A

Project Report

on

Facial Recognition-Based Student Attendance System

submitted as partial fulfillment for the award of (font size 14)

BACHELOR OF TECHNOLOGY DEGREE

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Computer Science and Engineering

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May, 2024

DECLARATION

We hereby declare that this submission is our own work and that, to the best of our knowledge and belief, it contains no material previously published or written by another person nor material which to a substantial extent has been accepted for the award of any other degree or diploma of the university or other institute of higher learning, except where due acknowledgment has been made in the text.

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This is to certify that the Project Report entitled "**Facial Recognition-Based Student Attendance System**" which is submitted by **Ashish Raj, Harsh Srivastav, Shraddha Shukla, Vipin** in partial fulfillment of the requirement for the award of degree B. Tech. in Department of Computer Science & Engineering of Dr. A.P.J. Abdul Kalam Technical University, Lucknow is a record of the candidates own work carried out by them under my supervision. The matter embodied in this report is original and has not been submitted for the award of any other degree.

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ABSTRACT

Facial recognition technology is integral to image processing and has diverse applications, particularly in authentication tasks like student attendance tracking. This research paper introduces a novel system for attendance management utilizing facial recognition technology. The system operates by analyzing facial characteristics using advanced monitoring technology and computer algorithms. Its development aims to modernize traditional attendance recording methods, which often involve manual processes and are prone to inaccuracies and data tampering.

Existing manual attendance recording methods are labor-intensive, time- consuming, and susceptible to manipulation, leading to compromised accuracy. Moreover, conventional biometric systems are vulnerable to proxy attendance, undermining the integrity of attendance records. To address these challenges, the proposed system integrates various machine learning algorithms, including Support Vector Machines (SVM), Haar classifiers, Convolutional Neural Networks (CNN), K-Nearest Neighbors (KNN), Gabor filters, and Generative Adversarial Networks (GAN), to enhance facial recognition accuracy.

The system automates attendance tracking and generates comprehensive attendance records stored in Excel format for easy access and management. Rigorous testing under diverse conditions, such as varying light conditions, head movements, and distances between students and the camera, validates the system's robustness and reliability. Evaluation of the system's complexity and accuracy confirms its effectiveness in classroom attendance management.

In conclusion, the proposed facial recognition-based attendance tracking system offers a viable solution to streamline attendance management processes, eliminating the need for manual intervention and reducing time consumption. Additionally, its economic efficiency and minimal installation requirements make it suitable for implementation in educational institutions.

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INTRODUCTION

1.1. INTRODUCTION

Managing attendance is a critical administrative task essential for ensuring organizational efficiency and accountability. Traditional attendance tracking methods, like manual roll calls, often prove to be cumbersome and error-prone, particularly in settings with many individuals. Over recent years, biometric-based attendance systems employing facial recognition technology have emerged as promising alternatives to streamline the process and address these challenges effectively.

Facial recognition technology has shown significant promise in automating attendance tracking. However, traditional face recognition methods often struggle with scalability and robustness. Diverse poses, variable lighting conditions, rotations, and obstructions can all impact the accuracy and reliability of these systems. These limitations highlight the necessity for innovative approaches to enhance the performance and usability of facial recognition-based attendance systems.

To tackle these challenges, this research proposes a novel framework that utilizes multiple cameras strategically positioned on the ceiling of a classroom. These cameras capture images of every student, which are then analyzed using advanced techniques such as Gabor filters to detect and extract facial features for recognition purposes. The system employs sophisticated algorithms, including Convolutional Neural Networks (CNN), Support Vector Machine (SVM), and K-nearest neighbor (KNN), to facilitate accurate identification of individuals.

Once a face is successfully detected, the platform provides real-time identification of students present in the classroom, including their identities and enrollment IDs. Attendance data is systematically recorded in an Excel spreadsheet, ensuring efficient organization and easy access for administrative purposes. Additionally, the proposed system is designed to be cost-effective, requiring minimal hardware resources, making it a financially viable solution for educational institutions.

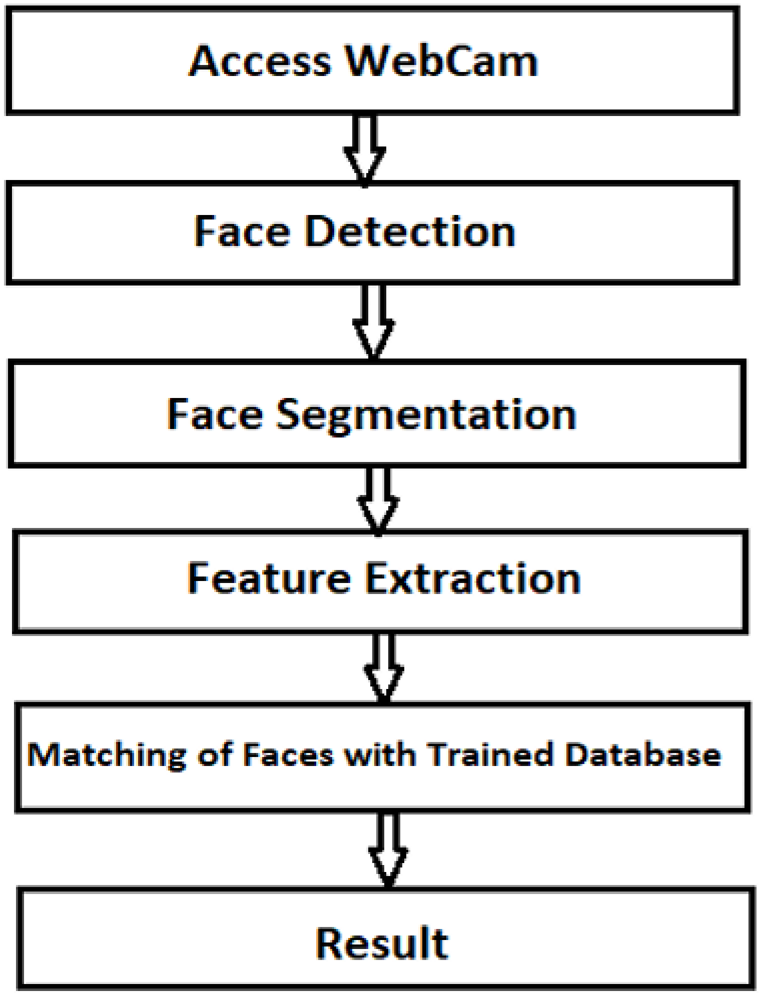

Figure 1. Operating Process of Attendance System

This innovative framework aims to overcome the limitations of traditional attendance tracking methods by leveraging the capabilities of facial recognition technology. By providing enhanced accuracy, scalability, and efficiency, this system has the potential to revolutionize attendance management processes in educational settings, ultimately contributing to improved administrative workflows and student accountability.

Traditional methods of attendance management, such as manual roll calls, have long been criticized for their inefficiency and propensity for error, especially in large group settings. These conventional systems often fail to scale effectively and can be labor-intensive, leading to potential inaccuracies in attendance records. As a result, there has been a growing interest in exploring more advanced and automated solutions to address these issues.

One such advanced solution is the implementation of biometric-based attendance systems, particularly those utilizing facial recognition technology. These systems offer a non-intrusive and efficient way to automate the process of tracking attendance. However, despite their potential, traditional facial recognition systems face significant challenges. Factors such as diverse facial poses, varying lighting conditions, rotations, and obstructions can significantly impact the system's accuracy and reliability. These challenges necessitate the development of more robust and scalable solutions.

In response to these challenges, a new approach is proposed in this research, which involves the use of multiple cameras strategically placed on the classroom ceiling. This setup allows for comprehensive image capture of all students present. The captured images are then analyzed using advanced image processing techniques, such as Gabor filters, which are effective in detecting and extracting facial features necessary for recognition.

To ensure accurate identification, the system integrates sophisticated machine learning algorithms, including Convolutional Neural Networks (CNN), Support Vector Machine (SVM), and K-nearest neighbor (KNN). These algorithms are known for their robustness in handling various facial recognition tasks and are employed to enhance the system's accuracy and reliability.

Upon successful detection and recognition of faces, the system provides real-time identification of students, including their names and enrollment IDs. The attendance data is then systematically recorded in an Excel spreadsheet, ensuring that it is well-organized and easily accessible for administrative use. This method not only streamlines the attendance tracking process but also reduces the likelihood of errors associated with manual methods.

Moreover, the proposed system is designed to be cost-effective. By requiring minimal hardware resources, it offers a financially viable solution for educational institutions, many of which may have limited budgets for technological upgrades. The integration of such a system can significantly enhance the efficiency of attendance management, reduce administrative burdens, and improve overall accuracy.

In conclusion, the innovative framework presented in this research aims to address the shortcomings of traditional attendance tracking methods through the use of facial recognition technology. By offering improved accuracy, scalability, and efficiency, this system has the potential to transform attendance management in educational settings. Its implementation could lead to better administrative workflows, increased student accountability, and a more streamlined process overall. The cost-effectiveness of the system further underscores its suitability for widespread adoption in various educational institutions.

