International Journal of Nanoelectronics and Materials
Volume 14 (Special Issue) December 2021 [207-218]

IR 4.0 Generation of Face Recognition Based System

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ABSTRACT

Nowadays, the usage of a manual attendance system has become irrelevant with the current technological advancements. Although, there are many advanced attendance systems such as RFID attendance. It does not solve the problem face in the manual system, like inaccurate data, falsification of attendance, and time-consuming. Therefore, this paper suggests a face recognition attendance system to improve these drawbacks, as it can offer accurate attendance and required less time in recording attendance. Viola-Jones algorithm and Histogram of Oriented Gradient (HOG) feature extraction are techniques applied in this paper. The Viola-Jones algorithm will detect faces on the received image while the HOG feature extraction technique algorithm extracts the facial feature and compare it with the database for face recognition. An android application was developed for the user to upload and check the attendance record done by the face recognition process.

Keywords: attendance system, face recognition, Viola-Jones algorithm, HOG feature extraction

1. INTRODUCTION

Industry Revolution 4.0 has taken the world by the storm and many things have moved towards the digital era but taking attendance in the Malaysian education system is still done manually. Recording attendance manually is a tedious and time-consuming process that educators had to go through before class starts and things get harder when the class size is large, with more than 70 students. In addition, fake attendance or attendance inaccuracy can occur either unintentionally or intentionally by the student. Over the years, there is some new advanced system [1, 4-7] that has been introduced but the same old problems as it persists which time-consuming and inaccurate in attendance recording. A method such as a barcode attendance system proposed in [1,4] required scanner installation which can be very costly to install and maintain. In addition, the QR code-based attendance system provides additional problems as it required Internet connectivity and took about 5 to10 minutes to obtain the class attendance which sometimes disrupts the learning process when the internet connectivity is slow.

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These issues have led to the proposal of the face recognition attendance system, which is more accurate, fast, and cost-efficient. The face is a unique feature to an individual which can be used for a positive authentication for an individual identity. Hence, to overcome the drawbacks, this paper has proposed the application face recognition in the android application. The developed system can store the uploaded class image from the smartphone and process the class attendance almost instantly with or without the presence of an internet connection. Therefore, the findings from this research can give a significant impact on Malaysia's education as it provides accurate and instant attendance records with minimum error without being too time-consuming.

2. SYSTEM DESIGN

In general, figure 1 shows the system architecture of the developed face recognition-based attendance system. The processes can be divided into three parts. Firstly, the image captured is the input for the proposed system. The face recognition process is the core of the developed system which is divided into three stages which is face detection, face feature extraction and comparison with database, and face recognition. The first stage is face detection where it will locate and identify any available face in the image. In the second stage, the selected algorithm will extract the face feature of the detected face and comparing the face feature found in the database through a training process. The last stage is face recognition where the identity of the detected face can be identified which leads to the marked attendance report.

Figure 2 shows the flowchart of the proposed system operation. First, the system received an image from the user and the received image will undergo pre-process before converting it into a grey image. Next, if the face detection algorithm detects any face in the image, it will crop the detected face in the image and resized it into a specific size. The cropped face will be analyzed using a feature extractor to extract the facial feature. The extracted features information will be used to compare with images available in the database. If the system detected a similar face in the database, the attendance will be marked in the attendance report as present and vice versa.

