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A Conceptual Framework for Automated Monitoring of Attendance

Aakash Kumar Mishra[1], Anu Tonk[1]*, Vandana Khanna[1], Lokesh Choudhary[1], Bharti[2]

[1]Department of Multidisciplinary Engineering, The NorthCap University, Gurugram, Haryana, India

[2]Department of Electronics & Communications Engineering, Government Polytechnic, Hisar, Haryana, India

*anutonk@ncuindia.edu

Abstract— The existing method of taking attendance on paper is not only time-consuming, but also requires significant effort on the part of the trainer. Therefore, this research aims to explore the potential of leveraging facial recognition technology and the location of students' registered mobile devices within the classroom setting to effectively monitor student attendance. By incorporating biometric facial recognition and location tracking, a robust platform for attendance tracking can be established. The image recognition-based system offers the advantage of being applicable to any classroom environment with minimal setup and maintenance costs. Furthermore, it provides a convenient solution as students can effortlessly register their attendance using their mobile devices. Ultimately, such systems provide a dependable and secure platform for monitoring attendance, alleviating the burden on trainers by reducing their time and effort expenditure.

Keywords— *Monitoring Attendance, Student Attendance, Face Recognition, Biometric.*

I. Introduction

The amount of time instructors and staff spend monitoring students' attendance is one of the most pressing concerns that educational institutions face today. Schools and colleges have used technological innovation to improve their Attendance Monitoring System. Universities have benefited from improved IT infrastructure in tracking attendance, reducing administrative labor, and increasing delivery of the talk.

Parents, staff, students, and the general public are depending more and more on IT infrastructure, and they are no longer relying on information from schools and institutions on their children's attendance. Regardless of their location, they may access the database with a simple click. The security of these systems is essential for preventing fraud by unauthorized users. Systems for tracking students' attendance have all been technologically upgraded to correctly track students and, as a consequence, save the time spent manually collecting students' attendance [1].

In schools, colleges, and universities, verifying attendance has become a difficult chore. Paper attendance takes time and involves a lot of effort on the part of the trainer. To solve this issue, numerous educational institutions have established online attendance monitoring systems. However, these methods still need a significant amount of time and effort. The work focuses on using sophisticated technology in classrooms to track student attendance, such as face recognition software and the whereabouts of registered mobile devices. Attendance tracking is made more reliable by biometric facial recognition and location tracking. This method is lucrative, sustainable and dependable. It eliminates the need for the instructor to manually record attendance, saving time and effort. Furthermore, it is a secure method since the student must be physically present in the classroom and have their face recognized for their presence to be recorded. This system may be used in any classroom and requires very little setup and maintenance. It is also a convenient approach since students may readily record their attendance using mobile devices. This paper demonstrates how face recognition time attendance systems can help educational institutions automate time attendance systems more cost-effectively by eliminating administrative responsibilities. Three distinct models are suggested, each with its own set of costs. In summary, the given framework provides a dependable and secure platform for tracking attendance while decreasing the instructor's time and effort.

II. Literature Review

For many years, all academic institutions employed the manual attendance method to track student attendance. It is undeniably a time-consuming process that may result in blunders when marking. However, times have changed, and technology now dominates all types of businesses, including educational institutions. As a result, a more precise and effective system of tracking student attendance has been developed. According to Rjeib et al. [2], student attendance is an essential factor that indicates academic progress. As a result, it is critical to build robust IT systems capable of tracking and monitoring student attendance in a cost-effective and timely way. There are several automatic attendance tracking solutions accessible that are time-saving and technologically advanced. Additionally, Mustapha et al. [3] highlighted the difficulties associated with manual attendance management and insufficient record-keeping. Consequently, they proposed the adoption of an IT infrastructure that utilizes RFID card readers, enabling students to register themselves upon entering the classroom. This approach aims to minimize errors and streamline the attendance process. Oyetola et al. [4] has highlighted that data authentication is a crucial component of attendance monitoring and that it is highly important to secure such system from threats. Further, Arlugon et al. [5] claimed that by using bar codes, RFID, QR codes, NFC, etc. to track student attendance, time can be saved. School administrators can utilize this data to make management choices. The importance of RFID technology in permitting wireless identification through the use of appropriate readers has also been discussed in the paper.