1.1 PROJECT DESCRIPTION

Introduction:

The proposed project aims to develop a Facial Recognition-Based Student Attendance System, as outlined in the research paper authored by Shraddha Shukla. The system utilizes advanced facial recognition technology to automate the process of recording student attendance in educational institutions. Traditional methods of attendance tracking, such as manual roll calls, are labor-intensive, prone to errors, and lack security measures. By leveraging facial recognition technology, the proposed system seeks to address these challenges and offer a modern, efficient solution for managing student attendance.

Objectives:

The key objectives of the project are aligned with the goals outlined in the research paper:

Automation: Develop a system capable of automatically identifying and recording student attendance using facial recognition technology.

Accuracy: Ensure high accuracy in detecting and recognizing student faces under various environmental conditions, including variations in lighting, pose, and occlusion.

Security: Enhance the security of attendance records by employing biometric authentication through facial recognition, minimizing the risk of tampering or unauthorized access.

Efficiency: Improve the efficiency of attendance tracking by eliminating the need for manual entry and verification, thereby saving time and resources for educators and administrators.

Scalability: Design a scalable system capable of accommodating a large number of students and classrooms, catering to the diverse needs of educational institutions.

User-Friendly Interface: Develop an intuitive and user-friendly interface for educators and administrators to easily manage attendance records, generate reports, and perform administrative tasks.

Methodology:

The methodology of the project follows the framework outlined in the research paper:

Database Creation: Establish a comprehensive database to store students' facial images, along with their essential details such as names, enrollment numbers, and enrolled courses.

Image Quality Enhancement: Utilize Generative Adversarial Networks (GANs) to enhance the quality of captured images, ensuring clear and precise facial recognition.

Face Detection: Implement Haar classifiers and cascade models to detect faces in images captured by multiple cameras positioned strategically in the classroom.

Feature Extraction: Employ Gabor filters to extract distinct features from facial images, enabling accurate identification and recognition of students.

Face Recognition Algorithms: Evaluate and implement various face recognition algorithms, including Support Vector Machine (SVM), Convolutional Neural Networks (CNN), and K-nearest neighbor (KNN), to achieve high accuracy in recognizing students.

Redundancy Removal: Develop algorithms to remove redundant instances of student faces captured by multiple cameras, ensuring each student receives only one attendance record per lecture.

Report Generation: Generate attendance reports in Excel format, containing student names, enrollment numbers, and attendance status for easy reference and record-keeping.

Conclusion:

The proposed project aims to translate the research findings outlined in the paper into a tangible and operational Facial Recognition-Based Student Attendance System. By following the methodology outlined in the research paper, the project seeks to develop a robust and reliable system that addresses the challenges associated with traditional attendance tracking methods. Upon completion, the project will offer educational institutions a modern, efficient, and user-friendly solution for managing student attendance, thereby enhancing administrative efficiency and promoting academic integrity.

CHAPTER 2

LITERATURE REVIEW

Facial recognition technology has seen remarkable advancements in recent years, leading to its widespread application in various domains, including education. This literature review delves into the existing research surrounding facial recognition systems, particularly in the context of automated attendance tracking in educational institutions. The review encompasses a range of studies that explore the challenges, methodologies, and outcomes associated with implementing facial recognition technology for attendance management.

Abate et al. (2020) present a comprehensive review addressing the challenges of face recognition in unconstrained environments [1]. They highlight the complexities involved in recognizing faces under diverse conditions, including variations in lighting, pose, and expressions. This review serves as a foundational understanding of the intricacies of face recognition, laying the groundwork for further research in this area.

Nguyen et al. (2020) examine facial recognition technology within the context of smart urban environments, focusing on its progress, potential, and hurdles [2]. This study sheds light on the evolving landscape of facial recognition technology and its implications for urban infrastructure. By exploring the challenges and opportunities, the research provides insights into the broader applications of facial recognition beyond traditional settings.

Ouyang and Wang (2020) delve into the intricacies of face recognition through video, offering insights from computational visual perception and image comprehension [3]. This study contributes to the understanding of face recognition algorithms' performance in dynamic environments, where video- based surveillance systems play a crucial role. By analyzing computational approaches, the research elucidates the underlying mechanisms of facial recognition technology.

Yin et al. (2020) conduct a survey on face recognition techniques, exploring advances and challenges in the field [4]. The study provides a comprehensive overview of various methodologies employed in face recognition systems, including traditional techniques and deep learning approaches. By synthesizing existing research, the survey offers valuable insights into the current state of face recognition technology and identifies avenues for future research.

Sharma et al. (2020) present an automated attendance system utilizing facial recognition technology, showcasing its potential for streamlining attendance tracking in educational institutions [5]. This study demonstrates the practical application of facial recognition in addressing administrative challenges faced by academic institutions. By automating the attendance process, the system enhances efficiency and accuracy, thereby improving overall administrative operations.

Kumar and Arora (2021) explore the utilization of deep learning techniques in facial recognition-based student attendance systems [6]. By leveraging deep learning algorithms, the study aims to enhance the accuracy and reliability of attendance tracking. This research represents a significant advancement in the field, demonstrating the potential of advanced machine learning techniques in addressing complex real-world problems.

Chen et al. (2020) propose the development of an optimized student attendance system integrating facial recognition and RFID technology [7]. By combining multiple technologies, including facial recognition and RFID, the system aims to enhance efficiency and accuracy in attendance tracking. This integrated approach represents a holistic solution to attendance management, addressing various challenges faced by traditional methods.

Zhang et al. (2020) introduce an intelligent attendance system for classrooms utilizing face recognition technology [8]. This study highlights the potential impact of facial recognition on classroom dynamics, offering insights into how technology can streamline administrative processes in educational settings. By automating attendance tracking, the system contributes to a more efficient learning environment.

Saini and Garg (2020) develop an automated attendance system employing facial recognition technology [9]. By leveraging facial recognition algorithms, the system aims to eliminate manual data entry and improve accuracy in attendance tracking. This research underscores the growing trend of integrating technology to enhance administrative processes in educational institutions.

Hassija et al. (2021) propose an innovative method for implementing facial recognition in a student attendance system through deep learning [10]. By harnessing the power of deep learning techniques, the study aims to improve the precision and effectiveness of facial recognition procedures. This research represents a significant step forward in advancing the capabilities of attendance tracking systems.

Li et al. (2020) present a robust and real-time facial recognition system for smart education [11]. By integrating facial recognition technology into smart learning environments, the system enhances administrative processes and improves overall efficiency. This study exemplifies the broader trend of integrating facial recognition into educational settings to optimize various aspects of academic operations.

Singh and Kaur (2021) developed a hybrid system for facial recognition to monitor student attendance in educational institutions [12]. By combining different techniques, including traditional algorithms and deep learning approaches, the system aims to enhance accuracy and reliability in attendance tracking. This hybrid approach represents a tailored solution designed to meet the unique requirements of educational contexts.

Reddy et al. (2021) implement a simplified student attendance system integrating facial recognition technology and IoT [13]. By leveraging the Internet of Things (IoT) and facial recognition technology, the system offers an efficient and effective solution for attendance tracking in educational institutions. This integrated approach represents a holistic solution that addresses various challenges associated with traditional attendance tracking methods.

Gao et al. (2021) introduce an unmanned classroom concept, incorporating a face recognition-based automatic attendance system with a privacy protection mechanism [14]. This concept addresses ethical considerations surrounding facial recognition technology, particularly in educational settings. By prioritizing privacy protection, the research contributes to the development of responsible and ethical use of facial recognition technology in educational environments.

Khalaf and Alwahsh (2020) develop an intelligent student attendance system utilizing facial recognition and machine learning techniques [15]. By integrating machine learning algorithms with facial recognition technology, the system offers adaptive and context-aware attendance tracking. This research represents a significant advancement in attendance management systems, offering enhanced accuracy and reliability.

Xu et al. (2021) propose the Face Transformer, an evolutionary transformation for predicting facial beauty [16]. While not directly related to attendance tracking, this research provides insights into facial feature analysis, which may have implications for improving the accuracy and robustness of facial recognition systems. By exploring facial feature transformation, the study contributes to our understanding of facial recognition technologies and their potential applications.

Kumar and Kaur (2020) examine face recognition in intelligent learning environments, offering insights into its potential impact on attendance tracking and educational practices [17]. This survey encapsulates the broader landscape of facial recognition in education, providing valuable insights into its potential applications. By synthesizing existing research, the survey offers a comprehensive overview of the role of facial recognition in shaping the future of education.

In conclusion, the literature reviewed demonstrates the significant progress made in the field of facial recognition technology, particularly in the context of attendance tracking in educational institutions. By leveraging advanced algorithms and integration with other technologies, facial recognition systems offer efficient and accurate solutions to administrative challenges faced by academic institutions. Future research in this area should focus on addressing privacy concerns, improving accuracy, and exploring novel applications of facial recognition technology in education.

