flow of the project o Determine the process that involves in a system Produce system design o database design o user interface design	Flowchart data flow diagram (DFD) Entity relationship diagram (ERD) Database design User interface design
Building	Write program code for the system	Prototype version system
User Evaluation	System test run Gather feedbacks from users	Test cases List of feedbacks
Refining Prototype	Recode the system	Another version of system prototype
Implementation	Coding finalization Deployment of system Report writing	Complete version of system Project report

3.2 Face Detection and Recognition

The facial recognition in this proposed system uses two main components, they are Haar Cascade Classifier and Local Binary Pattern Histogram Algorithm as discussed in Segment 2.1 and 2.2 respectively. The following summarizes the process of facial recognition:

i. The system first opens camera to capture a series of images repeatedly. The captured image will be displayed on the window and is updated constantly.

ii. Next, the system uses Haar Cascade Classifier to detect any face found in the image. Haar Cascade is an object that identifies faces. It detects faces by calculating sum of light and dark areas.

iii. Then, the detected face will be cropped out and stored into a folder. This is when the face registration take place.

iv. After that, the system will be able to recognize any registered face by comparing the current captured face with the face image stored in the folder.

v. The system recognizes faces by using Local Binary Pattern Histogram Algorithm. Again, the system will use Haar Cascade Classifier to detect faces from the image captured by the camera. Crops and converts to greyscale, then applies LBPH algorithm.

vi. The LBPH algorithm in general, converts a greyscale image into an image that consists only of black and white, as shown in Figure 3 (H).

vii. Then, a histogram will be constructed on the processed face image.

viii. The histogram will be used to compare with the current face captured by the camera to calculate similarity rate.

ix. The similarity rate is to be defined manually by the user. i.e., if the user set the similarity rate to be at least 40%, then the system will be able to recognize the face if the calculated similarity rate is higher than 40%.

This method has been implemented into this developed system.

4. Analysis and Design

This segment discusses findings from system analysis and design.

4.1 Functional & Non-Functional Requirement

Requirement analysis is the method of evaluating requirements that the designed system needs to meet, or the result of the proposed system's user expectation. Table 3 and Table 4 show the functional and non-functional requirements, respectively. Then, Table 5 lists all the data that will be collected by the system.

Table 3 listed 5 modules. However, the main module of the proposed system is the second module, which is Registration and Recognition. This module consists of registering face into the system and recognizing the registered face. Next, Table 4 shows 5 requirements for the non-functional of the proposed system. The requirements are Performance, Data Integrity, Usability, Capacity, and Data Collection.

Table 3: Functional Requirements

No	Module	Description
1	Account Registration & User Login	• Administrator (Manager) able to create accounts • Administrator (Manager) able to register employees' detail in the account • Administrator (Manager) able to login into account
2	Registration and Recognition	• System should be able to register face value into database • System should be able to capture real-time image through camera • System should be able to process captured image using Local Binary Pattern Histogram method • System should be able to recognize faces
3	Data Management	• Administrator (Manager) should be able to manipulate the data recorded by system
4	Data Analysis	• System should be able to perform arithmetic calculation • System should be able to calculate attendance, late, absent percentage • System should be able to calculate salary and wages automatically
5	Reporting & Notification	• System should be able to generate monthly report • System should be able to generate notification

Table 4: Non-Functional Requirements

No	Requirement	Description
1	Performance	• System shall be able to function at least 13 hours daily • System should be able to recognize multiple faces at once
2	Data Integrity	• System shall be able to record correct and precise data
3	Usability	• System shall be user-friendly and easy to use
4	Capacity	• System shall be able to accommodate at least 50 users (employee)
5	Data Collection	• System shall be able to collect any data that has been inputted

Table 5: Data Collection

Personal Data	Business Data	System Data
• Names • Face Image • ID	• Attendance Data • Notification Data • Warning Letter Data • Job Position • Base Salary	• Account Username • Account Password

Finally, Table 5 shows the lists of data collected by the system. There are three types of data: Personal Data, Business Data, and System Data. Generally, the most sensitive data, that is personal data, will only collect 3 items, they are names, face image, and ID. The other data are categorized in Business Data and System Data as illustrated in Table 5.

