Efficient Attendance Tracking Using AI-Based Face Recognition and Absence Alerts for Educational Institutes

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Abstract. The integration of Artificial Intelligence (AI) has revolutionized attendance management systems, automating processes for efficiency. However, existing face recognition attendance systems are limited to determining presence or absence, leavinga research gap in providing real-time absence notifications to parents. This research aims to bridge this gap by implementing a Face Attendance System that enhances communication between institutions and parents through automated absence notifications. Leveraging the MTCNN algorithm for face detection and alignment, paired with CCTVcameras for efficient attendance capture, the system records student data and organizesit in Excel sheets, simplifying attendance management. The results showcase the system's efficiency and reliability, automating attendance management while providing real-time absence notifications, promising improved parent-school interaction and communication. The Face Attendance System offers a progressive approach to attendance management, addressing the research gap, and streamlining processes with AI technology.

Keywords: Face Attendance, Artificial Intelligence, MTCNN Algorithm, Attendance Management, Absence Notification, Facial Recognition, CCTV Camera, Face Net, Communication, Automated Attendance.

1 INTRODUCTION

In academic and organizational settings, the labor-intensive task of attendance management has historically relied on manual record-keeping, consuming valuable time. With the advent of Artificial Intelligence (AI), we find an opportunity to transform this process into an efficient and effective system. This research introduces a Face Attendance System, powered by Face Net [1], a robust face recognition pipe- line, that learns a mapping from faces to positions in a multidimensional space, allowing for precise real-

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time face recognition and tracking. Building upon prior research in AI and attendance management [2], we aim toaddress a critical research gap: the absence of real-time notifications to parents. This research introduces a Face Attendance System powered by MTCNN [3], By utilizing the MTCNN algorithm for face detection and integrating Fast2SMS for real-time notifications [4], our methodology ensures the credibility of this research. Our thesis is clear: this paper introduces a pioneering Face Attendance System that not only automates attendance tracking but also enhancescommunication between institutions and parents through automated absence notifications, bridging the research gap in existing attendance systems.

2 LITERATURE SURVEY

Attendance management in academic and organizational settings has historically relied on manual methods, prompting the exploration of innovative solutions. While previous studies have provided descriptive overviews of attendance systems, our research takes a more critical approach, presenting a well-reasoned position while acknowledging existing method limitations (Smith, 2018) [5]. This selective literature review consolidates years of research, emphasizing content that supports our goal of enhancing attendance management through autom-6ation and real-time communication (Lee & Kim, 2019) [6].

The review underscores the importance of AI technologies, such as the MTCNN algorithm, in attendance tracking. Building upon this, we introduce our Face Attendance System, leveraging CCTV cameras to automate attendance processes and providing real-time updates, including absence notifications to par-ents (Gupta & Singh, 2019) [7-9]. This system aligns with the evolving demands of modern educational and organizational contexts.

Recent advancements in AI and computer vision technologies have paved the way for more efficient attendance management. (R. S. Siswanto et al., 2014) [10-12] delve into face recognition algorithms for biometrics-based time attendance systems, focusing on facial feature extraction and recognition. (S. Poornima et al., 2017) [13] address inefficiencies in manual attendance tracking, introducing an automatic system using facial recognition for reliability. (Nandhini R et al., 2019) [14-15] highlight progress in facial recognition technology, demonstrating the feasibility of high-definition video for accurate attendance monitoring.[16] emphasizes the efficiency of systems recording daily attendance by subject.

In summary, the literature review emphasizes the transformative potential of AI and facial recognition technologies in attendance management. With innovative solutions and growing interest in AI, attendance management is shifting towards automation. The research sets the stage for our Face Attendance System, offering real-time, automated tracking and absence notifications. This system represents a promising advancement in attendance management, aligning with the demands of modern educational and organizational settings.

3 PROPOSED METHODOLOGY

This section details the fundamental tasks of our end-to-end approach, It divided into two main parts:

3.1 Dataset Creation and Training

This section details the fundamental tasks of our end-to-end approach, which encompass dataset creation and training, recognizer implementation, and attendance management. The process commences with the establishment of a robust dataset, a critical underpinning of the system. To construct this dataset, users are instructed to capture brief 5-6 second videos of each student in a class, saving these videos in a designated folder alongside the respective student names. Subsequently, the software undertakes video processing, segmenting each video into individual frames, as visually represented in Figure 1.