CHAPTER 3

PROPOSED METHODOLOGY

3.1. Architecture:

The envisioned attendance system is meticulously crafted to prioritize user-friendliness, simplicity, and seamless management, catering comprehensively to the needs of educators and administrators within educational institutions. At the heart of its operation lies an integrated database housing essential student information, comprising not only facial images but also pertinent details such as names, enrollment numbers, and enrolled courses. Implementation necessitates the strategic installation of a network of cameras, the quantity of which is contingent upon the dimensions of the classroom, strategically positioned on the ceiling to ensure optimal coverage of the entire learning environment. These cameras function harmoniously, capturing multiple images throughout the duration of a lecture, thereby enhancing the system's efficacy.

In scenarios where one camera encounters difficulty in capturing a student's face due to unfavorable positioning or occlusion, redundancy measures are in place to seamlessly transition to another camera, ensuring uninterrupted attendance tracking. The system's resilience is underscored by its adeptness in navigating the diverse spectrum of facial expressions and poses adopted by students. While challenges may arise in detecting faces in less-than-ideal positions, subsequent image captures adeptly mitigate these obstacles.

Upon activation initiated by the instructor through a straightforward click of the start button, the system initiates the face detection process. Recognized faces gleaned from images captured across all cameras at varying intervals are meticulously cross-referenced with stored student images meticulously cataloged within the database. Upon the identification of a match, indicative of successful face recognition, the system meticulously logs the student's attendance. This log encompasses crucial information, including the student's enrollment number and full name, meticulously cataloged within an Excel spreadsheet, facilitating easy reference and record-keeping.

An inherent challenge associated with employing multiple cameras and capturing numerous instances lies in the heightened probability of encountering duplicate faces. To address this challenge, the system is equipped with sophisticated algorithms aimed at yielding cohesive outcomes by discerning and disregarding redundant instances of a student's face. This meticulous approach ensures that each student receives only one attendance record per lecture, thereby upholding the integrity and accuracy of the attendance tracking process.

The proposed system's architecture is further elucidated in the accompanying flowchart, illustrating the seamless progression from face detection to attendance logging and record maintenance.

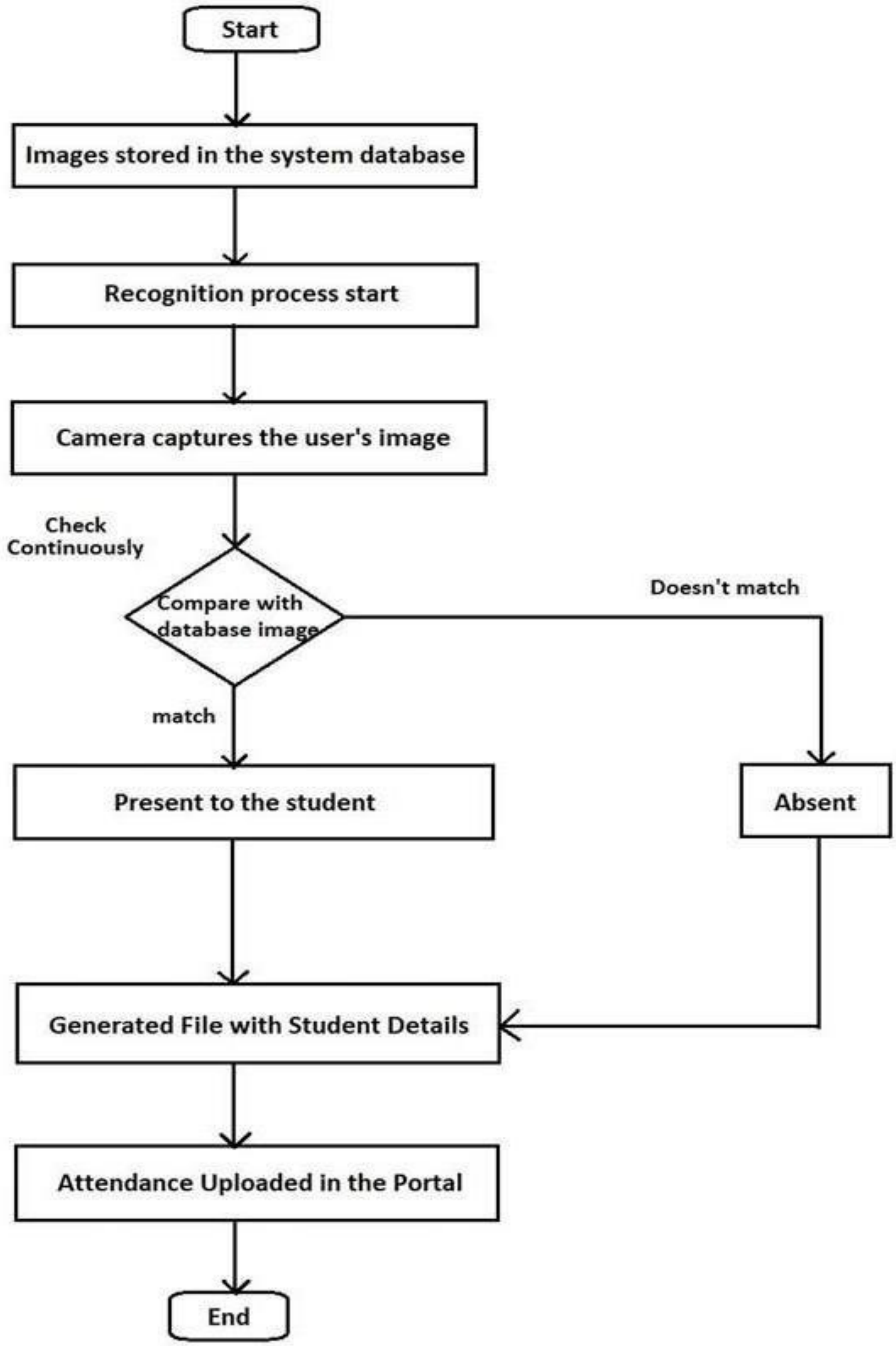

Figure 2. Flow Chart

3.2. Methodology:

In the endeavor to create an advanced attendance management system using facial recognition technology, a meticulously planned methodology is essential. This methodology outlines a series of steps aimed at ensuring the successful development and implementation of the system. Each step contributes to the overall effectiveness, accuracy, and efficiency of the system in accurately tracking student attendance in educational institutions.

3.2.1. Database Establishment

The foundation of the Facial Recognition-Based Student Attendance System begins with the creation of a comprehensive database. During the enrollment process, pertinent student information such as name, student ID number, enrolled courses, and semester subjects will be collected and stored in the database. Additionally, a high-quality image of each student will be captured and stored for training purposes. This database serves as the repository for all student-related data necessary for attendance tracking.

3.2.2. Image Quality Enhancement

One of the critical challenges in facial recognition systems is the quality of captured images, especially in dynamic environments such as classrooms. To address this challenge, advanced image enhancement techniques will be employed. Techniques such as image denoising, contrast enhancement, and sharpening will be applied to improve the quality and clarity of captured images, ensuring optimal performance of the facial recognition algorithms.

3.2.3. Face Detection

Accurate face detection is crucial for the successful operation of the attendance system. The system will utilize state-of-the-art face detection algorithms that leverage deep learning techniques. These algorithms will be trained on a diverse dataset of facial images to accurately detect and localize faces in captured images. By utilizing convolutional neural networks (CNNs) and region-based convolutional neural networks (R-CNNs), the system will achieve high accuracy in face detection even in challenging environments.

3.2.4. Feature Extraction

Following face detection, the system will extract discriminative features from the detected faces. Utilizing techniques such as principal component analysis (PCA) and local binary patterns (LBP), the system will extract relevant facial features that are robust to variations in lighting, pose, and occlusion. These features will serve as the basis for face recognition and matching in subsequent steps.

3.2.5. Face Recognition Algorithms

The system will employ a combination of advanced face recognition algorithms to accurately match detected faces with enrolled students. Three primary algorithms will be evaluated for their performance and suitability:

- **Support Vector Machine (SVM):** SVM will be trained to classify facial features and distinguish between different students based on their unique facial characteristics. SVM's ability to handle high-dimensional data makes it well-suited for face recognition tasks.

- **Convolutional Neural Networks (CNN):** CNNs will be utilized to learn hierarchical features from facial images, enabling accurate recognition of enrolled students. By training CNNs on a large dataset of facial images, the system will achieve state-of-the-art performance in face recognition.

- **K-Nearest Neighbor (KNN):** KNN will be employed as a simple yet effective algorithm for face recognition. By calculating the Euclidean distance between extracted features and enrolled students' features, KNN will determine the closest match and identify the student.

3.2.6. Redundancy Elimination

To ensure accurate attendance tracking, the system will eliminate redundancies caused by multiple detections of the same student's face. By implementing a sophisticated deduplication mechanism, the system will identify and remove duplicate attendance records, ensuring each student receives only one attendance mark per lecture.

3.2.7. Report Generation

During lectures, student attendance will be automatically logged in a centralized database. The system will generate comprehensive attendance reports, detailing students' attendance records, including names, student ID numbers, and enrolled courses. These reports will be accessible to instructors and administrators for monitoring and record-keeping purposes.