4.2 Data Flow Diagram

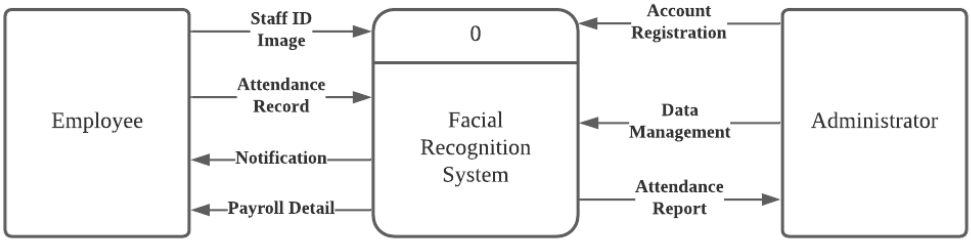

Figure 4: Context Diagram

Figure 4 illustrates context diagram for the proposed system. There are two (2) external entities which are employee and administrator. The employee can register a Face ID by scanning their faces into the system. Next, an employee can record their attendance by scanning their faces. Then, an employee can receive notification such as warning letter. Lastly, an employee can receive payroll detail. Administrators can register accounts for the system. Next, Administrators can perform data management such as scheduling, editing attendance, viewing attendance and deleting data. Finally, Administrators can generate reports from the system.

