Attendance Management System using Face Recognition

A Project Report

submitted in partial fulfillment of the requirements

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by

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ABSTRACT

Problem Statement: Traditional attendance systems often rely on manual methods or biometric techniques like fingerprint or iris scans, which are time-consuming, error-prone, and susceptible to security breaches.

Objective: This project aims to develop an efficient and secure Attendance Management System using Face Recognition technology to automate the attendance process, reducing manual effort and improving accuracy.

Methodology: State-of-the-art face detection and recognition techniques, such as Deep Learning-based models, were employed to accurately identify individuals in real-time video streams. A user-friendly interface was developed to manage the system, view attendance reports, and update student information.

Key Results: The system achieved high accuracy in face recognition, even under varying conditions, and successfully implemented real-time attendance tracking.

Conclusion: The developed Attendance Management System offers a reliable and secure solution for automating the attendance process. By leveraging advanced computer vision and machine learning techniques, the system provides accurate and efficient attendance tracking.

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CHAPTER-1
INTRODUCTION

1.1 Project Objective:

Attendance is prime important for both the teacher and student of an educational organization. So it is very important to keep record of the attendance. The problem arises when we think about the traditional process of taking attendance in class room.

Calling name or roll number of the student for attendance is not only a problem of time consumption but also it needs energy. So an automatic attendance system can solve all above problems.

There are some automatic attendances making system which are currently used by much institution. One of such system is biometric technique and RFID system. Although it is automatic and a step ahead of traditional method it fails to meet the time constraint. The student has to wait in queue for giving attendance, which is time taking.

This project introduces an involuntary attendance marking system, devoid of any kind of interference with the normal teaching procedure. The system can be also implemented during exam sessions or in other teaching activities where attendance is highly essential. This system eliminates classical student identification such as calling name of the student, or checking respective identification cards of the student, which can not only interfere with the ongoing teaching process, but also can be stressful for students during examination sessions. In addition, the students have to register in the database to be recognized. The enrolment can be done on the spot through the userfriendly interface.

1.2 Background:

Face recognition is crucial in daily life in order to identify family, friends or someone we are familiar with. We might not perceive that several steps have actually taken in order to identify human faces. Human intelligence allows us to receive information and interpret the information in the recognition process. We receive information through the image projected into our eyes, by specifically retina in the form of light. Light is a

form of electromagnetic waves which are radiated from a source onto an object and projected to human vision. Robinson-Riegler, G., & Robinson-Riegler, B. (2008) mentioned that after visual processing done by the human visual system, we actually classify shape, size, contour and the texture of the object in order to analyze the information. The analyzed information will be compared to other representations of objects or face that exist in our memory to recognize. In fact, it is a hard challenge to build an automated system to have the same capability as a human to recognize faces. However, we need large memory to recognize different faces, for example, in the Universities, there are a lot of students with different race and gender, it is impossible to remember every face of the individual without making mistakes. In order to overcome human limitations, computers with almost limitless memory, high processing speed and power are used in face recognition systems.

The human face is a unique representation of individual identity. Thus, face recognition is defined as a biometric method in which identification of an individual is performed by comparing real-time capture image with stored images in the database of that person (Margaret Rouse, 2012).

Nowadays, face recognition system is prevalent due to its simplicity and awesome performance. For instance, airport protection systems and FBI use face recognition for criminal investigations by tracking suspects, missing children and drug activities (Robert Silk, 2017). Apart from that, Facebook which is a popular social networking website implement face recognition to allow the users to tag their friends in the photo for entertainment purposes (Sidney Fussell, 2018). Furthermore, Intel Company allows the users to use face recognition to get access to their online account (Reichert, C., 2017). Apple allows the users to unlock their mobile phone, iPhone X by using face recognition (deAgonia, M., 2017).

The work on face recognition began in 1960. Woody Bledsoe, Helen Chan Wolf and Charles Bisson had introduced a system which required the administrator to locate eyes, ears, nose and mouth from images. The distance and ratios between the located features and the common reference points are then calculated and compared. The studies are further enhanced by Goldstein, Harmon, and Lesk in 1970 by using other features such as hair colour and lip thickness to automate the recognition. In 1988, Kirby and Sirovich first suggested principle component analysis (PCA) to solve face recognition problem. Many studies on face recognition were then conducted continuously until today (Ashley DuVal, 2012).

1.3 Problem Statement:

Traditional student attendance marking technique is often facing a lot of trouble. The face recognition student attendance system emphasizes its simplicity by eliminating classical student attendance marking technique such as calling student names or checking respective identification cards. There are not only disturbing the teaching process but also causes distraction for students during exam sessions. Apart from calling names, attendance sheet is passed around the classroom during the lecture sessions. The lecture class especially the class with a large number of students might find it difficult to have the attendance sheet being passed around the class. Thus, face recognition attendance system is proposed in order to replace the manual signing of the presence of students which are burdensome and causes students get distracted in order to sign for their attendance. Furthermore, the face recognition based automated student attendance system able to overcome the problem of fraudulent approach and lecturers does not have to count the number of students several times to ensure the presence of the students.