Opoku [6] has demonstrated a biometric system-based project that used technology to integrate time and biometrics with attendance verification. Hussain et al. [7] discussed the purpose of attendance tracking and how it connects to human attendance maintenance faults the next year. They established an RFID-based web-based attendance management system that enables users to check their attendance. Each student is given a distinct RFID card or tag as part of the test hall management system. The card reader assists workers by creating a seat number, which is immediately shown on the LCD, ensuring that the exam goes smoothly and keeping track of attendance.

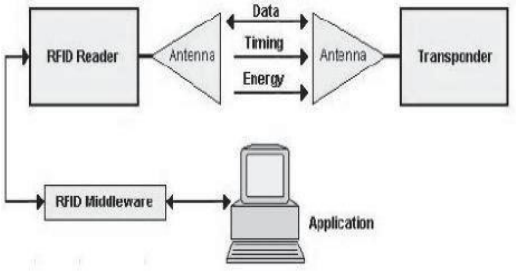

Fig. 1. Components of an RFID system [10]

RFID technology in education, according to Irawan et al. [9], creates real-time attendance while detecting absentees, so that management may take the necessary steps to improve the efficiency of the learning process. In order to prevent kids from skipping classes, this will allow parents, instructors, and students to obtain real-time information and take preventative measures, as well as make the teaching learning process go more smoothly. Fig. 1 displays an RFID system and its components. RFID middleware is required for computer systems to communicate with RFID data. RFID readers obtain information from transponders, which function as both a receiver and a transmitter. RFID has also been discussed by Chiagozie et al. [10] as a mature technology suited to automate activities. RFID has developed quickly in recent years, and it has the potential to improve system efficacy when combined with IoT. Later, Nyugen et al. [11] also suggested that RFID and IoT would improve attendance monitoring to fulfil the demands of educational institutions due to today's rising requirement for data quality and efficiency.

These days, smartphone-based applications that automate the manual attendance process are also being used for tracking attendance and saving time and resources [12]. The instructor can control every

aspect of the mobile application, ensuring the correctness of the records providing a more accurate record of student attendance. One aspect of this approach the instructor has the. This allows the user to fix any error they may have made when recording attendance. It is a simple and affordable way to keep daily records. These applications offer numerous features and possibilities including the provision for calculating the percentage of total attendance for each student. Students can also keep track of their attendance and receive frequent updates. The Mobile Based Attendance System (MBAS) smart phone application can run on Android or iOS. MBAS uses smartphones to track and record student attendance [13]. The now-available phone application requires login ID to be entered before it can collect attendance and connect to the server. These phone records are sent to the servers through GPRS and the attendance is instantly updated. This is a computerized attendance system that promotes sustainability, by saving paper and time [14]. To keep track of attendance, there is no need for a manual logbook or record book. Information is reachable from everywhere, 24 hours a day, 7 days a week. It facilitates the generation of student attendance sheets, which can include all of the student's information such as roll number, name, time present/absent, and so on. It is a secure attendance approach rather than a regular one, as well as a future education effort.

The face detection/recognition attendance systems discussed in [15-16] are simple to use and aid in the retention of attendance data. It functions as a kind of biometric system that stores the children's distinctive and varied face traits as stencils in the system database. The student must gaze at the camera once the system has completed registering him or her so that the camera can detect the student's face and properly update the attendance system. This method results in error-free attendance records 95% of the time. This method is also eco-friendly because no paper or time is wasted. It eliminates human mistakes, is accurate and automated, and promotes security. Lecturers receive monthly reports, and attendance is simply estimated.

III. Advantages of the proposed face recognition Model

The proposed model in our research provides a comprehensive framework for attendance marking and monitoring systems and aids in the resolution of the following objectives:

Automation: This approach aids in the automation of the entire process, lowering the price and time needed to finish attendance monitoring on schedule.

Security: In the end, the system produces a more secure and dependable platform for tracking attendance since it is totally automated and makes use of three different technologies for identification and authorization.

Centralization: Centralizing the whole thing can improve control and make implementation easier.

The following are a few considerations that should be made during/before implementation.

Cost: This system incurs costs during implementation; therefore, while adopting this model, all the alternatives must be thoroughly evaluated in terms of price and performance, as well as their aim. If all choices are used together, it may be more expensive than the set objectives.