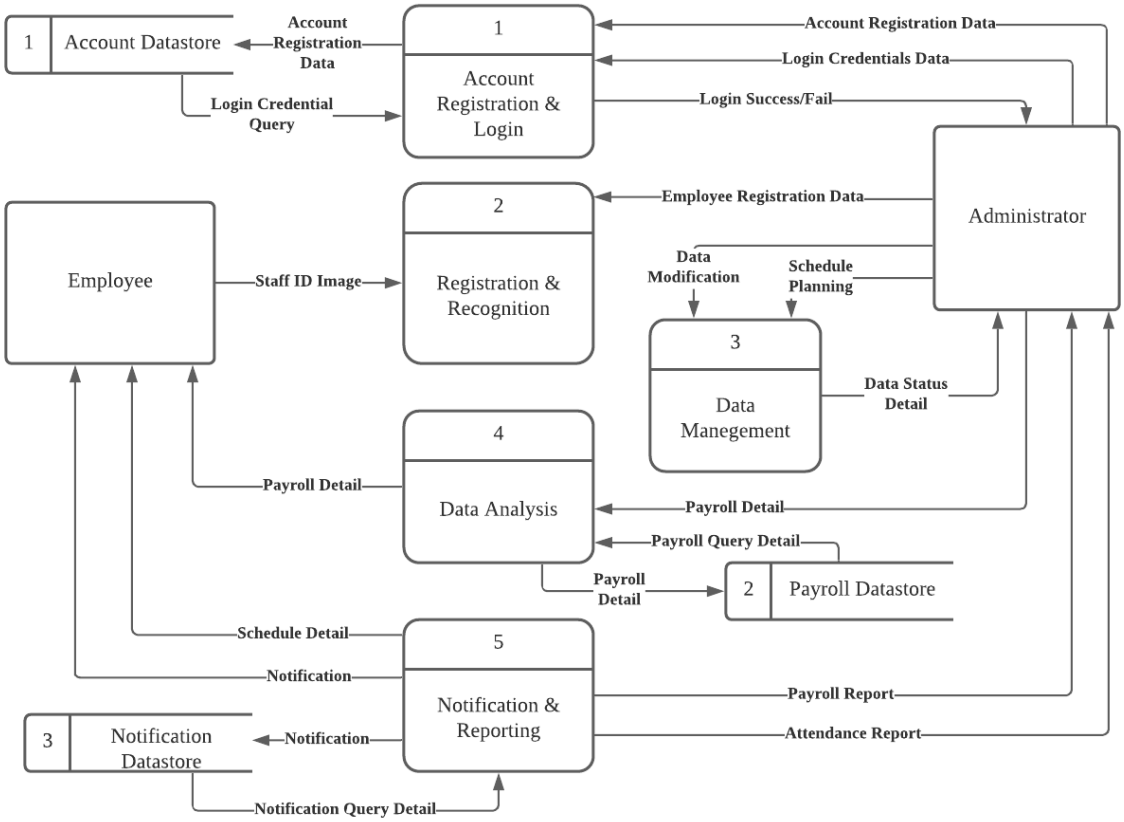

Figure 5: Data Flow Diagram Level 0 (DFD 0)

Figure 5 shows Data Flow Diagram Level 0 for the proposed system. There are five (5) processes, two (2) entities and three (3) datastores in this diagram. Generally, Account Registration and Login

processes enables admin to create an account and login into the system. Next, Registration and Recognition process handles facial registration and facial recognition. Next, Data Management process enables admin to modify and delete data stored in the system. Then, Data Analysis process enables the system to perform mathematic calculation automatically. Finally, Notification and Reporting generates monthly report, notification and warning letter automatically.

4.3 Entity Relationship Diagram

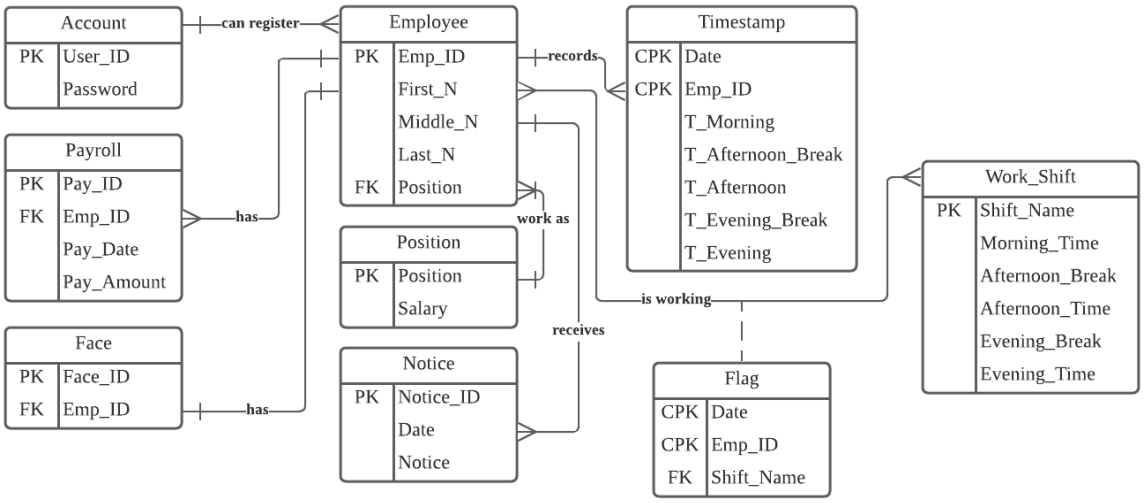

Figure 6: Entity Relationship Diagram

As shown in Figure6, there are total of nine (9) tables in the database. Generally, an account can register many employees. An employee has multiple payrolls, has only one face ID, has only one working position, can receives many notices, can record many timestamps, and can work for multiple work shift time. The following describes database schema:

i. `Account (User_ID, Password)`
ii. `Payroll (Pay_ID, Emp_ID, Pay_Date, Pay_Amount)`
iii. `Face (Face_ID, Emp_ID)`
iv. `Employee (Emp_ID, First_N, Middle_N, Last_N, Position)`
v. `Position (Position, Salary)`
vi. `Notice (Notice_ID, Date, Notice)`
vii. `Timestamp (Date, Emp_ID, T_Morning, T_Afternoon_Break, T_Afternoon, T_Evening_Break, T_Evening)`
viii. `Flag (Date, Emp_ID, Shift_Name)`
ix. `Work_Shift (Shift_Name, Morning_Time, Afternoon_Break, Afternoon_Time, Evening_Break, Evening_Time)`