The paper proposed by Zhao, W et al. (2003) has listed the difficulties of facial identification. One of the difficulties of facial identification is the identification between known and unknown images. In addition, paper proposed by Pooja G.R et al. (2010) found out that the training process for face recognition student attendance system is slow and time-consuming. In addition, the paper proposed by Priyanka Wagh et al. (2015) mentioned that different lighting and head poses are often the problems that could degrade the performance of face recognition based student attendance system.

Hence, there is a need to develop a real time operating student attendance system which means the identification process must be done within defined time constraints to prevent omission. The extracted features from facial images which represent the identity of the students have to be consistent towards a change in background, illumination, pose and expression. High accuracy and fast computation time will be the evaluation points of the performance.

1.4 Aims and Objectives:

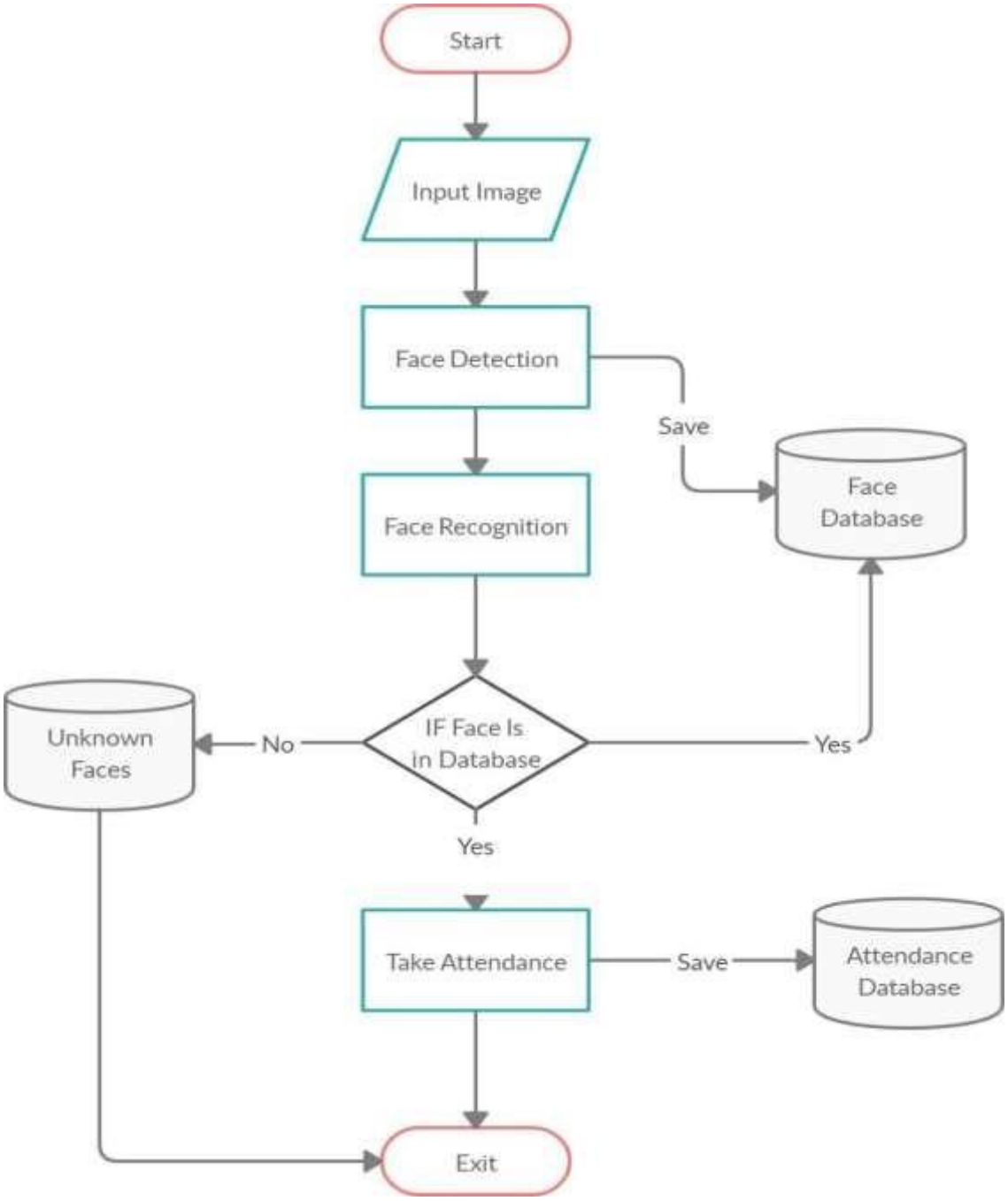
The objective of this project is to develop face recognition attendance system.

Expected achievements in order to fulfill the objectives are:

- To detect the face segment from the video frame.
- To extract the useful features from the face detected.

- To classify the features in order to recognize the face detected.
- To record the attendance of the identified student.

1.5 Flow chart



1.1 Project Outline

1.6 Scope of the project:

We are setting up to design a system comprising of two modules. The first module (face detector) is a mobile component, which is basically a camera

application that captures student faces and stores them in a file using computer vision face detection algorithms and face extraction techniques. The second module is a desktop application that does face recognition of the captured images (faces) in the file, marks the students register and then stores the results in a database for future analysis.

