Integrating Facial Recognition and GPS Technology for Efficient Attendance Management in Educational Institutions

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Abstract. This study explores the integration of facial recognition and GPS technology to enhance attendance management systems in educational institutions. By employing a two-layer verification process that combines face validation and location validation, the proposed system addresses common challenges of traditional attendance methods, such as proxy attendance and inefficient data management. The system not only improves accuracy and security but also provides valuable insights into attendance patterns through location-based analytics. Despite its advantages, the research highlights the need to address challenges related to data privacy, security, and user acceptance for successful implementation. Overall, this study contributes to the development of modern attendance management solutions, demonstrating the potential for increased efficiency and effectiveness in educational environments.

Keywords. Face recognition, GPS technology, Attendance, Management, Educational

1. INTRODUCTION

Face recognition-based attendance systems typically involve the following steps: capturing images of students/employees using a camera, detecting and extracting facial features from the images, comparing the extracted features with a pre-stored database to identify individuals, and automatically marking attendance (Sumithra et al., 2022; Chen, 2023; Dagade et al., 2023; Ojo et al., 2023). The advantages of using face recognition for attendance include: it is a contactless and non-invasive method, it can prevent proxy attendance and fraud, it is more efficient and less time-consuming compared to manual attendance taking, and it can be integrated with cloud-based systems to provide attendance data analytics (Modak et al., 2022; Nordin & Fauzi, 2020; Chavan et al., 2023; Suhaimin et al., 2021; Thirukrishna et al., 2023).

Several face recognition algorithms have been used in these systems, such as DLIB (Chen, 2023), Eigenfaces (Suhaimin et al., 2021), Local Binary Pattern Histogram (LBPH) (Ariansyah et al., 2021; Suhaimin et al., 2021), Convolutional Neural Networks (CNNs) (Ojo et al., 2023), and Triplet Loss Embedding (Pranoto & Kusumawardani, 2021). These algorithms have shown high accuracy in face detection and recognition (Chen, 2023; Ojo et al., 2023; Pranoto & Kusumawardani, 2021; Suhaimin et al., 2021; Suhaimin et al., 2021). To enhance the security and reliability of these systems, some studies have also incorporated anti-spoofing techniques (Hosen et al., 2023) and integration with other technologies like IoT and mobile apps (Nordin & Fauzi, 2020). AI technology will be very important here (Wayahdi et al.,

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2024; Wayahdi et al., 2021). Overall, the references reviewed demonstrate the feasibility and effectiveness of using facial recognition for attendance systems in various settings. This technology has the potential to improve efficiency, accuracy, and security compared to traditional attendance methods. In addition, location-based technologies are also widely practiced.

Attendance systems that utilize location-based technologies have been explored in various contexts, such as student attendance (Babatunde et al., 2022; Najaf et al., 2023; Rifky et al., 2023), employee attendance (Hidayat et al., 2023), and healthcare services (Gorham et al., 2022; Siskind et al., 2022). These systems aim to improve attendance monitoring and management by leveraging technologies like GPS, QR codes, Bluetooth, and facial recognition (Babatunde et al., 2022; Lee, 2020; Nguyen et al., 2022). The use of location-based attendance systems can help address issues such as fraudulent attendance records, lack of attendance discipline, and inefficient attendance data management (Babatunde et al., 2022; Hidayat et al., 2023). These systems can also provide valuable insights into attendance patterns and factors influencing attendance, such as geographical location, transportation accessibility, and socioeconomic factors (Gorham et al., 2022).

In the healthcare domain, location-based attendance systems have been used to track and manage attendance for various services, including emergency care, dialysis treatment (Gorham et al., 2022), and weight management programs. These systems can help improve attendance rates, service delivery, and patient outcomes (Siskind et al., 2022). However, the implementation of location-based attendance systems is not without challenges. Factors such as user privacy, data security, and user acceptance must be carefully considered (Babatunde et al., 2022; Rifky et al., 2023). Additionally, the availability and reliability of the underlying technologies, such as GPS and Wi-Fi networks, can impact the effectiveness of these systems (Rakhmania et al., 2022). Location-based attendance systems can improve attendance monitoring and management in various sectors, including education, healthcare, and the workplace.

