Bubungan Tinggi: Jurnal Pengabdian Masyarakat
http://ppjp.ulm.ac.id/journals/index.php/btj/index
e-ISSN: 2722-3043 p-ISSN: 2722-2934
Vol 7 No 2 2025
DOI: https://doi.org/10.20527/btjpm.v7i2.13885

Implementation of Smart Record System Based on Face Detection for Teacher Attendance Recording and Reporting Based on IoT

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Article Info

Article history:
Received: October 29, 2024
Accepted: January 14, 2025
Published: March 18, 2025

Keywords:
Attendance system
Community service
Data protection
Face detection
IoT
School management

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Abstract

Teachers and staff at Sekolah Alam Indonesia (SAI) Cibinong have been using a manual attendance system, which has caused delays in attendance recapitulation and inefficiencies in reporting and monitoring. To address this problem, the Participatory Action Research (PAR) method was adopted, emphasizing active involvement from the school community in every stage of the program. The PAR method was chosen because it fosters a collaborative approach, ensuring that the solution is tailored to the specific needs and context of the school. The Smart Record System, an automated Internet of Things system that uses facial detection technology for precise attendance recording and reporting, was introduced by the community service program to address this problem. To increase participants' understanding of data security, this program offered a seminar on Personal Data Protection in social media and system implementation. To guarantee efficient use of the technology, the methodology included system installation, integration with IoT components, and training sessions. After providing participants with practical system operation experience, system assessments and feedback gathering were conducted to gauge the implementation's efficacy. The outcomes demonstrated how the smart attendance system, which offered real-time attendance data and prompt reporting, greatly simplified the attendance management procedure. Based on the questionnaire responses, the system achieved an average user satisfaction score of 3.86 out of 5, reflecting a 77.2% positive agreement among users. Furthermore, the reliability of the questionnaire, measured by Cronbach's Alpha, was 0.85, indicating a high level of consistency in the responses. These quantitative findings confirm that the system significantly improved the efficiency of attendance management while being well-received by teachers and staff.

To cite this article: Hermawan, I., Yulianti, S. D., Murad, F. A., Setianto, B. D., Azhar, R. M. F., & Sutama, M. I. (2025). Implementation of smart record system based on face detection for teacher attendance recording and reporting based on iot. *Bubungan Tinggi: Jurnal Pengabdian Masyarakat*, *7*(2), 381-392.

INTRODUCTION

Accurate attendance records are essential in the education field, and the emergence of facial recognition technology offers a promising solution for automated student attendance

tracking (Rusdi et al., 2020). This paper presents the implementation of a smart record system that utilizes face detection and IoT technology to streamline teacher attendance recording and reporting.

The application of IoT in attendance management systems has been demonstrated through various studies. For instance, (El Mrabet and Moussa, 2020) discuss an IoT-based school attendance system that employs Radio Frequency Identification (RFID) technology to efficiently monitor student attendance without disrupting the learning process. This system minimizes the dropout rate and enhances the overall classroom experience by allowing educators to focus on teaching rather than administrative tasks. Similarly, the work by Velasco (Velasco, 2023) emphasizes the importance of user-friendly interfaces in attendance management, highlighting how IoT solutions can facilitate recording attendance and classroom entry logs while providing valuable data for future educational reference.

The proposed system aims to address the challenges associated with manual attendance-taking, such as errors, time-consuming procedures, and the potential for proxy attendance (Reddy et al., 2019).

Educational institutions are embracing technology more and more in the age of digital transformation to boost service delivery and administrative effectiveness. Attendance management is an essential component of school operations that directly impacts accountability and performance monitoring. Sekolah Alam Indonesia (SAI) Cibinong is one of several schools that still use manual attendance techniques. Decision-making procedures may be hampered by this method's human error risk, time commitment, and delays in producing attendance recapitulation reports.

The Smart Record System was implemented as a component of a community service initiative to solve these issues. This system uses Internet of Things (IoT)- enabled face detection technology to automate attendance reporting and recording. IoT makes real-time data collecting, processing, and remote access possible, improving the accuracy and efficiency of attendance management.