CHAPTER-2 LITERATURE REVIEW

2.1 Student Attendance System:

Arun Katara et al. (2017) mentioned disadvantages of RFID (Radio Frequency Identification) card system, fingerprint system and iris recognition system. RFID card system is implemented due to its simplicity. However, the user tends to help their friends to check in as long as they have their friend's ID card. The fingerprint system is indeed effective but not efficient because it takes time for the verification process so the user has to line up and perform the verification one by one. However for face recognition, the human face is always exposed and contain less information compared to iris. Iris recognition system which contains more detail might invade the privacy of the user. Voice recognition is available, but it is less accurate compared to other methods. Hence, face recognition system is suggested to be implemented in the student attendance system.

System Type	Advantage	Disadvantages
RFID card system	Simple	Fraudulent usage
Fingerprint system	Accurate	Time-consuming
Voice recognition system		Less accurate compared to Others
Iris recognition system	Accurate	Privacy Invasion

Table 2.1: Advantages & Disadvantages of Different Biometric System

2.2 Digital Image Processing:

Digital Image Processing is the processing of images which are digital in nature by a digital computer. Digital image processing techniques are motivated by three major applications mainly:

- Improvement of pictorial information for human perception
- Image processing for autonomous machine application
- Efficient storage and transmission.

2.3 Image Representation in a Digital Computer:

An image is a 2-Dimensional light intensity function

$$\mathbf{f}(\mathbf{x},\mathbf{y}) = \mathbf{r}(\mathbf{x},\mathbf{y}) \times \mathbf{i}(\mathbf{x},\mathbf{y}) \text{ - (2.0)}$$

Where, r (x, y) is the reflectivity of the surface of the corresponding image point. i (x,y) Represents the intensity of the incident light. A digital image f(x, y) is discretized both in spatial co-ordinates by grids and in brightness by quantization. Effectively, the image can be represented as a matrix whose row, column indices specify a point in the image and the element value identifies gray level value at that point. These elements are referred to as pixels or pels.

Typically following image processing applications, the image size which is used is $\mathbf{256 \times 256}$, elements, $\mathbf{640 \times 480}$ pels or $\mathbf{1024 \times 1024}$ pixels. Quantization of these matrix pixels is done at 8 bits for black and white images and 24 bits for colored images (because of the three color planes Red, Green and Blue each at 8 bits)[.

2.4 Steps in Digital Image Processing:

Digital image processing involves the following basic tasks:

- Image Acquisition - An imaging sensor and the capability to digitize the signal produced by the sensor.
- Preprocessing – Enhances the image quality, filtering, contrast enhancement etc.
- Segmentation – Partitions an input image into constituent parts of objects.
- Description/feature Selection – extracts the description of image objects suitable for further computer processing.
- Recognition and Interpretation – Assigning a label to the object based on the information provided by its descriptor. Interpretation assigns meaning to a set of labelled objects.

- Knowledge Base – This helps for efficient processing as well as inter module cooperation.

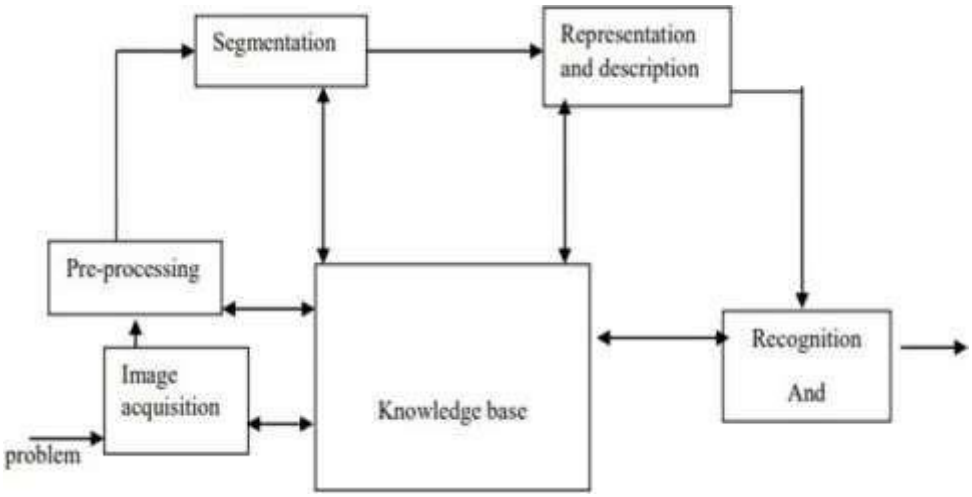


Figure 2.1 : A diagram showing the steps in digital image processing

2.5 Definition of Terms and History:

Face Detection

Face detection is the process of identifying and locating all the present faces in a single image or video regardless of their position, scale, orientation, age and expression. Furthermore, the detection should be irrespective of extraneous illumination conditions and the image and video content[5].

2.5.1 Face Recognition

Face Recognition is a visual pattern recognition problem, where the face, represented as a three dimensional object that is subject to varying illumination, pose and other factors, needs to be identified based on acquired images[6].

Face Recognition is therefore simply the task of identifying an already detected face as a known or unknown face and in more advanced cases telling exactly whose face it is[7].

Difference between Face Detection and Face Recognition

Face detection answers the question, Where is the face? It identifies an object as a “face” and locates it in the input image. Face Recognition on the other hand answers the question who is this? Or whose face is it? It decides if the detected face is someone .It can therefore be seen that face detections

output (the detected face) is the input to the face recognizer and the face Recognition's output is the final decision i.e. face known or face unknown.

