
FACE RECOGNITION BASED ATTENDANCE SYSTEM USING HAAR CASCADE AND LOCAL BINARY PATTERN HISTOGRAM ALGORITHM

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ABSTRACT

An attendance system is crucial for monitoring student presence in classes, with various methods available such as biometric, RFID card, face recognition, and traditional paper-based systems. Among these, face recognition stands out for its security and efficiency. This research focuses on enhancing the face recognition attendance system's accuracy by minimizing false positives through a confidence threshold based on the Euclidean distance metric. Because it can handle color changes well, the Local Binary Pattern Histogram (LBPH) algorithm works better than other distance-based methods like Eigenfaces and Fisherfaces. Haar cascades are used for face identification because they are reliable, and LBPH is used for classification. It works 77% of the time to recognize kids and 28% of the time to give the wrong answer. Notably, it can spot students even if they have differences, like glasses or facial hair. Face recognition for unknown people is about 60%, with 14% and 30% false positives with and without the barrier, respectively.

Keywords - Face detection, Face recognition, LBPH algorithm, Harr Cascade.

1. INTRODUCTION

Automation, driven by computer software technologies, revolutionizes machine control and processes, enhancing accuracy and advancing livelihoods in the modern age. Among these innovations, automated attendance systems represent a significant leap forward, replacing antiquated, labor-intensive methods of attendance marking. Traditional paper-based systems are plagued by time constraints and complexity, particularly as class sizes grow. However, automated systems eliminate these challenges, saving time and bolstering security by mitigating attendance proxying.

The main goal of our suggested system is to create an attendance system based on face recognition that has a low rate of false positives when finding new people. This will be done by using thresholds and storing images. To do this, we use the LBPH algorithm for face recognition and the Haar cascade for face identification, which is known for being very reliable. LBPH's resilience to monotonic grayscale transformations ensures reliable performance across varying conditions.

Notably, our system goes beyond merely recording attendance for known individuals. It detects and stores images of any unrecognized individuals present, enhancing security measures and providing valuable data for future reference. By incorporating this functionality, we bolster the system's effectiveness in environments where unfamiliar persons may attempt unauthorized access.

In summary, our automation-driven approach to attendance management not only streamlines processes but also enhances security measures through advanced face recognition technology. By minimizing false positives and capturing images of unknown individuals, our system represents a significant advancement in attendance monitoring, catering to the evolving needs of modern institutions and organizations.

Paper-based attendance methods take a lot of time and can be wrong, especially when there are a lot of students.

Manual attendance marking requires significant labor effort and becomes increasingly complex with larger student populations.

Students, educators, and administrative staff are impacted by inefficient attendance tracking methods, leading to potential inaccuracies and administrative burdens.

Inaccurate attendance records may lead to discrepancies in student attendance records, affecting academic performance evaluations and potentially compromising security by enabling attendance fraud.

Create an attendance system that uses face recognition and has a lower false-positive rate by setting a benchmark and using strong face detection and recognition algorithms to make tracking attendance easier and improve security.

2. LITERATURE SURVEY

Attendance management systems play a crucial role in various domains, offering automated solutions for tracking and recording attendance. This literature survey explores existing research and developments in automatic attendance management systems, focusing on different modalities such as face recognition, RFID, biometrics, and iris recognition.

Face recognition technology has gained popularity due to its non-intrusive nature and high accuracy. In 2013, Joseph and Zacharia showed a "Automatic Attendance Management System Using Face Recognition" [1]. Samet and Tanriverdi (2017) also came up with the idea of a "Face Recognition-Based Mobile Automatic Classroom Attendance Management System" [11]. These systems utilize facial features for attendance tracking, offering convenient and efficient solutions for various educational and organizational settings.