The program includes a session on personal data protection in social media and system implementation to raise staff and teacher awareness and digital literacy. Knowing how to safeguard personal information is essential for maintaining security and privacy in both personal and professional settings as technology in education grows.

The objectives of this community service are twofold: (1) to implement an automated attendance system that improves the effectiveness of attendance monitoring and reporting, as evidenced by a minimum of 95% accuracy in attendance recording, a 50% reduction in reporting time compared to manual methods, the generation of real-time reports that meet user requirements, and at least 80% user satisfaction based on feedback surveys; and (2) To educate participants on the importance of data protection in today’s digital age, as demonstrated by at least 80% of participants achieving improved understanding based on pre-test and post-test results, the ability to identify key data security risks relevant to their environment, the commitment to adopt data protection policies, and the availability of educational materials and guidelines for continued learning and application.

The program was designed using a participatory approach, involving teachers and staff in training sessions and system evaluations to ensure the solution's sustainability.

Recent studies have highlighted the advantages of integrating facial recognition technology into attendance systems. For instance, et al. emphasize that smart attendance automation systems can significantly improve accuracy, save time, and provide real-time updates, enhancing security and operational efficiency (Shamila et al., 2023). Furthermore, using machine learning algorithms in facial recognition systems allows for the precise identification of individuals, facilitating the generation of detailed attendance reports and

analytics that can inform administrative decisions (Mishra, 2023). This capability aligns with the growing trend toward smart education, where technology is harnessed to streamline administrative processes and improve educational outcomes (Badshah et al., 2023).

Moreover, integrating IoT technologies into attendance systems allows for seamless data transmission and real-time monitoring. et al. demonstrate how applying LoRa technology can address the challenges of large-scale attendance monitoring, ensuring effective data collection even in expansive environments (Noprianto et al., 2023). Similarly, Bluetooth Low Energy (BLE) technology in attendance systems has been explored, showcasing its potential to minimize operational costs while maintaining high accuracy in attendance tracking (Puckdeevongs et al., 2020). These technological advancements enhance the functionality of attendance systems and contribute to the broader goal of creating smart campuses that leverage interconnected devices for improved educational experiences (Sneesl et al., 2022).

In conclusion, implementing a Smart Record System based on face detection for teacher attendance recording and reporting is a timely response to the limitations of traditional attendance methods. By utilizing advanced technologies such as facial recognition and IoT, educational institutions can achieve greater accuracy, efficiency, and security in attendance management. This initiative not only aligns with current trends in smart education but also sets the foundation for future innovations in educational administration. To further enhance its impact, it is recommended to integrate predictive analytics into the system, enabling administrators to identify patterns in attendance and predict potential issues such as absenteeism. Additionally, incorporating mobile app integration could provide teachers and parents real-time updates on attendance and other relevant metrics, fostering better communication and engagement.

Based on the background of the problem mentioned above, the problem statements for this community service program are as follows: (1) How effectively is the Smart Record System improving Sekolah Alam Indonesia (SAI) Cibinong attendance management?, (2) To what extent are teachers and staff satisfied with implementing the Smart Record System?, and (3) How well do the seminar participants understand the importance of personal data protection after the training?

METHODS

In this work, we developed an IoT-based attendance recording system using the Participatory Action Research (PAR) methodology. PAR was chosen because it can involve all parties involved in the development process, including students, instructors, and school officials. This strategy is to develop a technical solution that meets users' needs in the field (Aliffianti & Dea, 2023; Rahmat & Mirnawati, 2020).

The community service program utilized the Participatory Action Research (PAR) method to implement a Smart Record System based on face detection for teacher attendance recording and reporting at SAI Cibinong, at Jl. Raya Cikaret No. 47, Harapan Jaya, Kec. Cibinong, Bogor Regency, West Java.

The methodology for this initiative was structured into several key phases, each designed to ensure effective community engagement and the successful deployment of the system in an educational setting.

1. **Requirement Analysis and Community Engagement:**
   This phase involved surveys and focus group discussions with stakeholders, including teachers, staff, and administrators, to gather specific requirements. Key performance indicators were identified to measure the system's success.
2. **System Design and Development:**

The system was designed using a modular approach, integrating an IoT-based face detection device with a web-based application interface. The face detection system employed the Haar Cascade Classifier algorithm for real-time face recognition, running on Raspberry Pi hardware for edge computing. The web application was developed using PHP with a Postgres SQL database for the back end.