Face Detection

A face Detector has to tell whether an image of arbitrary size contains a human face and if so, where it is. Face detection can be performed based on several cues: skin color (for faces in color images and videos, motion (for faces in videos), facial/head shape, facial appearance or a combination of these parameters. Most face detection algorithms are appearance based without using other cues. An input image is scanned at all possible locations and scales by a sub window. Face detection is posed as classifying the pattern in the sub window either as a face or a non-face. The face/nonface classifier is learned from face and non-face training examples using statistical learning methods[9]. Most modern algorithms are based on the Viola Jones object detection framework, which is based on Haar Cascades.

Face Detection Method	Advantages	Disadvantages
Viola Jones Algorithm	1. High detection Speed. 2. High Accuracy.	1. Long Training Time. 2.Limited Head Pose. 3.Not able to detect dark faces.
Local Binary Pattern Histogram	1.Simple computation. 2.High tolerance against the monotonic illumination changes.	1.Only used for binary and grey images. 2.Overall performance is inaccurate compared to Viola-Jones Algorithm.
Ada Boost Algorithm	Need not to have any prior knowledge about face structure.	The result highly depends on the training data and affected by weak classifiers.
SMQT Features and SNOW Classifier Method	1. Capable to deal with lighting problem in object detection. 2. Efficient in computation.	The region contain very similar to grey value regions will be misidentified as face.

Neural-Network	High accuracy only if large size of image were trained.	1. Detection process is slow and computation is complex. 2. Overall performance is weaker than Viola-Jones algorithm.

Table 2.2: Advantages & Disadvantages of Face Detection Methods

Viola-Jones algorithm which was introduced by P. Viola, M. J. Jones (2001) is the most popular algorithm to localize the face segment from static images or video frame. Basically the concept of Viola-Jones algorithm consists of four parts. The first part is known as Haar feature, second part is where integral image is created, followed by implementation of Adaboost on the third part and lastly cascading process.

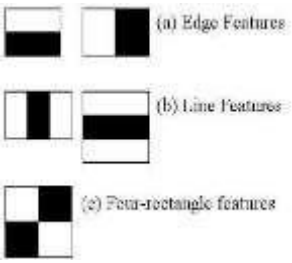


Figure 2.2: Haar Feature

Viola-Jones algorithm analyses a given image using Haar features consisting of multiple rectangles (Mekha Joseph et al., 2016).

In the fig shows several types of Haar features. The features perform as window function mapping onto the image. A single value result, which representing each feature can be computed by subtracting the sum of the white rectangle(s) from the sum of the black rectangle(s).

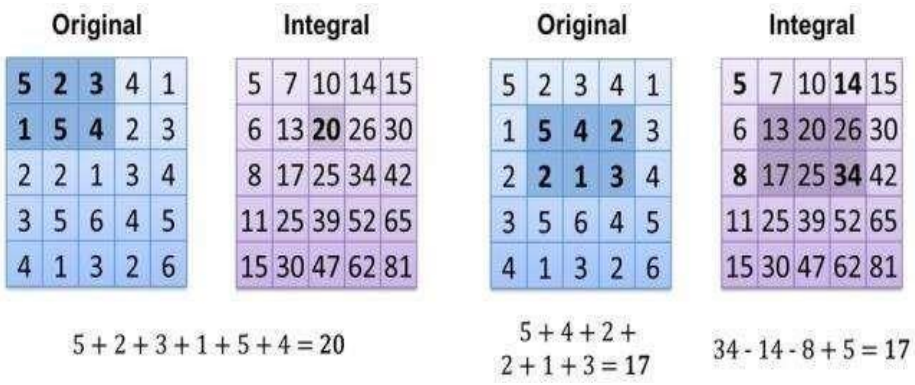


Figure 2.3: Integral of Image

The value of integrating image in a specific location is the sum of pixels on the left and the top of the respective location. In order to illustrate clearly, the value of the integral image at location 1 is the sum of the pixels in rectangle A. The values of integral image at the rest of the locations are cumulative. For instance, the value at location 2 is summation of A and B, (A + B), at location 3 is summation of A and C, (A + C), and at location 4 is summation of all the regions, (A + B + C + D). Therefore, the sum within the D region can be computed with only addition and subtraction of diagonal at location 4 + 1 − (2 + 3) to eliminate rectangles A, B and C.

2.5.2 Local Binary Pattern Histogram

Local Binary Pattern (LBP) is a simple yet very efficient texture operator which labels the pixels of an image by thresholding the neighborhood of each pixel and considers the result as a binary number.

It was first described in 1994 (LBP) and has since been found to be a powerful feature for texture classification. It has further been determined that when LBP is combined with histograms of oriented gradients (HOG) descriptor, it improves the detection performance considerably on some datasets. Using the LBP combined with histograms we can represent the face images with a simple data vector.

LBPH algorithm work step by step:

LBPH algorithm work in 5 steps.

1. **Parameters:** the LBPH uses 4 parameters:
   - **Radius:** the radius is used to build the circular local binary pattern and represents the radius around the central pixel. It is usually set to
     1.

