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A Real-Time Web-based Facial Recognition Attendance System

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Abstract : Facial recognition has become an important part of biometric verification. A facial recognition system can detect, track, identify, and verify the identity of an individual based on their faces captured using a camera that can be still or in real-time images. Facial recognition can be used in the attendance management system to record the attendance of an individual in any sector, including education. In educational institutions, attendance marking is one of the methods used to monitor students' presence in lectures. It is one of the ways to monitor their presence to ensure their participation in the lectures and class activities to enhance their academic achievement and reduce the frequency of absences without justifiable excuses. Typically, the conventional method used is through manual attendance marking on a piece of paper. This approach has been demonstrated to be forgery-prone, imprecise, and time-consuming as it is primarily dependent on the human factor. Thus, this paper proposes a web-based attendance system with facial recognition (WAS-FR). WAS-FR uses a live camera facial detection feed to display the student details and the current approximated location of the student in each of the student's enrolled courses to avoid fake attendance. WAS-FR is based on the facial recognition model that compares the facial descriptors of the real-time image from the camera to an uploaded image kept in the database. The majority of the respondents who tested WAS-FR strongly agreed that the system is easy, effective, and convenient to be used, showing a high mean value of 0.93, giving the system positive results overall. The facial recognition attendance system can quickly complete the tasks of student attendance check-in, which improve the efficiency of lectures as the attendance is done individually by the students.

Keywords: Biometric, Facial recognition, Identification, Attendance management

1. Introduction

In the current educational system, students' attendance in lectures is critical for measuring and monitoring their performance. Attendance marking is one of the ways used to monitor students' presence in lectures, to assure their involvement in lectures and class activities, to improve academic accomplishment, and limit the frequency of absences without solid reasons. The conventional approach

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employed at most institutions is manual attendance marking, which can be done by calling the student's name or marking it on a piece of paper. The conventional method has a lot of shortcomings as it relies mainly on the human factor which exposes the method to be forgery-prone, inaccurate, time-consuming, insecure, and can be distracting in a large classroom [1, 2]. To address the shortcomings of the conventional technique, an automated system is developed. Fingerprint biometrics is one of the earliest and most commonly used biometric technologies since fingerprints are the oldest type of biometric identification due to the uniqueness of fingerprint characteristics [3, 4]. However, for the fingerprint attendance system to be utilized at educational institutions, fingerprint scanners must be placed, which can be expensive to set up and manage across a wide area of educational establishments.

In addition to fingerprint recognition, facial recognition is a biometric approach that uses a person's facial traits to identify them. Facial traits, like fingerprints, are unique to each individual and can be utilized to identify and authenticate a person. A facial recognition system can use this uniqueness to accurately detect, track, identify, and verify the identity of an individual based on their faces captured using a camera that can be still or in real-time images. In an attendance management system, facial recognition can be used to record an individual's attendance [5-7]. A majority of mobile devices are equipped with a camera, facial recognition technology can be used from the user end without the need for the installation of special devices.

Therefore, this paper presents a web-based attendance system incorporating facial recognition (WAS-FR). To discourage false attendance, WAS-FR displays information and the student's current approximated position for each of the student's registered courses using a live camera face detection input. WAS-FR is based on a facial recognition model that matches the facial descriptors of the camera's real-time image to an uploaded image stored in the database. The system enables effective attendance marking through its functions to ensure that the students are present and located at the location that they are supposed to be, ready for the lectures, especially when lectures are being conducted online. The facial recognition system has greater accuracy and stability than other biometric systems because there are more points for facial-recognition identification. The system will help the lecturer or instructor take their student attendance more effectively and display the estimated location of the student. The facial recognition attendance system can swiftly perform the tasks of student attendance check-in, which improves the efficiency of lectures since attendance is performed by the students.

2. Methodology

The waterfall methodology was chosen for this project to construct the facial recognition attendance system due to its rigidity, ease of use, and each step having stated deliverables and a review procedure. The waterfall model represents the software development process as a sequential flow of events linearly. Phases are processed and completed one at a time in this model starting from planning, requirement analysis, system design, implementation, and system.

The first phase is planning where the facial recognition attendance system functions are listed. In this phase, the main requirements of the system are decided on. The system needs to be developed as a web-based system that is accessible by the students and instructors, requiring only an Internet connection. This simplifies the accessibility of the system on any devices that the students and instructors might use. The other main criteria of the systems other than web-based are the system should have facial detection and the location of the user. These are important to ensure the students and instructors are on the correct course enrolled and at the location, they claimed to be when registering their attendance, ready for the lectures. The goal of this project is to create a facial recognition attendance system that will assist the attendance marking more effectively with the requirements, it is web-based, has facial detection and location, and the system should be able to be used by the students and instructors.