4.4 System Flowchart

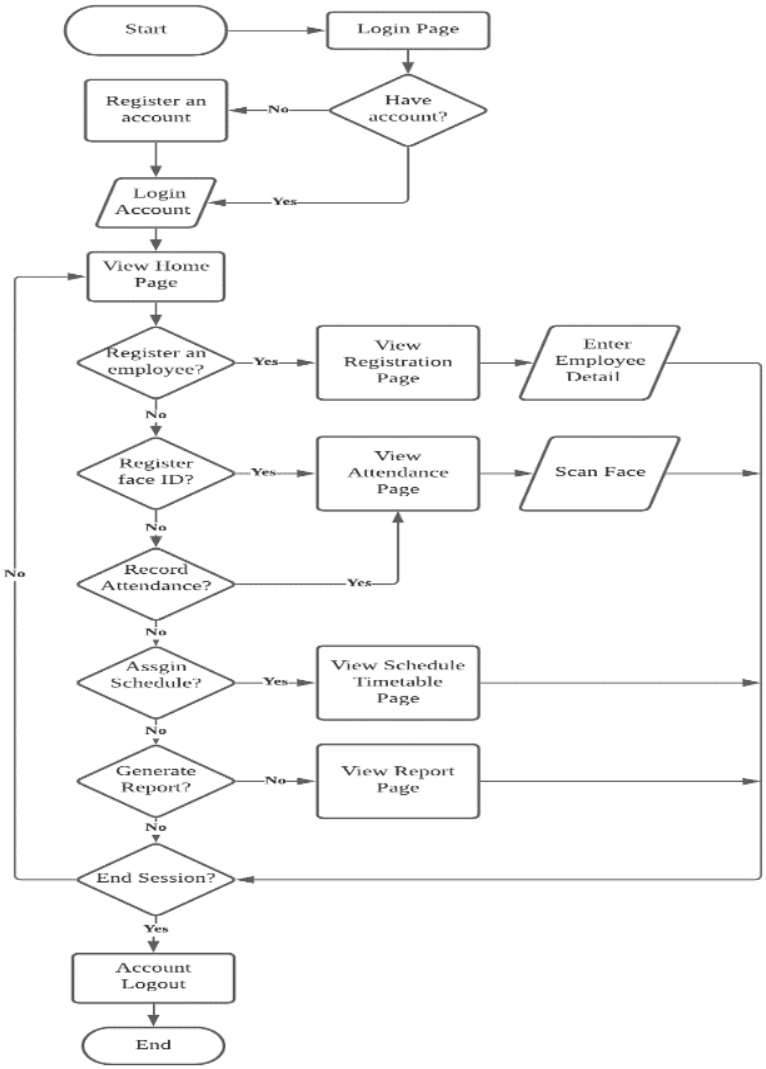

Figure 7: System Design Flowchart

As seen in Figure 7, on the login screen, the system will start. If the administrator has an account, the administrator can go to the homepage directly or continue with registration of the account. Administrators would then gain access to the system's various related features, such as employee registration, face ID registration, attendance monitoring, work schedule setting, and reporting. Finally, the account will be signed out if the user wishes to end the session.

4.5 User interface

Figures 8, 9 and 10 demonstrate the user interface for the login page, attendance page, and report page, respectively. An online platform called Moqups is used to create the user interface. In the login tab, only the username and password to log in will be included. Next, the attendance tab allows for face registration and face recognition features. Lastly, on the report tab, the attendance analysis reported by the worker will be displayed.