- **Neighbors:** the number of sample points to build the circular local binary pattern. Keep in mind: the more sample points you include, the higher the computational cost. It is usually set to 8.
- **Grid X:** the number of cells in the horizontal direction. The more cells, the finer the grid, the higher the dimensionality of the resulting feature vector. It is usually set to 8.
- **Grid Y:** the number of cells in the vertical direction. The more cells, the finer the grid, the higher the dimensionality of the resulting feature vector. It is usually set to 8.

2. **Training the Algorithm:** First, we need to train the algorithm. To do so, we need to use a dataset with the facial images of the people we want to recognize. We need to also set an ID (it may be a number or the name of the person) for each image, so the algorithm will use this information to recognize an input image and give you an output. Images of the same person must have the same ID. With the training set already constructed, let's see the LBPH computational steps.
3. **Applying the LBP operation:** The first computational step of the LBPH is to create an intermediate image that describes the original image in a better way, by highlighting the facial characteristics. To do so, the algorithm uses a concept of a sliding window, based on the parameters radius and neighbors.

CHAPTER 3

Proposed Methodology

3.1 System Design

Overall System Architecture

The proposed Attendance Management System (AMS) using Face Recognition will consist of the following key components:

1. Face Detection and Recognition Module:
    - Employs state-of-the-art deep learning models (e.g., YOLOv8, EfficientDet) for real-time face detection.
    - Utilizes advanced face recognition algorithms (e.g., ArcFace, CosFace) to identify individuals based on their facial features.
2. Database Module:
    - Stores student or employee information, including personal details, enrollment numbers, and facial embeddings.
    - Maintains attendance records, including date, time, and recognized individuals.
3. User Interface:
    - Provides a user-friendly web-based interface for administrators to:
        - Manage user accounts and permissions.
        - View real-time attendance data and historical records.
        - Generate comprehensive attendance reports and analytics.
        - Configure system settings, such as camera settings and recognition thresholds.

System Workflow

1. Face Capture: The system captures real-time video frames from surveillance cameras or webcams.
2. Face Detection: The face detection module identifies faces within each frame.
3. Face Recognition: The recognized faces are compared to the database of enrolled faces using a similarity metric (e.g., cosine similarity, Euclidean distance).

4. Attendance Marking: If a match is found, the system records the attendance of the identified individual.
5. Database Update: The attendance record is stored in the database along with the timestamp and other relevant information.
6. Report Generation: The system generates various reports, such as daily, weekly, and monthly attendance reports, to provide insights into attendance patterns and trends.

3.2 Requirement Specification

3.2.1 Hardware Requirements

- Cameras: High-resolution cameras capable of capturing clear images in various lighting conditions.
- Computer System: A robust computer system with the following specifications:
  - Processor: Intel Core i5 or equivalent
  - RAM: 8GB or more
  - Storage: 256GB SSD or more
  - Graphics Card: NVIDIA GPU (optional, for accelerated deep learning computations)
- Network Infrastructure: Reliable network connectivity for real-time data transmission and database access.