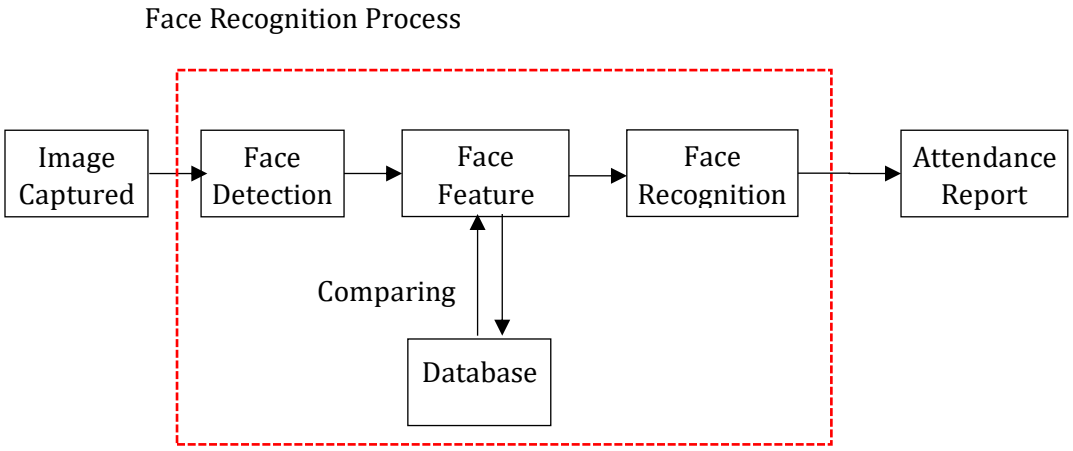

Figure 1. The block diagram of the system architecture.

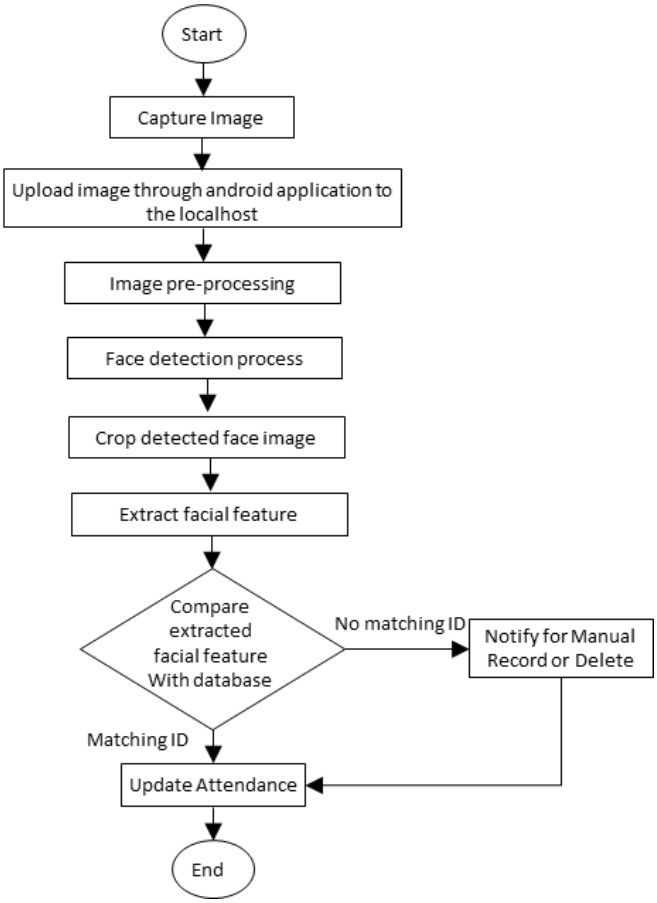

Figure 2. Flowchart of the proposed system.

3. METHODOLOGY

3.1 Database of Images

The image database is important as it was used to train the system to recognize the subjects and provide a platform to accurately measure the chosen method performance. In this paper, a custom database consists of 6 subjects was developed. For each subject, 20 images with different facial poses were taken. The facial pose consists of a frontal face and face poses ranging from 0° to 180° rotation as shown in figure 3. Each of the images was taken with a clear homogenous background while the illumination for each image was kept similar with each image was given adequate lighting without any variation. This ensures that there was no part of the images was overexposing or underexpose. Then, the images went through the pre-processing step and were change to the grey-scale image. Then, the facial area of the image was manually cropped and resized into a 112 × 90 pixels image. Figure 4 shows a flowchart for the development of the custom database. In addition, the FEI database [8] was used to measure the performance of face detection in various face poses.