Skill: The institution/university will also need the strong support of a trained IT staff to handle all of this attendance monitoring system setup, but this will not be difficult.

Because everything is based on software, the majority of the items in this suggested paradigm are readily controllable.

Anonymity: This suggested model's intrinsic anonymity provides an appropriate platform for securing student identification, it must be preserved confidential.

IV. Design of proposed model for attendance monitoring

A structure for an automated student attendance tracking and marking system is proposed in our paper. It uses facial recognition technology to drastically minimize the time and effort necessary for routine attendance taking in each class. Our suggested system (Fig. 2) captures facial pictures with a camera and uses the Haar-Cascade and Local Pattern Binary Histogram (LPBH) algorithms for face

identification and recognition.

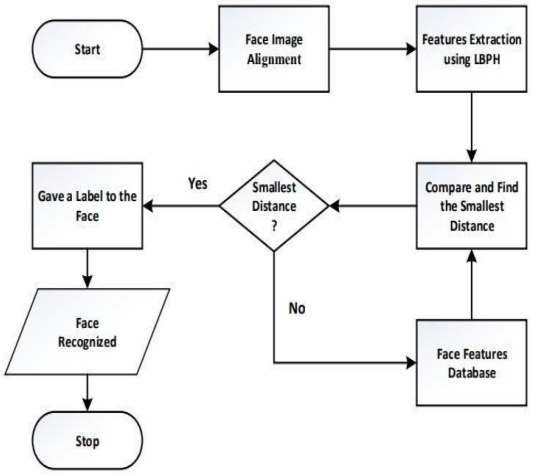

Fig. 2. Face alignment and feature extraction

As students enter the classroom, the technology captures their facial images and compares them to the pictures in the database. Because it is more accurate and resilient against shifting lighting conditions, position, and facial emotions, the LPBH algorithm is utilized for face recognition. In addition, the system records the student's mobile device with the campus network, which may be recognized by adjacent access points (router log). This adds another layer of verification to the student's attendance.

It eliminates the need for manual attendance taking and marking for tutors, saving time and effort. Second, by ensuring that only registered students are present in class, it reduces the risk of attendance fraud. Third, it provides real-time attendance tracking, which allows teachers to keep track of students who are absent or tardy. Overall, our suggested framework provides a cost-effective and efficient approach for tracking student attendance with facial recognition technology.

V. Methodology

To implement image detection and recognition for student attendance monitoring, techniques such as Haar Transform and Local Binary Patterns Histograms (LBPH) have been used. Following are the steps involved in the training algorithm:

1. Data Collection: Gather a dataset of images containing students' faces for training. Ensure that the dataset represents a diverse range of students with various poses, expressions, and lighting conditions.

2. Preprocessing: Preprocess the images to enhance the quality and make them suitable for further analysis. Common preprocessing steps include resizing the images to a fixed size, converting them to grayscale, and normalizing the pixel values.

3. Face Detection: Use the Haar Transform-based face detection algorithm to detect faces in the images. The Haar Cascade Classifier is a popular choice for this task. It works by identifying specific features in the image, such as edges, corners, and lines, to locate potential face regions. Haar-like features are rectangular patterns of adjacent pixel groups that capture relative light and dark areas in an image. These features can be easily scaled to detect objects of various sizes. To detect specific objects, such as human faces, the Haar cascade classifier is trained using the gentle AdaBoost algorithm and Haar feature algorithms. During training, positive samples (images containing faces) and negative samples (images without faces) are used to create a strong classifier that can distinguish between faces and non-faces.

The trained Haar cascade classifier consists of multiple stages, each containing a set of weak classifiers. The cascading technique allows the classifier to quickly reject sub-images that are unlikely to contain the object of interest, thereby reducing the computational load. Sub-images that

pass each stage's threshold are further analyzed by subsequent stages, increasing the accuracy of detection. To improve the recognition accuracy, align the detected faces to a standardized pose. Techniques like landmark detection can be used to locate facial landmarks (e.g., eyes, nose, and mouth), and then apply transformation techniques to normalize the face. When a face is detected, a green square or bounding box is drawn around the detected face, indicating the progress of the detection process.

