Face Recognition Technique for Attendance Management System

by

Muhammad Arif Akmal bin Khalid
18543

Dissertation submitted in partial fulfilment of
the requirements for the
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Universiti Teknologi PETRONAS
32610 Bandar Seri Iskandar
Perak Darul Ridzuan

CERTIFICATION OF APPROVAL

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Approved by,

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(DR. MOHANA SUNDARAM MUTHUVALU)

UNIVERSITI TEKNOLOGI PETRONAS
BANDAR SERI ISKANDAR
PERAK
JANUARY 2017

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

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MUHAMMAD ARIF AKMAL BIN KHALID

ABSTRACT

Attendance is crucial to track the presence of students especially in Universiti Teknologi PETRONAS because they need to achieve the minimum percentage of attendance to sit for a final examination. The lecturer needs to call the name of the students to ensure they are attending the class but it will consume longer time to finish the job. So, the lecturer will pass the attendance sheet to the students so that they will mark the attendance on their own. The problem arises when the students will try to cheat by asking their friends to put the signature on behalf of themselves. Thus, a reliable attendance management system is needed to solve this problem. The aim of this project is to develop a system that is able to mark the attendance for the students by recognizing the face. There are four main stages to develop this system. First, the user's face need to be detected by the system. Second, the system was optimized for image processing that consume a lot of processing power due to heavy computation. Third, the database was created by collecting information and images from subjects. Finally, the Graphic User Interface (GUI) was created to be used by the students. In this project, two different cases were tested. For Case 1, a total of 10 students have been tested. There were four confidence levels had been used, 70, 80, 90 and 100. For Case 2, 22 students involved during the testing. The output from the second case is 63.63%. This project is a success because the system is able the recognize the face of the users and the attendance management system is able to record the attendance.

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CHAPTER 1
INTRODUCTION

1.1 Background of Study

Attendance is crucial to track the students or employees because attendance will be used to know whether they are presence or not in the building. Failing to do so will result them to be punish by the management. To avoid from the problem, they will ask their friends to sign in the attendance for them but that act is unethical. It will take the times to handle huge classroom or offices with the number of users exceed than one hundred [1]. The attendance management system is very important in order to discipline the students, even the employers and employees need to follow the systems to ensure they present for works.

For school, the teachers will need to call out every students' names to mark the attendance by putting an indication '✓' when the students are present while 'X' when the students are absent. However, this method is not suitable because it will take a longer time. If there are more than 40 students in the class, at least ten minutes will be wasted in order to check the attendance. At the end of every months, the teacher will need to do headcount for the students' attendance since they are recorded using paper. This method is consuming time because all works need to do manually. The difficulty of the system increases when the number of students in the class increases [2].

The conventional method being used to take attendance in university is by putting a signature on the attendance sheet provided by the lecturers. But this method is not efficient because students can cheat by requesting their friend to put a signature on behalf of themselves. A lecturer cannot afford to waste time by calling the student names for attendance because there will be more than one hundred students in a certain class. The students are desperate to cheat because they want to avoid from being barred taking the final examination.

Currently in offices, a card will be provided to each staff and they will need to slot in the card in a time machine to record their attendance. This method will consume less time but the disadvantage of it is the staff can help other by slotting the card on behalf of their friend. So, this method also expose the employees to do unethical act in order for them to help their friends. Some employer will try to expose the unethical

acts of the employees by using Closed-circuit Television (CCTV) installed in the premise. But it would be wiser to exploit the CCTV by integrating it with biometric system to take the attendance.

The better way to improve attendance management system is by making use of biometric. Biometric system can make use of human characteristics such as retina, fingerprint, and face. Usage of biometric for attendance management system will reduce the unethical act of the users because every human has different biometric properties even though they are a twin. Biometric had already implemented for attendance management system but due to the cost factor, people are still using the old method to take the attendance.

1.2 Problem Statement

Taking attendance is a troublesome process because a lot of time will be wasted to ensure the attendance is correct. To track the attendance of the students, lecturer need to call out each student names to ensure they are present in the class or the lecturer can pass the attendance sheet to the students and they will put their signature to indicate they present in the class. But some students will try to put a signature on behalf of their friends. To avoid these from happening, a reliable attendance management system is required. By using biometric attendance management system, students cannot cheat when taking attendance because they need to use their biometric property to sign in the attendance. One of the biometric system available is face recognition technique. Face recognition technique is complex due to image processing but by using proper application, face recognition technique will be able to produce a good result.

1.3 Objectives

The objectives of the study are:

a) To create a system that is able to detect and recognize students' faces.
b) To establish a system for attendance management system.

1.4 Scope of Study

In this study, face recognition technique will be used for the students attendance management system in Universiti Teknologi PETRONAS (UTP). The hardware used in this project are Raspberry Pi 2 Model B as microcontroller, webcam as input for face recognition and monitor to display the Graphic User Interface (GUI). The software involved are OpenCV to process the algorithm for the image processing, SQLite to create the database and PyQt to create the layout of the GUI. Two cases are being considered for the testing purpose for testing purposes as shown in table below.

	Male	Female	Total
Case 1	10	0	10
Case 2	14	8	22

Table 1 : Number of subjects for each case

CHAPTER 2
LITERATURE REVIEW

2.1 Attendance Management System

Attendance Management System (AMS) is an application being developed to track the attendance of the users. By using this system, the process of taking attendance will become more efficient and faster because it will be done by the system. The input for verification during taking attendance is varies depending on the demand of the management. For example, Radio Frequency Identification (RFID) and biometrics properties can be used to increase the efficiency of the system. The cost to implement the system will be higher when the input for verification is more advance, i.e. by using iris recognition [3] and fingerprint scanner [4].

In school, the teachers will take the attendance of the students during the first period of the class. The teacher will call the name of the students one by one to ensure all students are attending the class [5]. Since this method is just recording the attendance on the paper, so it will not be systematic because, at the end of the month, the teacher will need to calculate the percentage of the attendance every student. More time will be wasted because the teacher need to do the headcount manually.

In university, mostly the lecturers will pass the attendance sheet to the students so that the students will be able to mark their attendance [6]. This method will lessen the burden of the lecturer to call out the name of the students but it will give the chance to the students to cheat. The students will ask their friends to put a signature on behalf of themselves. Attendance is important to university students because it will ensure them to proceed to next semester and able to sit for a final examination. This method will only reduce the time for attendance taking process but promote the students to put a signature on behalf on their friends, making it not efficient.