Figure 3: Shows the different facial poses of a subject

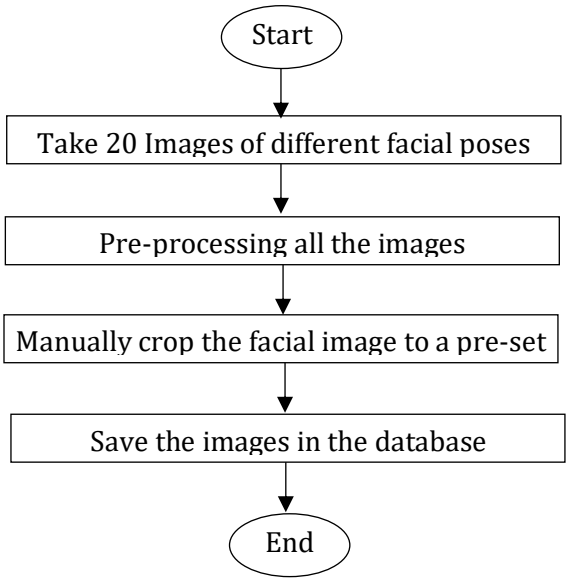

Figure 4. Flowchart of a database development process.

3.2 Face detection

Face detection is an important step as it is the method to locate and identify the presence of human faces in digital images. If it detected any face in an image, the system will crop the face image from the image for the next process. However, if the proposed method fails to detect any face image in the inputted image even there is a face available in the image, the system's performance will significantly drop. Therefore, the proposed method must be selected carefully as there are varieties of techniques available [2,3,9]. It was decided that the Viola-Jones algorithm is used in this paper.

In general, the Viola-Jones algorithm uses the integral representation of an image called the integral image and Haar features as shown in figure 5 to detect different facial features such as the nose and the eye. The training method used the Adaboost classifier to train a stronger classifier by cascading weak classifiers together. Wen-Yao et al [10] stated that these characteristics have helped the algorithm to has higher detection, especially in real-time detection. However, the traditional method of the Viola-Jones algorithm can only be performed efficiently when detecting frontal face but is not robust against varying face poses. Therefore, the implementation of the Viola-Jones algorithm in MATLAB was used instead of the traditional algorithm.

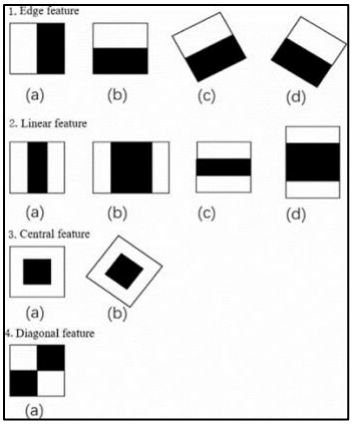

Figure 5. Four type of Haar feature

The implementation of the Viola-Jones algorithm used Haar features to encode facial features while classification and regression tree analysis (CART) provides the ability to model higher-order dependencies between facial features. Hence, it is more robust to a slight tilt in the face pose. Based on the authors in [11, 12], the Viola-Jones algorithm provides the highest detection rate and required less time. Figure 6 outlines the process of face detection used in the experimentation. When the system received an image, it was pre-processed before converting it into a grey-scale image. The function of pre-processing is to reduce the effect of uneven illumination in the image. The Viola-Jones algorithm will locate and detect any face in the image and automatically cropped the detected face image and saved it into a specific file.