This research aims to integrate facial recognition technology and GPS in an attendance management system in educational institutions, with the hope of improving the efficiency, accuracy, and security of attendance recording. The proposed system will prevent cheating and provide location-based analytics for attendance pattern insights. This research will also identify challenges, such as data privacy, security, and user acceptance,

to contribute to the development of a more modern and responsive attendance system in educational environments.

2. LITERATURE REVIEW

A study entitled "Development of an Improved Convolutional Neural Network for an Automated Face-Based University Attendance System" (Ojo et al., 2023) explained that while many studies support the effectiveness of facial recognition-based attendance systems, there are some conflicting arguments and findings. Another study, "Automated Attendance System using Real-Time Face Recognition and MySQL Database" (Sumithra et al., 2022) explained that the system could significantly reduce human error and the time required for attendance recording. Another study, "Smart System for Attendance Based on Face Recognition" (Chavan, 2023) explained the development of a face recognition-based attendance management system that aims to overcome the weaknesses of manual methods that are time-consuming and prone to fraud. Therefore, although face recognition-based systems show great potential, further research is needed to overcome these challenges and ensure the system's reliability in a broader context.

A study entitled "Face Recognition Attendance Monitoring System" (Dagade et al., 2023) explained that the system could significantly reduce the time required to record attendance and improve accuracy, with accuracy reaching 99.38%. Another study, "Study on Student Attendance System Based on Face Recognition" (Chen, 2023) explained that facial recognition-based attendance systems have great potential to improve the efficiency and accuracy of recording student attendance, with some studies reporting recognition accuracy reaching 91% under good lighting conditions. Another study, "Opening Doors Using Internet of Things (IoT) Based Face Recognition" (Ariansyah et al., 2021) explained facial recognition systems could be applied in the context of security, especially in the development of Internet of Things (IoT)-based door opening systems. Another study, "Mobile Based Student Attendance System Using Geo-Fencing With Timing and Face Recognition" (Babatunde et al., 2022), explained that this system not only reduces the time required to record attendance but also improves accuracy by utilizing facial recognition, which can achieve a high level of accuracy under optimal conditions. However, criticisms have been raised regarding limitations in detecting faces that are not directly facing the camera and challenges in varying lighting conditions.

3. METHODS

This research uses a waterfall model-based process framework approach (Wayahdi & Ruziq, 2024) to provide an organized structure at each stage of system development. Starting from planning, modeling, constructing, testing, and deployment. The planning stage begins with identifying the needs of educational institutions related to the attendance management system. This research mapped out requirements, such as accuracy in facial recognition. The facial recognition system identifies the face image with their current face. Other technologies, such as geolocation for location verification, are also used.

Backend modeling is made using Laravel because a simple way to build an API with a secure authentication system is to use Laravel. The mobile app was designed using Flutter, a framework that targets fast and consistent development across multiple platforms, especially mobile. By applying a good System Development Life Cycle method, this system will be easy to develop further. This will also make it easier if there is a need for improvement in this system.

4. **RESULTS**

The implementation of this system includes all views of the validation process before sending attendance, and also monitoring attendance. This system was built to facilitate the attendance process, both from the side of employees who take attendance or from the side of administrators who want to monitor the attendance records of all users. For the mobile application, users will first be asked for their email and password to log into their account. Here, the mobile application is built using the Flutter framework with a state management provider.



