FACIAL RECOGNITION ATTENDANCE SYSTEM

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ABSTRACT

The main purpose of this project is to build a face recognition-based attendance monitoring system for educational institution to enhance and upgrade the current attendance system into more efficient and effective as compared to before. The current old system has a lot of ambiguity that caused inaccurate and inefficient of attendance taking. Many problems arise when the authority is unable to enforce the regulation that exists in the old system. Thus, by means of technology, this project will resolve the flaws existed in the current system while bringing attendance takingto a whole new level by automating most of the tasks.

The technology working behind will be the face recognition system. The human face is one of the natural traits that can uniquely identify an individual. Therefore, it is used to trace identity as the possibilities for a face to deviate or being duplicated is low. In this project, face databases will be created to pump data into the recognizer algorithm. Then, during the attendance taking session, faces will be compared against the database to seek for identity. When an individual is identified, its attendance will be taken down automatically saving necessary information into a database system. At the end of the day, the attendance information regarding an individual can be accessed from a web server hosted by the raspberry pi.

In short, this upgraded version of attendance monitoring system not only saved many resources, but also provides huge convenience to the authority as many process are automated.

1: Introduction

This is a project about *Facial Recognition-Based Attendance Monitoring System for Educational Institution*. In this chapter, the problem and motivation, research objectives, project scope, project contributions and the background information of the project will bediscussed in detail.

Problem Statement and Motivation

According to the previous attendance management system, **the accuracy of the data** collected is the biggest issue. This is because the attendance might not be recorded personallyby the original person, in another word, the attendance of a particular person can be taken by a third party without the realization of the institution which violates the accuracy of the data. For example, student A is lazy to attend a particular class, so student B helped him/her to sign for the attendance which in fact student A didn't attend the class, but the system overlooked this matter due to no enforcement practiced. Supposing the institution establish an enforcement, it might need to waste a lot of human resource and time which in turn will not be practical at all. Thus, all the recorded attendance in the previous system is not reliable for analysis usage. The second problem of the previous system is where it is **too time consuming**. Assuming the time taken for a student to sign his/her attendance on a 3-4 paged name list is approximately 1 minute. In 1 hour, only approximately 60 students can sign their attendance which is obviously inefficient and time consuming. The third issue is with the

accessibility of those information by the legitimate concerned party. For an example, most of the parents are very concerned to track their child's actual whereabouts to ensure their kid really attend the classes in college/school. However in the previous system, there are no ways for the parents to access such information.

Therefore, evolution is needed to be done to the previous system to improve efficiency, data accuracy and provides accessibility to the information for those legitimate party.

Research Objectives

In order to solve the drawbacks of the previous system stated in 1.1, the existing system will need to evolve. The proposed system will reduce the paper work where attendance will no longer involve any manual recording. The new system will also reduce thetotal time needed to do attendance recording. The new system will acquire individual attendance by means of facial-recognition to secure data accuracy of the attendance.

The followings are the objectives of this project:

To develop a portable Smart Attendance System which is handy and self-powered.
To ensure the speed of the attendance recording process is faster than the previous system which can go as fast as approximately 3 second for each student.

Have sufficient memory space to store the database.
Able to recognize the face of an individual accurately based on the face database.
Allow parents to track their child's attendance.
Develop a database for the attendance management system.
Provide a user friendly web interface for admins to access the attendance database and for non-admins (parents) to check their child's attendance.

Allow new students or staff to store their faces in the database by using a GUI.
Able to show an indication to the user whether the face- recognition process issuccessful or not.

Project Scope and Direction
The main intention of this project is to solve the issues encountered in the old attendance system while reproducing a brand new innovative smart system that can provide convenience to the institution. In this project, a smart device will be developed which is capable of recognising the identity of each individuals and eventually record down the data into a database system. Apart from that, a website will be developed to provide visual access to the information. The followings are the project scopes:

The targeted groups of the attendance monitoring system are the students and staff of an educational institution.

The database of the attendance management system can hold up to 2000 individual'sinformation.

The facial recognition process can only be done for 1 person at a time.
There will be two types of webpage interface after the login procedure for the admins and the non-admins respectively.

The project has to work under a Wi-Fi coveraged area, as the system need to updatethe database of the attendance system constantly.

The smart device is powered up by power bank to improve the portability of thedevice.

Impact, significance and contributions
Many attendance management systems that exist nowadays are lack of efficiency and information sharing. Therefore, in this project, those limitations will be overcome and alsofurther improved.