The second phase is the requirement analysis. In this phase, the data and specifications of the project are collected to define the scope and system's features that need to be considered in developing the system. The website has an interface that has the option for the users to register and log in as a student or instructor, depending on the account type. In this phase, the information to be displayed if the user is a student or instructor is decided on. Instructors have more access to the system than the students as they will be able to view the students' information.

The third phase is the system design. In this phase, the software and languages to develop WAS-FR are finalized. WAS-FR uses JavaScript API, adopting the existing face-api.js for facial detection and identification that are built on TensorFlow. As for the estimated students' location, Geolocation API is used where if the user permits it, it can detect the current location and displaying on the web application. These are combined in simple HTML, PHP, and CSS that are used to structure the web pages and content. In addition, a cloud database is used and built to store the information such as the students' and instructors' details and images that are uploaded. A prototype of the WAS-FR system is developed as the outcome of this phase to allow the users to experience interacting with the system.

The next phase is implementation. As shown in Figure 1, before the attendance system can be used, the user needs to register and fill up their detail and upload a photo of them, preferably with minimal distraction in the background. This photo will be used as the comparison photo by the facial recognition model during facial detection.

Students and instructors have different functions that they can access. Instructors can create classes, and view the summarized attendance report of the students which included the students estimated location while students can scan their attendance once the instructor has created the class as shown in **Figure 2.**

Based on the system design and requirement analysis, WAS-FR has successfully been developed and is ready for implementation. The system can be accessed from www.270236.noradila.com. The API of facial recognition and estimated location are verified to ensure the output is as expected as shown in **Figure 3**. The images of the students that are registered and uploaded to the database are checked to ensure the images are of good quality, have minor background distractions, and can detect and map to the correct person as it is supposed to. The final phase is the system. The system is thoroughly tested to ensure the requirements and functions are working as intended. The results from the tests are then analyzed and changes or any adjustments will be made to the system as needed.