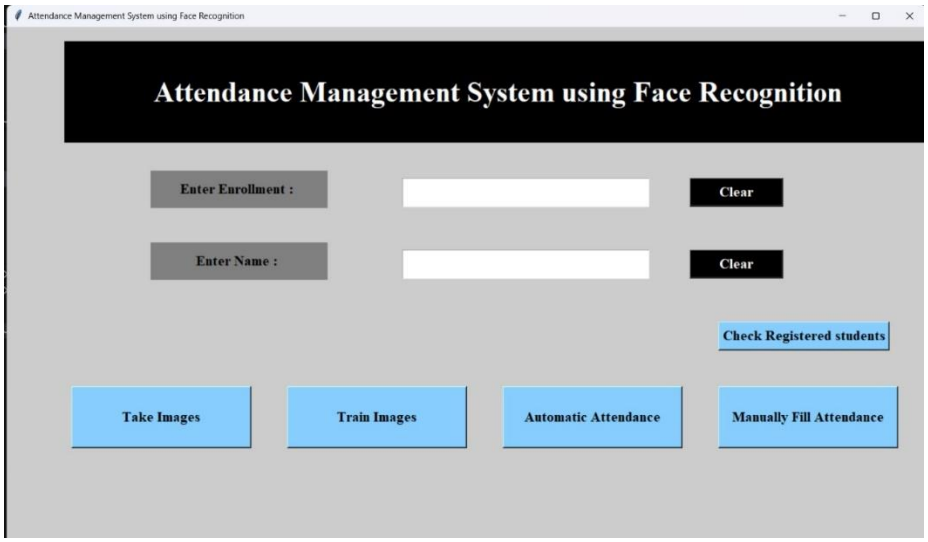
3.2.2 Software Requirements

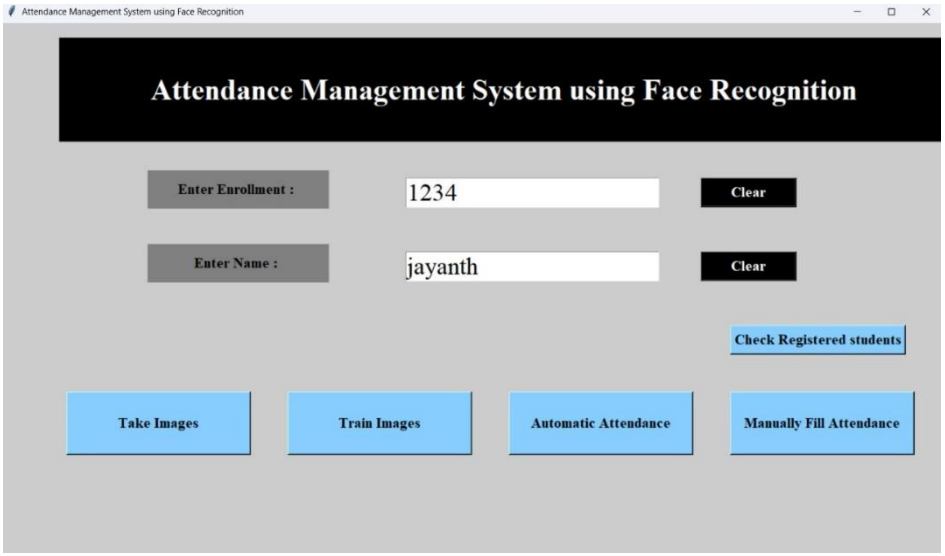
- Operating System: Windows 10, Linux (Ubuntu, Debian), or macOS
- Programming Languages: Python, C++
- Deep Learning Frameworks: TensorFlow, PyTorch
- Computer Vision Libraries: OpenCV
- Database System: MySQL, PostgreSQL
- Web Framework: Flask, Django
- Front-end Technologies: HTML, CSS, JavaScript
- Cloud Platform (Optional): AWS, Google Cloud Platform, Azure

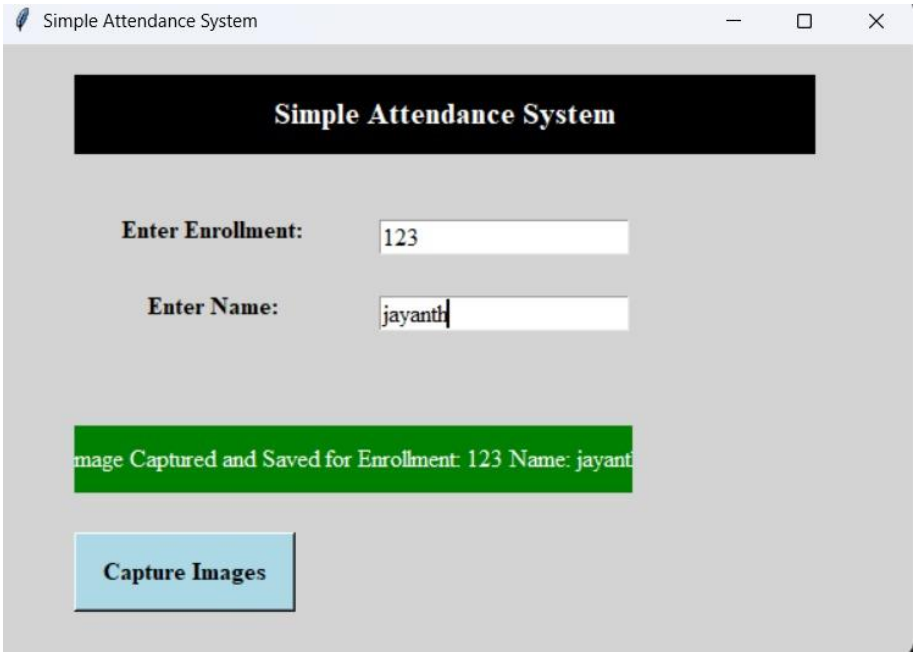
CHAPTER 4

Implementation and Result

4.1 Snap Shots of Result :






Simple Attendance System
Simple Attendance System
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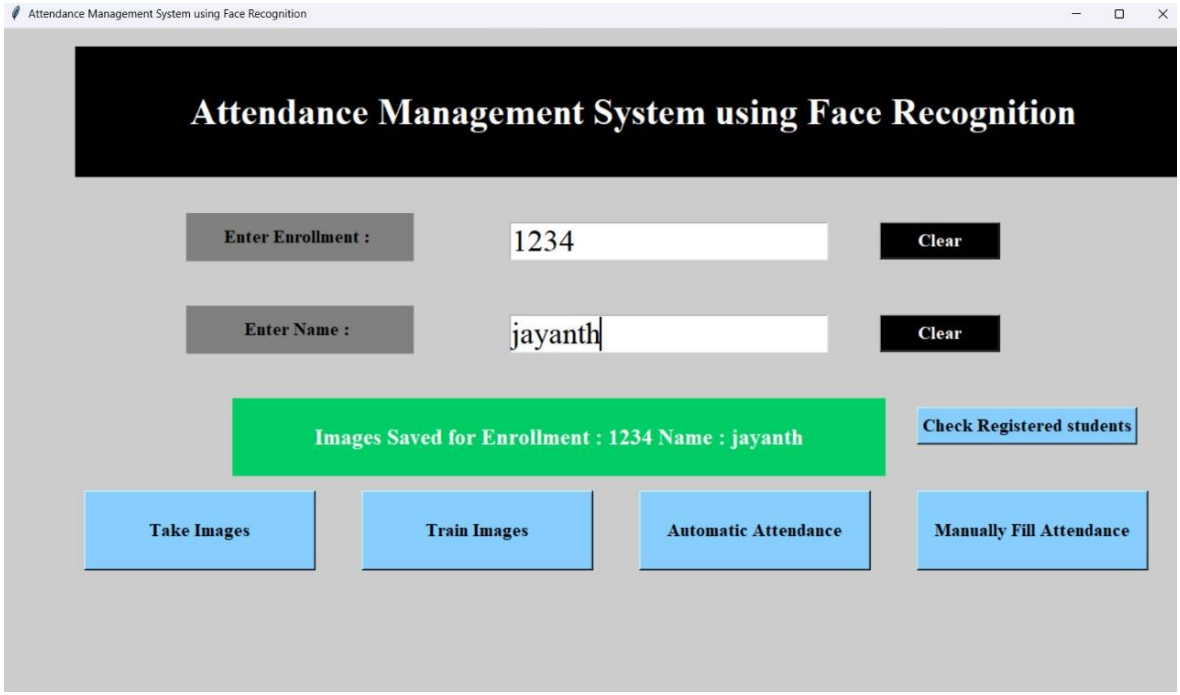
Capture Images