The impact and the contribution of this project is as follow:

Students will be more punctual on attending classes. This is due to the attendance of a particular student can only be taken personally where any absentees will be noticed bythe system. This can not only train the student to be punctual as well as avoids any immoral ethics such as signing the attendance for their friends.

The institution can save a lot of resources as enforcement are now done by means of technology rather than human supervision which will waste a lot of human resourcesfor an insignificant process.

as there is Wi-Fi coverage which makes the attendance system to be portable to be placed at any intended location. For an example, the device can be placed at the entrance of the classroom to take the attendance.

It saves a lot of cost in the sense that it had eliminated the paper work completely.
The system is also time effective because all calculations are all automated.

In short, the project is developed to solve the existing issues in the old attendance system.

Background Information
Project Field

The project is developed based on the IoT (Internet of Things) concept where smart device is used to manage systems. IoT is generally about numerous device being interconnected uniquely in the existing internet infrastructure where information are shared among them. It can be viewed as a nervous system that links anything or everything together.It is usually achieved using sophisticated sensors and chips which are embedded in the physical things for real-time information retrieval. Data collected will then be analysed where intelligent decision will be taken by machines without human intervention to either solve the existing problem or to improve the current situation. In short, the IoT technology enhances many existing system to be more efficient and smarter.

The application area of this project is involved in the smart cities sub-field. Smart cities is a development vision using Information & Communication technology (ICT) in urban advancement where city's assets will be managed by smart devices to improve efficiency and also to reduce human resource consumption. By integrating these concepts, a Smart attendance monitoring system will be developed.

Back in the years, attendance management system in school/colleges was done by manual reporting where the student's attendance were recorded by placing a mark or signature beside their name in a name list to indicate their presence in a particular class. While the staff in the institution will report their attendance through the punch card machinewhich also have to be done manually. Later on, some of those attendance systems had evolved into using smart cards to replace signature markings where each students/staff will be required to report their attendance using a smart card embedded with a unique identification chip.

2: Literature Review

Traditionally attendance was taken manually which is very time consuming and often leads to human error. Additionally, there are many uncertainties towards the sources of the attendance records which in fact, most of the attendance records are not retrieved from the actual situation. The old method that uses paper sheets for taking student's attendance can no longer be used. Based on the research, there are many solutions that are available to solve thisissue.

According to research journal *"Attendance System Using NFC Technology with Embedded Camera on Mobile Device" (Bhise, Khichi, Korde,Lokare, 2015).* The attendance system is improved by using Near Field Communication (NFC) technology and mobile application. According to the research paper, each student is given a NFC tag that has a unique ID during their enrolment into the college. Attendance of each class will then be takenby touching or moving these tags on the lecturer mobile phone. The embedded camera on thephone will then capture the student's face to send all the data to the college server to do validation and verification. The

advantages of this method are where the NFC is simple to use, and the speed of connection establishment is very high. It indeed speeds up the attendance taking process a lot. However, this system couldn't automatically spot the violation when the NFC tag is not personally tagged by the original owner. Apart from that, the convenience of the system which uses the mobile phone as the NFC reader was actually an inconvenience to the lecturer. Imagine if the lecturer had forgotten to bring their mobile phones to work, what would be the backup procedure for the attendance to be recorded? Moreover, most of the lecturer will not likely to prefer their personal smart phones to be used in this way due to privacy matter.

The second research journals *"Face Recognition Based Attendence Marking System" (Senthamil Selvi, Chitrakala, Antony Jenitha, 2014)* is based on the identification of face- recognition to solve the previous attendance system's issues. This system uses camera to capture the images of the employee to do face detection and recognition. The captured imageis compared one by one with the face database to search for the worker's face where attendance will be marked when a result is found in the face database. The main advantage of

3: System Design

The design part of the attendance monitoring system is divided into two sections which consist of the hardware and the software part. Before the software part can bedeveloped, the hardware part is first completed to provide a platform for the software to work. In the hardware part, the process of the raspberry pi's setup configuration will be briefly explained in this chapter. While in the software development part, there will be two major process flow which will be further discussed in Chapter 4.
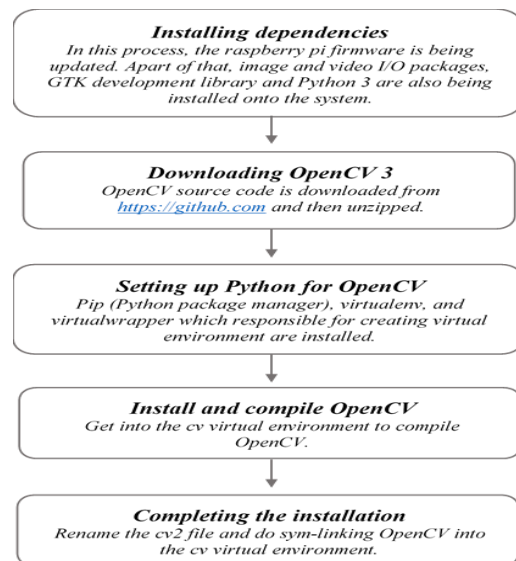
3   Hardware Development