Offices are using the better system but not efficient enough. Each employee is given a card to mark their attendance by slotting it into time recorder machine. This system will able to track the attendance of the employees since their attendance is being recorded in that card but they can ask their colleague to slot in the card for them. Once again, this common method is not efficient enough to track the employees.

But there is some place where the management really cares about the attendance. They are willing to invest money on it so that students cannot cheat for attendance. According to Want China Times, two Chinese universities, Henan University of Technology and Minjiang University have applied face recognition technology for attendance management system. This is to prevent the students from registering the attendance for their classmates. The result obtained by School of Journalism and Communication at the Henan University of Technology is impressive, all students attend the lecture with 100% registered attendance. The drawback of the system is that, when the number of students in the class is too large, longer times will be needed to complete the process [7].

2.2 Biometric System

2.2.1 Types of Biometric System

Biometric is the characteristic properties available on human, i.e. finger, retina, iris and face. These properties are unique because they are not same even though the person has a twin that looks alike. Using biometric as input for verification in AMS will make the system more efficient because the users cannot cheat due to the privilege of biometric properties. The comparison between biometric technology isexplained in Table 1.

Biometric Technology	**Accuracy**	**Cost**	**Devices Required**	**Social acceptability**
Iris recognition	High	High	Camera	Medium-low
Retina scan	High	High	Camera	Low
Face recognition	Medium-low	Medium	Camera	High
Voice recognition	Medium	Medium	Microphone	High
Fingerprint	High	Medium	Scanner	Medium
Signature recognition	Low	Medium	Optic pen and touch panel	High

Table 2 : Comparison of biometric technology (Source from [1])

Khatun *et al.* [8] have implemented iris recognition for Attendance Management System. Iris is a reliable attribute because it will stay the same after it had been fully develop after the tenth month. Khatun *et al.* [8] proposed to use low-cost equipment such as computer, webcam, and server to setup the system. Iris recognition is using image processing, by scanning the iris of the users. After that, the image of the iris will be stored as a reference and will be compared later during real time usage. Khatun *et al.* [8] proved that their project managed to get 82.2% accuracy after testing.

Mittal *et al.* [9] are making use of a fingerprint to be integrated with AMS for their project. The project is using a fingerprinting scanner, a computer to store the data, a microcontroller which is Arduino and a servo motor. The team prepared two system to be used, Access Control System (ACS) and Classroom Attendance Management System (CAMS). Both of the systems are using the fingerprint as input to be processed as verification. ACS is being used to open the door and only users with authentication will be allowed to open the door. CAMS will be used to track the record for the users' attendance by using the fingerprint. The result of the project is separate into two since there are two systems in this project. The accuracy for ACS is 87% while the accuracy for CAMS is 92%.

Based on Table 2, it is stated that facial recognition has medium-low accuracy compare to others but the cost is among the lowest to be applied. The iris recognition, retina recognition, and facial recognition use camera to get the input but facial recognition has highest social acceptability which makes it easy to be used by the users. Facial recognition can be applied for the tracking system, which makes it can detect the face and determine whether the person is registered or outsider.

2.2.2 Face Recognition Technique

The Figure 1 below shows the flow of image processing for face detection.

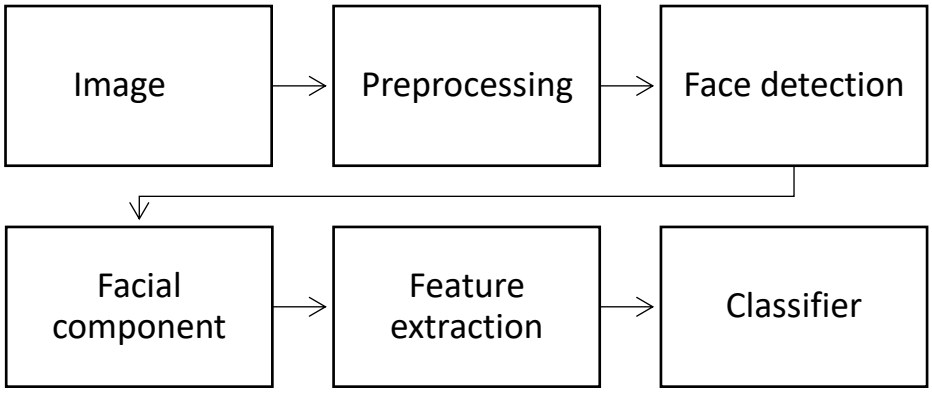

Figure 1 : Flow of image processing for face detection

Face detection is hard to use since the face of the human is a dynamic object and the appearance has a high degree of variability when being process in computer. There are three categories for face image processing; face tracking, face detection, and face recognition. Some example of applications for face tracking and face recognition are controlling systems and wrongdoer recognition [11]. The effectiveness of these process is affected by the accuracy of face detection process. There are many algorithms being use for these process but there are advantages and disadvantages depending on the usage. Since image processing is a heavy computational process, so the hybrid method will help to fasten the process of face detection.

For example, Niazi and Jafar [11] through their project able to detect a person face of regions by using Hue, Saturation and Value (HSV) colour method. For the project Haar classifiers is applied to detect human faces followed by Adaptive Boosting (AdaBoost) classifier to enhance the output. Niazi and Jafar [11] highlighted the importance of face detection steps for implementation of AdaBoost classifier. Achieving high percentage of success for face detection is possible nowadays due to advance technology but it will be need to be done in a controlled situation. The early start-up of face recognition happens around 1990s [12].

Generally, three methods i.e. detection using colour, detection using motion, and detection in an uncontrolled situation are used for face detection. Detection by colour will be using red, green and blue (RGB) values of colours that had made up the face, to find the high potential area showing the face. With the help of filters, the

creation of binary image is possible, the area of skins will be indicated with value ‘1’ while non-skin area will be indicated using value ‘0’. So the area of eyes will be indicated with value 0 picturing it as two holes. Shimomoto, Kimura and Bel [12] are able to differentiate the eyes from the face by using detection by colour method. This method is very easy to be done but the efficiency is low due to there are many colour of skins.