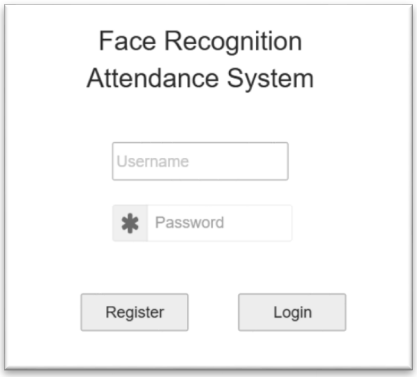

Figure 7: User Interface for Login Page

Figure 8: User Interface for Attendance Page

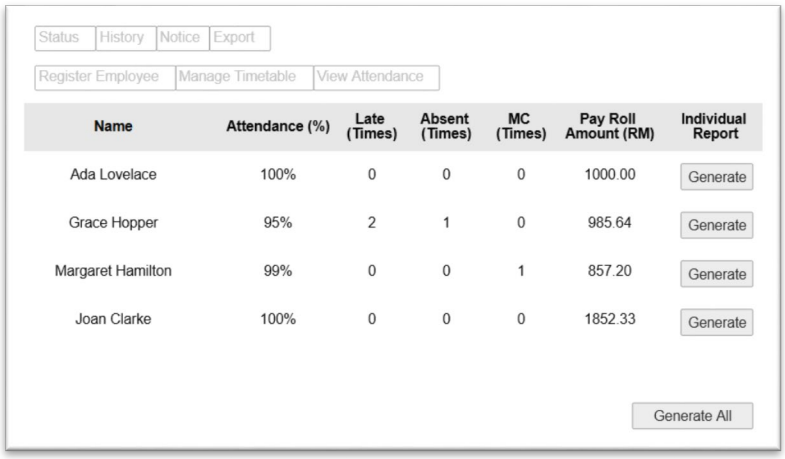

Figure 9: User Interface for Report Page

5. Implementation and Testing

Table 6 and Table 7 shows the lists of used software to develop the system and the test result for all 5 modules respectively. Whereas Figure 10 and Figure 11 shows the source code for facial registration and the output respectively. Then, Figure 12, Figure 13, and Figure 14 exhibits some of the screenshots of the system.

Table 6: Software for System Development

Software	Purpose
Adobe Dreamweaver	To develop website
XAMPP	To implement MySQL database
Microsoft Visual Studio	To develop facial recognition system

Table 6 lists 3 software used to build the facial recognition system. Generally, the system is developed into 2 separate entities, they are website and facial recognition entity. Website is built to allow the system to output the data in a well format manner. However, in order to build facial recognition, it has to be built outside of the website. Finally, XAMPP is a distributor that allows researcher to implement MySQL database with ease.

```
while(True):
    ret, img = cam.read()
    img = cv2.flip(img, 1) # flip video image vertically
    gray = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)
    faces = face_detector.detectMultiScale(gray, 1.3, 5)
    for (x,y,w,h) in faces:
        cv2.rectangle(img, (x,y), (x+w,y+h), (255,0,0), 2)
        count += 1
        # Save the captured image into the dat
        # asets folder
        if(count>10):
            cv2.imwrite("dataset/" + str(name_input) + "." + str(face_id) + ".png", gray[y:y
              +h,x:x+w])
    cv2.imshow('image', img)
    k = cv2.waitKey(100) & 0xff
    # Press 'ESC' for exiting video
    if k == 27:
        break
    elif count >= 15: # Take 15 face sample and stop video
        break
```