3. **Hardware Deployment and Integration:**
   The IoT device was equipped with a camera module for face detection and a Wi-Fi module to transmit data to the server. The system was tested to ensure seamless integration with the school's network infrastructure and compliance with data privacy standards.
4. **Testing and Training:**
   A pilot test was conducted in a controlled environment to evaluate system performance. Teachers and staff were provided training on using the system effectively, including managing attendance data and generating reports.
5. **Deployment and Monitoring:**
   The system was deployed in the school, and its performance was monitored over several weeks. Feedback from users was collected to address any technical or usability issues and refine the system further.

The stages in community service are shown in Figure 1.

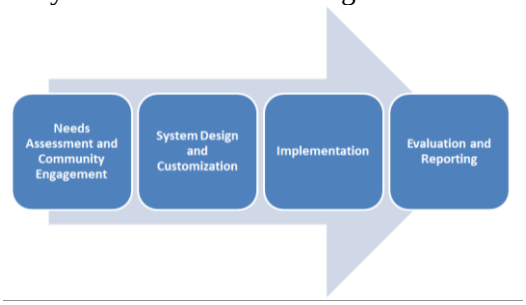

Figure 1 Diagram of the community service activity process

From Figure 1, the steps involved were as follows:

1. **Needs Assessment and Community Engagement:**
   The initial phase involved conducting a needs assessment to identify the specific challenges faced by the educational institution regarding teacher attendance management. Meetings and discussions were held with school administrators, teachers, and other stakeholders at SAI Cibinong to gather insights and ensure that the proposed solution would effectively address their needs.
2. **System Design and Customization:**
   - Based on the needs assessment, the system architecture was designed, integrating IoT-enabled cameras for capturing teachers' images, a face detection algorithm for identity verification, and a cloud-based server for data storage and reporting.
   - The system was customized to meet the school's specific requirements, including adjustments to the user interface, report formats, and data privacy considerations. This involved the development of an **IoT-based device** for real-time face detection and attendance tracking, seamlessly integrated with a **web-based application interface**. The IoT device was designed to capture and process attendance data and transmit it to the web application for further analysis and reporting. The web interface was tailored to allow easy access for administrators and teachers to manage attendance records, generate customized reports, and ensure compliance with data privacy standards. This comprehensive approach

ensured that the system effectively addressed the school's operational needs while maintaining user-friendliness and security.

3. **Implementation:**
   - The Smart Record System was piloted at SAI Cibinong for a designated period. During this time, the system's performance was closely monitored, and feedback was collected from users, including teachers, administrators, and students.
   - Feedback was used to make necessary adjustments to the system, improving its functionality and user experience.
   - Recognizing the importance of data security in systems that handle sensitive information, a dedicated seminar on data security was organized as part of the methodology. This seminar covered key topics such as the importance of data protection, best practices for maintaining the security of the face recognition system, and compliance with relevant data privacy regulations.
   - The seminar was targeted at school administrators, IT staff, and any personnel involved in handling the system's data. It aimed to equip them with the knowledge and skills needed to safeguard the system against potential security threats and ensure the privacy of teacher data.
4. **Evaluation and Reporting:**
   - The system's effectiveness was evaluated based on key performance indicators, such as attendance record accuracy, time efficiency, data security, and user satisfaction. These metrics were compared to the pre-implementation situation to assess the system's overall impact.
   - A detailed report summarizing the community service program's outcomes, including the effectiveness of the data security measures, lessons learned, and recommendations for similar initiatives in other educational settings, was prepared.
   - The following is a draft of the questionnaire questions to assess the seminar participants' satisfaction level indicated in Table 1.