Attendance Management System using Face Recognition
Attendance Management System using Face Recognition
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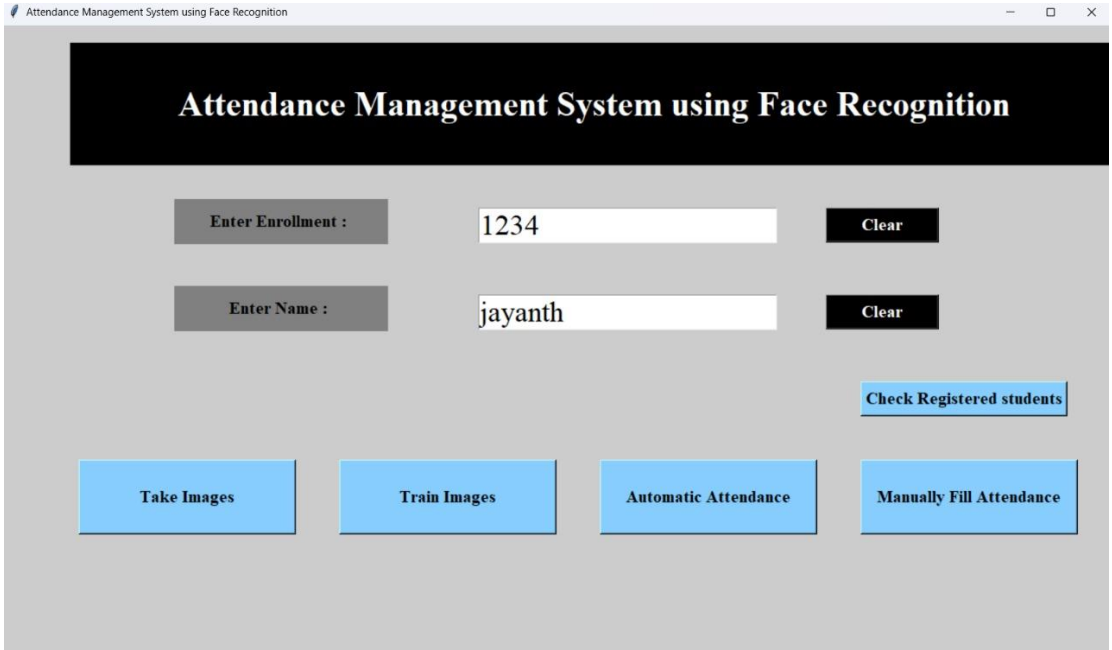
Check Registered students
Take Images
Train Images
Automatic Attendance
Manually Fill Attendance