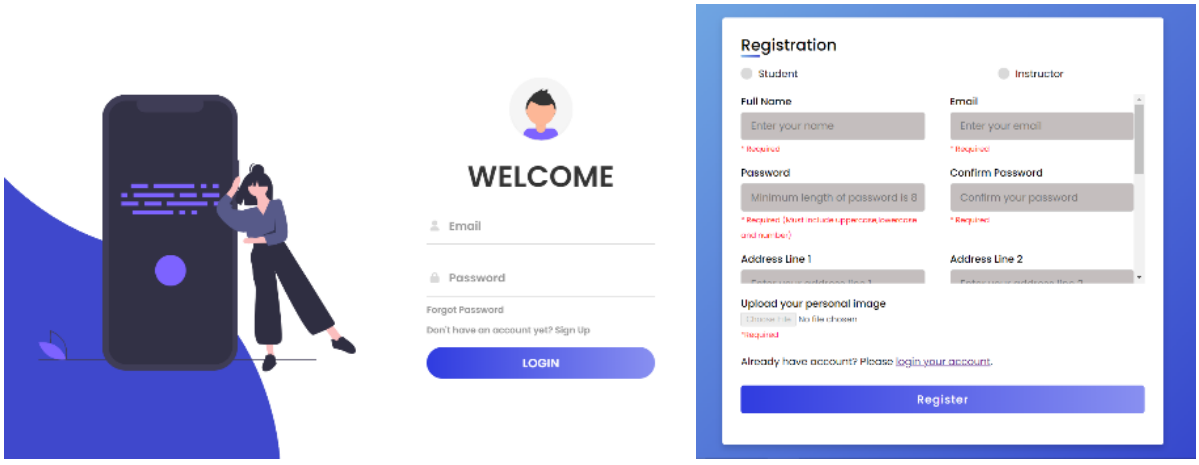

Figure 1: WAS-FR login and register interfaces

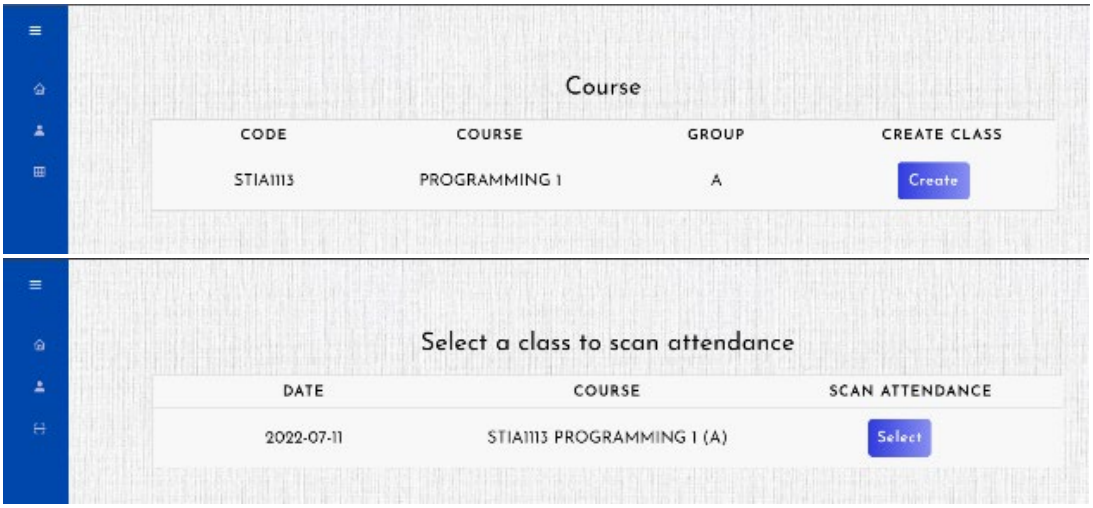

Figure 2: WAS-FR instructor's and student's different access interfaces

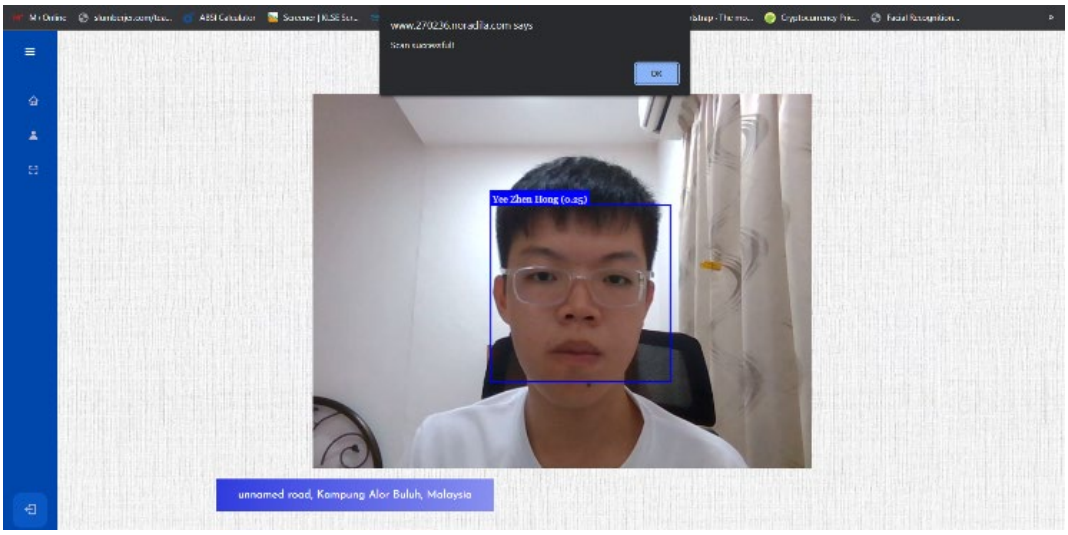

Figure 3: WAS-FR detects the student's name and estimated location

3. Results and Discussion

The evaluation method used to gather information on the field testing is through an online questionnaire which is Google Form. Google Meet also has been used to have a live survey and Google Form is provided for them to evaluate the system. The respondents of this evaluation are students from Universiti Utara Malaysia (UUM) and other universities, and the instructors are from UUM. The number of respondents found is approximately 30. The WAS-FR system was demonstrated and tested by the respondents. A Google Form is provided to the respondents to answer the related question based on their observation of the system

The type of evaluation chosen is the Diffusion of Innovation (DOI) adapted from a study by Kaur et al. (2020) [8]. DOI was designed to better understand the way a product or service emerges, gains popularity, and reaches over general public [9]. In this study, DOI is used to understand different aspects of user behavior regarding the facial recognition system. This is based on three main measures, namely relative advantage, compatibility, and complexity. Relative advantage measures the additional benefit that the system gives over its predecessors. Compatibility refers to the potential user's assessment of the system's compatibility with the demands and ideals. Complexity is the potential user's assessment of its ability to understand and operate the system. These three study measures are positively associated with the users' intentions to use the system [8]. A 5-point Likert scale ranging from Strongly disagree to

Strongly agree is used. Descriptive statistics (mean and standard deviation) are calculated to describe the characteristics of the respondents. These indicators are analyzed to understand the respondents' take on the system.