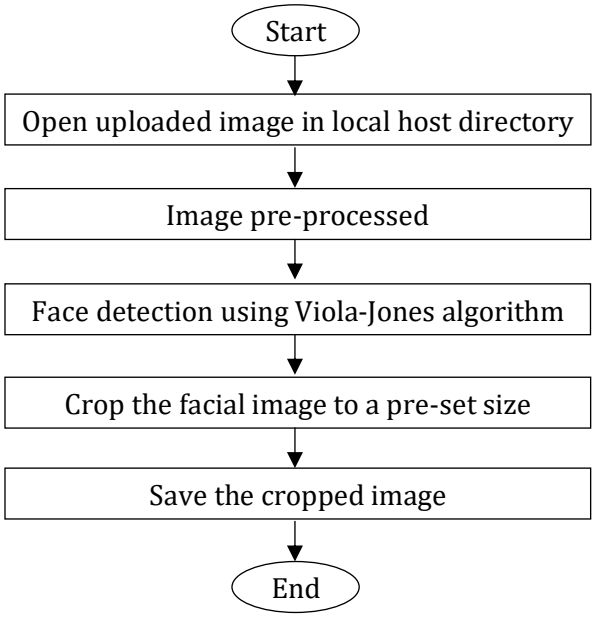

Figure 6. Flowchart of the face detection process

3.3 Face recognition

In general, face recognition is a classification problem where the objective is to classify the input face image to the correct identity. Over the years, numerous models have been introduced such as the HOG descriptor and SURF algorithm [13]. However, the HOG descriptor was used due to its robustness toward uneven illumination, lightweight, and can easily implement in MATLAB. In addition, based on the author in [14], the HOG descriptor has the fastest time with a fairly high true positive rate when compared to other methods. According to the author in [15], image recognition was achieved by calculating the histogram of gradient direction in the image region as shown in figure 7. Figure 8 shows the face recognition flowchart that starts with the descriptor extracting the required information from the cropped image and compares it with the database's extracted feature. If there is a match in the database, the face in the cropped image can be identified. However, if the cropped face image does not match any subject in the database, the user will promptly notify by the system.

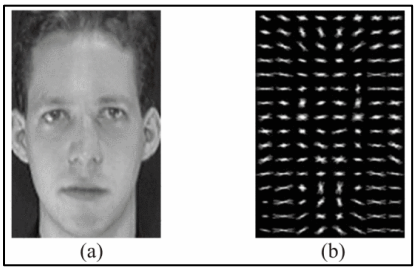

Figure 7. (a) The image in face database (b) the visual image of HOG of a human face [15]

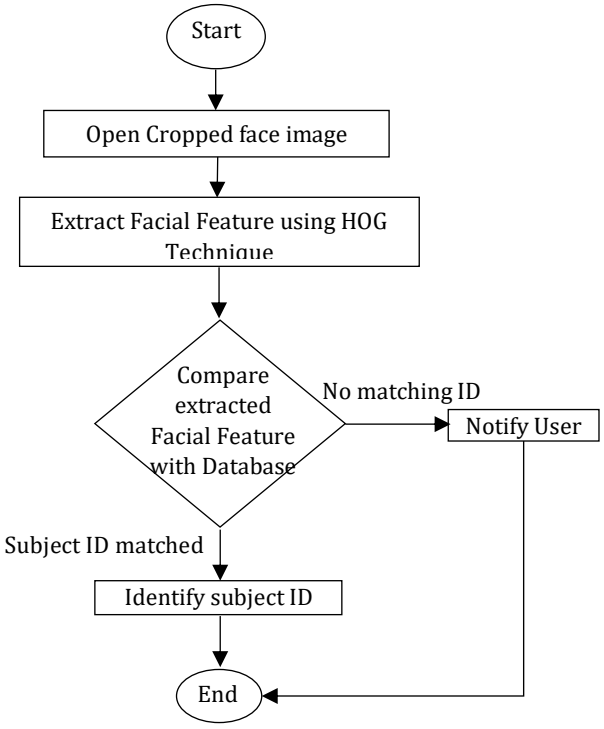

Figure 8. Flowchart of the recognition process

3.4 Development of Android Application

The face recognition attendance system was designed in MATLAB 2020a and the users have no real interface to connect to the system remotely from other locations. Therefore, creating an android application will give access to the proposed system via the internet. The method of using the android application has been implemented by other research such as R. Apoorv[3] and A. F. Abdul Fatah et al[17] in their respective attendance system.

Therefore, Android Studio was used to design an android application to allow the user to use the face recognition attendance system. The android application consists of the new user login page, the home page, attendance upload, and attendance checklist as shown respectively in figure 9. To navigate between pages, a navigation menu was created to ease the user experience as shown in Figure 10. The new user login allows new users to create their profiles while user login allows an existing user to login into the application. The attendance upload gives access to the user to upload their class image. The image will be processed for attendance based on the face detected in the image. The user can get the class attendance through the attendance checklist page where is shown as a Google spreadsheet allowing manual rectification if needed. Figure 11 shows the flowchart of the android application.