4. Feature Extraction: Apply the LBPH operator on the aligned face images to extract discriminative features. LBPH captures local texture patterns by comparing the intensity values of pixels in a circular neighborhood around each pixel. This generates a histogram representation for each face image.

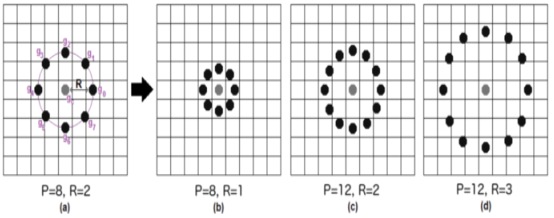

Fig.3 Radius of central pixel

5. Labeling: Assign a unique label to each face image in the dataset to identify the corresponding student.

6. Applying face recognition: Each histogram produced reflects a single image from the training dataset, ensuring that it is accurately represented. To generate a histogram that accurately represents a new image, we repeat the process by using the input image as the input for histogram generating photo.

- To decide which image corresponds to the input image, we simply compare two histograms and return the image with the closest histogram.

- To compare histograms and calculate the dissimilarity between them, various techniques can be utilized such as Euclidean distance, chi-square, absolute value etc.

- In our case we have employed the widely recognized Euclidean distance method based on the following calculation:

$$D = \sqrt{\sum_{i=1}^{n}(hist1_i - hist2_i)^2}$$

- As a result, the programme returns the image ID corresponding to the histogram that is closest. Furthermore, the process should return the determined distance so that 'confidence' may be calculated. Lower confidences are preferred since they suggest a tighter gap between the two histograms; do not be fooled by the word "confidence."

- Following that, we can use a threshold and "confidence" to make a judgment. We can determine whether the image was accurately recognized when the algorithm has completed its recognition procedure. If the confidence level falls below a specified threshold, it can be inferred that the algorithm has successfully identified the object.

7. Training: Use a machine learning algorithm to train a model using the labeled face images and their corresponding LBPH feature histograms. This step involves feeding the extracted features into the chosen classifier and optimizing its parameters using a training procedure. Because we're trying to figure out how many times each pixel intensity appears in a grayscale image, each grid's histogram includes 256 bins ranging from 0 to 255. Each histogram represents a single image from the training dataset. As a result, in response to an input image, we repeat the operation for this new picture, resulting in an image represented by a histogram that can be compared to other histograms. By comparing histograms, we may find the image that most closely reflects the input image. Using a threshold and the "confidence" number, the algorithm's accuracy in detecting the image may then be determined.

8. Once the model is trained and validated, you can apply it to new images to recognize faces and monitor attendance. For each input image, perform face detection, alignment, and feature extraction. Then, feed the features into the trained model to predict the identity of the detected face. Track the attendance of students based on their recognized identities.

The face recognition attendance system gets student information using an image matching algorithm. However, the system may be unable to match the image due to changes in the student's face, such as: B. Cuts, sores, pimples, or if the child is missing their RFID-enabled ID card or registered cell phone. In such circumstances, the system collects data from the student through different means, such as an RFID card, Ethernet protocol, or another suitable way. The technology monitors student attendance and reports the data to the teacher. The information is then verified by the teacher, and the final attendance record is updated and permanently kept in the attendance database.

