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Smart Campus: Smart Attendance Management System Using Face Recognition

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Abstract
This Review Paper studies several research papers based on the Smart Attendance system for recording attendance based on facial recognition. Efficient and accurate attendance management is a crucial task in various educational and organizational settings. Traditional methods of manual attendance tracking are time-consuming and error-prone. The proposed system utilizes computer vision and deep learning techniques to recognize and verify the identity of individuals in a given environment. Through the deployment of facial recognition algorithms, it captures and matches facial features with existing records in a database, allowing for seamless and efficient attendance tracking.

Keywords: OpenCV, Dlib, ResNet, PCA, Modified Local Binary Pattern Histogram (MLBPH), Deep Metric Learning, CNN, eigen values, Haar-Cascade Classifier

1. Introduction

The conventional method of management of attendance can turn out to be a great burden on the teachers if it is done manually. They are time-consuming and a great aid for proxy. Hence, there is a requirement for a computer-based student attendance management system which will assist the faculty in maintaining attendance records automatically. A smart attendance system can streamline the attendance management process, reduce administrative burden, and enhance accuracy in various educational and organizational settings.

The project “Smart Attendance Management System using Facial Recognition” is a modern solution designed to streamline and automate attendance tracking by leveraging cutting-edge facial recognition technology. This system offers real-time, accurate, and efficient attendance management.

Capturing and matching facial features with pre-registered individuals, eliminates the need for manual attendance processes, reducing administrative workload and improving overall accuracy. This project holds promise for various settings, from educational institutions to corporate offices, where precise attendance tracking is essential.

The Paper published by Dhanush Gowda H.L [1] utilised Dlib’s face recognition model over the traditional image classification pipeline. The Dlib’s Face Recognition module is based on a CNN architecture called ResNet and deep Metric Learning which is a class of techniques that uses Deep Learning. For enrolment, we define a smaller ResNet neural network. Training was also done using this network.

The Paper published by T.Raut [2] implemented an effective system which will mark the attendance of students automatically by recognizing their faces as soon as one enters class, showing absent students, attendance graph, and student database. The Local Binary Pattern Histogram (LBPH) algorithm technique

is a simple solution to the face recognition problem, which can recognize both the front face and the side face. However, the recognition rate of the LBPH algorithm under some conditions is decreased. To solve this problem, a modified LBPH algorithm based on the pixel of the neighbourhood grey median (MLBPH) is proposed.

M.H. Modh Kamil [3] developed an effective attendance system based on face recognition and face mask detection which achieved an accuracy of about 81.8% based on a pre-trained model for face recognition and 80% for face mask detection. With the integration of Python and PHP scripting programs, the developed system will be able to perform processing on online servers, while being accessible to users through a browser from any terminal.

G.B. Harish [4] emphasized the use of the Viola-Jones algorithm which is the most popular algorithm to localize the face segment from static images or video frames. The first part is known as the Haar feature, second part is where an integral image is created. Other than this, Local Binary Pattern (LBP) is used which is a simple yet very efficient texture operator. The hardware used is NVIDIA Jetson Nano Developer Kit which is a small, powerful computer that lets you run multiple neural networks in parallel for applications like image classification, object detection, segmentation, and speech processing.

Neela A. Kumar [6] addressed the need for a fast face and robust detection algorithm hence the Viola-jones algorithm is used for face detection, PCA for feature selection and SVM for classification. Viola-jones detection algorithm gives a high detection rate and is efficient for real-time applications for its efficiency. PCA is used for the extraction of principal components of multi-dimensional data.

The paper published by E Charan Sai[9] emphasized the use of the Haar-Cascade System, which trains machine learning to detect objects in an image. For face recognition, a Local Binary Pattern Histogram is employed. The fundamental idea behind the Haar-based face detector is that the region with the eyes should be darker than the forehead and checks when looking at most frontal images, and the region with the mouth should be darker than the cheeks.

2. Literature Review

In the study conducted by Hajar Filali et al. [1], a comprehensive comparison of four machine-learning techniques for face recognition was presented. The methods, Haar-AdaBoost, LBP-AdaBoost, GF-SVM, and GF-NN, were evaluated based on their ability to learn and execute tasks that are challenging for conventional algorithmic methods. Haar-AdaBoost and LBP-AdaBoost utilized the Boosting algorithm to obtain an optimal classifier for a cascade classification. On the other hand, GF-SVM and GF-NN incorporated the Gabor filter to eliminate specific characteristics during the classification process. The research findings emphasized the importance of considering system-specific factors, as the detection time varied across the evaluated methods. Notably, the Haar-AdaBoost approach outperformed the other methods in terms of output rate, establishing its superiority. As a result, Haar-AdaBoost was identified as the most suitable technique for face recognition in the context of a smart attendance system. This underscores the significance of choosing the appropriate machine learning algorithm for optimal performance in attendance tracking applications. In Paper [2] Arun Katara et al. conducted a comprehensive analysis of various attendance systems, including RFID cards, fingerprint recognition, iris recognition, and face recognition. The study critically assessed the limitations of each method, highlighting issues such as card-sharing in RFID systems and the time-consuming nature of fingerprint verification. The researchers argued that face recognition systems represent a more efficient alternative for student attendance due to the constant visibility of the human face and its relative simplicity compared