There are 30 respondents from students and instructors. There are 18 (60%) females and 12 (40%) males. There are 2 respondents (6.7%) aged 18 years old, five respondents (16.7%) aged 20 years old, one respondent (3.3%) aged 21 years old, six respondents (20%) aged 22 years old, 11 respondents (36.7%) aged 23 years old, three respondents (10%) aged 24 years old, one respondent (3.3%) aged 25 years old and one respondent (3.3%) aged 32 years old. The respondents from different departments and semesters are selected to test WAS-FR to understand their take on the system, considering their different backgrounds and program of study. 14 respondents (46.7%) are from fifth to sixth semesters while eight respondents (26.7%) are from third to fourth semesters, three respondents (10%) are from first to second semesters, four respondents (13.3%) are from seventh to eighth semester and one respondent (3.3%) who don't form any of the semesters. There are seven (23.3%) from the School of Computing (SOC), five respondents (16.7%) from the School of Education (SOE), four respondents (13.3%) from the School of Economics, Finance & Banking (SEFB), three respondents (10%) from the School of Quantitative Science (SQS) and also the same amount of the respondents from Tunku Puteri Intan Safinaz School of Accountancy (TISSA), two respondents (6.7%) from School of Multimedia Technology & Communication (SMMTC) and Tunku Abdul Rahman University College (TARUC). Lastly, there is one respondent from the School of Law (SOL), School of Business Management (SBM), Han Chiang, and UNIMAP.

3.1 Comparison Result in Relative Advantage Measure

Table 1 shows the four items that are measured in relative advantage. All of the items show high mean values of μ =0.91 and 0.90 with low standard deviations of 0.10 and 0.11 in terms of the advantages, convenience, efficiency, and effectiveness of WAS-FR compared to the normal or traditional attendance system. It can be noted that in terms of convenience, μ =0.90 where it can be concluded that even though the majority strongly agreed with the item statement, it should be considered the individual preference of using the normal attendance system. This needs to be proved by evaluating the system with a larger number of respondents.

Table 1: Relative advantage items

Measurement Items	Mean (μ)	Std dev (σ)
The facial recognition attendance system has more advantages than the normal attendance system.	0.91	0.11
The facial recognition attendance system is more convenient than the normal attendance system.	0.90	0.11
The facial recognition attendance system is more efficient than the normal attendance system.	0.91	0.10
The facial recognition attendance system is more effective than the normal attendance system.	0.91	0.10

3.2 Comparison Result in Compatibility Measure

In compatibility, there are three measurement items as shown in **Table 2**. The first item is related to the current university lifestyle where the use of devices and technologies is the norm, showing a high mean value of 0.92 and low σ =0.10 and in terms of the effectiveness to the users, with the value of μ=0.90 and σ =0.11. However, compared to the compatibility of WAS-FR with the existing attendance system that is currently in use, it shows a lower mean value of 0.86. This is because the current attendance system that UUM is using, uses QR codes as the main method for attendance marking. Modification is required to include facial recognition in the existing system.

Table 2: Compatibility items

Measurement Items	Mean (μ)	Std dev (σ)
Using the facial recognition attendance system is compatible with the university lifestyle of the student and the instructor.	0.92	0.10
Using the facial recognition attendance system is completely compatible with the current attendance system.	0.86	0.11
I think that using the facial recognition attendance system would make it more effective for me to take attendance.	0.90	0.11

3.3 Comparison Result in Complexity Measure

In complexity, four measurement items are used as shown in **Table 3**. All of the items show a low standard deviation value of 0.10. However, in terms of the mean value, the item on the speed of marking attendance using WAS-FR shows the value of μ=0.89 which is slightly lower than the other items. This is because WAS-FR is developed to be run on the individual's device. Thus, older devices might face the problem of slower facial and location detection than newer models of devices due to the specification and support of the devices. The other items on the level of complexity of WAS-FR, overall strongly agreed that the system is easy, effective, and convenient to be used with high mean values above 0.91.