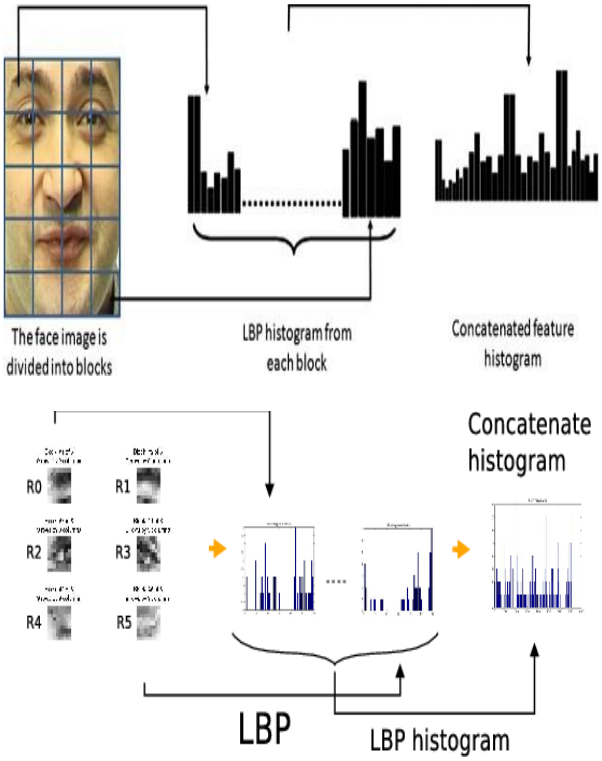

Fig.4. Extracting image from LBP Histogram

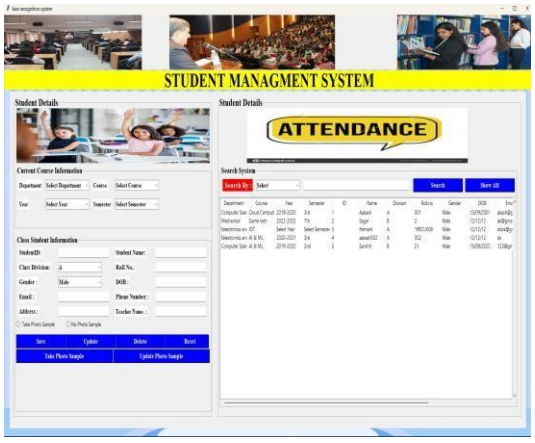

Fig.5 Student dashboard output

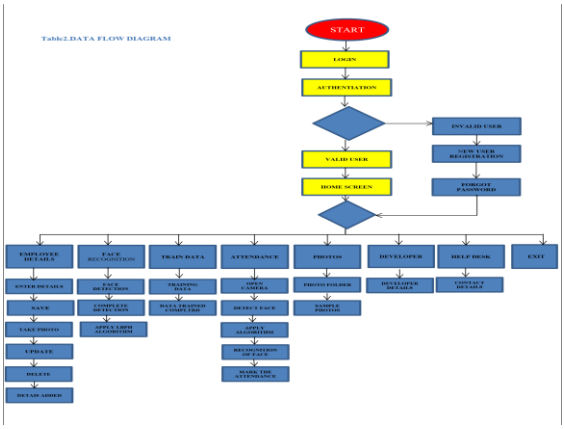

Fig. 6. Data Flow Diagram

Table 1: Attendance monitoring systems reported in the literatur

Author(s)& Year	Technology	Sector	Main Findings
Patel et al. 2012	RFID	Academic	A real-time intelligent method for monitoring student attendance was proposed [17].
Singhal, & Gujral, 201	RFID	Academic	Implemented a GSM cellular network-based SMS technique for BF remote monitoring attendance [18].
Saparkhojayev & Gaverein,20	RFID	Academic	Presented an RFID-based attendance system at Kazakhstan's Suleyman Demirel University [19].
Benyo et al., 2012	NFC	Academic	Introduced and created a self-contained student attendance system using NFC [20].
Chiagozie, & Nwaji, 2012	RFID	Academic & Organization	Proposed an RFID-based door unit for a time-attendance control system [21].
Talaviya et al., 2013	Fingerprint-Zigbee	Academic	A mobile attendance system was created to precisely track and record student attendance in classes using fingerprint technology and a GSM network. Additionally, the system facilitates the transfer of attendance records to parents via a GSM-based mobile network [22].
Behara & Raghunadh, 2013	Face recognition	Organization	Proposed an automated system for managing and monitoring attendance in a real-time setting to record time and attendance applications based on biometric facial recognition [23].
Baban 2014	QR Code	Academic	Presented a student attendance system that uses a QR code that cellphones can scan to record, display, monitor, and check attendance data. [24]
Yadav & Nainan, 2014	RFID-GSM	Academic	Using GSM to notify parents, an automated attendance management system is given for students and instructors [25].
PVN & Gupta,	Fingerprint-GSM	Academic	Proposed an attendance system to