For detection using motion, the face rarely static on camera, so using this fact, it is usable to analyse the part that is moving as an image showing the face [12]. But there is a possibility this method will fail if there are other disturbances moving in the same image. To lower the failure, the method can be applied when the both human’s eyes blink simultaneously. For example, when the eyes blinking at the same time, the recognition rate will be higher [13].

For detection in an uncontrolled situation, the help from artificial intelligence (AI) is being used, for example, Neural Network but the disadvantage of it consumes more time making it unappropriated for real-time application [12].

a) Effect of Graphic Processing Unit

Nowadays the power of Graphic Processing Unit (GPU) is very high, equip with multi-core processors, higher Graphic Double Data Rate (GDDR) memory and able to do the fast decoding for video outputs. Using those features, the image processing will become easier since the processing of the image requires high processing power to avoid lagging and fast output delivery. The conventional usage of Closed-circuit Television (CCTV) is equipped with decoder cards to produce analog outputs. However, this method is very expensive and the connections itself will make the installation procedure more difficult. To save the budget, upgrade the current Personal Computer (PC) with better GPU card so that the video rendering process will become faster and allow the filter of the video to be more precise. Using Raspberry Pi, Saiz and Gallego are able to decode and render up to 100 video streams using their current system with the help of a machine, equipped with 24 monitors. The system is working and showing good performance.

b) Multiprocessing

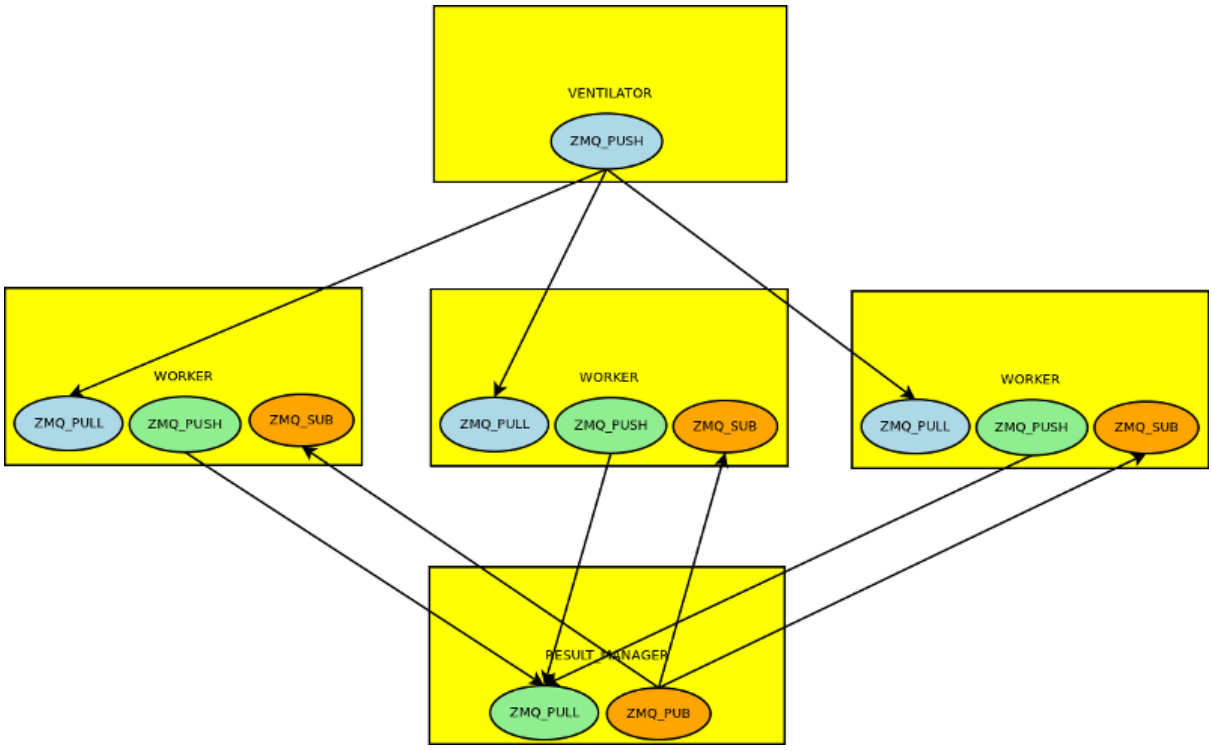

Figure 2 : Working Concept of ZeroMQ's multiprocessing (source from [14])

One of the methods to optimize the process of face recognition is by using all cores in the microcontroller. Since Raspberry Pi 2 is built with quad cores, by using all of it will improve the face recognition process. The source code needs to be arranged properly with correct syntax to enable multiprocessing. For Python, a multiprocessing tool is already available to be use and the example of the tool is ZeroMQ [15].

The working concept of ZeroMQ is by dividing the task. For example, the ventilator is the master or brain of the system. The ventilator will distribute the task among the workers and workers will do the jobs equally. If there are three workers, the task will be distributed to the three of them equally. After the workers finished their task, all output will be sent to the result manager. Result manager will combine all obtained output and display the outcome of the process. ZeroMQ can be used in most Operating System (OS) making it suitable to be used for the optimization process.

c) Types of algorithms

For face recognition, there are several algorithms that can be used and each one of them will have different performance depending on the quality of the sources. The three major algorithms for face recognition are Eigenfaces, Fisherfaces, and Local Binary Pattern Histograms (LBPH). Özdil *et al.* [16] in his work makes the comparison between these three algorithms using same platforms.

Principal Component Analysis (PCA) can be used to lower the dimension of an image matrix and Eigenfaces is using PCA as its foundation. The face images extracted from the source will be represented in a *x*-dimensional space and PCA will perform the linear transform. After that, a subspace dimensional will be obtained showing the maximum variance in the *x*-dimensional space whether the subspace is smaller or bigger than the *x*-dimensional space. The PCA will maximise the inter and intra class scattering. The inter class scattering will help the recognition process and the intra class scattering will occur when the variance of illumination is present during face recognition causing low classification.

Fisherfaces algorithms will use Linear Discriminant Analysis (LDA) focusing on increasing the inter class differences rather than trying to focus on the data. There will be two scatter matrices, within- class and between-class. The LDA will try to utilise the between-class scattering matrix and reducing the within-class scattering matrix. The higher differences between within-class scattering matrix and the between-class scattering matrix, the higher performance of the recognition.