The hardware used in this project so far consists of

only 4 components which are:

- Raspberry Pi 3
- Raspberry Pi 8mp Camera Module
- Power Supply Cable
- 16Gb Micro SD Card Class 10

3.1.1   Installing OpenCV into the Raspberry Pi

In this project, OpenCV is used to do facial recognition where the whole program willbe coded in Python Language. The installation of OpenCV is merely not enough, therefore, OpenCV is installed with Python bindings to bridge Python and C++ in OpenCV. In short, the binding is crucial to enable the calling of a C++ function from Python. The following is a brief walkthrough on the installation process that had done:

Installing dependencies
In this process, the raspberry pi firmware is being updated. Apart of that, image and video I/O packages, GTK development library and Python 3 are also being installed onto the system.

↓

Downloading OpenCV 3
OpenCV source code is downloaded from https://github.com and then unzipped.

↓

Setting up Python for OpenCV
Pip (Python package manager), virtualenv, and virtualwrapper which responsible for creating virtual environment are installed.

↓

Install and compile OpenCV
Get into the cv virtual environment to compile OpenCV.

↓

Completing the installation
Rename the cv2 file and do sym-linking OpenCV into the cv virtual environment.

Setting up the Pi Camera Module

After installing the Pi Camera Module onto the raspberry pi board, the next step is to enable the camera module. Before being able to do that, the raspberry pi firmware is being updated first. Then, the camera module is being enabled by going into the configuration menuat the terminal. Next, the raspberry pi is rebooted. In order for python to

3   Software Development

There are two major system flows in the software development section as shown below:

- The creation of the face database
- The process of attendance taking

4: Software Development

The creation of the face database

Specific requirements

There will be several requirements to achieve the creation of the face database. The below are the required software or packages needed to accomplish this objective.

Required software: OpenCV 3.4, Python 3
Required packages: tkinter package - To provide user interface
picamera module – To interact with the raspberry pi's camera

Methodology

Before the attendance management system can work, there are a set of data needed to be inputted into the system which essentially consist of the individual's basic information which is their ID and their faces. The first procedure of *portrait acquisition* can be done by using the Raspberry Pi Camera to capture the faces of the individual. In this process the system will first detect the presence of a face in the captured image, if there are no face detected, the system will prompt the user to capture their face again until it meets certain number of portraits which will be 10 required portraits in this project for each student. The decision of storing only 10 portrait per student is due to the consideration of the limited storage space in the raspberry pi because the total amount of students in the university is considered heavy. Then, the images will undergo several *pre-processing* procedures to obtaina grayscale image and

cropped faces of equal sized images because those are the pre- requisites of using the *EigenFaces* Recognizer. Both of the processes mentioned above can berepresented in the diagram below.
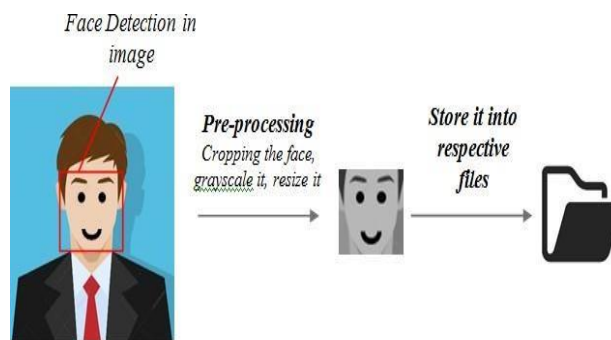