Attendance Management System using Face Recognition
Attendance Management System using Face Recognition
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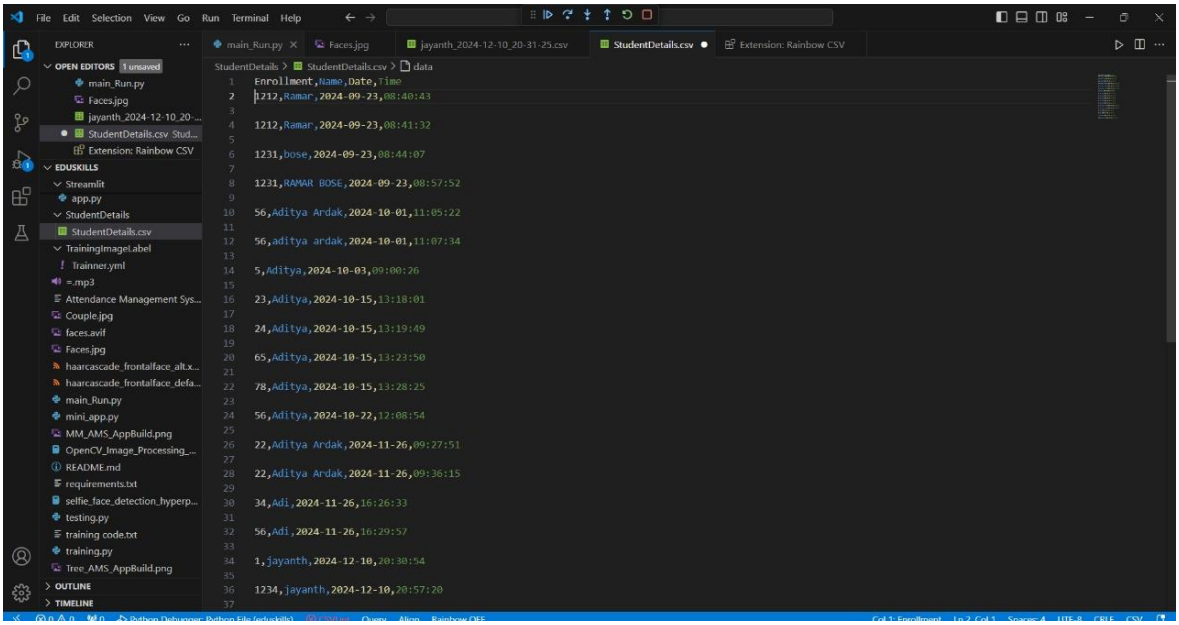
Take Images
Train Images
Automatic Attendance
Manually Fill Attendance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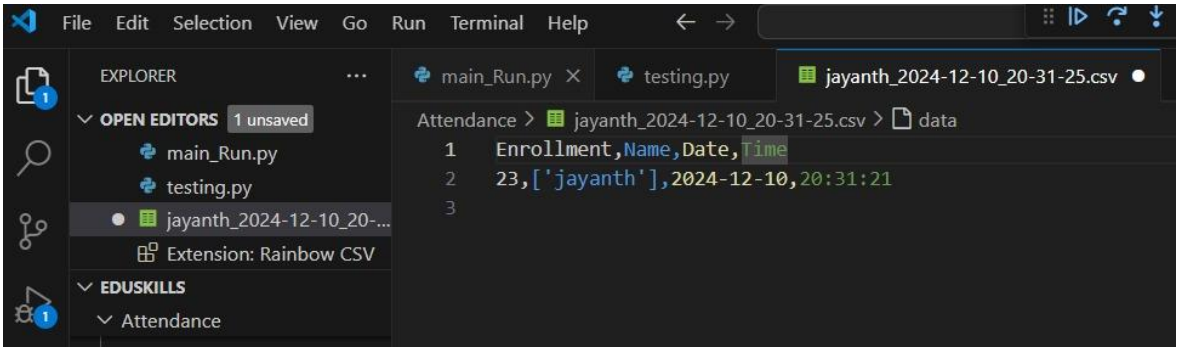
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EDUSKILLS
Attendance
main_Run.py
testing.py
jayanth_2024-12-10_20-31-25.csv
Attendance > jayanth_2024-12-10_20-31-25.csv > data
1 Enrollment,Name,Date,Time
2 23,['jayanth'],2024-12-10,20:31:21
3

4.1GitHub Link for Code:

https://github.com/jayanth1220/jayanthveludhandi-attendance-management-system

CHAPTER 5

Discussion and Conclusion

5.1 Future Work

In the future, several enhancements can be made to improve the accuracy, efficiency, and robustness of the facial recognition attendance management system:

Model Optimization: Implementing more advanced and optimized deep learning models such as convolutional neural networks (CNNs) with transfer learning techniques (e.g., using pre-trained models like VGGFace, FaceNet, or OpenFace) can significantly enhance facial recognition accuracy.

Handling Diverse Conditions: Improving the model's performance in diverse conditions such as varying lighting, angles, and backgrounds is crucial. Techniques like data augmentation and adding more diverse training data can help address these issues.

Real-Time Processing: Optimizing the system for real-time processing to ensure quick and accurate attendance marking. This could involve using more powerful hardware, efficient coding practices, and parallel processing techniques.

Security Enhancements: Incorporating security measures to prevent spoofing attacks using techniques like liveness detection, which ensures that the captured image is from a live person and not a photograph or video.

Scalability: Enhancing the system's scalability to handle a larger number of users and faces. This could involve optimizing the database management system and using distributed computing techniques.

User Interface Improvements: Developing a more intuitive and user-friendly interface for both administrators and users to interact with the system efficiently.

Integration with Other Systems: Integrating the attendance system with other institutional systems like payroll, academic records, and communication tools to provide a more comprehensive solution.

Ethical and Privacy Considerations: Addressing ethical and privacy concerns by implementing strict data protection policies, anonymization techniques, and ensuring compliance with relevant regulations such as GDPR.

5.2 Conclusion

In conclusion, the development of an attendance management system using facial recognition in Python represents a significant advancement in automating and streamlining the attendance tracking process. The project demonstrates the practical application of machine learning and computer vision technologies in solving real-world problems. By leveraging facial recognition, the system offers a contactless, efficient, and accurate method for recording attendance, reducing administrative workload, and minimizing errors associated with manual entry.

The contributions of this project are multifaceted:

Automation and Efficiency: The system automates the attendance process, saving time and effort for both students and administrative staff. It ensures that attendance records are maintained accurately and promptly.

Improved Accuracy: The use of facial recognition technology enhances the accuracy of attendance records, reducing the chances of proxy attendance and human errors.

User Convenience: The contactless nature of the system provides a convenient and hygienic way for users to mark their attendance, especially important in the context of health concerns like the COVID-19 pandemic.

Scalability and Flexibility: The system is designed to be scalable and flexible, making it suitable for various institutions and organizations of different sizes and requirements.

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