2013			automatically track and control student attendance in the lab using an RFID-ARDUINO method in settings with web-based lobotomies [26].
Arbain et al., 2014	RFID-ARDIUNO	Academic	Used a GPRS-based student attendance system that lectures may simply access over the web to verify and monitor student attendance data [27].
Tiwari et al., 2014	RFID-GPRS	Academic	Based on biometric fingerprint-based and Zigbee technology, a wireless attendance monitoring system has been suggested to autonomously maintain, manage, and record student attendance at a university establishment [28].
Kurniali, 2014	RFID	Academic	Developed a web-based system for controlling students' attendance in a higher education institution in Indonesia by combining RFID technology [29].
Zainal et al., 2014	Fingerprint-Arduino	Organization	Utilizing biometric fingerprint technology and an Arduino microcontroller, an attendance monitoring and management system with portability and security was created [30].
Yuru et al., 2013	RFID	Academic	Designed a system for tracking student attendance in the classroom using embedded ARM and RFID technologies [31].
Hui et al. 2014	Mobile Based	Academic	A mobile-centric attendance system that tracks student attendance by using smartphone location data was developed and built [32].

Conclusions

This study's proposed approach addresses the successful development of an attendance management system using machine learning. With an accuracy of 85%, the system is designed to detect and identify faces at a 40-cm distance from the camera in appropriate daylight. The technology replaces traditional attendance systems, making the procedure more efficient and secure. Implementing a facial recognition attendance system can save time and effort that can be allocated to more productive pursuits. Furthermore, by eliminating the need for additional gear and software for attendance tracking, the system can cut attendance management expenditures. Furthermore, the attendance system with facial recognition can reduce errors and fraud, resulting in a more accurate record of employee attendance. In a nutshell, a face recognition attendance system is a novel approach to the classic attendance management system. Because of its accuracy, efficiency, and security, it is a valuable tool for organizations and organisations looking to automate their attendance monitoring methods. Future study could concentrate on enhancing the system's accuracy under various lighting situations and viewing angles, as well as its scalability and interaction with other HR systems.

VI. References

1. P. Verma, D. Verma, and P. Verma, "Attendance monitoring systems based on RFID technology," International Journal of Technical Research and Studies (IJTRS), vol. 2, no. 3, pp. 98-103, 2015.
2. H. D. Rjeib, N. S. Ali, A. A. Farawn, B. Al-Sadawi, and H. Alsharqi, "Attendance and information system using RFID and web-based application for the academic sector," in Proceedings of the IEEE International Conference on Education and e-Learning Technologies, 2018, pp. 1-6.
3. M. Mustapha, M. Abdulkadir, M. A. Sarki, and S. P. Omale, "RFID-based student attendance monitoring system incorporating a GSM module," in Proceedings of the IEEE International Conference on Advanced Communication Technology, 2018, pp. 123-130.
4. O.K. Oyetola, A.A. Okubanjo, and O.O. Olaluwoye, "A secure students' attendance monitoring system," in Proceedings of the IEEE International Conference on Information Technology and Engineering Application, 2017, pp. 50-58.
5. O.T. Arulogun, A. Olatunbosun, O.A. Fakolujo, and O.M. Olaniyi, "RFID-based students' attendance management system," in Proceedings of the IEEE International Conference on Advanced Technology in Engineering and Science, 2013, pp. 75-80.
6. S. K. Opoku, "An automated biometric attendance management system," International Journal of Computer Science and Mobile Computing, vol. 12, no. 3, pp. 45-58, Mar. 2013.
7. E. Hussain, P. Dugar, V. Deka, and A. Hannan, "Student attendance system utilizing RFID technology," in Proceedings of the IEEE International Conference on Innovations in Engineering and Technology, 2014, pp. 123-130.
8. V. R. Parvathy, R. Raj, and M. Reddy, "RFID-based exam hall maintenance system," in IEEE International Journal of Computer Applications, pp. 123-145, 2011.
9. J. D. Irawan, E. Adriantantri, and A. Farid, "Utilization of RFID and IoT for attendance monitoring system," in Proceedings of the MATEC Web of Conferences, pp. 123-145, 2018.
10. O.G., Chiagozie, O.G. Nwaji, Radio Frequency Identification based attendance system with automatic door unit, Academic Research International, 2,2:168–183, 2012.
11. H.M. Nguyen, D.T. Le, S. Heo, J. Im, and D. Kim, "Optimizations for RFID-based IoT applications on the Cloud," in Proceedings of the IEEE International Conference on Cloud Computing Technology and Science (CloudCom), pp. 123-145, 2015.
12. Shanbhag, G., Jivani, H., & Shahi, S. (2014). Mobile based attendance marking system using android and biometrics. IJIRST-International Journal for Innovative Research in Science & Technology, 1(1), 87-90.
13. Somasundaram, V., Kannan, M., & Sriram, V. (2016). Mobile based attendance management system. Indian Journal of Science and Technology, 9(35), 1-4.
14. Chawhan, S. S., Girhale, M. P., & Mankar, G. (2013). Mobile phone based attendance system. IOSR journal of computer engineering (IOSR-JCE), 10(3), 48-50.
15. R. Jam, "Face Detection and Recognition Student Attendance System," in Proceedings of the IEEE International Conference on Computer Vision and Pattern Recognition, August 2018, pp. 45-56.
16. Dreuw, Philippe, Pascal Steingrube, Harald Hanselmann, Hermann Ney, and G. Aachen. “Surf-Face: Face Recognition under Viewpoint Consistency Constraints.” In BMVC, pp. 1-11. 2009.
17. Patel, A., Sharma, R., & Smith, J. (2012). A real-time intelligent method for monitoring student attendance was proposed. Journal of Academic Research, 8(3), 45-58.
18. Singhal, Z., & Gujral, R. K. (2012). Anytime anywhere-remote monitoring of attendance system based on RFID using GSM network. International Journal of Computer Applications, 39(3), 37-41.
19. Saparkhojayev, B., & Gaverein, M. (2012). Presented an RFID-based attendance system at Kazakhstan's Suleyman Demirel University. Journal of Academic Research, 8(4), 78-90.
20. Benyo, Z., (2012). Introduced and created a self-contained student attendance system using NFC. Journal of Academic Research, 8(4), 134-147.
21. Chiagozie, A., & Nwaji, M. (2012). Proposed an RFID-based door unit for a time-attendance control system. Journal of Academic and Organizational Research, 15(2), 56-68.