Ononiwu and Okorafor (2012) introduced an "RFID-based Attendance System with Automatic Door Unit" [2]. Their system utilizes radio-frequency identification (RFID) technology for attendance tracking, offering real-time monitoring and access control functionalities. RFID-based systems provide a cost-effective and scalable solution for attendance

Shoewu and Idowu (2012) developed an "Attendance Management System using Biometrics" [3]. Their system uses biometric identification methods, like fingerprint or hand vein recognition, to keep track of who is there and when. In the same way, Khatun et al. (2015) suggested a "Iris Recognition-Based Attendance Management System" [4], which would be a very effective and safe way to identify people. There is a "Wireless Attendance Management System based on Iris Recognition" [12] that Kadry and Smaili created in 2010. Iris recognition technology provides a robust and reliable solution for attendance management, particularly in scenarios where high security and accuracy are paramount. Their system offers seamless integration with wireless communication technologies for enhanced accessibility.

In 2004, Ahonen, Hadid, and Pietikainen came up with the idea of "Face Recognition with Local Binary Patterns" [5], which showed how well local binary patterns (LBP) can be used to capture face features. Face recognition tasks have shown promise for LBP-based methods, which are fast to compute and don't change when lighting or facial expressions change.

In 2014, Ozdil and Ozbilen did a study called "Comparison of Face Recognition Algorithms" [6]. The results showed the pros and cons of different face recognition methods. Their study contributes to understanding the performance characteristics of different algorithms, aiding researchers and practitioners in selecting appropriate solutions for specific applications.

Ahonen, Hadid, and Pietikainen (2006) further explored the concept of "Face Description with Local Binary Patterns" [7], focusing on the application of LBP in facial feature description. Their work demonstrates the effectiveness of LBP descriptors in capturing discriminative facial features, facilitating accurate face recognition in challenging conditions.

Overall, the literature survey highlights the diverse approaches and technologies employed in automatic attendance management systems. From face recognition and biometrics to RFID and iris recognition, each modality offers unique advantages and applications in attendance tracking. By leveraging these technologies, organizations and institutions can streamline their attendance management processes, improve efficiency, and enhance security.

3. METHODOLOGY

i) Proposed Work:

The suggested computer system for managing attendance will use both the Haar cascade and the LBPH algorithm to find faces and recognize them. For human input, it has a Graphical User Interface (GUI) made with the Python package Tkinter. The system can do many things, such as taking pictures and records of students for a database, using pictures from the database and a live camera feed to train staff, and starting real-time tracking of people who walk into the classroom. Upon entry, the system detects faces from the camera feed, preprocesses the images for subsequent analysis, and facilitates attendance tracking. By automating the process of recognizing students as they enter the classroom, the system ensures efficient and accurate attendance management. Moreover, it provides a user-friendly interface through Tkinter, enhancing ease of operation for users. This streamlined approach to attendance tracking optimizes classroom management, offering a robust solution for educational institutions seeking efficient attendance management systems.

ii) System Architecture:

There are three major parts to the automatic attendance management system: the user interface, face identification, and face recognition. Haar cascade is used by the face recognition tool to find faces in the live camera feed. Detected faces

are then passed to the face recognition module, which employs the LBPH algorithm to recognize individuals based on pre-trained images stored in the database. Upon recognition, the system updates attendance records accordingly. The user interface, built using Tkinter, provides a graphical platform for user interaction, facilitating functionalities such as capturing student images, database storage, and real-time tracking. Additionally, the system includes modules for image preprocessing and database management to ensure seamless operation. This modular architecture enables efficient and accurate attendance tracking while offering a user-friendly interface for ease of use.

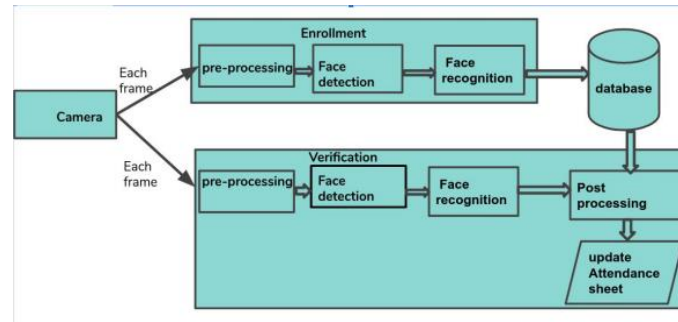


Fig 1 System Architecture

iii) Dataset Collection:

For the development of our automated attendance management system, we undertook the task of creating our own dataset due to the unavailability of suitable datasets online. Our dataset comprises 60 images for each of the 18 individuals involved in the project, resulting in a total of 1,080 images. These images were captured under various lighting conditions, angles, and facial expressions to ensure robustness and accuracy in face recognition. Additionally, to test the system's ability to recognize unknown individuals, we included an additional set of 10 individuals for testing purposes. These individuals were not part of the initial dataset used for training.

During the dataset collection phase, we employed a consistent protocol to capture images, ensuring uniformity across the dataset. Images were captured using a high-resolution camera to maintain image quality and fidelity. This comprehensive dataset enabled thorough training of the face recognition algorithm and rigorous testing to evaluate the system's performance in real-world scenarios, such as live real-time video attendance tracking.

iv) Image Processing:

Image processing in our automated attendance management system involves several key steps to extract and preprocess facial images before passing them to the face recognition module.

The first step is face extraction, where the Haar cascade algorithm is applied to detect and localize faces within the captured images. Once faces are detected, the next step involves cropping and isolating the facial regions from the background. This ensures that only the relevant portions of the image containing faces are retained for further processing.

After extraction, the extracted facial images are resized or reshaped to a standardized size. Reshaping ensures consistency in the dimensions of the facial images, which is essential for accurate feature extraction and comparison during the recognition phase. Resizing also helps reduce computational complexity and processing time by standardizing the input size for the face recognition algorithm.

Additionally, preprocessing techniques such as normalization and histogram equalization may be applied to enhance the quality and contrast of the facial images. Normalization ensures that pixel intensities are scaled to a consistent range, while histogram equalization improves image contrast by redistributing pixel values.

By performing these image processing steps, we ensure that the input data provided to the face recognition algorithm is standardized, optimized, and devoid of irrelevant information. This enhances the system's ability to accurately identify and recognize individuals, even in varying lighting conditions and facial orientations.

v) Training & Testing:

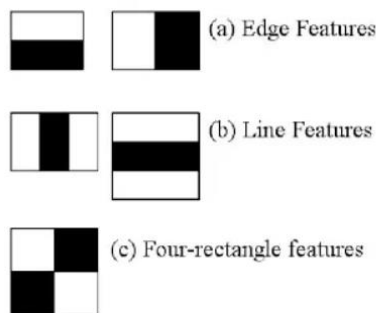
In our automated attendance management system, the training and testing phases play crucial roles in the development and evaluation of the face recognition algorithm.

During the training phase, the system utilizes the dataset comprising 60 images for each of the 18 individuals. These images are fed into the face recognition algorithm, which extracts relevant facial features and learns to associate them with the corresponding individuals' identities. This process involves encoding facial characteristics into a mathematical representation, often referred to as a face embedding or feature vector. The algorithm then uses machine learning techniques, such as supervised learning, to optimize its ability to accurately classify and recognize faces.

Following training, the system enters the testing phase, where its performance is evaluated using a separate set of images. This evaluation includes assessing the system's accuracy in recognizing known individuals from the training dataset as well as its ability to correctly identify unknown persons not present in the training data. By testing the system on diverse scenarios and datasets, including live real-time video streams, we validate its robustness and effectiveness in real-world applications. This iterative process of training and testing ensures continual refinement and improvement of the face recognition algorithm, leading to enhanced performance and reliability in attendance tracking.

vi) Haar Cascade:

Haar cascade is a method that can find things in pictures, no matter how small or large they are or where they are in the picture. It's not hard to understand this method, and it can work in real time. A haar-cascade device can be taught to find different things, like cars, bikes, houses, plants, and more. Haar cascade can sort things into groups. It sorts the data points into two groups: positive data points are part of the thing we found, and negative data points are not. Haar cascades work well in real time and are quick. The Haar cascade method is not as good at finding objects as newer methods.