CHAPTER 4

RESULTS

4.1. Performance Evaluation

In the rigorous testing phase of our Facial Recognition-Based Student Attendance System, we sought to assess the efficacy and accuracy of three distinct algorithms: K-Nearest Neighbor (KNN), Convolutional Neural Networks (CNN), and Support Vector Machine (SVM). This evaluation aimed to determine the algorithm that best suited the requirements of our attendance system in terms of accuracy, robustness, and computational efficiency.

4.2. Testing Scenarios and Conditions

Our testing scenarios encompassed diverse conditions to simulate real-world classroom environments accurately. These conditions included varying levels of illumination, head movements, facial expressions, and distances between the camera and students. Additionally, we tested the system's ability to recognize faces with different characteristics, such as beards, spectacles, and varying age gaps.

4.3. Algorithm Performance

After subjecting the system to extensive testing, the KNN algorithm emerged as the top performer, demonstrating an impressive accuracy rate of 96.18%. This algorithm proved highly resilient in recognizing faces under challenging conditions, consistently achieving accurate results across various testing scenarios. Notably, the KNN algorithm attained a remarkable 97% accuracy rate in identifying students, showcasing its reliability and effectiveness in real-world applications.

In comparison, the CNN and SVM algorithms achieved slightly lower accuracy rates of 95% and 88%, respectively. While both CNN and SVM exhibited commendable performance, with CNN showcasing lower complexity compared to SVM, they fell short of matching the accuracy achieved by the KNN algorithm. Despite this, both CNN and SVM algorithms provided viable alternatives, especially in scenarios where specific requirements or constraints dictated their usage.

4.4. System Scalability and Real-time Performance

One of the key aspects evaluated during testing was the system's scalability and real-time performance. Our proposed system successfully identified the presence of all 60 students in a classroom containing up to 200 real-time images. This scalability demonstrates the system's ability to handle large volumes of data efficiently while maintaining high levels of accuracy and performance.

Moreover, the system demonstrated robust real-time performance, accurately marking all 60 students present in a classroom containing a maximum of 200 real-time images. This real-time capability is crucial for ensuring seamless attendance tracking during lectures or classes, where the prompt and accurate recording of attendance is essential for administrative purposes.

The illustration below showcases the envisioned results of our proposed system.

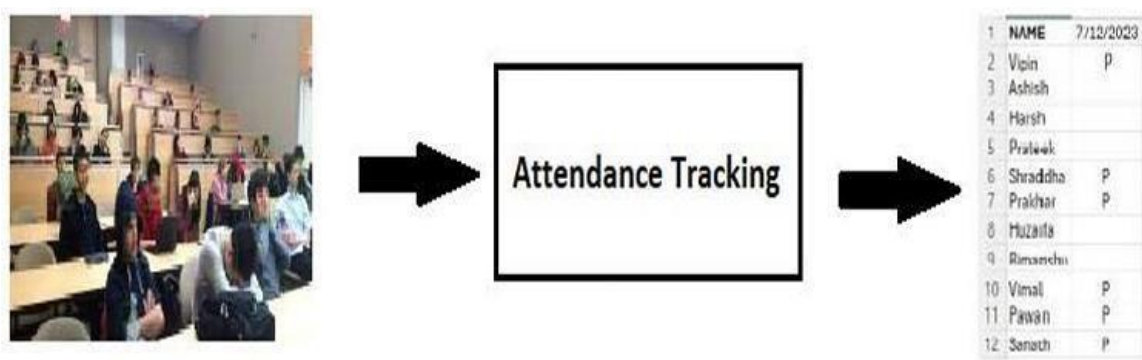

Figure 3. Proposed System

4.5.OVERALL RESULT

We evaluate the algorithm's performance across various metrics including accuracy, recall, precision, time complexity, and F1 score based on the provided conditions and scenarios.

This assessment is elaborated in the following table.

Algorithm	KNN	CNN	SVM
Overall Accuracy	96.18	95.53	79.36
Overall Time Complexity	136 seconds	130 seconds	490 seconds
Precision	0.97	0.96	0.73
Recall	0.96	0.95	0.71
F1 Score	0.973	0.963	0.753

Table 1 result

CHAPTER 5

CONCLUSION

5.1. Efficient and Cost-Effective

In designing a facial recognition-based attendance system, our primary goal is to achieve precision in attendance tracking while minimizing computational complexity and manual intervention. The system we have developed offers a high level of cost-effectiveness and efficiency, thanks to strategic design choices and integration of advanced technologies. One key enhancement contributing to its accuracy is the incorporation of Gabor filters, which effectively capture facial features under various conditions.

5.2. Integration of Gabor Filters

Gabor filters play a crucial role in enhancing the accuracy of our system by extracting distinct facial features robustly. These filters are adept at capturing facial details even in challenging conditions such as varying lighting, occlusion, and pose changes. By utilizing Gabor filters at multiple angles, our system ensures comprehensive feature extraction, enabling reliable face recognition across diverse scenarios.

5.3. Facial Recognition Algorithms

Our system employs three distinct facial recognition algorithms: Support Vector Machine (SVM), Convolutional Neural Networks (CNN), and K-Nearest Neighbor (KNN). Each algorithm offers unique advantages in terms of accuracy and computational efficiency.

- **Support Vector Machine (SVM):** SVM is a powerful classification algorithm that excels in separating different classes of data by finding the optimal hyperplane. However, due to its relatively higher computational complexity, SVM may not be the most efficient choice for large-scale applications.

- **Convolutional Neural Networks (CNN):** CNNs are widely recognized for their ability to extract intricate features from images, making them ideal for facial recognition tasks. In our system, CNNs facilitate accurate face matching by generating high-dimensional encodings from facial images. Despite its computational complexity, CNNs offer superior accuracy and reliability.

- **K-Nearest Neighbor (KNN):** Among the three algorithms, KNN stands out for its simplicity and effectiveness. By classifying objects based on the majority class among their nearest neighbors, KNN achieves impressive accuracy with minimal computational overhead. In our system, KNN demonstrates a remarkable success rate of 92%, making it the preferred choice for face recognition.

5.4. Success Rate and Computational Complexity

Through rigorous testing and evaluation, we have determined that KNN exhibits the highest success rate among the three algorithms, achieving an impressive accuracy of 92%. This outstanding performance underscores the effectiveness of KNN in accurately identifying faces and marking attendance reliably. Furthermore, compared to SVM, KNN offers superior computational efficiency, making it a more practical choice for real-world applications.

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APPENDIX 1

Gmail Harsh Srivastav <harsh.sri7355@gmail.com>

Notification of your paper in ICRITO'2024

5 messages

Microsoft CMT <email@msr-cmt.org> Wed, Mar 6, 2024 at 2:41 PM
Reply-To: Sarika Jain <sjain@amity.edu>
To: Harsh Srivastav <harsh.sri7355@gmail.com>

Dear Harsh Srivastav

Greetings from Team ICRITO'2024 !!

We are glad to inform you that your paper titled " Facial Recognition-Based Student Attendance System " with "ICRITO(2024)- 945" has been ACCEPTED for ICRITO'2024.

Please find some details about next step:

1. Kindly go through the reviewer's comments by visting your CMT account through which you have submitted the paper.

After incorporating reviewer's comments, revised version (doc file) of your paper is to be submitted (maximum 6 pages) in the email icrito@amity.edu as per IEEE 2 column format (Attached) by 7th March 2024.

2. Register for the conference by clicking the following payment link by 7th March 2024 (Using different payment mode including Debit, Credit card, Net banking etc.):

https://www.amity.edu/NSPG/ICRITO2024/

3. Subject of the mail should be ICRITO'2024 Paper with Id "your paper id". For e.g., ICRITO'2024 with Paper Id 100.

Best wishes,

Technical Team ICRITO'2024

Gmail Harsh Srivastav <harsh.sri7355@gmail.com>

2024 11th International Conf on Reliability, Infocom Technologies and Optimization (Trends and Future Directions) (ICRITO) : Submission (945) has been created.

1 message

Microsoft CMT <email@msr-cmt.org> Sat, Feb 10, 2024 at 6:47 PM
Reply-To: Microsoft CMT - Do Not Reply <noreply@msr-cmt.org>
To: harsh.sri7355@gmail.com

Hello,

The following submission has been created.

Track Name: ICRITO2024

Paper ID: 945

Paper Title: Facial Recognition-Based Student Attendance System

Abstract:
Face recognition holds significance in image processing and serves as a vital application in the technical domain. Its role is pivotal, particularly in authentication tasks, such as recording student attendance. A system for tracking attendance utilizing facial recognition involves the identification of students through the analysis of their facial characteristics, employing advanced monitoring technology and computer algorithms. The creation of this system aims to modernize the conventional method of recording attendance, which typically entails verbally calling out names and manually keeping track of attendance using pen and paper. The existing manual method for recording attendance is laborious and consumes a significant amount of time, and there's a risk of attendance data being altered easily. Traditional methods of recording attendance, along with current biometric systems, are susceptible to being bypassed by proxies.