Figure 4.1.1: Image Acquisition and Pre-processing procedures

Flow Chart of the image acquisition process

The development of the face database is an important phase before any facial recognizing process can be carried out. It acts as a library to compare against with whenever the system wanted to identify a person. In the image retrieval process, the system will first prompt for an input from the user to enter their ID number. The system will then validate the entered input and then check for duplication in the system. In order to proceed, the entered input must contain only 7 digits of number. Apart from that, the ID inputted have to be a non- registered ID to ensure no duplication. After that, a directory is created for each individual where their portraits will be stored inside of it. It is a compulsory to store 10 portraits per person in the file. After the acquisition of image is done, the images undergo a pre-processing before storing it into the respective folder.
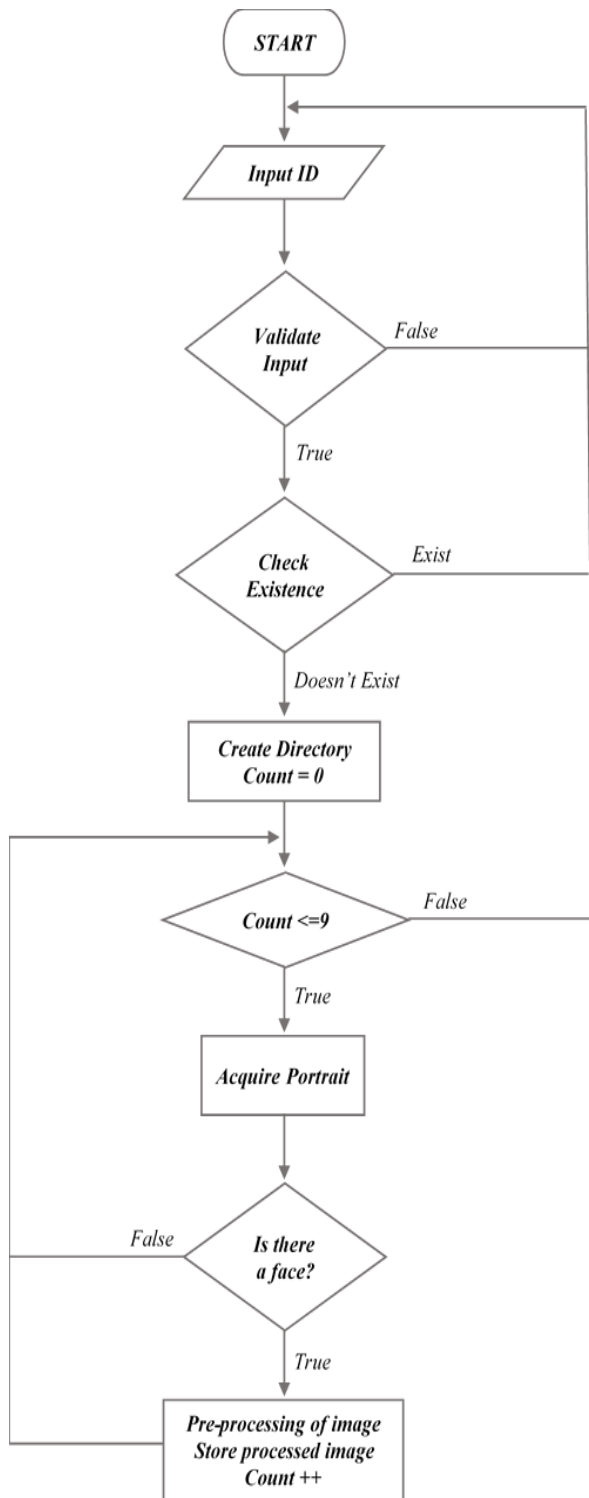
Figure 4.1.4: Flow Chart of the image retrieval process

The above flowchart is only the program flow for the image acquisition process which describes the program flow for the script *create_database.py*. There are two more python scripts that responsible for the remaining execution which will be explained in the Files included

There are in total 3 python scripts, 1 bash file, 1 csv file, 1 yml file and 1 folder needed in the face database creation part. 3 of the python scripts will be included in the bash file for 2 reasons. Firstly, it is to provide convenience to the user whenever they wanted to register images for new students. By running those script in bash, the user can avoid some ambiguous steps such as tuning to the cv environment before the script is being able to run from terminal because the bash file will handle the environment tuning. Secondly, the csv file creation and also the training process can be automated after the images are added. This function is crucial as it forces the yml file to be up to date before any recognition process is done just in case the user mistakenly missed this step.