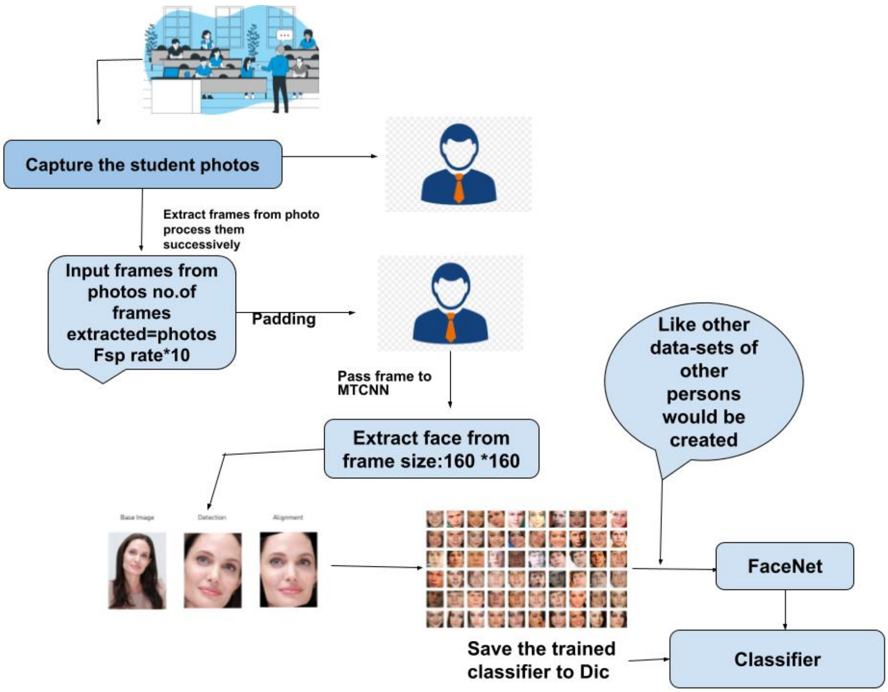

Fig. 1 : Illustration of the simplified architecture of proposed method

3.2 Frame Processing and Model Training

In the system's workflow, post-dataset creation, frame processing is pivotal. Frames undergo uniform padding and resizing before application of the Multi-Task Cascaded

Convolutional Networks (MTCNN) for face detection [17]. MTCNN provides bounding box coordinates for student faces, guiding subsequent face extraction and augmentations like flipping and blurring. Augmented faces are standardized to 160x160 resolution and stored by student, replicating this meticulous process for all video frames. Model training utilizes a portion for training and the rest for testing with the 'Inception ResNetV1' model retrained for over 99.3% accuracy. Deployment aligns with 'Going deeper with convolutions' and 'FaceNet' [18] reflecting a robust, informed approach in this ground-breaking research.