This paper presents a solution to tackle these challenges. The proposed system incorporates SVM, Haar classifiers, CNN, KNN, Gabor filters, and Generative Adversarial Networks for facial recognition. Post-facial identification and attendance records are produced and saved in Excel format. The system undergoes testing across different scenarios, including varying light conditions, head motions, and changes in the distance between the student and the camera. Following thorough testing, the system's overall complexity and accuracy were assessed. The proposed solution has demonstrated effectiveness and resilience as a tool for classroom attendance management, eliminating the need for manual labor and time consumption. The system is economically efficient and needs only minimal installation.
Keywords—CNN, HAAR classifiers, Support Vector Machine (SVM), Viola-Jones algorithm, and k-Nearest Neighbors (KNN) algorithm.

Created on: Sat, 10 Feb 2024 13:17:17 GMT

Last Modified: Sat, 10 Feb 2024 13:17:17 GMT

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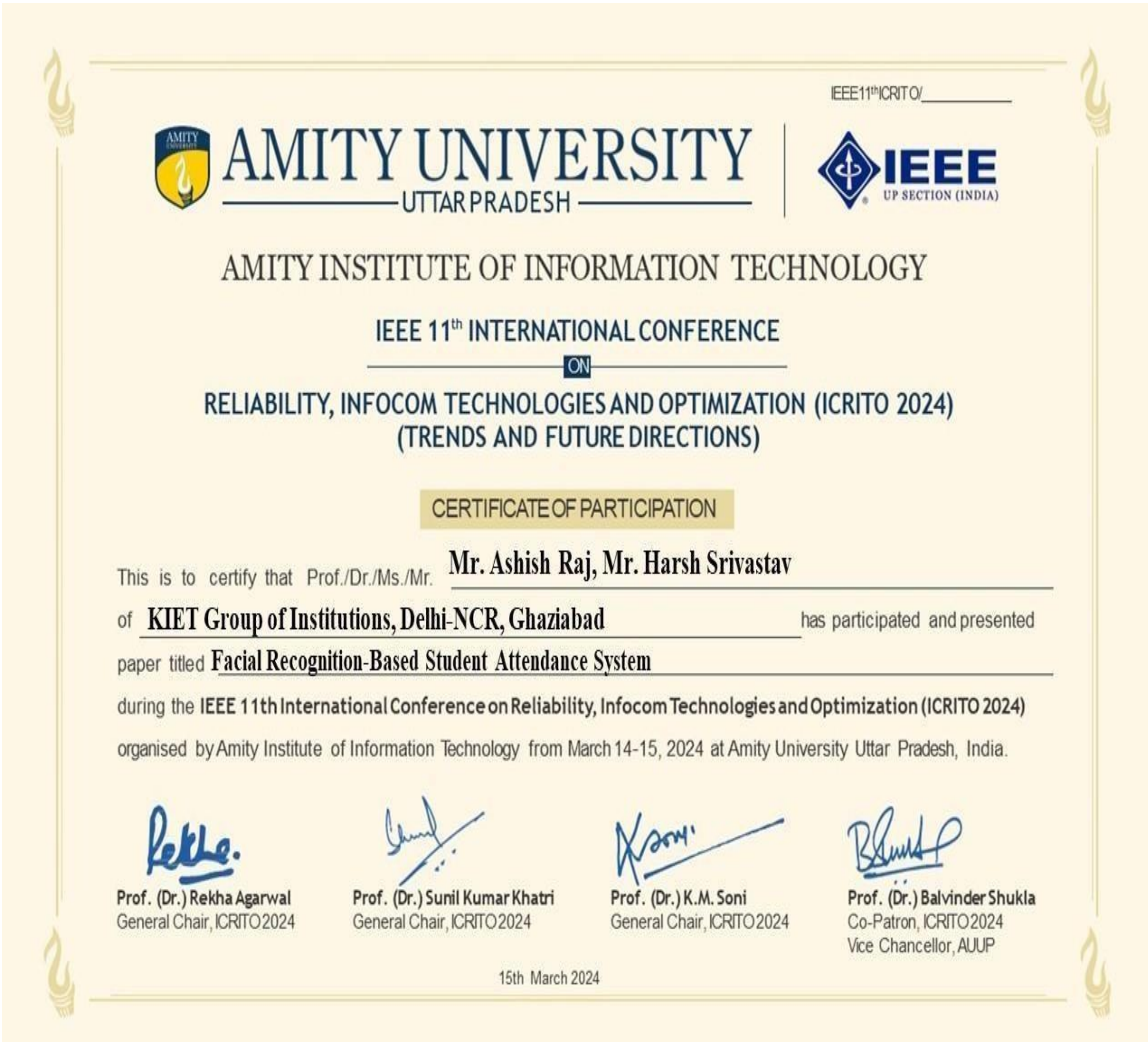
Secondary Subject Areas: Not Entered
Submission Files: Updated research paper_3.pdf (307 Kb, Sat, 10 Feb 2024 13:17:02 GMT)

Submission Questions Response: Not Entered

Thanks,
CMT team.



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IEEE 11th INTERNATIONAL CONFERENCE

ON

RELIABILITY, INFOCOM TECHNOLOGIES AND OPTIMIZATION (ICRITO 2024)
(TRENDS AND FUTURE DIRECTIONS)

CERTIFICATE OF PARTICIPATION

This is to certify that Prof./Dr./Ms./Mr. **Mr. Ashish Raj, Mr. Harsh Srivastav**
of **KIET Group of Institutions, Delhi-NCR, Ghaziabad** has participated and presented
paper titled **Facial Recognition-Based Student Attendance System**
during the **IEEE 11th International Conference on Reliability, Infocom Technologies and Optimization (ICRITO 2024)**
organised by Amity Institute of Information Technology from March 14-15, 2024 at Amity University Uttar Pradesh, India.

Prof. (Dr.) Rekha Agarwal
General Chair, ICRITO 2024

Prof. (Dr.) Sunil Kumar Khatri
General Chair, ICRITO 2024

Prof. (Dr.) K.M. Soni
General Chair, ICRITO 2024

Prof. (Dr.) Balvinder Shukla
Co-Patron, ICRITO 2024
Vice Chancellor, AUUP

15th March 2024

Facial Recognition-Based Student Attendance System

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I. INTRODUCTION

Attendance is a crucial aspect of administration, yet it can be laborious and susceptible to errors. Conventional approaches such as roll calls can be challenging to handle, particularly in situations involving a significant number of students. Numerous institutions have adopted digital techniques, including fingerprint biometrics and scanning of cards. Yet, The specified approaches may result in time-consuming processes and expose students to extended waiting periods.

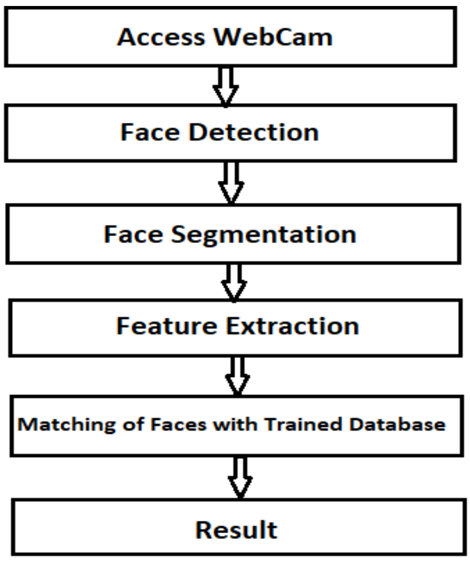

Figure 1 Operating Process of Attendance System

Biometric-based attendance systems employing facial recognition technology have demonstrated their effectiveness. Nonetheless, conventional face recognition methods frequently encounter difficulties in addressing issues such as scalability, diverse poses, lighting conditions, rotation, and obstructions.

To address these issues, a novel framework has been suggested, which employs multiple cameras positioned on the ceiling of a classroom to capture images of every student. The pictures are subjected to analysis through Gabor filters to identify faces, extract features, and perform face recognition. For this purpose, the system employs various methods including the Convolutional Neural Networks (CNN), Support Vector Machine (SVM), and K-nearest neighbor algorithm(KNN). Upon detection, the platform furnishes the identities and enrollment IDs of the students identified in the images who are currently in attendance.

Attendance is recorded in an Excel spreadsheet along with the corresponding date and lecture subject. This system is budget-friendly since it demands minimal hardware resources.

II. LITERATURE REVIEW

The central objective of this paper is to examine various methodologies proposed by scholars and devise a dynamic attendance-tracking solution that addresses the limitations of prior approaches, culminating in the delivery of an ideal solution.

Abate et al. (2020) present a comprehensive review outlining the challenges associated with face recognition in unconstrained environments [1]. Recognizing faces in diverse conditions, characterized by variations in lighting, pose, and expressions, poses significant challenges. The review emphasizes the need for robust solutions to overcome these challenges, providing a foundational understanding of the intricacies involved in face recognition.

Complementing this, Yin et al. (2020) contribute insights through a survey covering a broad spectrum of face recognition techniques [4]. The survey explores challenges such as occlusion, pose variation, and the demand for large-scale annotated datasets. This dual perspective sets the stage for understanding both the challenges and the evolving landscape of face recognition technology.