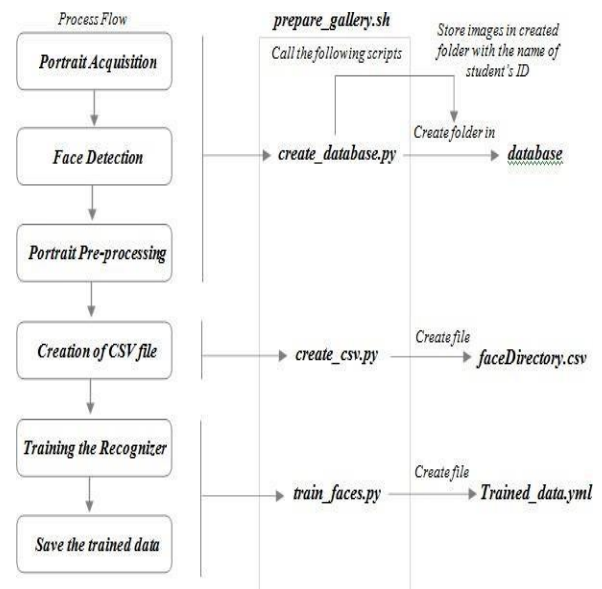Python scripts: *create_database.py*, *create_csv.py*, *train_faces.py*

Figure 4.1.5: The relationships between the files during the face database creation

Here, the sample images of the faces used in this project are the faces downloaded from the internet. This is due the insufficient reluctance of real person to join the testing community. Thus, this problem is solved by using the downloaded faces to form the face database while adding some of the real images captured from the system's pi camera to prepare the database for verification test. The specific face database being used is named AT&T Facedatabase which can be obtained from http://www.cl.cam.ac.uk/research/dtg/ attarchive/facedatabase.html. In the provided

database, there are 40 different subjects each with 10 sets of their very own portrait captured at a different timeline. This database consists of subjects with different expressions such as a smiling or frowning and etc. Apart from that, some of the subjects have different variation on their face such as wearing glasses in some of their portraits. Therefore, this database is relatively applicable to this system since the required amount of sample portrait for each person by this system is also similar as the provided amount of portrait by the downloaded database.
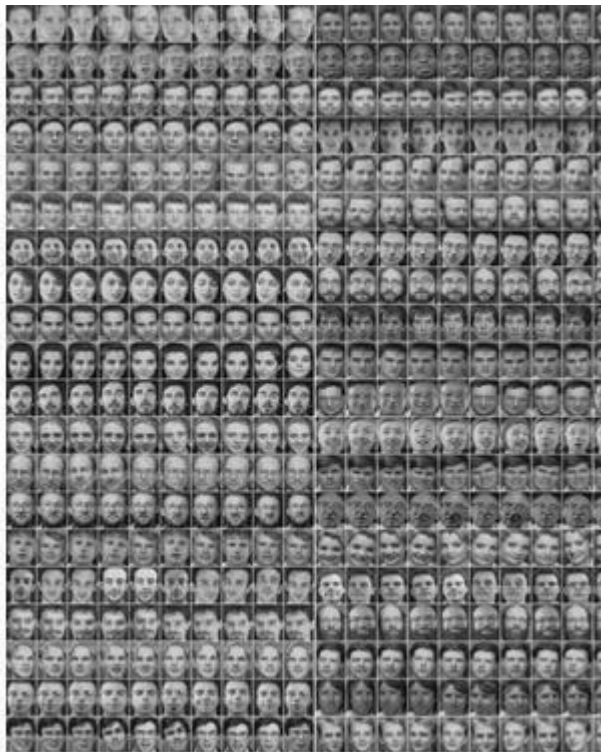

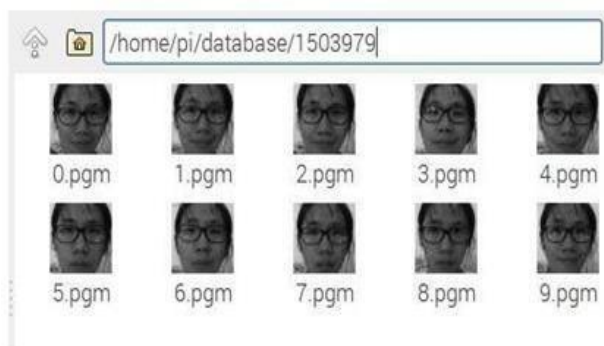**Figure 4.1.6: Images provided by the AT&T Facedatabase (AT&T Laboratories Cambridge, 2002)**

Figure 4.1.7: Sample images taken through the system's pi camera

Implementation and Testing

The followings are the implementation test and its results produced during the creation of face database in the raspberry pi.