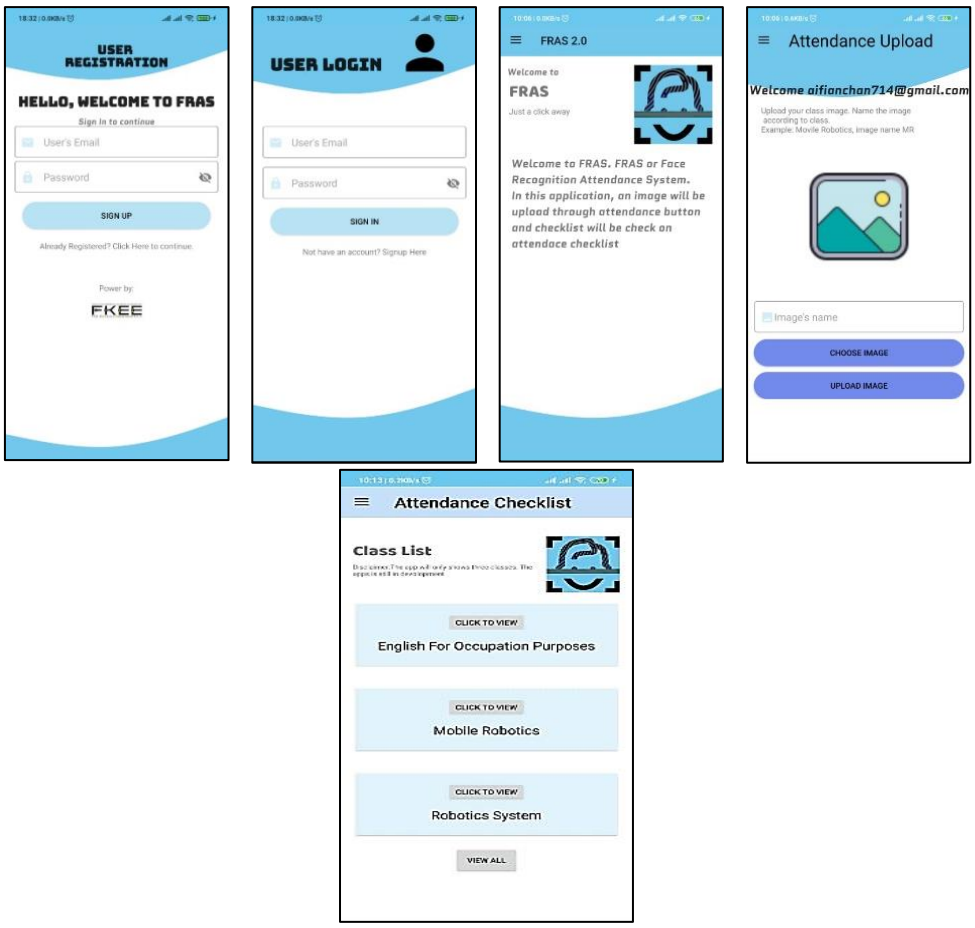

Figure 9. Shows the designed layout of each page in android studio

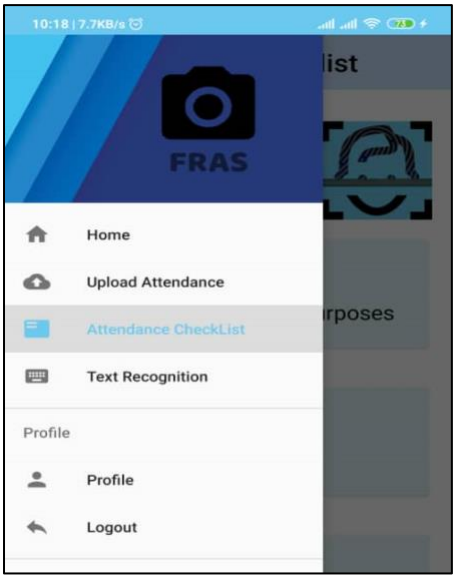

Figure 10. Navigation menu in android application

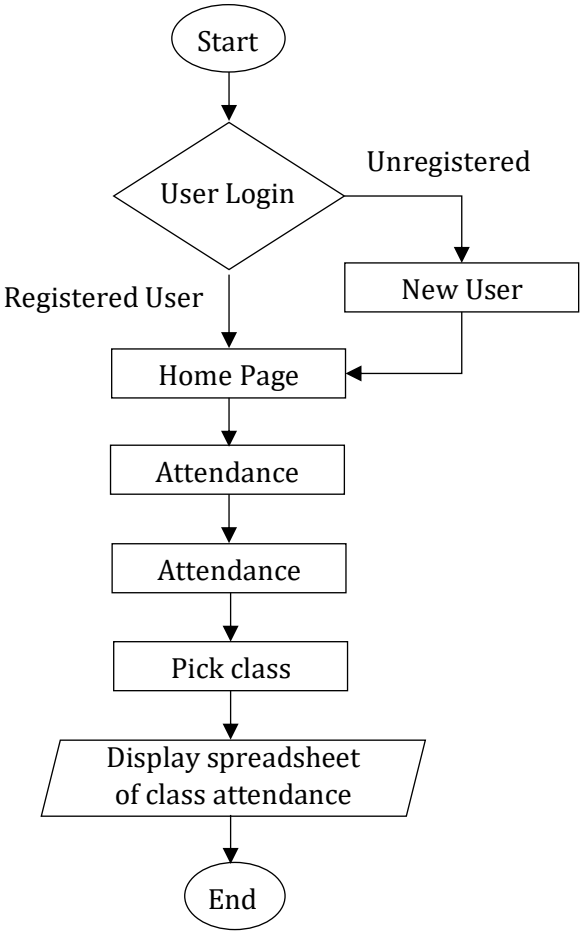

Figure 11. Flowchart of android application

4. RESULTS AND DISCUSSION

4.1 Face detection result for face poses detection

The face detection experimentation will measure the effectiveness of the method chosen earlier in comparison with MTCNN [2] of one the best algorithm on face detection techniques. The comparison will be done based on the ability to detect a face in various face poses. and the detection