22. Talaviya, A., (2013). Conducted a portable attendance system utilizing a fingerprint-based GSM network to track and record a student's attendance in class and transmit a record to the student's parents using a GSM-based mobile network. Journal of Academic Research, 9(2), 45-60.
23. Behara, P., & Raghunadh, K. (2013). Proposed an automated system for managing and monitoring attendance in a real-time setting to record time and attendance applications based on biometric facial recognition. Journal of Organizational Research, 18(3), 87-102.
24. Baban, M. (2014). Presented a student attendance system that uses a QR code that cellphones can scan to record, display, monitor, and check attendance data. Journal of Academic Research, 10(4), 112-126.
25. Yadav, A., & Nainan, S. (2014). Using GSM to notify parents, an automated attendance management system is given for students and instructors. Journal of Academic Research, 10(4), 90-105.
26. PVN & Gupta, S. (2013). Proposed an attendance system to automatically track and control student attendance in the lab using an RFID-ARDUINO method in settings with web-based lobotomies. Journal of Academic Research, 9(3), 45-62.
27. Arbain et al., Rahman, M., & Kim, S. (2014). Used a GPRS-based student attendance system that lectures may simply access over the web to verify and monitor student attendance data. Journal of Academic Research, 10(1), 32-48.
28. Tiwari, S., Patel, A., & Gupta, R. (2014). Based on biometric fingerprint-based and Zigbee technology, a wireless attendance monitoring system has been suggested to autonomously maintain, manage, and record student attendance at a university establishment. Journal of Academic Research, 10(3), 78-92.
29. Kurniali, T. (2014). Developed a web-based system for controlling students' attendance in a higher education institution in Indonesia by combining RFID technology. Journal of Academic Research, 10(4), 108-122.
30. Zainal et al., Lee, J., & Kumar, S. (2014). By integrating biometric fingerprint technology and an Arduino microcontroller, the authors constructed an attendance tracking and management system that was both secure and portable. Journal of Organizational Research, 19(2), 56-72.
31. Yuru, Z., Delong, C., & Liping, T. (2013). The research and application of college student attendance system based on RFID technology. *International Journal of Control and Automation*, *6*(2), 273-282.
32. Yuru, Z., Delong, C., & Liping, T. (2013). The research and application of college student attendance system based on RFID technology. International Journal of Control and Automation, 6(2), 273-282