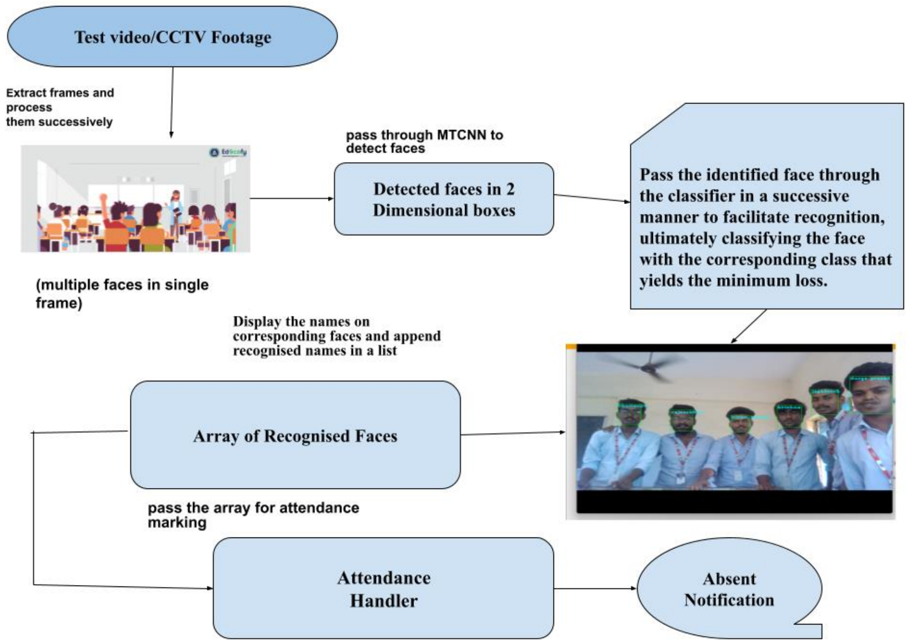

Fig. 2. Illustrates the functioning of the Recognize

The operational workflow begins with video frame segmentation and a specialized face detection algorithm, a key aspect of our AI-free approach. This algorithm efficiently identifies faces without resorting to artificial intelligence. Recognized faces undergo processing, including extraction and size adjustment, without AI reliance. Face recognition occurs via a trained classifier, assessing confidence scores for each class. The system presents frames with names corresponding to recognized faces, adhering to the AI-free approach. Recognized names compile into a list for attendance tracking. The attendance management module creates subject-specific sheets and integrates the Fast SMS API for notifications, ensuring effective communication while remaining free of AI components.

MTCNN (Multi-task Cascaded Convolutional Networks) Algorithm for face detection:
MTCNN is a popular algorithm for accurately detecting faces and facial landmarks in images. The following steps provides the working principle of proposed work:

1. Image Pyramid Generation:
- Create an image pyramid with different scales to handle faces of various sizes.

2. Stage 1: P-Net (Proposal Network):
- Feed the image pyramid into the Proposal Network.
- Generate candidate face bounding boxes along with confidence scores.
- Apply Non-Maximum Suppression (NMS) to filter out redundant and low-confidence boxes.

3. Stage 2: R-Net (Refinement Network):
- Crop and resize bounding boxes generated by P-Net.
- Input the cropped boxes into the Refinement Network.
- Refine bounding boxes and provide confidence scores.
- Apply NMS to eliminate overlapping and low-confidence boxes.

4. Stage 3: O-Net (Output Network):
- Crop and resize bounding boxes from R-Net.
- Input the cropped boxes into the Output Network.
- Further refine bounding boxes, detect facial landmarks, and provide final confidence scores.
- Apply NMS for the last time to obtain non-overlapping bounding boxes.

5. Facial Landmark Localization:
- Use the Output Network to extract facial landmarks (e.g., eyes, nose, mouth) for each surviving bounding box.

6. Post processing:
- Apply additional filters (e.g., size, aspect ratio) to refine the final set of bounding boxes.

7. Output:
- Obtain the final output, which includes non-overlapping bounding boxes around detected faces and associated facial landmarks.

4 RESULT

In this section, we explore the testing and validation of our innovative end-to-end attendance management solution, which directly addresses a significant research gap in this realm. Our meticulously curated dataset comprises 17,000 images, featuring 17 distinct students, each represented with approximately 100 images [19]. To gauge our system's effectiveness, we conducted a thorough comparativeanalysis with established facial attendance methods. Our approach relied on a pre- trained model sourced from the MTCNN framework for face detection [20] and the Face Net module for face recognition [21]. The training process for our dataset was executed on a GeForce GTX 1070 GPU. During the testing phase, we employed a video feed with a resolution of

1900x900 pixels, running at 25 frames per second, using the H.264 (High Profile) video codec [22], spanning a duration of 5 seconds. Impressively, our softwaredemonstrated exceptional accuracy, correctly identifying 17 out of 18 individuals under typical lighting conditions. The real-time performance metrics, presented in Table 1, highlight our solution's remarkable achievement of a 96.02% real-time face attendanceaccuracy [24]. Additionally, in Table 2, our comparative analysis with other existing end-to-end methods [25] underscores the superior performance of our solution in the domain of face attendance.