rate on the database such as the FEI database [8]. Figure 12 shows the result of face detection on the different poses of the face using the FEI database.

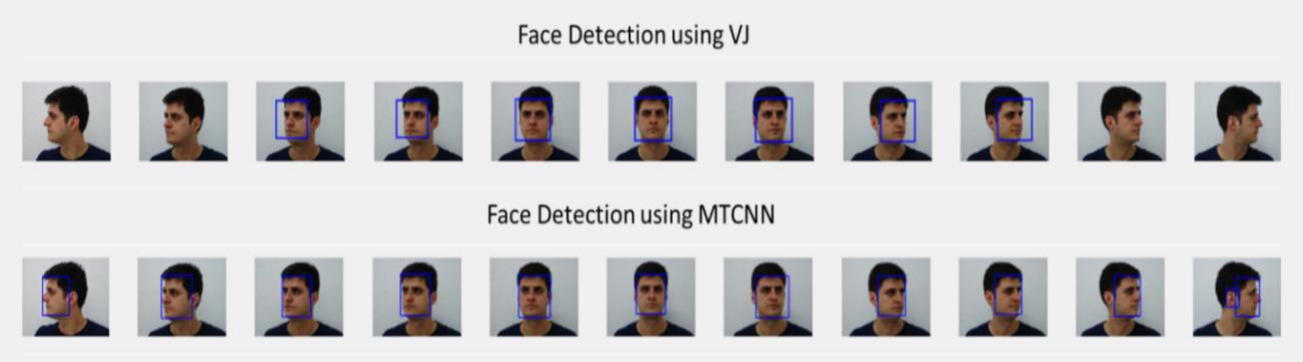

Figure 12. Shown face detection on different face poses using two different method

Based on testing using the FEI database, MTCNN has a better detection rate on extreme face pose. However, the Viola-Jones algorithm is better for the system as extreme poses can be eliminated by the user as they can control the face poses of the student. In addition, MTCNN is required slightly more time to process and required training which consumes more time.