The new algorithm, Local Binary Patterns Histogram (LBPH) was introduced by Ojala *et al.* [17] to focus on texture description. This algorithm will label each pixel with decimal, Local Binary Patterns (LBP) codes to explain the local structure of the pixel. Referring to Figure 3**,** the value of the pixel at the center will be subtracted from the value of neighbouring pixels using the clockwise sequence from top left corner. If the result is positive then the binary value will be 1 and if the result is negative, the binary value will be 0. As result, eight digit binary values will be obtained and these binary values will be converted to LBP codes to be placed on the coordinates of pixel in matrix.

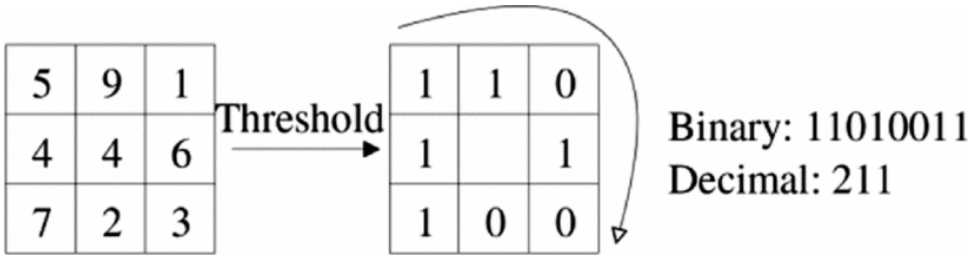

Figure 3 : Working concept of LBPH (source from [15])

The disadvantage of using LBPH is that it cannot cover large size images because it uses 3×3 matrices. Ojala *et al.* [17] improvised the algorithm to be used for any radius and number of sampling points operator and called the new algorithms as Extended LBPH (ELBPH). Referring to Figure 4**,** *P* will indicate the number of neighbour while *R* will indicate the radius of a circle where the points are located.

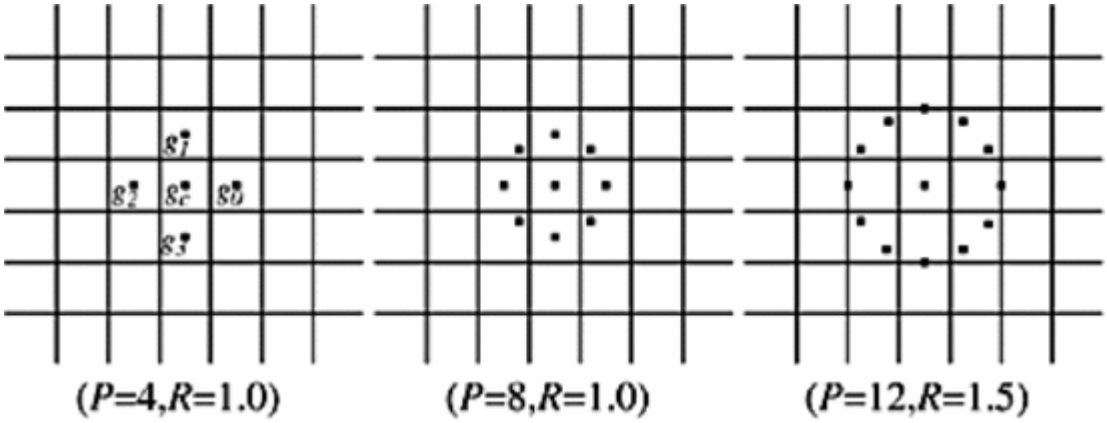

Figure 4 : Working concept of ELBPH (source from [15])

For face recognition, Local Binary Patterns Histograms (LBPH) are selected because LBPH contain information for the distribution of the local patterns and due to the large size of the face image to be used by LBPH calculation, the images will be separate to smaller size according to Yang and Wang [18] for better recognition. To determine whether two or more images belong to the same person, the histogram of images will be compared using Chi-square statistic similarity.

d) Comparison between algorithms

Özdil *et al.* [16] perform experiments with two conditions. The first one will be using the small size of training set compare to the testing set. The second experiment will be using 60% of the total images as training set while another 40% as the testing set. Two males are being selected, Buffy and Nicholas while Michelle will be the only female in the experiments. The reason two males are being used is because face recognition work wells for the male gender. Two platforms are being used for the face recognition algorithms because the performance of the Central Processing Unit (CPU) will affect the performance of the face recognition. The Intel will be equipped with 2.7 GHz processor with 4GB RAM while ARM will be equipped with 1GHz processor and 512MB RAM. Özdil et al. [16] intended to help the reader to optimize the face recognition when being applied in a system. The result for the time taken to process the images is being computed using three different algorithms i.e. Eigenfaces, Fisherfaces and LBPH. For Experiment 1, Eigenfaces algorithms works well in Intel platform with 1.91 seconds while Fisherfaces works well in Arm platform with 8.3 seconds. Surprisingly in experiment 2, LBPH showed a great result in both platforms faster than Eigenfaces and Fisherfaces. LBPH has highest hit ratio in both experiments indicating it is suitable to be used on any platform.

e) Improving Face Recognition Accuracy

Increasing the face recognition accuracy can be done in multiple ways depending on the categories and among them, illumination variation is the hardest to be adjusted. First, the face for a person will have many images as a low-dimensional linear subspace in the facial area. Second, the face images' illumination will be normalize using the gray level distribution and finally representing the face image by extracting illumination-invariant features.

Weber-face (WF) and adaptive singular value decomposition ASVD can be used to correct the illumination variation problem. WF will search the illumination invariant representation of face images on different light conditions while ASVD will attempt to compensate the illumination by referring to the singular value decomposition (SVD).

Tran *et al.* [19] suggest to use WB to train the images by extracting them as illumination-invariant features but the images will have a small difference. Later Tran *et al.* [19] used singular value decomposition (SVD) method to the previously extracted images. Continue with encoded the images using Local Binary Pattern (LBP) descriptors and finally, the encoded images will be extracted to histogram-based features.

Tran *et al.* [19] proposed method combining Weber-face and Local Binary Pattern (LBP) that produces the highest average accuracy which is 99.20% compare to others. This experiment also manages to point out that LBP has higher accuracy compare to Local Ternary Pattern, making it more suitable to be used for face recognition..