Interface of dialog box when the *prepare_gallery.sh* bash file is executed:
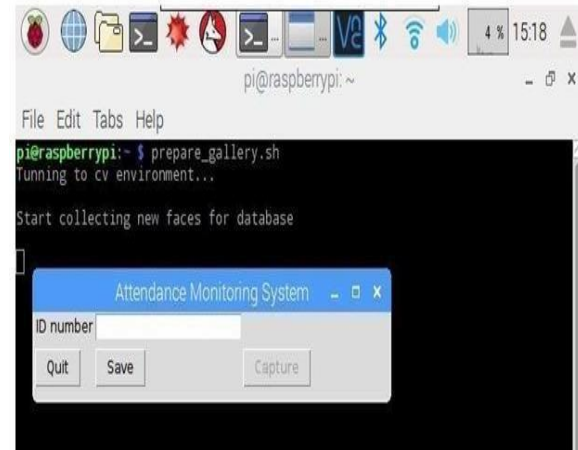

Figure 4.1.8: Interface displayed when *prepare_gallery.sh* is executed
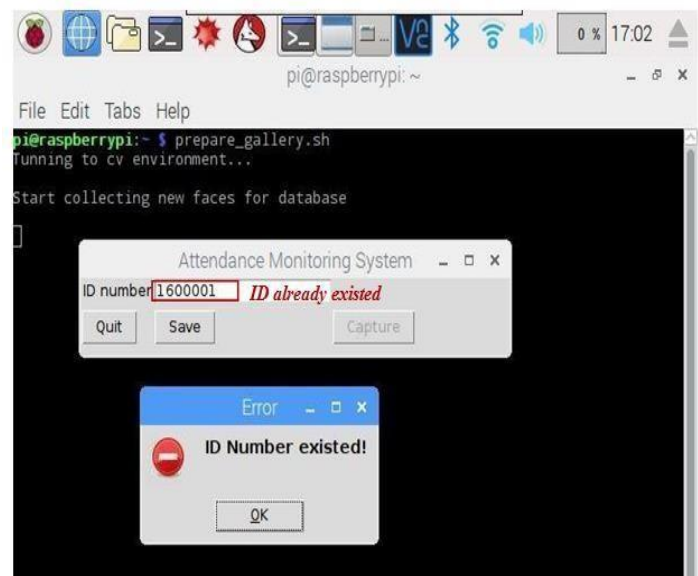
Invalid input ID (Existed ID) test:

Figure 4.1.9: Test result for invalid ID (1st attempt) nvalid input ID (ID consist alphabet) test:
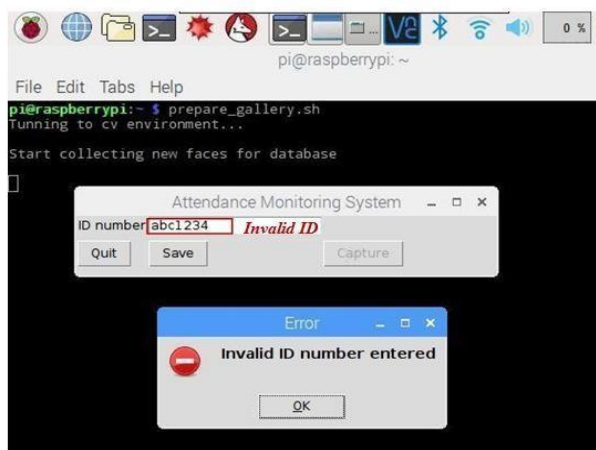
Figure 4.1.10: Test result for invalid ID (2nd attempt)

Invalid input ID (ID longer than 7) test:

Figure 4.1.11: Test result for invalid ID (3rd attempt)

Valid input ID (ID valid and not exist) test:
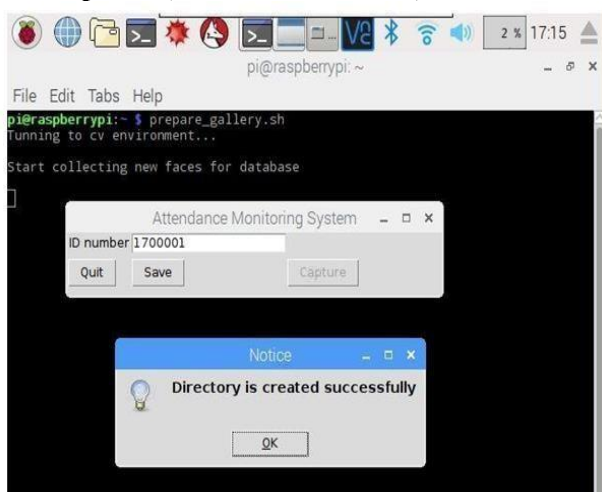
Figure 4.1.12: Test result for valid ID