Table 1 List of questions

No	question
1	The seminar material was delivered clearly and easily understood.
2	The resource person is competent and has mastered the topic of personal data security.
3	The seminar provided new knowledge about risks in social media.
4	The explanation regarding how to protect personal data is very useful.
5	The time provided for the seminar is sufficient and proportional.
6	Presentation of material using interesting presentation media.
7	The resource person responded well to participants' questions.
8	The committee organized the event well and professionally.
9	Information regarding the seminar was conveyed clearly before the event.
10	This seminar encouraged me to be more careful in using social media.
11	I feel more prepared to safeguard my data after attending this seminar.
12	The seminar atmosphere supports concentration and effective learning.
13	I am satisfied with the facilities provided during the seminar.
14	The duration of each session is neither too long nor too short.
15	The material discussed is relevant to my needs.
16	I would recommend this seminar to others.
17	The resource person provides concrete examples that are relevant to everyday life.

No	question
18	This seminar provides practical solutions to maintain data security.
19	I gained new insights into privacy policies on digital platforms.
20	Overall, I am satisfied with the organization of this seminar.

RESULTS AND DISCUSSION

1. Needs Assessment and Community Engagement

The implementation of this community service activity began with a meeting between a team of lecturers from the Jakarta State Polytechnic's Multimedia Network Engineering study program and the SAI Cibinong. From the meeting, it was found that SAI Cibinong needed a system to manage teacher and staff attendance data. The current system still uses a conventional system, so recapitulation takes time. Based on this needs analysis, a solution was proposed: creating an IoT-based attendance system using face detection.

2. System Design and Customization

At this stage, based on the needs analysis obtained in the previous stage, the needs for creating a smart attendance system based on facial recognition are designed. They are defined starting from functional and non-functional needs.

We continued with implementation in the form of a prototype. After the device is made, it is integrated with a website-based system, and system integration and system functionality testing are carried out. Figures 2 shows the device used to create an IoT-based smart record system.

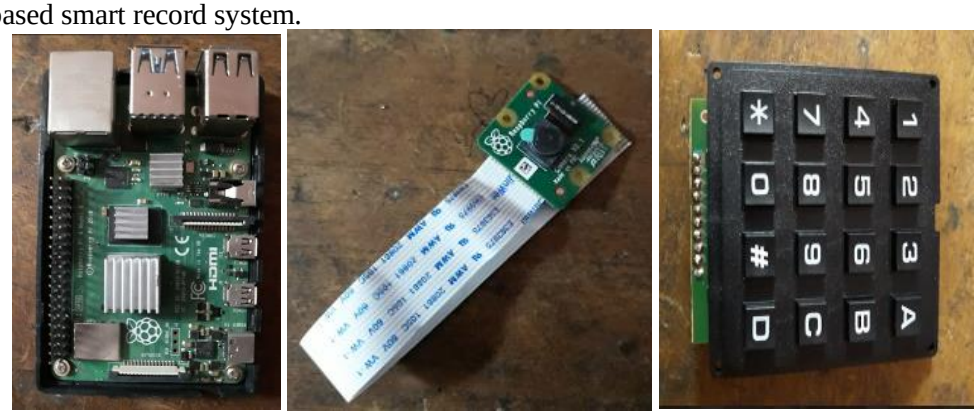

Figure 2 The device used to create an IoT-based smart record system

3. Implementation

After the tool's design and testing were completed, teachers and staff at SAI Cibinong were socialized to use the smart record system. In addition to socialization, a seminar on the importance of maintaining data security was also held. This stage was carried out on Wednesday, August 28, 2024. At this stage, the participants were very enthusiastic about listening to what the community service team from PNJ conveyed and the presentation of material from the speakers. The following is documentation on the implementation of socialization and seminars of community service activities at SAI Cibonong (see Figure 3).

Figure 5 The implementation of socialization and seminars of community service activities at SAI Cibonong

4. Evaluation and Reporting

Evaluation is the process of identifying the implementation of a program by measuring or assessing the plan and implementation with the desired objectives (Saraswati, 2020). Evaluation is carried out by looking at the final results of the program that has been implemented and then comparing them with the results that should have been achieved as the program's initial goal. During a program, evaluation is used as a process of assessment and re-examination, which is useful for assessing and improving the program so that it is in accordance with the initial plan. This community service activity was evaluated using a questionnaire to obtain opinions from respondents (Pujihastuti, 2010). The questionnaire used the Likert method, with answer choices representing each attitude (Chomeya, 2010). The questionnaire measured the interest of teachers and staff at SAI Cibinong using a smart system record, program benefits, and longing for the community service program.