Figure 1. Mobile App Login Screen



Figure 3. Face Validation Page Screen



Figure 2. Mobile App Home Page Screen



Figure 4. Location Validation Page Screen

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In Figure 1, it can be seen that there are two fields that must be filled in, namely email and password to log in to the application. On the home page screen (Figure 2), basic information such as profile picture and user name will be displayed. Then the time logged in today, and also the attendance history for the past month. Then if the user wants to create attendance, the user must first perform face validation/face recognition (Figure 3). If the face match percentage is met, then the user can make attendance. After validating the face, the user will then validate the location (Figure 4). If the user is in the radius of the office location adjusted by the admin, then the user can send attendance. But if the user is outside the radius of the office location that has been determined, then the send attendance button will not be pressed.

Then from the admin side, to see a list of users who take attendance in the attendance menu (Figure 5). In this menu, it will be displayed who the users are, and it will be recorded what time they came and what time they left. There is also a record of how long they worked.

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Figure 5. Attendances Menu View

5. DISCUSSION

Attendance systems that use GPS technology are considered reliable. By combining face validation and location validation, this system will ensure that the attendance records created are accurate and secure. Facial recognition eliminates user fraud in taking attendance, which is common in traditional methods. While GPS validation confirms the user's presence at the specified location, so the user must actually be present at the office

location. This two-layer verification has simplified the attendance process, making it more reliable and secure.

This system has successfully reduced the time required for recording attendance compared to manual methods. In addition, real-time data processing through the Laravel backend further accelerates the attendance tracking process, allowing administrators to monitor attendance instantly without manual logging.

6. CONCLUSION

In conclusion, this study successfully integrates facial recognition and GPS technology to enhance attendance management systems in educational institutions, addressing key challenges associated with traditional methods, such as proxy attendance and inefficient data handling. The proposed system employs a two-layer verification process, combining face validation and location validation, which ensures accurate and secure attendance records while minimizing fraud. However, challenges related to data privacy, security, and user acceptance must be carefully considered to ensure effective implementation. This research contributes to the advancement of modern attendance management solutions, highlighting the potential for improved efficiency and responsiveness in educational settings.

7. LIMITATION

A good attendance system has a combination of various modules, where each module performs a different function, and this also requires different requirements. In this system, the performance of the face recognition module is highly dependent on environmental factors, such as lighting and visibility. Stable internet is also needed to get an accurate GPS location. In addition, users who still do not understand how to use technology must also be given tutorials or training in advance to be able to use this attendance system.

8. REFERENCES

Ariansyah, W., Ilham, D. N., Khairuman, K., & Candra, R. A. (2021). Opening doors using Internet of Things (IoT) based face recognition. Brilliance: Research of Artificial Intelligence, 1(2). https://doi.org/10.47709/brilliance.v1i2.1095