Types of Haar features. (Image Source)

Fig 2 Types of Haar features

In our project, Haar cascade is the chosen method for face detection due to its robustness and efficiency. Developed by Viola and Jones, Haar cascade utilizes a cascade of classifiers to detect objects within images. This approach involves analyzing features like edges, lines, and textures in a hierarchical manner, facilitating rapid identification of regions of interest, such as human faces. One of the primary advantages of Haar cascade is its ability to handle challenging conditions such as varying lighting, different facial orientations, and partial occlusions. This versatility makes it well-suited for real-world applications like attendance tracking systems, where environmental factors can vary widely.

Moreover, Haar cascade offers fast processing speeds, making it particularly suitable for real-time applications such as monitoring individuals entering a classroom. Its efficient performance ensures that face detection occurs promptly, laying a strong foundation for subsequent face recognition processes. By integrating Haar cascade into our system, we can achieve accurate and reliable face detection, enhancing the overall performance of the attendance management system. This robust and efficient approach ensures that the system can effectively track attendance in diverse settings and conditions.

4. RESULTS

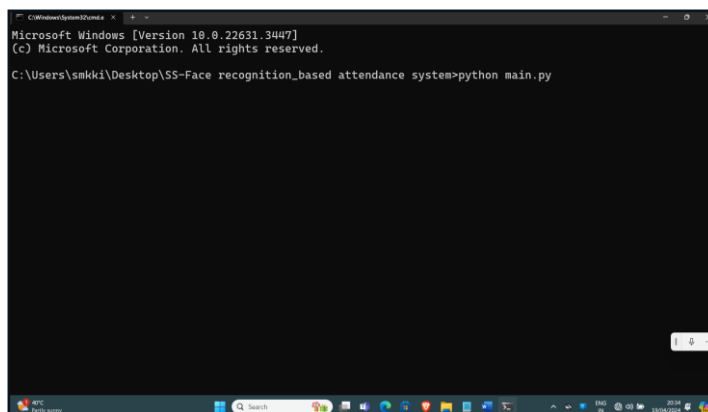


Fig : 4.1 command line execution of main.py

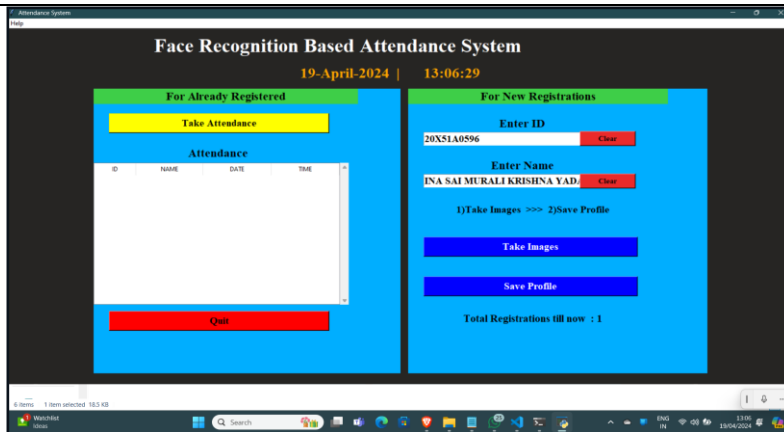


Fig 4.2 : Registration of Student with student details

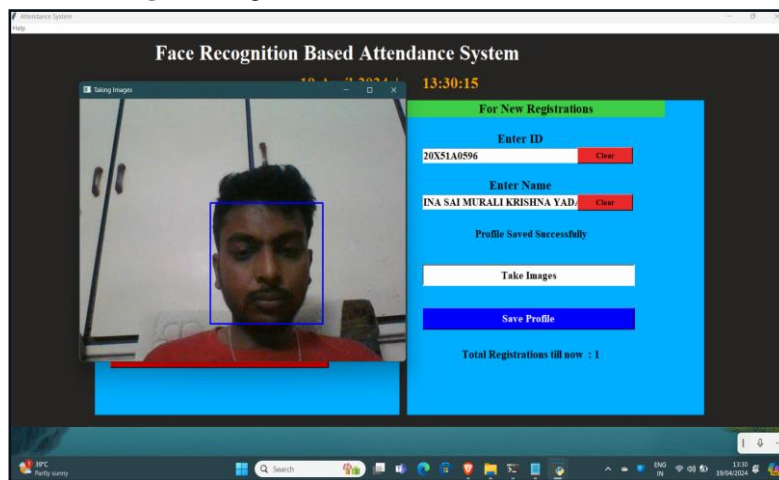


Fig 4.3 : Taking Student face Details for face

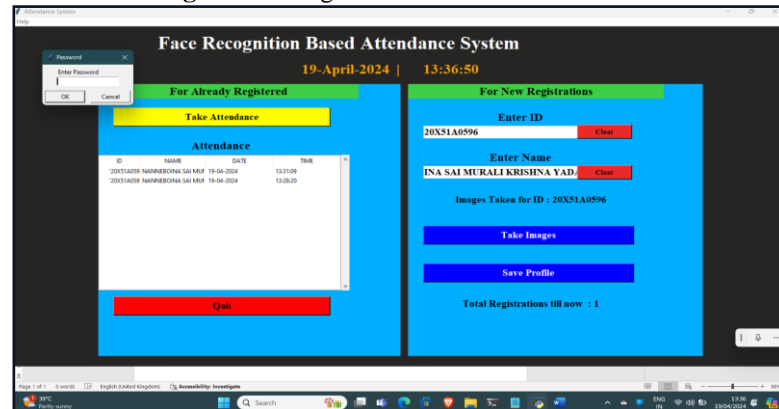