to iris recognition. This comparative analysis underscores the need for attendance systems that balance security and practicality. The study provides valuable insights into the shortcomings of existing methods and recommends the adoption of face recognition systems to address these challenges in the context of student attendance. The third paper [3] by M.H. Modh Kamil explores the integration of RFID and face recognition in a smart student attendance system. The research emphasizes the dual advantages of RFID for quick attendance recording and an Android-based system for efficient reporting. The system's integration with face recognition aims to track students entering and leaving the classroom, providing a comprehensive solution for attendance management. This paper aligns with the contemporary trend of utilizing Android-based solutions in education technology and emphasizes the need for streamlined and automated attendance tracking processes. The integration of face recognition alongside RFID technology reflects a forward-looking approach, acknowledging the evolving landscape of attendance management in educational institutions. In Paper [4] by G.B. Harish, the focus is on the paramount importance of maintaining accurate attendance records for evaluating student performance. The paper acknowledges the variety of methods employed by institutes, ranging from manual, paper-based approaches to the adoption of automatic attendance through biometric techniques. The study emphasizes the critical role of face recognition in modernizing attendance-tracking methods, aligning with the overarching goal of improving efficiency and accuracy in educational institutions. This paper contributes to the literature by highlighting the significance of adopting advanced biometric techniques, specifically face recognition, as a means to enhance the overall performance evaluation process in educational institutions. Neela A. Kumar [6] introduces a mobile-based attendance system that incorporates both NFC technology and face recognition. The study addresses the limitations of traditional attendance methods, such as human errors and impracticalities associated with fingerprint scanning in certain conditions. The proposed system, utilizing Raspberry Pi and cloud storage, aims to overcome these challenges, aligning with the broader trend of integrating mobile and cloud technologies into attendance management. The inclusion of face recognition, coupled with NFC technology, offers a comprehensive solution that not only enhances accuracy but also embraces the convenience of mobile devices. The paper underscores the potential of these technologies to revolutionize attendance tracking, particularly in contexts where traditional methods fall short.

3. Evolution of Attendance System

3.1. Manual Attendance System

In the early 19th century, companies started adopting methods to mark the attendance of their employees. This involved using tools like time clocks and written registers to document when the employees started and finished their work shifts. In the late 19th century, the introduction of punch cards revolutionized attendance marking. Employees would use punch cards to "punch in" when they arrived at work and "punch out" when they left. However, despite being an improvement over manual methods, this system had its drawbacks.

One significant issue was the susceptibility to errors, as manual data entry and calculations were prone to mistakes and errors. Additionally, a common problem known as "buddy punching" emerged, where one employee would clock in on behalf of another, leading to incorrect attendance records. Moreover, managing and processing the data collected from these punch cards was a labour-intensive task, needing significant administrative effort.

Similarly, in educational settings, teachers traditionally rely on methods like taking roll calls or using attendance sheets to track student attendance. However, these methods can also encounter challenges such

as errors in recording attendance and students attempting to deceive by getting themselves marked present when they are absent.

Overall, while these early methods laid the foundation for systematic attendance tracking, they were limited by their reliance on manual processes and were vulnerable to various errors and issues that necessitated the development of more sophisticated digital solutions.

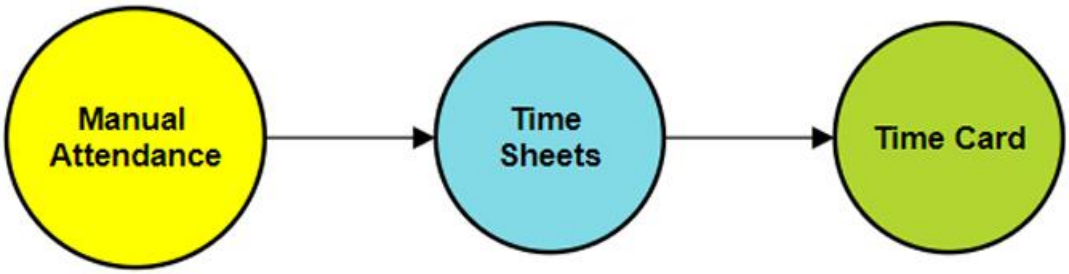

Figure 1 Evolution of Manual Assessment

3.2. Magnetic Stripe Cards Attendance System

A magnetic stripe card attendance system uses plastic cards with a magnetic stripe containing encoded data. Each card is assigned to an individual and programmed with their identification information. When individuals arrive or leave, they swipe their cards through a magnetic stripe reader. The reader reads the encoded data from the card's magnetic stripe and logs the attendance information into the system, recording the time and date of the swipe.