Table 2 shows the results of the questionnaires completed by teachers and staff who participated in the seminar on Personal Data Protection in Social Media Use.

Table 2 The results of the questionnaire

Respondent	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
R1	4	4	4	4	4	4	4	4	4	4
R2	4	4	4	4	2	4	4	4	4	4
R3	4	4	4	4	4	4	4	4	4	4
R4	4	4	4	5	4	4	4	4	4	5
R5	4	4	4	4	3	4	4	4	4	4
R6	4	5	5	5	4	4	4	3	2	4
R7	4	4	4	4	4	4	4	4	4	4
R8	5	5	4	5	4	4	4	4	4	4
R9	4	4	4	4	4	4	5	4	3	5
R10	4	4	4	3	3	3	4	4	3	3
R11	4	4	4	4	3	3	3	4	4	3
R12	3	4	4	4	3	3	4	4	4	4
R13	4	4	4	4	4	3	4	4	4	4
R14	4	4	4	4	3	3	4	4	4	4
R15	4	4	4	4	2	3	4	4	3	4
R16	4	4	5	4	4	4	4	4	4	4
R17	5	5	5	5	4	4	4	4	3	5

Respondent	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
R18	4	1	4	5	4	4	4	4	4	5
R19	4	4	4	4	4	4	4	4	4	4
R20	4	4	4	4	4	4	4	4	4	4
R21	4	4	3	4	3	4	3	2	3	3
Average	4.05	4.00	4.10	4.19	3.52	3.71	3.95	3.86	3.67	4.05
Respondent	**P11**	**P12**	**P13**	**P14**	**P15**	**P16**	**P17**	**P18**	**P19**	**P20**
R1	4	4	4	4	4	4	4	4	4	4
R2	4	2	4	2	4	3	4	4	4	4
R3	4	4	4	4	4	3	4	4	4	4
R4	4	4	4	4	3	3	4	4	4	4
R5	4	4	4	3	4	4	4	4	4	4
R6	4	2	4	4	3	4	4	4	4	4
R7	4	4	4	4	4	3	4	4	4	4
R8	4	4	4	4	4	4	5	4	5	4
R9	5	5	4	4	4	3	4	4	4	4
R10	3	3	3	3	3	3	4	3	3	3
R11	4	4	3	4	4	3	3	3	4	4
R12	4	4	4	4	4	3	4	4	4	3
R13	4	4	4	3	4	4	4	4	4	4
R14	4	3	4	3	4	4	4	4	4	4
R15	4	3	4	3	4	4	4	4	4	4
R16	4	4	4	4	4	4	4	4	4	4
R17	4	4	3	3	4	3	4	5	4	4
R18	5	5	4	4	4	5	4	5	4	4
R19	4	4	4	4	4	4	4	4	4	4
R20	4	4	4	4	3	3	4	4	4	4
R21	3	3	3	3	3	3	3	3	3	3
Average	4.00	3.71	3.81	3.57	3.76	3.52	3.95	3.95	3.95	3.86

The questionnaire results show an average score of 3.86, indicating that respondents generally provided positive or favorable responses, leaning toward agreement with the statements provided.

Additionally, **Cronbach's Alpha** value of **0.85** demonstrates a high level of reliability, meaning that the questionnaire is consistent and the responses are dependable. A value above 0.7 suggests that the set of questions used in the survey reliably measures the intended constructs.

The average score is 3.86 on a scale of 1 to 5. This translates to 77.2% agreement, indicating that most respondents responded favorably. The positive response (77.2%) shows that the participants understand and agree with the seminar topics. These findings indicate that the seminar on Personal Data Protection in Social Media Use was well-received.

Figure 8 shows the graph of the average scores from the questionnaire completed by the respondents.