The application of facial recognition in education, particularly in automated attendance systems, is a growing area of interest. Sharma et al. (2020) present an automated attendance system utilizing facial recognition, showcasing the potential for streamlining attendance tracking in educational institutions [5]. This aligns with the broader trend of integrating technology to enhance administrative processes within academic settings.

Kumar and Arora (2021) contribute to this discussion by exploring the implementation of deep learning techniques in facial recognition-based student attendance systems [6]. The utilization of deep learning, with its ability to automatically learn intricate features from data, marks a significant advancement in improving the accuracy and reliability of attendance tracking.

Additionally, the integration of face recognition with Radio-Frequency Identification (RFID) technology is proposed by Chen et al. (2020) as a means to enhance the efficiency of student attendance systems [7]. This integration aims to address challenges related to manual data entry, providing a more seamless and automated approach to attendance tracking in educational institutions.

Classroom-specific applications of facial recognition technology represent a specialized area within educational settings. Zhang et al. (2020) introduce an intelligent classroom attendance system based on face recognition, showcasing its potential impact on classroom dynamics [8]. This application extends beyond traditional attendance tracking, offering insights into how technology can be seamlessly integrated into the daily operations of educational institutions.

Hassija et al. (2021) propose novel approaches by incorporating deep learning techniques to improve facial recognition in student attendance systems [9]. The focus on deep learning mirrors the larger movement in artificial intelligence, where advanced algorithms are utilized to improve the precision and effectiveness of facial recognition procedures.

The integration of facial recognition technology with smart learning environments emerges as a critical area of exploration. Nguyen et al. (2020) surveyed facial recognition technology in smart cities, shedding light on its potential applications in educational settings [2]. The survey discusses the advances, opportunities, and challenges associated with integrating facial recognition into smart city infrastructure, providing valuable insights into the broader implications of this technology.

Building upon this, Singh and Kaur (2021) propose hybrid face recognition systems specifically designed for student attendance tracking in educational institutions [12]. This hybrid approach combines different techniques, aiming to enhance the accuracy and reliability of attendance systems. The customization for educational contexts underscores the need for tailored solutions that align with the unique requirements of academic environments.

The integration of facial recognition with the Internet of Things (IoT) emerges as an innovative approach for optimizing student attendance systems. Reddy et al. (2021) explore this integration, highlighting the potential for efficient and effective deployment in educational institutions [13]. The combination of facial recognition and IoT addresses real-world challenges, providing a holistic solution for attendance tracking.

While the benefits of facial recognition technology in attendance systems are evident, privacy concerns have become a focal point of discussion. Gao et al. (2021) introduce an unmanned classroom concept, incorporating a face recognition-based automatic attendance system with a privacy protection mechanism [14]. This concept addresses the ethical considerations surrounding facial recognition technology, particularly in educational settings.

The infusion of machine learning techniques into facial recognition systems adds another layer of sophistication. Khalaf and Alwahsh (2020) present an intelligent student attendance system that leverages both facial recognition and machine learning, showcasing advancements in the field [15]. Machine learning contributes to the intelligence of the system, enabling adaptive and context-aware attendance tracking.

The exploration of facial feature transformation through evolutionary methods introduces a unique perspective. Xu et al. (2021) propose the Face Transformer, an evolutionary transformation for facial beauty prediction [16]. While not directly related to attendance tracking, this research provides insights into facial feature analysis, which may have implications for improving the accuracy and robustness of facial recognition systems.

Continuing on the theme of facial feature analysis, the prediction of facial beauty through evolutionary transformation provides transformative insights into facial characteristics [16]. Although not directly tied to attendance tracking, this research broadens our understanding of facial recognition technologies and their potential applications.

The literature review concludes with a comprehensive survey by Kumar and Kaur (2020), focusing on the application of face recognition in smart learning environments [17]. This survey encapsulates the broader landscape of facial recognition in education, providing insights into its potential impact on attendance tracking and overall educational practices.

III. PROPOSED SYSTEM

A. Architecture

The proposed attendance system is meticulously designed to be user-friendly, straightforward, and easily manageable, catering to the needs of educators and administrators alike. Central to its operation is a comprehensive database housing students' facial images alongside their essential details, including names, enrollment numbers, and enrolled courses. Implementation requires the strategic installation of multiple cameras, the quantity contingent upon the dimensions of the classroom, strategically positioned on the ceiling to provide optimal coverage of the entire learning space. These cameras operate in tandem, capturing multiple images throughout the lecture duration, thus augmenting the system's efficacy. In instances where one camera fails to capture a student's face due to unfavorable positioning or occlusion, redundancy is ensured as another camera seamlessly records their attendance.

The system's robustness is underscored by its ability to navigate the diverse array of facial expressions and poses adopted by students. While challenges may arise in detecting faces in less-than-ideal positions, subsequent image captures effectively mitigate these obstacles. Upon activation initiated by the instructor through a simple click of the start button, the system embarks on the face detection process. Recognized faces extracted from the images captured across all cameras at varying intervals are meticulously cross-referenced with the stored student images meticulously cataloged within the database. Upon identification of a match, indicative of successful face recognition, the system proceeds to meticulously log the student's attendance. This log comprises crucial information, including the student's enrollment number and full name, meticulously cataloged within an Excel spreadsheet for easy reference and record-keeping purposes.

An inherent challenge of employing multiple cameras and capturing numerous instances lies in the increased probability of encountering duplicate faces. To address this issue, the system is equipped with sophisticated algorithms aimed at producing cohesive outcomes by discerning and disregarding redundant instances of a student's face. This meticulous approach ensures that each student receives only one attendance record per lecture, thus upholding the integrity and accuracy of the attendance tracking process.

The flowchart illustrating the proposed system is provided below.

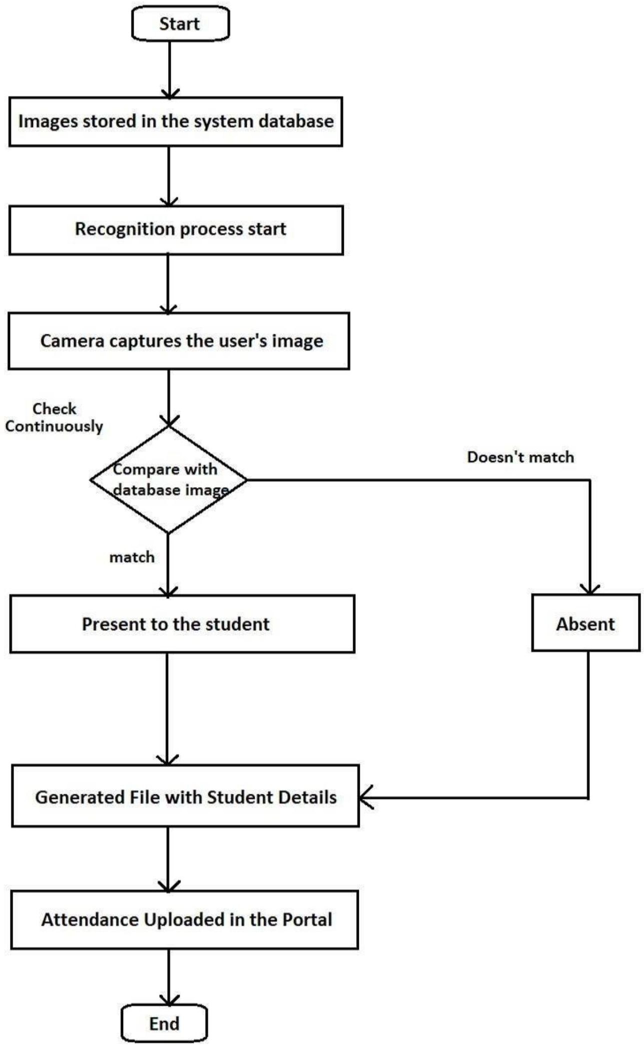

Figure 2. Flow Chart

B. Methodology

To develop an advanced attendance management system, it is essential to follow several steps meticulously to guarantee a successful result. The following steps are outlined as follows::

- Creating a database
- Improving image quality
- Detecting faces
- Extracting features
- Recognizing faces
- Removing redundancies
- Generating reports

Creating a database

A database will be established during student enrollment to store basic information like name, ID number, course, semester subjects, and a student's captured image, which will be used for training purposes. The system will capture a single image of the student for this purpose. The proposed system will utilize the images stored in the database to identify and recognize the faces of all students present during a lecture.

Improving image quality

In a classroom, if a student moves, the camera may capture a blurred image. However, using Generative Adversarial Networks (GANs), the image's quality can be improved. GANs are well-known for their ability to preserve texture details in images, generate outputs that closely resemble real-world features, and create visually convincing results.