CHAPTER 3
METHODOLOGY

3.1 Propose System Design Flow

The Figure 5 shows the flow of system development

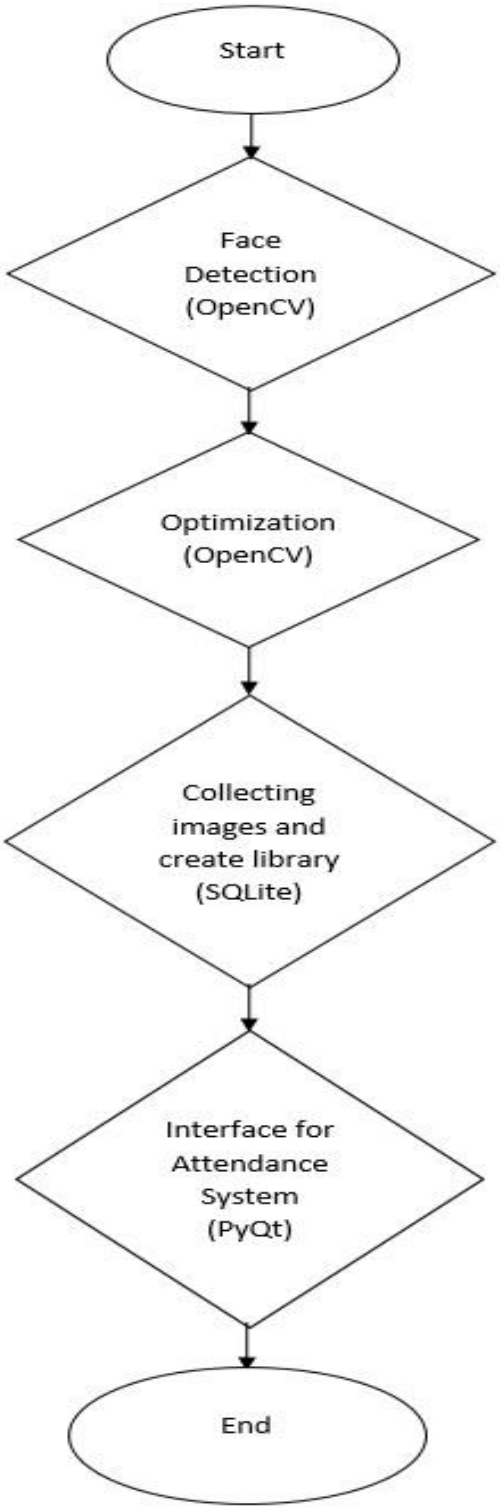

Figure 5 : Flow of system development

During face detection phase, the basic of image processing will be studied. There are many usages of image processing, for example, car detection and face detection. The open source of the code already available the internet, but the method to apply the source code is important since it will need to be integrated with attendance management system. Using Haar Cascade Classifier proposed by *Viola et al.* [20] will be able to detect the faces during image processing process.

For the optimization phase, the studies of core optimization will be conducted. Raspberry Pi 2 has four core in the processor but only one is being used under default condition. Adjustment of the source code will be made in order to enable the multiprocessing to be done. By changing minimum size required to be processed in the captured images, unnecessary processing will be eliminated and lessen the burden of the processer. The impact of doing so will reduce the accuracy of the face detection but smooth processing will be able to compensate the weakness.

For registering faces phase, pictures will be taken from students and will be upload into the faces library. If the system is able to detect the faces of the students, then this stage has already passed. But the method of storing the image will need to be considered because this images will be compared during face recognition in order to detect the face of the students. The accuracy of face recognition depends on the training images [16]. The variation when taking face images will contribute more appropriate output to the face recognition. Also, background, lighting, and orientation of those images need to be taken into consideration because same face images will not improve the accuracy of the system.

Lastly, an interface for the attendance management system will be built. Using this interface, the system will automatically mark the attendance of the students after it is able the detect the face of the registered students. The usage of Graphic User Interface (GUI) will make the system become more friendly usage because it can easily access by the users.

3.2 Testing

From Table 1, for Case 1, 10 male students combining four first year students from Applied Physics course and six final year students from Electrical and Electronics Engineering course are tested. For Case 2, 14 final year male students and eight final year female students from Electrical and Electronics Engineering course are tested. Each subject will contribute ten pictures of their faces taken from the different angle to varies the database. After that pictures had been inserted into the database with their necessary details, such as, full name, student ID and course, the testing had been conducted. All subjects are being gathered in a room, one by one student is being called their name to move in front of the camera for testing purpose. They are given 15 seconds to adjust their face using different angle so that the system is able to detect their face.

CHAPTER 4
RESULTS AND DISCUSSION

4.1 Face Detection

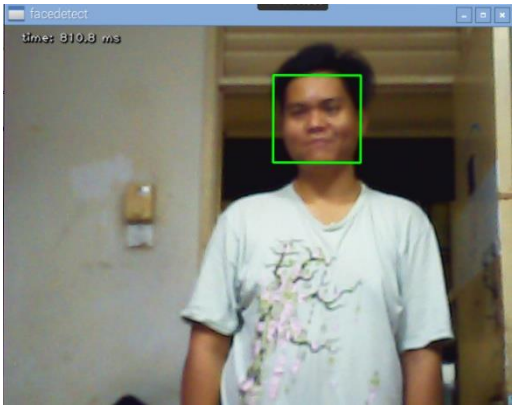

Figure 6 : Face detection for one person

Based on Figure 6, the source code is working correctly after being tested on Raspberry Pi 2 model B because it is able to detect the face for one person. The main concern is that the delay for the picture is long which is 810.8 ms. During testing, the displayed video is slowed and the movement of the person is delayed. This condition is not favourable since it can make the detection process slow.

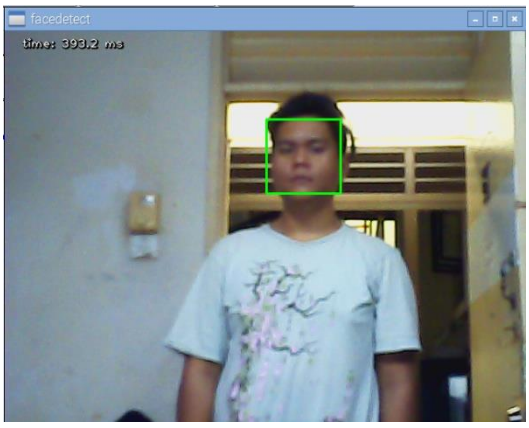

Figure 7 : Face detection for multiple persons

Under the same conditions as previously, multiple persons are being used for the face recognition. The result show that the delay almost same as before, making the system less inefficient. To improve the delay time, the step to be done is optimization.