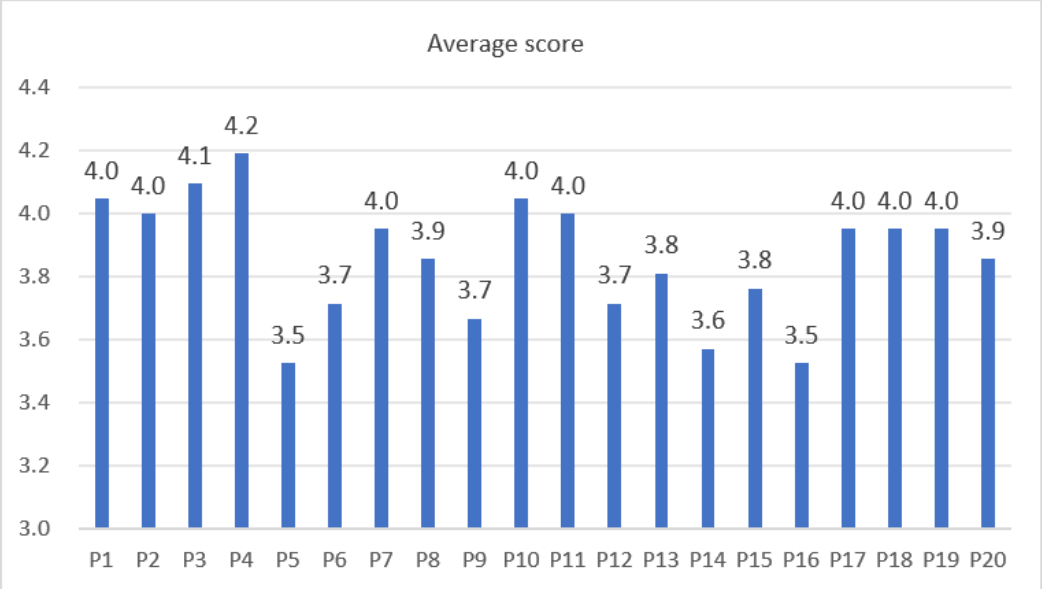

Figure 8 Graph of average community satisfaction scores

CONCLUSION

Implementing the Smart Record System based on face detection has successfully addressed the issue of delayed attendance recapitulation at SAI Cibinong. A questionnaire was distributed to teachers and staff to evaluate the system's effectiveness and user satisfaction. The analysis of the responses revealed an average score of 3.86 out of 5, indicating 77.2% agreement, which reflects a generally positive perception of the system. Furthermore, the reliability of the questionnaire, measured by Cronbach's Alpha, was 0.85, demonstrating a high level of internal consistency and reliability in the responses. These results confirm that the Smart Record System is effective and well-received by its users. The transition from manual attendance recording to an IoT-based automated system has streamlined attendance management, providing real-time data and timely reporting. This new system has enhanced the efficiency of school administration and improved the accuracy of attendance records.

In addition to system implementation, the seminar on Personal Data Protection in social media enriched participants' knowledge about safeguarding personal information in the digital age. This aspect of the program further emphasized the importance of digital literacy and responsible technology use among educators.

The evaluation results, gathered through questionnaires distributed to teachers and staff, demonstrate high satisfaction with the seminar and the new attendance system. Based on the responses from 21 participants across 20 questions, the average score was 3.86 out of 5, indicating that most respondents agreed or had a positive perception of the seminar content and system implementation. This translates to 77.2% of the maximum possible score, reflecting a positive attitude toward the program.

Similar technology-driven projects should be investigated in other educational contexts in the future to promote creativity and appropriate technology use. Further streamlining processes and establishing a smooth digital environment would be achieved by developing and integrating the recently deployed system with other current systems inside the organization, such as academic management, student attendance, or library management

systems. In addition to increasing efficiency, this integrated strategy would offer a thorough platform to facilitate improved decision-making and overall institutional performance.

CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest.

AUTHOR CONTRIBUTIONS STATEMENT

SDY wrote the draft article with input from all authors. IH and FAM designed the methods and directed the project; BDS, RMF, and MIS carried out experiments or community service.

ACKNOWLEDGMENTS

The author would like to thank the informatics and computer engineering department of Jakarta State Polytechnic for its assistance and support in completing this community service. The author would also like to thank Sekolah Alam Indonesia (SAI) Cibinong for permitting this activity, who has agreed to participate.

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