Figure 10: Face Registration Source Code Part 1

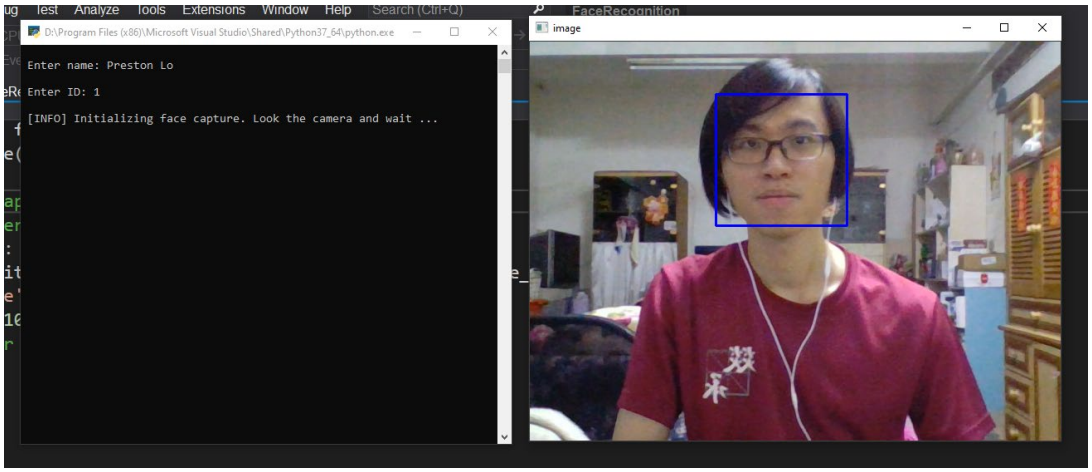

Figure 11: Face Registration User Interface

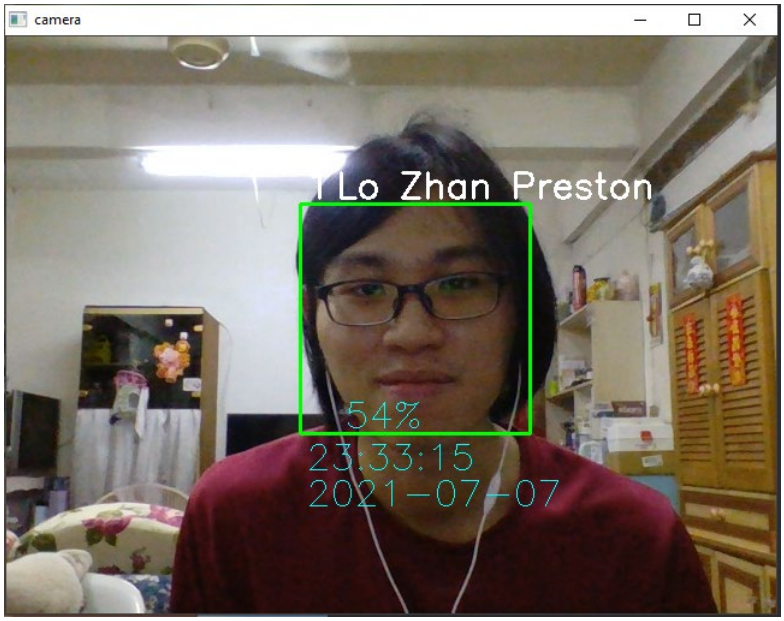

Figure 12: Face Recognition

Month: July

Employee	Attendance (%)	Late	Early	No Record	Base Salary (RM)	Final Salary (RM)
1 Lo Zhan Preston	66.666666666667	0Time(s)	2Time(s) 2021-07-08	0Time(s)	2200	2180
2 Abu bin Ahmad	50	1Time(s) 2021-07-01	1Time(s) 2021-07-01	0Time(s)	1500	1480
3 Chin Qing Qing	50	1Time(s) 2021-07-04	1Time(s) 2021-07-04	0Time(s)	2000	1980
4 Kelvin Song	66.666666666667	1Time(s) 2021-07-09	1Time(s) 2021-07-09	0Time(s)	2200	2180
5 David Chu	0	2Time(s) 2021-07-10	2Time(s) 2021-07-10	0Time(s)	1500	1460
10 Ramesh Armaan	25	1Time(s) 2021-07-02	2Time(s) 2021-07-02	0Time(s)	1500	1470