Detecting faces

To detect faces, 70 facial landmarks are taken into account. These landmarks help in detecting faces using Haar classifiers. Haar classifiers depend on artificial intelligence methodologies, whereby a cascade model undergoes training utilizing an extensive assortment of affirmative and negative visual data. Subsequently, this function is employed on additional images to identify faces. These classifiers are generated by calculating the difference between the cumulative pixel values under the black and white areas. Initially, it was considered challenging to implement 6000 features for each window frame. Consequently, features were consolidated into stages termed cascades within a classifier.

To eliminate redundant features and select only appropriate ones, AdaBoost is used. These selected attributes, known as weak classifiers, are combined with weights to form a face detection method. AdaBoost is employed to create a linear combination of weak classifiers, resulting in the creation of a strong classifier.

Extracting features

Utilizing Gabor filters at various angles is a vital step in extracting distinct features from facial images. This process is essential because an effective feature extractor should choose a function that remains unaffected by occlusion, lighting conditions, surrounding context, and changes in pose. To address spatial distortions resulting from variations in position and lighting, 2D Gabor filters are utilized.

Recognizing faces

Three face recognition algorithms, namely Support vector machine(SVM), Convolutional neural networks(CNN), and K-nearest neighbor (KNN), were assessed in terms of their accuracy, resilience, and computational efficiency.

A. K-Nearest Neighbor Algorithm

KNN, a machine learning algorithm, is commonly known as a lazy learning or memory-based technique. This occurs because it merely retains the understandings derived from the training instances without forming a model based on them. The Euclidean distance metric is commonly employed in KNN (K-Nearest Neighbors) to ascertain the positions of data points. To categorize an object using the KNN (K-Nearest Neighbors) algorithm, the process involves determining the predominant class among its closest neighbors through a majority vote. The object is then assigned to the class that is most frequently represented among its k nearest neighbors, where k represents a specified positive integer. If the value of k is 1, then the object is allocated to the class of its closest neighbor.

B. Convolutional Neural Networks

CNNs, also known as Convolutional Neural Networks, possess the ability to extract an extensive range of features from images, making them a highly proficient tool. This approach can also be used to recognize faces. To generate features of the face captured in RGB color format, Convolutional Neural Networks use 70 facial reference points resulting in 128-dimensional encodings. The process involves comparing faces by matching their respective encodings. It is possible to modify the tolerance level to adjust the level of strictness in the face comparison process.

Removing redundancies

The system is equipped with several cameras that have the ability to capture the face of a student in various images. During a lecture, the marking of attendance for a student will be done only based on one face to avoid any repetition.

Generating reports

During a lecture, student attendance is marked in an Excel sheet by putting a tick next to their name and enrollment number for face recognition reports.

IV. RESULT

The system was subjected to testing with three distinct algorithms, with the KNN algorithm demonstrating the highest accuracy rate at 96.18%. Testing scenarios encompassed diverse conditions, including varying levels of illumination, head movements, facial expressions, and distances between the camera and students. The system successfully recognized faces with and without beards, as well as individuals wearing spectacles, even differentiating between faces with a two-year age gap. The KNN algorithm attained a 97% accuracy rate, while CNN and SVM achieved accuracies of 95% and 88%, respectively. The CNN model was found to have the least complexity among other models, whereas SVM exhibited the highest complexity. The proposed and tested system accurately identified the presence of all 60 students in a classroom containing up to 200 real-time images. The system proposed and tested successfully marked all 60 students present in a classroom containing a maximum of 200 real-time images.

Our proposed system's outcome is depicted in the illustration presented below.

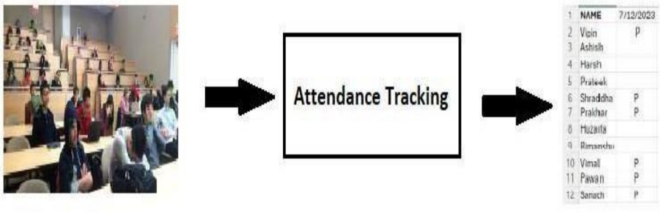

Figure 3. Proposed System

V. Overall Result

Upon examination of the given conditions and scenarios, we assess the algorithm's overall accuracy, recall, precision, time complexity, and F1 score.

The statement above is explained in the table presented below.

Algorithm	KNN	CNN	SVM
Overall Accuracy	96.18	95.53	79.36
Overall Time Complexity	136 seconds	130 seconds	490 seconds
Precision	0.97	0.96	0.73
Recall	0.96	0.95	0.71
F1 Score	0.973	0.963	0.753

Table 1 result

VI. CONCLUSION

The designed system aims to produce precise outcomes while minimizing computational hurdles. It offers high cost-effectiveness and requires minimal manual intervention. The integration of Gabor filters has significantly enhanced accuracy. Face recognition employs three distinct algorithms: Support vector machine (SVM), convolutional neural networks (CNN), and K-nearest neighbor (KNN). Within these choices, the K-nearest neighbor proves to be the most accurate with a success rate of 92%. CNN exhibits lower computational complexity compared to the less efficient SVM algorithm.

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Plagiarism Report

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I. INTRODUCTION

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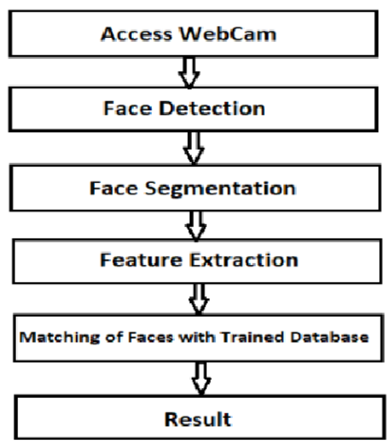

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To address these issues, a novel framework has been suggested, which employs multiple cameras positioned on the ceiling of a classroom to capture images of every student. The pictures are subjected to analysis through Gabor filters to identify faces, extract features, and perform face recognition. For this purpose, the system employs various methods including the Convolutional Neural Networks (CNN), Support Vector Machine (SVM), and K-nearest neighbor algorithm(KNN). Upon detection, the platform furnishes the identities and enrollment IDs of the students identified in the images who are currently in attendance.

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Additionally, the integration of face recognition with Radio-Frequency Identification (RFID) technology is proposed by Chen et al. (2020) as a means to enhance the efficiency of student attendance systems [7]. This integration aims to address challenges related to manual data entry, providing a more seamless and automated approach to attendance tracking in educational institutions.

Classroom-specific applications of facial recognition technology represent a specialized area within educational settings. Zhang et al. (2020) introduce an intelligent classroom attendance system based on face recognition, showcasing its potential impact on classroom dynamics [8]. This application extends beyond traditional attendance tracking, offering insights into how technology can be seamlessly integrated into the daily operations of educational institutions.

Hassija et al. (2021) propose novel approaches by incorporating deep learning techniques to improve facial recognition in student attendance systems [9]. The focus on deep learning mirrors the larger movement in artificial intelligence, where advanced algorithms are utilized to improve the precision and effectiveness of facial recognition procedures.

The integration of facial recognition technology with smart learning environments emerges as a critical area of exploration. Nguyen et al. (2020) surveyed facial recognition technology in smart cities, shedding light on its potential applications in educational settings [2]. The survey discusses the advances, opportunities, and challenges associated with integrating facial recognition into smart city infrastructure, providing valuable insights into the broader implications of this technology.

Building upon this, Singh and Kaur (2021) propose hybrid face recognition systems specifically designed for student attendance tracking in educational institutions [12]. This hybrid approach combines different techniques, aiming to enhance the accuracy and reliability of attendance systems. The customization for educational contexts underscores the need for tailored solutions that align with the unique requirements of academic environments.

The integration of facial recognition with the Internet of Things (IoT) emerges as an innovative approach for optimizing student attendance systems. Reddy et al. (2021) explore this integration, highlighting the potential for efficient and effective deployment in educational institutions [13]. The combination of facial recognition and IoT addresses real-world challenges, providing a holistic solution for attendance tracking.

While the benefits of facial recognition technology in attendance systems are evident, privacy concerns have become a focal point of discussion. Gao et al. (2021) introduce an unmanned classroom concept, incorporating a face recognition-based automatic attendance system with a privacy protection mechanism [14]. This concept addresses the ethical considerations surrounding facial recognition technology, particularly in educational settings.

The infusion of machine learning techniques into facial recognition systems adds another layer of sophistication. Khalaf and Alwahsh (2020) present an intelligent student attendance system that leverages both facial recognition and machine learning, showcasing advancements in the field [15]. Machine learning contributes to the intelligence of the system, enabling adaptive and context-aware attendance tracking.

The exploration of facial feature transformation through evolutionary methods introduces a unique perspective. Xu et al. (2021) propose the Face Transformer, an evolutionary transformation for facial beauty prediction [16]. While not directly related to attendance tracking, this research provides insights into facial feature analysis, which may have implications for improving the accuracy and robustness of facial recognition systems.

Continuing on the theme of facial feature analysis, the prediction of facial beauty through evolutionary transformation provides transformative insights into facial characteristics [16]. Although not directly tied to attendance tracking, this research broadens our understanding of facial recognition technologies and their potential applications.