4.2 Optimization

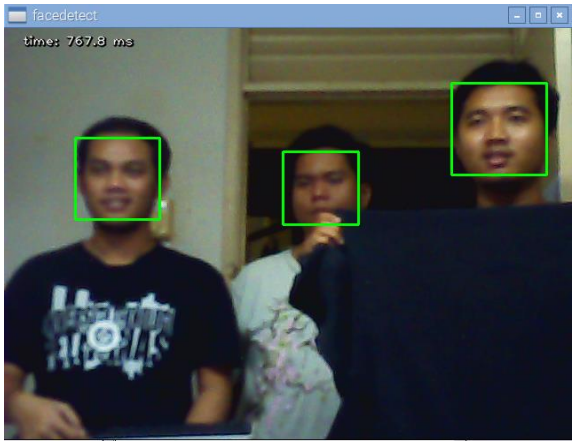

Figure 8 : Face detection for one person after optimization

Based on Figure 8, the delay time has decreased to 393.2 ms which is 49% from original compared to the result before being optimizing. The detection process has become faster but the drawback will be low accuracy for face detection. This is due to the minimum size to detect object has been increased by 66.67%. But in this stage, the goal has been achieved which is to reduce the delay time.

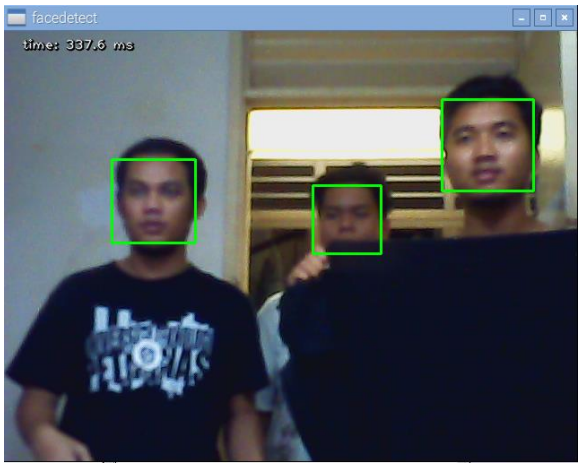

Figure 9 : Face detection for multiple persons after optimization

Based on Figure 9, the delay time has reduced to 337.6 ms which is 43.97% less from the previous result before being optimizing. The situation is same as before, the minimum size to detect the object has been increased by 66.67%. After reducing the accuracy, the face detection still able to detect multiple faces in the frames.

4.3 Collecting Images for Database

Figure 10 : Example of faces in the database

The subjects need to provide ten photos containing their faces and each photo will be taken in the different background because it will help to increase the efficiency. Multiple photos of a subject will train the system to be able to recognize the subject under different angles and backgrounds. The photos are being cropped using simple source code being produced using Python. The HAAR classifier is being set in the source code as it is able to detect the face.

The source code will change the photos obtained from the subjects to gray scale first. Then it will detect the face using HAAR classifier and crop the area around the face. This process will be done to all subjects with a total of 240 photos that will be cropped. The cropped faces files will be named according to their student ID because this will help the system to differentiate between the subjects. All information about the subjects, for example, full name, student ID and course will be entered into the database using SQLite software. SQLite will automatically perform the required table to store the data of the subject and it will be integrated with the main system.

4.4 Interface for Attendance Management System

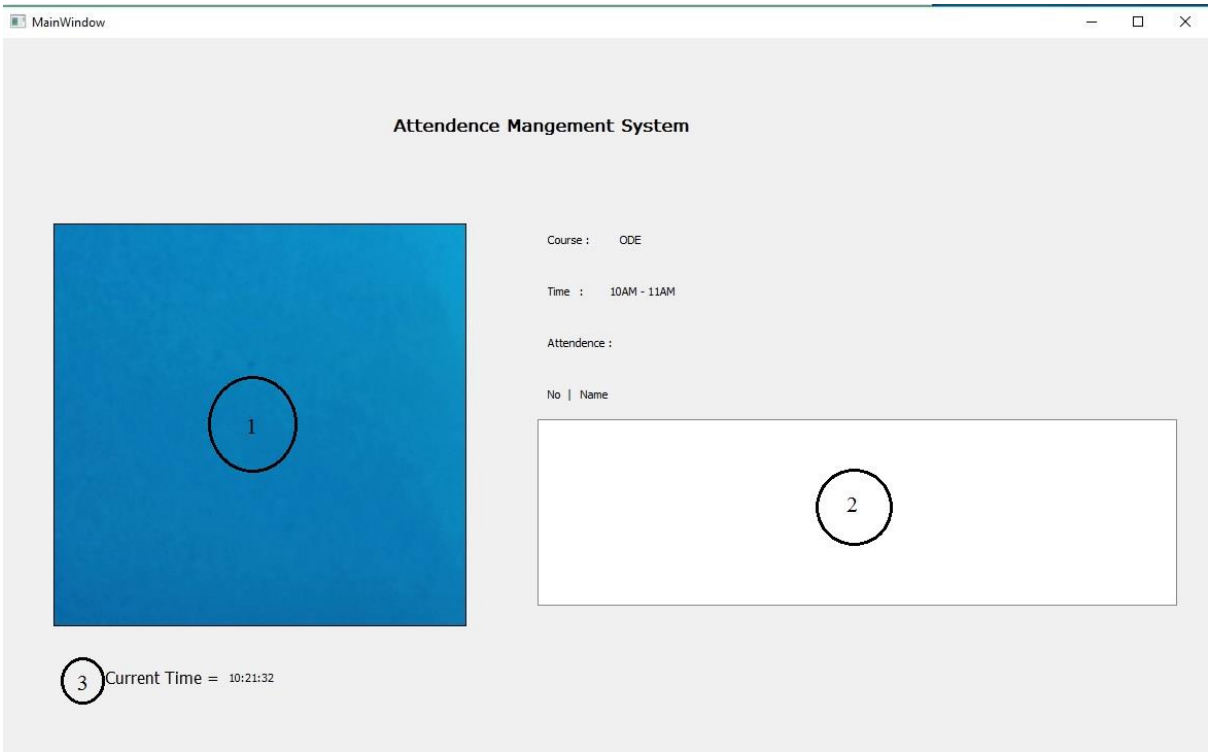

Figure 11 : The layout of the Graphic User Interface (GUI)

The GUI is being designed using PyQt, an open-source software that is available to be used. The PyQt was selected because the face detection and face recognition source code are made of Python language, so integrating same programming language will be easier compared to combining different type of programming language.