Previous Month Next Month

Figure 13: System Report Page

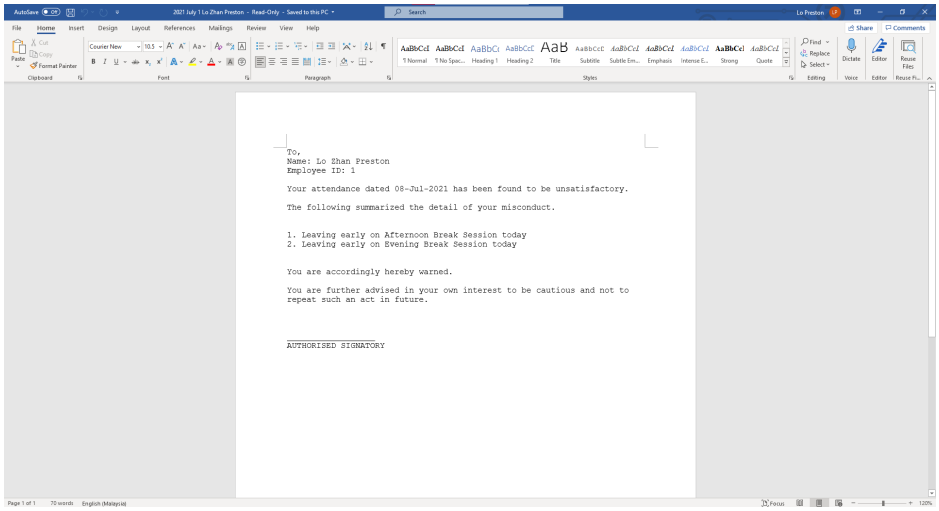

Figure 14: Warning Letter

Figure 10 shows the python source code in Microsoft Visual Studio for facial registration. Whereas Figure 11 displays the output of the source code as illustrated in Figure 10. Generally, a library called Open-CV or CV2 is used to develop the facial registration. Open-CV is an open-source library which is designed to allow computers to perform visionary operations. Next, a haar cascade classifier is used to allow computers to detect faces in the image that the computer captures. The haar cascade classifier is stored inside the variable `face`. Lastly, the output is shown in Figure 11. The terminal on the left requests for inputs for name and ID from the user, whereas the image window on the right capture images and detects faces.

Next, Figure 12 displays the face recognition of the system. On the top of the green square, employee ID will be displayed, followed by employee's name. Then, similarity rate will be displayed at the bottom inside the green square. In this case, the similarity rate is 54%. After that, the time and date of capturing will be displayed beneath the green square.

Figure 13 illustrates the report page of the system. Generally, the information that will be displayed are as follows: Month, Employee ID, Employee Name, Attendance Percentage, Late to Work Count, Leaving Early from Work Count, No Record for Attendance Count, Base Salary, Final Salary. Final salary is affected by Late and Early count. Each time an employee is late for work or leaves early from work, a RM 10 deduction will be applied towards respective base salary.

Figure 14 shows the warning letter generated automatically by the system whenever there's an employee misbehaved for their attendance performance. The warning letter consists of information about the date of occurrence, name, ID, list of misbehaviour, and lastly a warning message to the receiver.

Table 7: Testing Result for Each Module

Module	Test Case ID	Description	Result
Account Registration and Login	M1-1	Account Registration	Pass
	M1-2	Account Login	Pass
	M1-3	Check Account Credentials	Pass
Registration and Recognition	M2-1	Employee Registration	Pass
	M2-2	Schedule Registration	Pass
	M2-3	Face Registration	Pass
	M2-4	Face Recognition	Pass
	M2-5	Attendance Record	Pass
Data Management	M3-1	Data Modification	Pass
	M3-2	Data Deletion (Schedule)	Pass
	M3-3	Data Deletion (Employee)	Pass
Data Analysis	M4-1	Auto Computation	Pass
	M4-2	Attendance Computation	Pass
	M4-3	Late Detection	Pass
	M4-4	Early Leaves Detection	Pass
	M4-5	No Record Detection	Pass
	M4-6	Salary Computation	Pass
Reporting and Notification	M5-1	Data Retrieval	Pass
	M5-2	Report Generation	Pass
	M5-3	Notification Generation	Pass
	M5-4	Warning Letter Generation	Pass

Table 7 display all the test cases performed for each of the modules of the system. The test was performed by the researcher, and there is only one tester for the testing process. The result shows that all test cases were passed. In general, the main module, which is Registration and Recognition, had undergone 5 tests, they are Employee Registration, Schedule Registration, Face Registration, Face Recognition, and Attendance Recording. All these tests ran smoothly as expected.