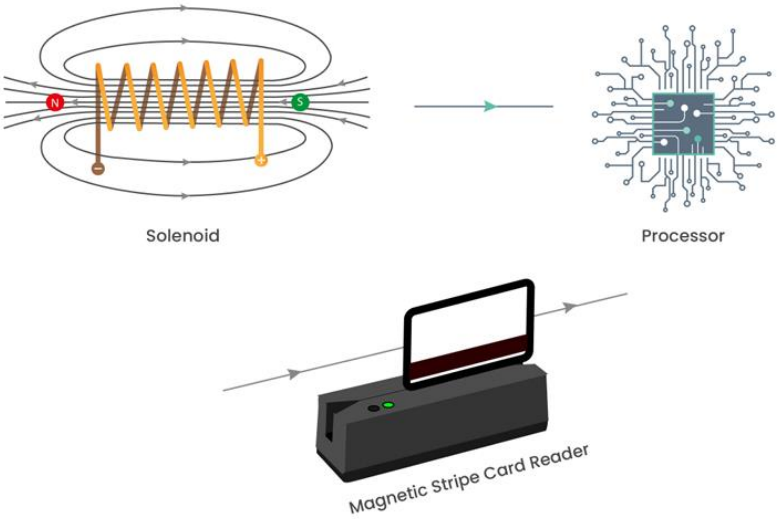

Figure 2 Working of Magnetic Stripe Card Reader

3.3. Biometric Attendance System

Biometrics is the measure of biological or behavioral features which are used for the identification of individuals. Biometric authentication (or realistic authentication) is used in computer science as a form of identification and access control.

There are two types of biometrics

1. Physiological biometrics: Physiological biometrics is based on a behavioral trait of an individual. It involves all physical characteristics like ears, eyes, iris, fingerprints, etc.

2. Behavioral biometrics: Behavioral Biometrics is the scientific study of how people and animals' bodies function. Biometric systems use unique physical or behavioral characteristics, such as fingerprints, iris patterns, or facial features, for individual identification and authentication.

These systems offer high accuracy, non-transferability, and resistance to fraud. They are commonly used in attendance tracking, access control, and identity verification applications. However, they require specialized hardware and raise privacy concerns regarding the collection and storage of biometric data.

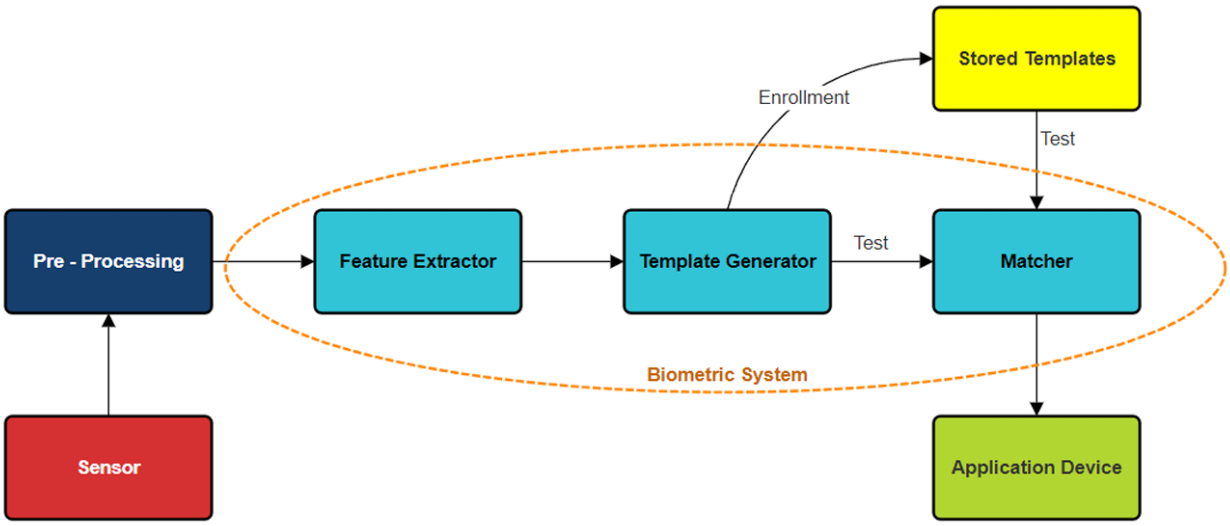

Figure 3 Generalised Architecture of Biometric System

4. Applications

The implementation of a smart attendance marking system leveraging face recognition technology presents a myriad of applications across diverse sectors. The versatility of this system extends beyond traditional attendance tracking, offering innovative solutions for enhanced security, streamlined processes, and improved overall efficiency.