Portrait Capture (No Face) test:
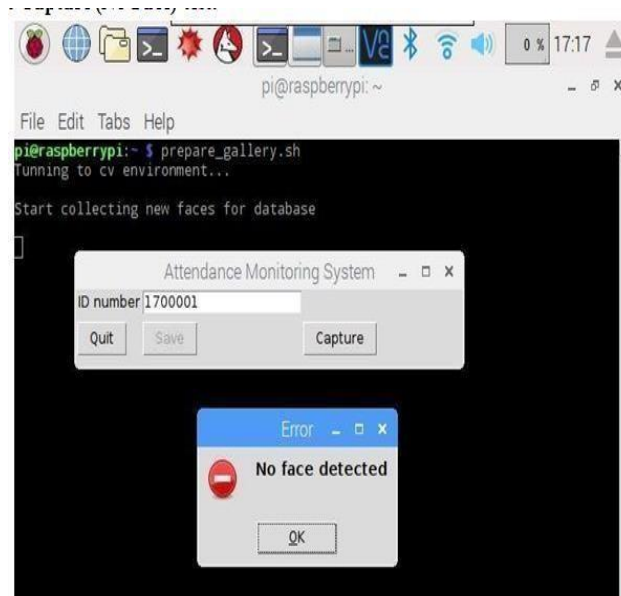
Figure 4.1.13: Test result for invalid face capture

Portrait Capture (Normal) test:
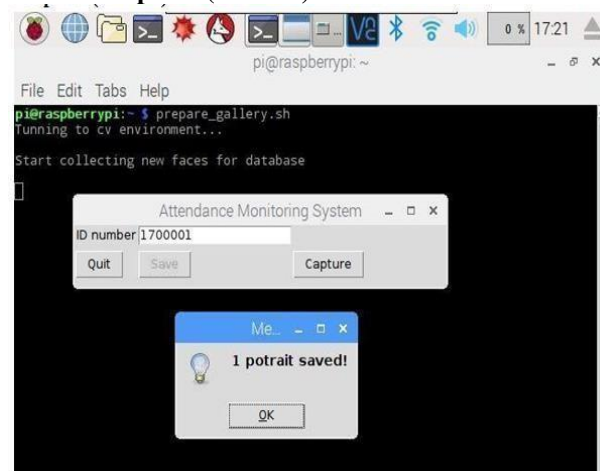
Figure 4.1.14: Test result for valid face capture

Implementation and Testing

The followings are the implementation test and its results produced during the attendancetaking process.

Interface of the "*Record Attendance*" page

RECORD ATTENDANCE

Timetable ID	Subject Name	Day	Start Time	End Time	Session
1000001	BASIC MICROPROCESS OR AND INTERFACING	Tuesday	1100	1300	L1
1233211	SUN ZI'S ART OF WAR AND BUSINESS STRATEGIES	Saturday	1500	1700	P2
2221111	ALGORITHMS ANALYSIS	Friday	0900	1200	T14
6666666	COMMUNITY PROJECT	Wednesday	0800	1000	L3
9812523	CIRCUIT THEORY	Wednesday	1600	1730	P6

Pages: 1 2 Next Last 1 of 2

Select the timetable ID according to the current session.

Timetable ID: _____ Date: dd/mm/yyyy

Submit

Figure 4.2.15: Interface of the Record Attendance Page

Authorized User Login:

In this project, the attendance management system webpage designed is protected by authorized logins. Some of the pages are not accessible by a non-authorized user such as the "Record Attendance" page and "Registration Forms" page. When either one of this page is clicked by the user, the following interface will appear to prompt for a login.

Figure 5.2.8: Login prompt from record attendance page

Figure 5.2.9: Login prompt from registration forms page

As for authorized user, they can easily login into the system by either clicking on the orange "LOGIN" word or by choosing the "ADMIN LOGIN" tab which a login page will then appear as below.

Figure 5.2.10: Login page into the UTAR Attendance System

Apart from that, in the authorized user category, there are two different authorized users with different access priority. To be able to gain full control on the customization of the webpage, the user have to login as the "*root*" user, whereas the "*contributer*" type user can only access both the record attendance and registration forms page to record attendance or communicate with the database. This user is not allowed to make any changes to the design of the webpage. Usually, the "*root*" user will be held by the website owner while the "*contributor*" user will be held by the staff or lecturer in the institution. As the "*root*" user, he/she has the power to create more "*contributor*" users. The Email and Password for both of the mentioned users can be obtained in *Chapter 4 (4.2.3 (d)) & (4.2.3 (e))*.