Table 8: Face Similarity Rate Test Result

Condition	Similarity Rate
Normal Light	54%±
Dim Light	30% ±
Take Off Spectacles (Normal Light)	39% ±

Table 8 illustrates the similarity rate displayed by the system when performing facial recognition. When face capturing is done in normal lightning environment, the similarity rate displayed by the system is around 54% plus minus. Next, when the environment has dim lights, the similarity rate had reduced to 30% plus minus. Finally, taking off spectacles will result in reduced similarity rate to 39% plus minus. This test result shows that the face recognition will be having reduced performance under dim light environment as well as having slight changes of human face such as taking off spectacles.

6. Conclusion

The attendance system is built to help general companies to have an easier attendance recording and record keeping process. The system is designed using structured approaches and local binary pattern

histogram (LBPH) algorithm techniques.The system provides advantages of automates attendance recording, fasten the process of attendance recording, arrange schedule or timetable with ease, and able to record and retrieve data in real time. However, the system has few limitations. The system is unable to accommodate large number of users, the system is unable to detect faces with high accuracy, and the system has 2 separate platform which unable to be integrated into one entity. To solve the limitation, the researcher suggested to implement an extra module to manage the memory usage. Finally, increase the sample size of the face image taken by the system to increase accuracy.

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.

References

[1] A. Fong. (2005, June). Overview of Punch Card & Card Reader Systems. In Appendix V, Version 1.

[2] B. Camburn, V. Viswanathan, J. Linsey, D. Anderson, D. Jensen, R. Crawford, ... & K. Wood. (2017). Design prototyping methods: state of the art in strategies, techniques, and guidelines. *Design Science*, *3*.

[3] T. Ahonen, A. Hadid & M. Pietikäinen. (2004, May). Face recognition with local binary patterns. In *European conference on computer vision* (pp. 469-481). Springer, Berlin, Heidelberg.

[4] R. Zeffane, M.E. Ibrahim & R. Al Mehairi. (2008). Exploring the differential impact of job satisfaction on employee attendance and conduct. *Employee Relations*.

[5] H. Yang & X. Han. (2020). Face Recognition Attendance System Based on Real-Time Video Processing. *IEEE Access*, *8*, 159143-159150.

[6] K. Jacksi, F. Ibrahim & S. Zebari. (2018). Student Attendance Management System. *Scholars Journal of Engineering and Technology*, *6*(2), 49-53.

[7] K.S. do Prado. (2017). Face Recognition: Understanding LBPH Algorithm. *2017, Towards Data Science*.

[8] R. Yustiawati, N.L. Husni, E. Evelina, S. Rasyad, I. Lutfi, A. Silvia, ... & A. Rialita. (2018, October). Analyzing of Different Features Using Haar Cascade Classifier. In *2018 International Conference on Electrical Engineering and Computer Science (ICECOS)* (pp. 129-134). IEEE.

[9] S. Sawhney, K. Kacker, S. Jain, S.N. Singh & R. Garg. (2019, January). Real-Time Smart Attendance System using Face Recognition Techniques. In *2019 9th International Conference on Cloud Computing, Data Science & Engineering (Confluence)* (pp. 522-525). IEEE.

[10] W. Zeng, Q. Meng & R. Li. (2019, March). Design of intelligent classroom attendance system based on face recognition. In *2019 IEEE 3rd Information Technology, Networking, Electronic and Automation Control Conference (ITNEC)* (pp. 611-615). IEEE.

[11] P. Viola & M. Jones. (2001, December). Rapid object detection using a boosted cascade of simple features. In *Proceedings of the 2001 IEEE computer society conference on computer vision and pattern recognition. CVPR 2001* (Vol. 1, pp. I-I). IEEE.

[12] A. Hadid, M. Pietikainen & T. Ahonen. (2006). Face description with local binary patterns: Application to face recognition. *IEEE transactions on pattern analysis and machine intelligence*, *28*(12), 2037-2041.

[13] T.V. Priya, G.V. Sanchez & N.R. Raajan. (2018). Facial recognition system using local binary patterns (LBP). *International Journal of Pure and Applied Mathematics*, *119*(15), 1895-1899.