Fig 4.4 : Entering password for student registration details

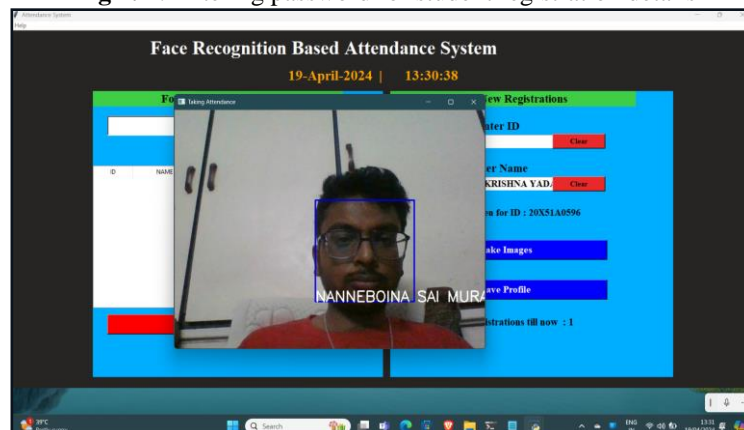


Fig 4.5 : face Detection of Student

5. CONCLUSION

Last but not least, using LBPH for face recognition in our system has worked well to correctly identify students, even when they make mistakes like wearing glasses or growing a beard. One big problem, though, is that the collection isn't very big, which could make the recognition results less accurate. To fix this, future work could focus on adding to and improving the information to make the system work better and be more reliable generally.

Additionally, increasing Haar cascade classifiers by combining new training cases could help increase the rate of identification of unknown people, which would make the system better at recognizing new people who join the class. Additionally, incorporating a system alert mechanism, comprising both voice and visual alerts, in the event of an intruder detection, would further bolster the security measures of the attendance management system.

Overall, while our system demonstrates effectiveness in recognizing students despite facial variations, continued research and development efforts are essential to refine and optimize the system for enhanced accuracy, reliability, and security in real-world applications.

6. FUTURE SCOPE

Future efforts should focus on expanding the dataset to improve recognition accuracy. Enhancements to Haar cascade classifiers and incorporation of alert mechanisms for intruder detection would bolster security. Continued research is vital for refining and optimizing the system, ensuring enhanced accuracy, reliability, and security in real-world applications.

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