Referring to Figure 11, the ① will display the output from the camera which is the face of the user. If the system is not able to detect the face, it will be showed as 'Unknown' but if the system is able to recognize the face of the user, it will display the name of the user. Meanwhile, ② is the place where information about the user being display after it had been recognized by the system. The information such as full name, student ID and course will be display on this box. Whereas,③ will shows the current time of the system.

4.5 Testing

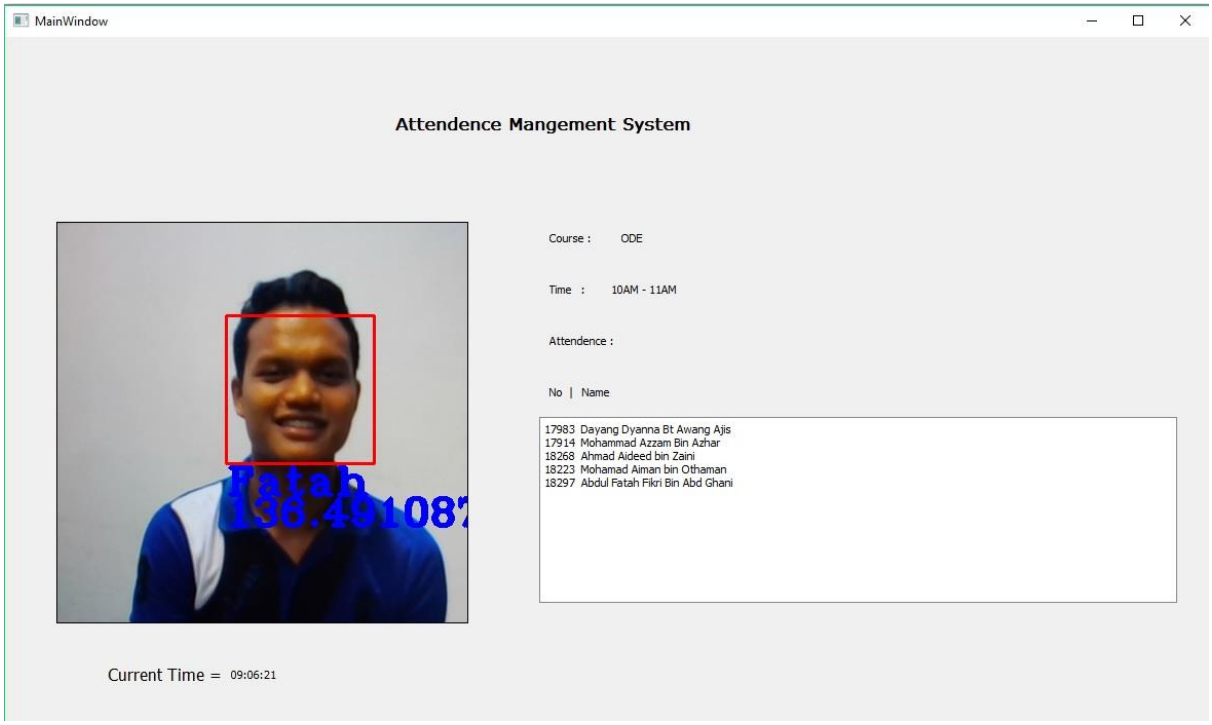

Figure 12 : The image during testing

The system is able to recognize the face of the user and it will make a box around the user's face with showing the nickname of the user. The number below the nickname will represent the similarity of the current face to the images that had been stored in the database. To box on the right side will display the student ID and full name of the recognized user. To be able to mark for the attendance, the user needs to achieve the similarity of 100% for 10 times. After satisfying the condition, the information will be display on the right box. There are two cases being conducted for testing purposes of this system.

4.5.1 Case 1

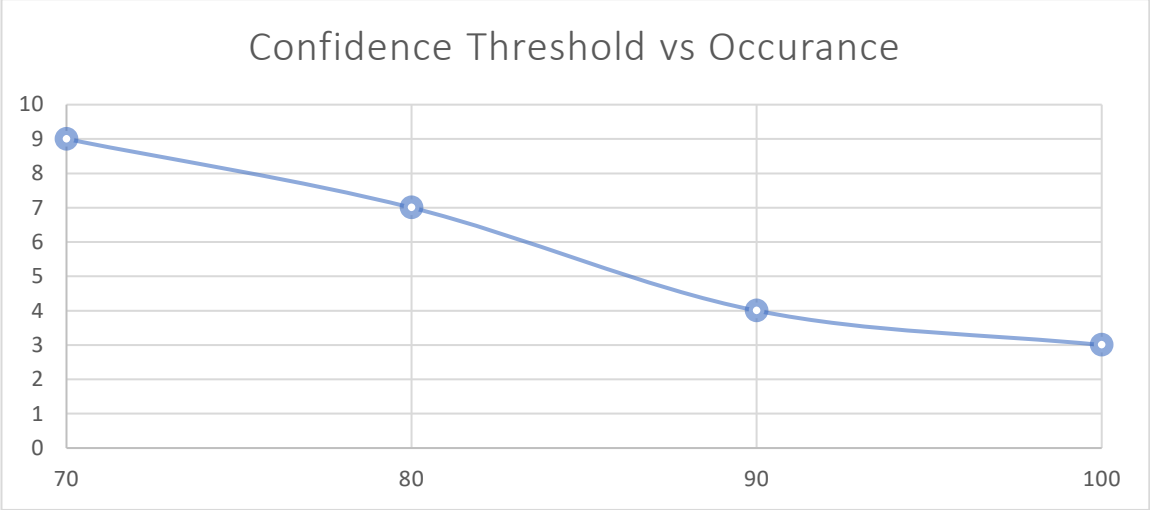

Figure 13 : Result for Case 1

The first case is conducted to verify the effect of different confidence threshold on the subjects. The value of confidence level or similarity can be seen on the GUI after it recognizes the user. First, the confidence threshold being set at 70 and all subjects are being called their name to come in front of the camera for face recognition. After the result is being recorded, the confidence threshold is being increase by 10% to 100%.