The literature review concludes with a comprehensive survey by Kumar and Kaur (2020), focusing on the application of face recognition in smart learning environments [17]. This survey encapsulates the broader landscape of facial recognition in education, providing insights into its potential impact on attendance tracking and overall educational practices.

III. PROPOSED SYSTEM

A. *Architecture*

The proposed attendance system is meticulously designed to be user-friendly, straightforward, and easily manageable, catering to the needs of educators and administrators alike. Central to its operation is a comprehensive database housing students' facial images alongside their essential details, including names, enrollment numbers, and enrolled courses. Implementation requires the strategic installation of multiple cameras, the quantity contingent upon the dimensions of the classroom, strategically positioned on the ceiling to provide optimal coverage of the entire learning space. These cameras operate in tandem, capturing multiple images throughout the lecture duration, thus augmenting the system's efficacy. In instances where one camera fails to capture a student's face due to unfavorable positioning or occlusion, redundancy is ensured as another camera seamlessly records their attendance.

The system's robustness is underscored by its ability to navigate the diverse array of facial expressions and poses adopted by students. While challenges may arise in detecting faces in less-than-ideal positions, subsequent image captures effectively mitigate these obstacles. Upon activation initiated by the instructor through a simple click of the start button, the system embarks on the face detection process. Recognized faces extracted from the images captured across all cameras at varying intervals are meticulously cross-referenced with the stored student images meticulously cataloged within the database. Upon identification of a match, indicative of successful face recognition, the system proceeds to meticulously log the student's attendance. This log comprises crucial information, including the student's enrollment number and full name, meticulously cataloged within an Excel spreadsheet for easy reference and record-keeping purposes.

An inherent challenge of employing multiple cameras and capturing numerous instances lies in the increased probability of encountering duplicate faces. To address this issue, the system is equipped with sophisticated algorithms aimed at producing cohesive outcomes by discerning and disregarding redundant instances of a student's face. This meticulous approach ensures that each student receives only one attendance record per lecture, thus upholding the integrity and accuracy of the attendance tracking process.

The flowchart illustrating the proposed system is provided below.

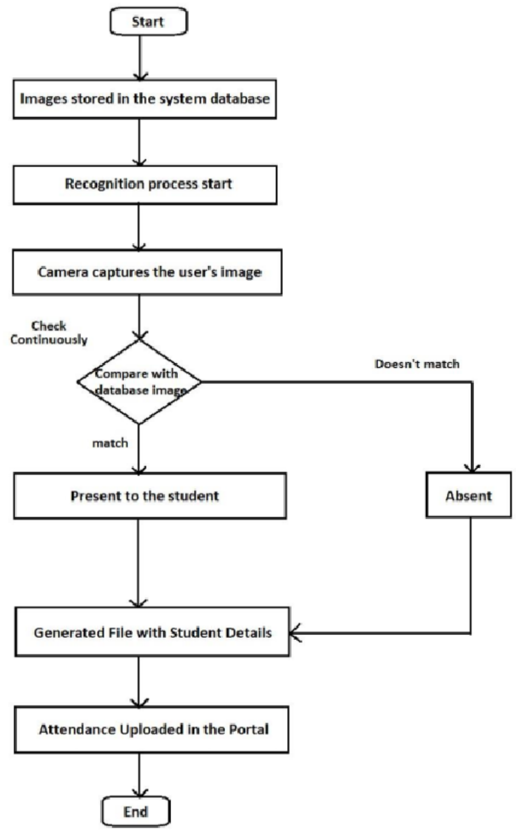

Figure 2. Flow Chart

B. *Methodology*

To develop an advanced attendance management system, it is essential to follow several steps meticulously to guarantee a successful result. The following steps are outlined as follows::

- Creating a database
- Improving image quality
- Detecting faces
- Extracting features
- Recognizing faces
- Removing redundancies
- Generating reports

Creating a database

A database will be established during student enrollment to store basic information like name, ID number, course, semester subjects, and a student's captured image, which will be used for training purposes. The system will capture a single image of the student for this purpose. The proposed system will utilize the images stored in the database to identify and recognize the faces of all students present during a lecture.

Improving image quality

In a classroom, if a student moves, the camera may capture a blurred image. However, using Generative Adversarial Networks (GANs), the image's quality can be improved. GANs are well-known for their ability to preserve texture details in images, generate outputs that closely resemble real-world features, and create visually convincing results.

Detecting faces

To detect faces, 70 facial landmarks are taken into account. These landmarks help in detecting faces using Haar classifiers. Haar classifiers depend on artificial intelligence methodologies, whereby a cascade model undergoes training utilizing an extensive assortment of affirmative and negative visual data. Subsequently, this function is employed on additional images to identify faces. These classifiers are generated by calculating the difference between the cumulative pixel values under the black and white areas. Initially, it was considered challenging to implement 6000 features for each window frame. Consequently, features were consolidated into stages termed cascades within a classifier.

To eliminate redundant features and select only appropriate ones, AdaBoost is used. These selected attributes, known as weak classifiers, are combined with weights to form a face detection method. AdaBoost is employed to create a linear combination of weak classifiers, resulting in the creation of a strong classifier.

Extracting features

Utilizing Gabor filters at various angles is a vital step in extracting distinct features from facial images. This process is essential because an effective feature extractor should choose a function that remains unaffected by occlusion, lighting conditions, surrounding context, and changes in pose. To address spatial distortions resulting from variations in position and lighting, 2D Gabor filters are utilized.

Recognizing faces

Three face recognition algorithms, namely Support vector machine(SVM), Convolutional neural networks(CNN), and K-nearest neighbor (KNN), were assessed in terms of their accuracy, resilience, and computational efficiency.

A. *K-Nearest Neighbor Algorithm*

KNN, a machine learning algorithm, is commonly known as a lazy learning or memory-based technique. This occurs because it merely retains the understandings derived from the training instances without forming a model based on them. The Euclidean distance metric is commonly employed in KNN (K-Nearest Neighbors) to ascertain the positions of data points. To categorize an object using the KNN (K-Nearest Neighbors) algorithm, the process involves determining the predominant class among its closest neighbors through a majority vote. The object is then assigned to the class that is most frequently represented among its k nearest neighbors, where k represents a specified positive integer. If the value of k is 1, then the object is allocated to the class of its closest neighbor.

B. *Convolutional Neural Networks*

CNNs, also known as Convolutional Neural Networks, possess the ability to extract an extensive range of features from images, making them a highly proficient tool. This approach can also be used to recognize faces. To generate features of the face captured in RGB color format, Convolutional Neural Networks use 70 facial reference points resulting in 128-dimensional encodings. The process involves comparing faces by matching their respective encodings. It is possible to modify the tolerance level to adjust the level of strictness in the face comparison process.

Removing redundancies

The system is equipped with several cameras that have the ability to capture the face of a student in various images. During a lecture, the marking of attendance for a student will be done only based on one face to avoid any repetition.

Generating reports

During a lecture, student attendance is marked in an Excel sheet by putting a tick next to their name and enrollment number for face recognition reports.

IV. RESULT

The system was subjected to testing with three distinct algorithms, with the KNN algorithm demonstrating the highest accuracy rate at 96.18%. Testing scenarios encompassed diverse conditions, including varying levels of illumination, head movements, facial expressions, and distances between the camera and students. The system successfully recognized faces with and without beards, as well as individuals wearing spectacles, even differentiating between faces with a two-year age gap. The KNN algorithm attained a 97% accuracy rate, while CNN and SVM achieved accuracies of 95% and 88%, respectively. The CNN model was found to have the least complexity among other models, whereas SVM exhibited the highest complexity. The proposed and tested system accurately identified the presence of all 60 students in a classroom containing up to 200 real-time images. The system proposed and tested successfully marked all 60 students present in a classroom containing a maximum of 200 real-time images.

Our proposed system's outcome is depicted in the illustration presented below.

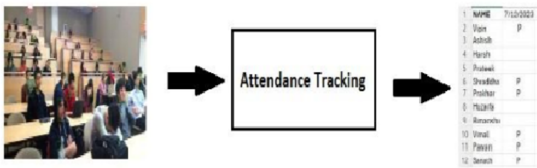

Figure 3. Proposed System

V. Overall Result

Upon examination of the given conditions and scenarios, we assess the algorithm's overall accuracy, recall, precision, time complexity, and F1 score.

The statement above is explained in the table presented below.

Algorithm	KNN	CNN	SVM
Overall Accuracy	96.18	95.53	79.36
Overall Time Complexity	136 seconds	130 seconds	490 seconds
Precision	0.97	0.96	0.73
Recall	0.96	0.95	0.71
F1 Score	0.973	0.963	0.753

Table 1 result

VI. Conclusion

The designed system aims to produce precise outcomes while minimizing computational hurdles. It offers high cost-effectiveness and requires minimal manual intervention. The integration of Gabor filters has significantly enhanced accuracy. Face recognition employs three distinct algorithms: Support vector machine (SVM), convolutional neural networks (CNN), and K-nearest neighbor (KNN). Within these choices, the K-nearest neighbor proves to be the most accurate with a success rate of 92%. CNN exhibits lower computational complexity compared to the less efficient SVM algorithm.

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