4.2 System Performance

This section shows the result obtained when running the system in a real-life situation. The test was conducted using two subjects in the same class. Figure 13 shows the developed Graphical User Interface (GUI) for the MATLAB program which gives the administrator access to manage the system. Starting from the power button, class available, troubleshooting, or manual rectification on attendance if needed. Firstly, the user uploaded a class image from their gallery as shown in figure 14. Here, the user needs to ensure the image taken is clear with minimal blur. Next, name the image with an abbreviation either MR for mobile robotic class, RS for robotic system class, and Eng for English class as shown in figure 15. When the image is uploaded, it will be placed in the localhost directory as shown in figure 16.

Figure 13. The design of GUI using MATLAB software.

Figure 14. The Attendance Upload screen

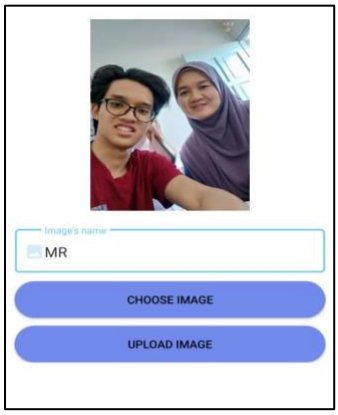

Figure 15. Selected image to be uploaded

The uploaded image was. pre-processed and the Viola-Jones algorithm will locate and detect the available face in the image. Figure 17 shows the cropped face image found by the Viola-Jones algorithm. Then, the HOG descriptor extracts facial features from the cropped images. The extracted

information was used to compared features in the face database. The matching image from the database can be confirmed when the comparison process is completed as shown in figure 18. Finally, the attendance can be marked and since there are two subjects presents in the image. Both students are marked as present as shown in figure 19. The overall process does not require a long time to be completed.

Figure 16. Uploaded image in localhost.

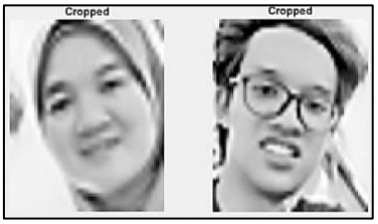

Figure 17. Cropped facial image

Figure 18. The result for selected the subject

	A	B	C	D	E
2					
3		Idenfication\Date		29/6/2020	
4	No	Student's Name	Matrix Number	1	2
5	1	Student 1	NA	present	
6	2	Student 2	NA	present	

Figure 19. The attendance report for the Mobile Robotic class

5.0 CONCLUSION

Through the proposed system, recording attendance is much easier and faster. Furthermore, it has eliminated the drawbacks that the manual and previous method face without required any expensive equipment or jeopardize the accuracy of the attendance. Hence, deploying the system in Malaysia's education system helps educators in recording class attendance as it is reliable, user-friendly, and timesaving. In addition, educators can monitor and manage students more efficiently as fake attendance problems can be curb. For future work, to improve the reliability of the proposed system, there are a few steps that can be taken. First, change the model or algorithm for face detection to a more advanced method such as MTCNN to provide a higher detection rate on different face poses under an unconstrained environment. In addition, changes the platform used for attendance checklist from google spreadsheet to a better platform such as MySQL. This can accommodate more classes and students, and at the same time provide a faster and accurate way to manually rectify attendance if needed.

ACKNOWLEDGEMENTS

The authors would like to thank University Tun Hussein Onn Malaysia for providing grant RE-GG (H884) funding and Advanced Telecommunication Centre (ATRC) for supporting this research.

REFERENCES

[1] Sudha, K. L., Shinde, S., Thomas, T., & Abdugani, A.,"Barcode based student attendance system." International Journal of Computer Applications vol. **119**, no. 2 (2015) pp. 1-5.