- Babatunde, A. N., Oke, A. A., Babatunde, R. S., Ibitoye, O., & Jimoh, E. R. (2022). Mobile based student attendance system using geo-fencing with timing and face recognition. Advances in Multidisciplinary and Scientific Research Journal Publication, 10(1), 75–90. https://doi.org/10.22624/AIMS/MATHS/V10N1P8
- Chavan, A., Wable, S., More, S., Sanap, Y., & Manwatkar, A. (2023). Smart system for attendance based on face recognition. International Research Journal of Modernization in Engineering Technology and Science. https://doi.org/10.56726/irjmets40296
- Chen, X. (2023). Study on student attendance system based on face recognition. Journal of Physics: Conference Series, 2492(1). https://doi.org/10.1088/1742-6596/2492/1/012015
- Dagade, O., Janjire, T., Jagdale, S., & Jawanjal, S. (2023). Face recognition attendance monitoring system. International Journal for Research in Applied Science and Engineering Technology, 11(10), 1598–1601. https://doi.org/10.22214/ijraset.2023.56266
- Gorham, G., Howard, K., Cunningham, J., Lawton, P. D., Ahmed, A. M. S., Barzi, F., & Cass, A. (2022). Dialysis attendance patterns and health care utilisation of Aboriginal patients attending dialysis services in urban, rural and remote locations. BMC Health Services Research, 22(1). https://doi.org/10.1186/s12913-022-07628-9
- Hidayat, M. M., Ramdana, B. K. A., Julianti, A., & Muzzani, A. A. (2023). Development of employee online attendance system using webcams and web-based location (Case study of CV. OTW Computer Gusaha).
- Hosen, M. A., Moz, S. H., Khalid, M. M. H., Kabir, S. S., & Galib, S. M. (2023). Face recognition-based attendance system with anti-spoofing, system alert, and email automation. Radioelectronic and Computer Systems, 2023(2(106)), 119–128. https://doi.org/10.32620/REKS.2023.2.10
- Lee, D. (2020). Bluetooth-based smart attendance system. International Journal of Engineering and Advanced Technology, 9(3), 3851–3854. https://doi.org/10.35940/ijeat.C6280.029320
- Modak, S., Shah, H., Surana, R., & Mishra, D. (2022). A systematic review of attendance systems based on face recognition. https://doi.org/10.36106/paripex
- Najaf, A. R. E., Alexander, J. D., Tarmidzi, K., & Kurnia, F. (2023). Designing a webbased elementary school attendance system using the Laravel framework. RIGGS: Journal of Artificial Intelligence and Digital Business, 1(2), 64–68. https://doi.org/10.31004/riggs.v1i2.116
- Nguyen, V. D., Khoa, H. V., Kieu, T. N., & Huh, E. N. (2022). Internet of Things-based intelligent attendance system: Framework, practice implementation, and application. Electronics (Switzerland, 11(19). https://doi.org/10.3390/electronics11193151

- 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), 193–202. https://doi.org/10.3991/IJIM.V14I05.13311
- Ojo, O. S., Oyediran, M. O., Bamgbade, B. J., Adeniyi, A. E., Ebong, G. N., & Ajagbe, S. A. (2023). Development of an improved convolutional neural network for an automated face-based university attendance system. ParadigmPlus, 4(1), 18–28. https://doi.org/10.55969/paradigmplus.v4n1a2
- Pranoto, H., & Kusumawardani, O. (2021). Real-time triplet loss embedding face recognition for authentication student attendance records system framework. Joiv International Journal on Informatics Visualization, 5(2), 150–155. https://doi.org/10.30630/joiv.5.2.480
- Suhaimin, M. S. M., Hijazi, M. H. A., Kheau, C. S., & On, C. K. (2021). Real-time mask detection and face recognition using eigenfaces and local binary pattern histogram for attendance system. Bulletin of Electrical Engineering and Informatics, 10(2), 1105–1113. https://doi.org/10.11591/EEI.V10I2.2859
- Sumithra, M., Chezhian, P. V., Kumar, K. R., & Kumar, S. N. (2022). Automated attendance system using real-time face recognition and MySQL database. Journal of Cognitive Human-Computer Interaction, 15–18. https://doi.org/10.54216/JCHCI.020102
- Thirukrishna, J. T., Revathi, A. M., Shashank, Y., Pandith, T., & Samarth, N. (2023). Smart attendance system using face recognition. Asian Journal of Engineering and Applied Technology, 12(2), 34–39. https://doi.org/10.51983/ajeat-2023.12.2.3968
- Wayahdi, M. R., & Ruziq, F. (2024). Designing a used goods donation system to reduce waste accumulation using the WASPAS method. Sinkron, 8(4), 2325–2334. https://doi.org/10.33395/sinkron.v8i4.14115
- Wayahdi, M. R., Ginting, S. H. N., & Syahputra, D. (2021). Greedy, A-Star, and Dijkstra's algorithms in finding shortest path. International Journal of Advances in Data and Information Systems, 2(1), 45–52. https://doi.org/10.25008/ijadis.v2i1.1206
- Wayahdi, M. R., Ruziq, F., & Ginting, S. H. N. (2024). AI approach to predict student performance (Case study: Battuta University). Journal of Science and Social Research.