Figure 5.2.11: Users created in Wordpress for this project

Other Pages:

Apart from the pages created above, there are 3 additional pages created just for viewing purpose where the records in the database can be viewed here.

- Staff Directory page
- Student Directory page
- Course Directory page

The Staff and Student Directory pages only display a direct Staff and Student tables from the database, whilst in the Course Directory page, it allows user to enter a specific Subject ID to enable the viewing of all its timetable details.

UTAR ATTENDANCE SYSTEM
Online Attendance Monitoring System

Figure 5.2.12: Staff Directory page

UTAR ATTENDANCE SYSTEM
Online Attendance Monitoring System

Figure 5.2.13: Student Directory page

UTAR ATTENDANCE SYSTEM
Online Attendance Monitoring System

Figure 5.2.14: Course Directory page

5.1 Webpage Analysis

Most of the webpage content are displayed by Wordpress, however some of the webpage have filtering functions that are actually executed from a *php* file where query is used to filter the required data from the database. In this project, all the created *php* files are stored under

the path */var/www/html/wordpress* in the raspberry pi. The followings are the corresponding

php file working behind the service provided by the webpage.

Registration Forms:
- Course Registration Form ⊔ *student_details.php*
- Course Timetable Form ⊔ *timetable_details.php*
- Staff Registration Form ⊔ *staff_details.php*
- Student Registration Form ⊔ *student_details.php*

Attendance:
- View Attendance by Student ⊔ *show_attendance.php*
- View Attendance by Subject ⊔ *show_course_attendance.php*

Record Attendance ⊔ *student_attendance.php*

Course Directory ⊔ *show_timetable.php*

*Note: All the *php* files above can be found in the attached cd.

6: Conclusion

Project Review

After conducting this project, attendance can now be taken with a portable mini box (raspberry pi + pi camera) in a Wifi coverage area. This technology can reduce the effort of enforcing students to attend classes as everything is automated. Since Wifi coverage is not a problem for most of the institution, by using a mobile phone, the lecturer can enter the currentclass session's information into the Attendance Management System Webpage hosted by the raspberry pi to start the attendance taking process. This had provided convenience not only tothe lecturer but also to the students because the attendance taking process for a class of approximately 100 students can be done in 5 minutes which is way more faster than the old method of passing attendance sheet around in the classroom which created a lot of issues to the institutions and inconvenience to the students. Other than that, this system provides excellent graphical interface to the user. Data accessing can be easier nowadays simply by logging in into the webpage where searching of a record can be done easily. This also reduces the need of the lecturer to keep on entering the attendance record manually into the system.

Contributions of this project

The attendance taking process had never been an easy task to every institution. The old method of using paper to collect the attendance had created numerous troubles to the institution. However, with the invention of this project using the raspberry pi to solve issues like this can somehow be very effective for the institution. This project utilized the presenceof genuine characteristic in every student to conduct the attendance taking procedure which never been practised before in history. In directly, the achieved objectives of this project had induced the following effects.

- Students cannot sign the attendance for their friend.
- The process of attendance taking is now paperless where resources can be saved.
- Apart from resources, this system also saves a lot of time.
- Enforcement is done indirectly without human workforce.
- Students will be more punctual to class.
- It is almost impossible to sabotage the system.
By implementing this system, lecturer can just sit back and collect the attendance withoutworries.

Further Developments

Since the development time for this project is very limited, the designed system onlyconsists of the minimum function required for it to work. However, it can be further improved to maximise the usage of the raspberry pi to produce a better system. The followings are the further developments for the project to be improved.

- Provide a better domain name for the webpage.
- Improve the face recognition algorithm.
- Provide better search functions in the webpage.
- Expand the storage of the raspberry pi.
- Develop a fingerprint recognition mechanism to enhance the recognition system.
- Improves the system so that it can eliminates the need of lecturer input before therecognition procedure can start.

- Improves the database so that it can also stores the information of the subjects taken by each student to facilitate the attendance marking procedure.

Conclusion

Before the development of this project. There are many loopholes in the process of taking attendance using the old method which caused many troubles to most of the institutions. Therefore, the facial recognition feature embedded in the attendance monitoring system can not only ensure attendance to be taken accurately and also eliminated the flaws in the previous system.

By using technology to conquer the defects can not merely save resources but also reduces human intervention in the whole process by handling all the complicated task to the machine. The only cost to this solution is to have sufficient space in to store all the faces into the database storage. Fortunately, there is such existence of micro SD that can compensate with the volume of the data. In this project, the face database is successfully built. Apart from that, the face recognizing system is also working well.

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