Based on Figure 13, the system is able to detect nine out of ten subjects at 70 confidence threshold and at 80 confidence threshold, it was able to recognize seven subjects. Moving to 90 confidence threshold, only four subjects are able to be detected and at highest confidence threshold which is 100, only three subjects are able to be recognized. The higher confidence threshold being used, the lower occurrence of the face being able to recognize. The factor that affects this result is the low resolution images that are being used in the database. Since the images in the database are the reference, they need to be in high quality so that the system will be able to get high recognition rate during comparing those images with images from the cameras.

4.5.2 Case 2

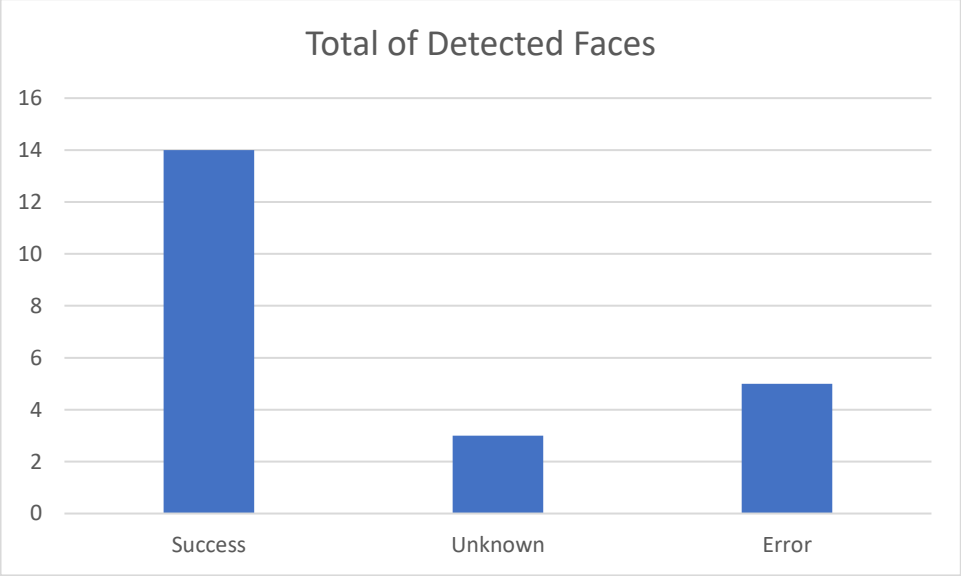

Figure 14: Total faces detected by the system during testing

The second case was conducted for the in larger scale. 22 subjects from final year Electrical and Electronics Engineering course are being selected, containing 14 males and eight females. All of them will provide 10 images containing their face only with the different background and basic information about themselves.

The confidence threshold was set at 100 and the system will need to recognize their face 10 times before automatically display their information on the system. When the system displays the information on the GUI, it will indicate that it attendance for that user had already been taken. 14 subjects are able to be recognized by the system, five subjects are wrongly recognized by the system and three subjects cannot be recognized by the system.

Two of the subjects which are labelled as unknown are wearing a cap during the testing. Since both of them are not wearing cap for the images in database, it makes the system unable to recognize them due to different of face images during testing. The forehead was covered by the cap, so the system is not able to recognize the user due to different shape of face. Five users are wrongly recognized as another user by the system. This is because the images in the database are not constant. There are many subjects in this case and each one of them is using different resolution when taking the photo. So, to get more accurate result, all users need to use the same type of resolution so that the system will not misinterpret the faces during the recognition process. The accuracy of this system is 63.63% for the Case 2.

The main factor affecting the experiment is the pixel of the camera. The pixel of a camera being used to capture the image is low which is only 1.3 Mega Pixel (MP) while the images in the database are being captured by using phone's camera which most of it is greater than 10MP. This large different between made the major effect to the output since the system is comparing the images with the different pixel. Since the system is being taught to compare those images by using pixel, the similarity will not be the same due to the different quality. Higher pixel means the image will be more accurate compared to the original face.

The quality of images in the database is more than 10 Megapixels(MP) while the quality of the images from the camera being used is 1.3MP only. Based on the calculation, the difference between pixels is 87%. The difference is very huge and this is the main factor affecting the testing. To compare the images, the size of pixels need to be same so that precise comparison can be made. Since LBPH algorithm is comparing the binary values from the pixels, the judgement cannot be made correctly due to the nonlinear size of the pixels. The calculation for difference between pixels from the testing camera and image from database is shown below,

$$\frac{1.3MP}{10MP} x\ 100\% = 13\%$$

According to Boom *et al.* [21], they found that low pixels will have more error during face recognition process. The lower resolution of the image, the higher the error detected for face recognition process.

CHAPTER 5
CONCLUSION AND RECOMMENDATIONS

The aim of this project is to create a low cost and functional system to track the attendance of the students. The project is able to detect and recognize the faces of the users. Based on the result from Case 2, 14 out of 22 subjects had been recognized successfully by the system. After recognizing the faces, the system is able to differentiate whether the faces had been registered or not. The system is able to key in the attendance for the users. This project consists of three main equipment, Raspberry Pi 2 Model B as the microcontroller, camera to capture the images and monitor to display the GUI. The software involved are OpenCV to apply the face recognition algorithms in the system, SQLite to create and store the database and PyQt to design the GUI. For Case 1, there were four confidence levels had been used, 70, 80, 90 and 100 while the accuracy for case 2 is 63.63%.

Usage of Internet of Things (IoT) will ease the management of the database for the system. Currently, the database is being stored in a computer and it will inefficient to make the computer as storage since breakdown can happen due to hardware limitation. The database is crucial in every system, so storing the database on online cloud storage will ensure the database will be kept safely. The images stored in the database need to be in high quality so that the system will not recognize the users with someone else. Also, high performance camera for the input will enhance the result and it is recommended for system to run using better resolution camera.

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