4.1 Educational Institutions

In educational settings, the smart attendance system serves as an invaluable tool for automating the attendance marking process. Students simply need to be present within the camera's field of view, eliminating the need for manual roll calls. This not only reduces administrative workload but also provides real-time attendance data, aiding educators in monitoring student attendance patterns.

4.2 Corporate Environments

The application of face recognition in corporate environments streamlines employee attendance management. By integrating this technology into access control systems, companies can enhance security measures. Additionally, automated attendance tracking fosters a more efficient human resources management process by providing accurate and up-to-date attendance records.

4.3 Public Transportation

Smart attendance systems using face recognition can be integrated into public transportation systems to monitor passenger flow. This aids in optimizing transportation services, ensuring accurate data on the number of passengers at various times. The system can contribute to efficient scheduling and resource allocation, ultimately improving the quality of public transportation services.

4.4 Healthcare Facilities

In healthcare settings, the implementation of face recognition for attendance tracking enhances the efficiency of medical staff management. It ensures that medical professionals are present and accounted for during their shifts, contributing to better patient care and overall hospital management.

4.5 Government Institutions

Government institutions can benefit from face recognition based attendance systems in various departments. These systems enhance accountability by providing accurate attendance records for government employees. Additionally, they contribute to a more transparent and streamlined bureaucratic process.

In summary, the smart attendance marking system using face recognition technology has extensive applications that extend across various sectors, contributing to increased efficiency, security, and streamlined processes.

5. Conclusion

In conclusion, the smart attendance marking system using face recognition technology represents a paradigm shift in attendance tracking methodologies. Its non-intrusive nature, coupled with high accuracy and versatility, positions it as a transformative solution for a wide array of applications. The literature survey has provided a comprehensive overview of the current state of research, highlighting the progress made, challenges faced, and potential avenues for future exploration. As we look ahead, it is evident that the integration of face recognition technology into attendance systems will continue to shape the landscape of automated attendance tracking. The ongoing refinement of algorithms, advancements in hardware capabilities, and the establishment of ethical guidelines will play pivotal roles in determining the trajectory of technology. In closing, this review not only contributes to the academic understanding of smart attendance marking systems but also serves as a guide for practitioners, policymakers, and researchers involved in the development and implementation of face recognition technology in diverse domains

$$(a + b)^2 = a^2 + b^2 + 2ab \quad (1)$$

$$y^4 + \frac{xy}{2} = \frac{x^3}{3} - xy^2 + y^2 - \frac{1}{7} \quad (2)$$

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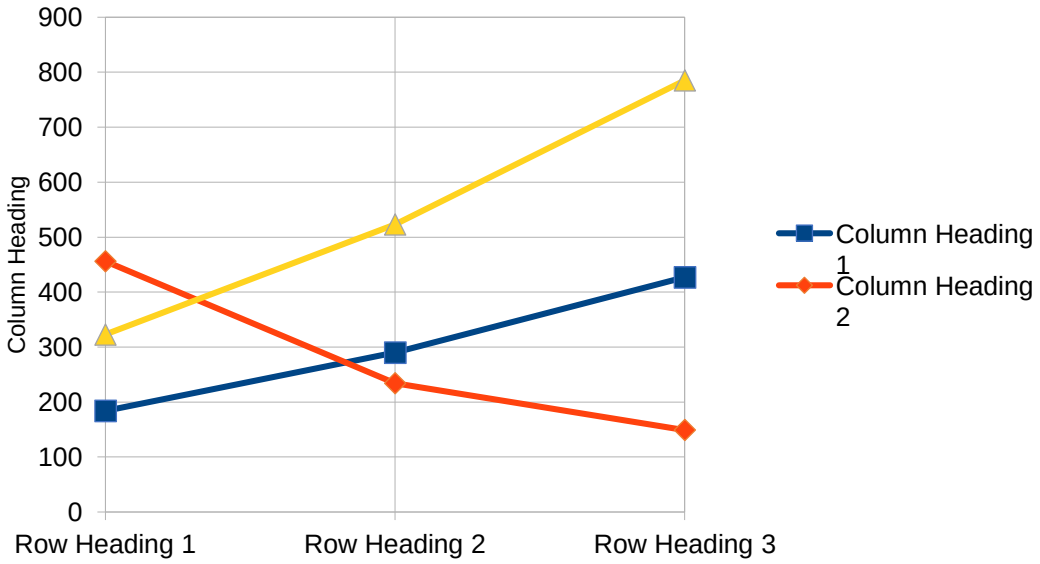
Row Heading 1	184	456	323
Row Heading 2	290	234	523
Row Heading 3	427	149	785
Total	901	839	1631

The above data is pictured in the next graph.

Figure 4: Temperature After Each Pass



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