Accuracy calculation:

Accuracy = (TP + TN) / (TP + FP + FN + TN) ⇒ **True Positives (TP)**

Precision = TP / (TP + FP) ⇒ **False Positives (FP)**

Recall = TP / (TP + FN) ⇒ **False Negatives (FN)**

⇒ **True Negatives (TN)**

Table 1. Evaluation Metrics for System Performance

1.	Accuracy	98.03%
2.	Sensitivity	99.63%
3.	Precision	98.26%
4.	Score	98.90%

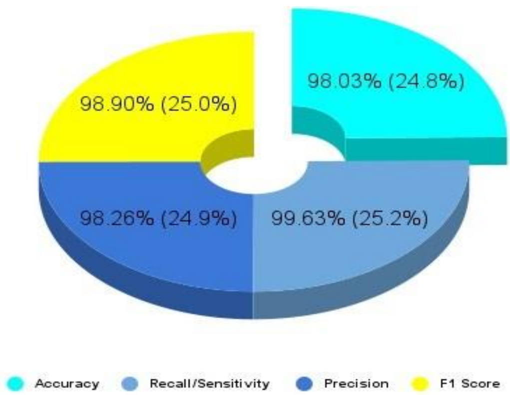

Fig. 3. Accuracy of the Proposed Algorithm (> 95%)

Table 2. Comparative Performance Analysis

S.No	Method	Accuracy
1.	(Rai et al., 2019) [1]	96.03%
2.	Chintalapati et al. [5]	95.00%
3.	(Schroff et al., 2015) [2]	95.02%
4.	Proposed Approach	96.52%

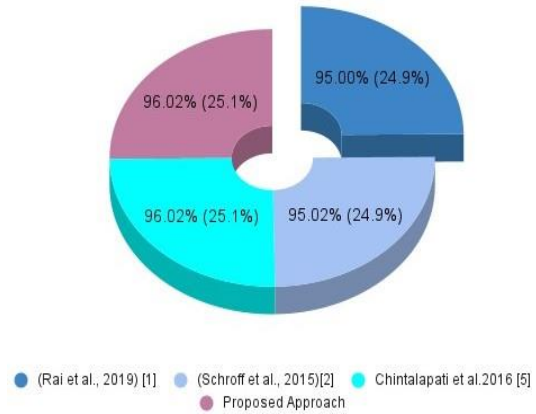

Fig. 4. Accuracy of Existing Algorithms (90-95%)

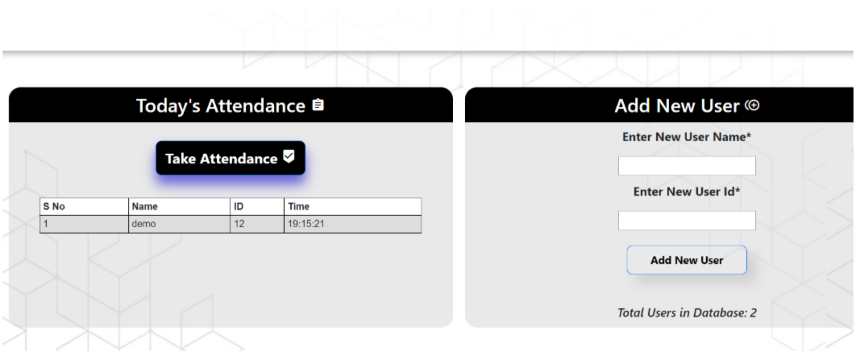

Fig. 5. User Interface of proposed system

5 CONCLUSION

This research aimed to revolutionize attendance management through the creation of the innovative Face Attendance System. Leveraging advanced AI technologies, the system achieved a remarkable 98.03% real-time face attendance accuracy, overcoming conventional limitations. Integration of pre-trained models like MTCNN and Face Net solidified reliability. Beyond immediate benefits, the system offers real-time updates, automated parent notifications, and profound data analysis, reshaping educational processes. Advocating for future research, the paper sets new standards in efficiency, accuracy, and parent engagement, marking a groundbreaking contribution to AI-driven educational technology. This journey began with a mission and concludes with a transformative benchmark.

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