[2] Zhang, K., Zhang, Z., Li, Z., & Qiao, Y., "Joint face detection and alignment using multitask cascaded convolutional networks," IEEE Signal Processing Letters, vol. **23**, no. 10 (2016) pp.1499–1503.

[3] Barnouti, N. H., Al-Dabbagh, S. S. M., Matti, W. E., & Naser, M. A. S., "Face Detection and Recognition Using Viola-Jones with PCA-LDA and Square Euclidean Distance," International Journal of Advanced Computer Science and Applications, vol. **7**, no. 5 (2016) pp. 371–377.

[4] Elaskari, S., Imran, M., Elaskri, A., & Almasoudi A., "Using barcodes to track student attendance and assets in higher education institutions," in Procedia Computer Science 184, (2021) pp. 226–233.

[5] Apoorv, R., & Mathur, P., "Smart attendance management using Bluetooth Low Energy and Android," in IEEE Region 10 Conference, (2016) pp. 1048-1052.

[6] Shah, S. N., & Abuzneid, A., "IoT Based Smart Attendance System (SAS) Using RFID," in IEEE Long Island Systems, Applications and Technology Conference, (2019) pp. 1-6

[7] Aravindhan, K., Sangeetha, S. K. B., Periyakaruppan, K., Keerthana, K. P., Sanjaygiridhar, V., & Shamaladevi, V., "Design of Attendance Monitoring System Using RFID," 2021 7th International Conference on Advanced Computing and Communication Systems, vol**. 1**, (2021) pp.1628–1631.

[8] Tenorio, E. Z., & Thomaz, C. E., "Analise multilinear discriminante de formas frontais de imagens 2D de face," in proceedings of the X Simposio Brasileiro de Automacao Inteligente SBAI, (2011) pp. 266-271.

[9] Deng, J., Guo, J., & Zafeiriou, S., "Single-Stage Joint Face Detection and Alignment," in Proceedings of the IEEE/CVF International Conference on Computer Vision Workshops, (2019) pp. 1836-1839.

[10] Lu, Wen-Yao, and Y. A. N. G. Ming., "Face detection based on Viola-Jones algorithm applying composite features," in 2019 International Conference on Robots & Intelligent System, (2019) pp. 82-85.

[11] Ramakrishna, B. B., & Kumari, M. S. "A comparative study on face detection algorithms." in 2017 International Conference on Energy, Communication, Data Analytics and Soft Computing, (2017) pp. 151–159.

[12] Dang, K., & Sharma, S., "Review and comparison of face detection algorithms," in 2017 7th International Conference on Cloud Computing, Data Science & Engineering-Confluence, (2017) pp. 629-633.

[13] He, Q., He, B., Zhang, Y., & Fang, H., "Multimedia based fast face recognition algorithm of speed up robust features," Multimedia Tools and Applications, vol. **78**, no. 17 (2019) pp. 24035-24045.

[14] Kortli, Y., Jridi, M., Al Falou, A., & Atri, M., "A comparative study of CFs, LBP, HOG, SIFT, SURF, and BRIEF techniques for face recognition," Pattern Recognition and Tracking XXIX, vol. **10649**, (2018) pp. 106490M

[15] Wang, H., Zhang, D., & Miao, Z., "Fusion of LDB and HOG for Face Recognition," "Fusion of LDB and HOG for Face Recognition," 2018 37th Chinese Control Conference, (2018) pp. 9192-9196.

[16] Elrowayati, A. A., Alrshah, M. A., Abdullah, M. F. L., & Latip, R., "HEVC Watermarking Techniques for Authentication and Copyright Applications: Challenges and Opportunities," in IEEE Access 8 (2020) pp. 114172-114189.

[17] Fatah, A. F. A., Mohamad, R., & Rahman, F. Y. A., "Student Attendance System Using An Android Based Mobile Application," in 2021 IEEE 11th IEEE Symposium on Computer Applications & Industrial Electronics, (2021) pp. 224-227