Table 3: Complexity items

Measurement Items	Mean (μ)	Std dev (σ)
Using the facial recognition attendance system would make it easier to take attendance.	0.91	0.10
Using the facial recognition attendance system would enable me to take attendance more quickly.	0.89	0.10
Using the facial recognition attendance system would make it more effective for me to take attendance.	0.93	0.10
Using the facial recognition attendance system would be more convenient for me to take attendance.	0.93	0.10

3.4 Comparison Result in Intentions to Use Measure

Table 4 shows the intentions to use items that are associated with the previous three measures, relative advantage, compatibility, and complexity. In terms of the respondents' expectation of using WAS-FR, it shows the mean value of 0.84 which is slightly lower than expected from the results in previous sections. This is understandable as facial recognition techniques have been around for several years but the implementation is yet to be seen in many educational institutions. There have been initiatives by schools and universities in Malaysia on facial recognition systems, however, due to other reasons and risks such as cost and security, it has not been implemented widely. A higher mean value of 0.89 can be seen in the items recommending WAS-FR which shows, in terms of using the system, the respondents as users are ready in adopting the system.

Table 4: Intentions to use items

Measurement Items	Mean (μ)	Std dev (σ)
I expect my use of the facial recognition attendance system in the future.	0.84	0.12
I will recommend to my friends to use the facial recognition attendance system.	0.89	0.14

The results of the evaluation can be concluded as good, showing positive results based on the respondents' high mean and low standard deviation values. WAS-FR system can be used as it enables the students and instructors to effectively and efficiently complete the tasks of student attendance check-in. The majority of the respondents preferred to use and are satisfied with WAS-FR.

4. Conclusion

A facial recognition system is a unique biometric verification method using an image that can detect, track, identify and authenticate an individual's identification. Due to the benefits that facial recognition poses, it can be used in the attendance management system to record the individual's attendance, specifically in this paper, for educational institutions. This paper introduced WAS-FR, a web-based attendance system with facial recognition. The vast majority of the respondents who tested WAS-FR strongly agreed that the system is simple, practical, and pleasant to use, resulting in favorable overall findings. WAS-FR is also suitable as the use of devices and technologies is the norm which resulted in high intention to use the system. The system is planned to continuously be upgraded by adding more functions to complete the system as a whole, that connects different departments within the institution as required in accordance with the security and privacy regulations.

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References

[1] Bhattacharya, S., Nainala, G.S., Das, P., & Routray, A. (2018). "Smart Attendance Monitoring System (SAMS): A Face Recognition Based Attendance System for Classroom Environment". 2018 IEEE 18th International Conference on Advanced Learning Technologies (ICALT), pp. 358-360.

[2] Selvi, S., Rath, M., Hemrom, N. N. J., Bhattacharya, A., & Biswal, A. K. (2017). "Implementation of Fingerprint-Based Biometric System and Its Integration with HRMS Application at RDCIS, SAIL". Proceedings of the International Conference on Microelectronics, Computing & Communication Systems, pp. 25–33.

[3] Ujan, I. A., & Ismaili, I. A. (2011). Biometric attendance system. In the 2011 IEEE/ICME International Conference on Complex Medical Engineering, pp. 499-501. IEEE.

[4] Chandramohan, J., Nagarajan, R., Dineshkumar, T., Kannan, G., & Prakash, R. (2017). Attendance monitoring system of students based on biometric and GPS tracking system. International Journal of Advanced Engineering, Management and Science, 3(3).

[5] Alghamdi, S. (2019). "Monitoring Student Attendance Using A Smart System at Taif University". International Journal of Computer Science & Information Technology (IJCSIT), 11(1).

[6] Bai, X., Jiang , F., Shi , T. & Wu, Y., (2020). "Design of Attendance System Based on Face Recognition and Android Platform", 2020 International Conference on Computer Network, Electronic and Automation (ICCNEA), pp. 117-121.

[7] Nordin, N., & Fauzi, N. H. M. (2020). "A Web-Based Mobile Attendance System with Facial Recognition Feature". International Journal of Interactive Mobile Technologies, 14(5).

[8] Kaur, P., Dhir, A., Bodhi, R., Singh, T., & Almotairi, M. (2020). "Why do people use and recommend m-wallets?". Journal of Retailing and Consumer Services, 56, 102091.

[9] Rogers, E.M. (2003). “Diffusion of Innovations”, Fifth ed. Free Press, New York.