FACIAL RECOGNITION-BASED ATTENDANCE TRACKING

A PROJECT REPORT

Submitted by

Anshika Singh 21BCS8162

Akhilesh Kumar 20BCS9907

Shubham Kumar 21BCS8135

Simranjeet Kaur 20BCS5199

Anshul Saxena 20BCS9538

in partial fulfillment for the award of the degree of

BACHELOR OF ENGINEERING

IN

COMPUTER SCIENCE & ENGINEERING

Chandigarh University

April 2024

BONAFIDE CERTIFICATE

Certified that this project report **"FACIAL RECOGNITION-BASED ATTENDANCE TRACKING"** is the bonafide work of "Anshika Singh , Akhilesh Kumar , Shubham Kumar , Simranjeet Kaur , Anshul Saxena" who carried out the project work under my/our supervision.

SIGNATURE

Dr. Navpreet Kaur Walia

HEAD OF THE DEPARTMENT

Computer Science & Engineering

SIGNATURE

ER. Darshan Kaur ,

Assistant Professor

Computer Science & Engineering

Submitted for the project viva-voce examination held on

INTERNAL EXAMINER

EXTERNAL EXAMINER

ACKNOWLEDGMENT

We express our deep sense of gratitude to our respected and learned guides, **Er. Darshan kaur** for their valuable help and guidance, We are thankful to them for the encouragement they have given us in completing the project.

We are also grateful to respected **Prof. Dr. Navpreet Kaur Walia HOD(CSE-ADI)** for permitting to utilize all the necessary facilities of the institution.

We are also thankful to all the other faculty & and staff members of our department for their kind cooperation and help.

Regards,

Shubham Kumar	**21BCS8135**
Akhilesh Kumar	**20BCS9907**
Anshika Singh	**21BCS8162**
Simranjeet Kaur	**20BCS5199**
Anshul Saxena	**20BCS9538**

TABLE OF CONTENTS

List of Figures

ABSTRACT

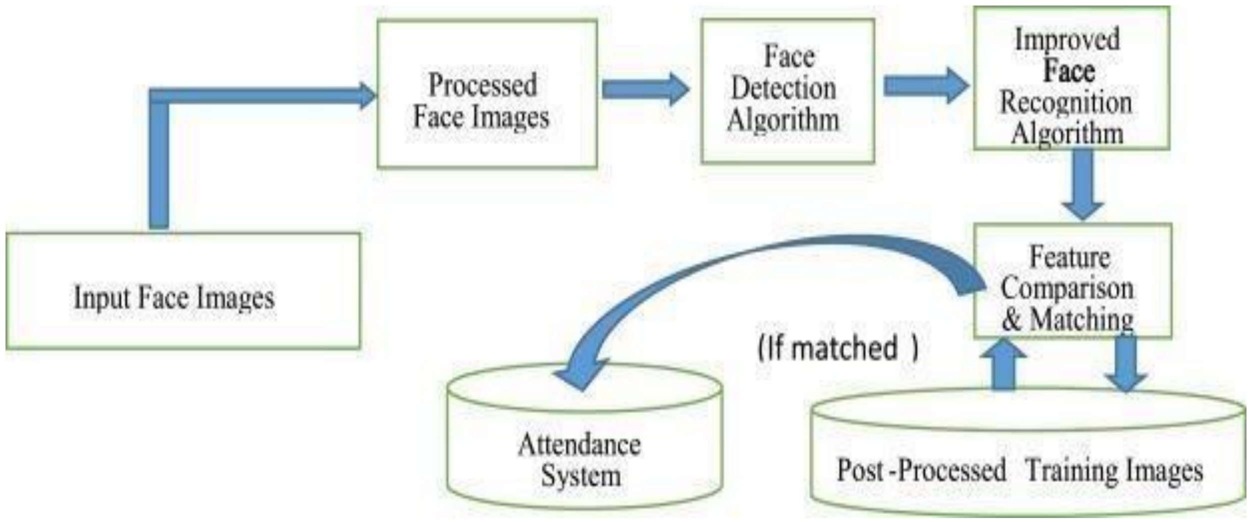
In colleges, universities, organizations, schools, and offices, taking attendance is one of the most important tasks that must be done on a daily basis. The majority of the time, it is done manually, such as by calling by name or by roll number. The main goal of this project is to create a Face Recognition-based attendance system that will turn this manual process into an automated one.

This project meets the requirements for bringing modernization to the way attendance is handled, as well as the criteria for time management. This device is installed in the classroom, where students' information, such as name, roll number, class, sec, and photographs, is trained. The images are extracted using Open CV. Before the start of the corresponding class, the student can approach the machine, which will begin taking pictures and comparing them to the qualified dataset. The web camera of the laptop and the algorithms of HOG. The image is processed as follows: first, faces are identified using a Haar cascade classifier, then faces are recognized using the LBPH (Local Binary Pattern Histogram) Algorithm, histogram data is checked against an established dataset, and the device automatically labels attendance. An Excel sheet is developed, and it is updated every hour with the information from the respective class instructor.

सार

कॉलेजों, विश्वविद्यालयों, संगठनों, स्कूलों और कार्यालयों में, उपस्थिति लेना सबसे महत्वपूर्ण कार्यों में से एक है जिसे दैनिक आधार पर किया जाना चाहिए। अधिकांश समय, यह मैन्युअल रूप से किया जाता है, जैसे नाम या रोल नंबर से कॉल करके। इस परियोजना का मुख्य लक्ष्य एक चेहरा पहचान-आधारित उपस्थिति प्रणाली बनाना है जो इस मैन्युअल प्रक्रिया को स्वचालित में बदल देगा। यह परियोजना उपस्थिति को संभालने के तरीके में आधुनिकीकरण लाने की आवश्यकताओं के साथ-साथ समय प्रबंधन के मानदंडों को भी पूरा करती है। यह उपकरण कक्षा में स्थापित किया जाता है, जहां छात्रों की जानकारी जैसे नाम, रोल नंबर, कक्षा, सेकंड और फोटोग्राफ की जानकारी दी जाती है। छवियाँ ओपन सीवी का उपयोग करके निकाली गई हैं। संबंधित कक्षा शुरू होने से पहले, छात्र मशीन के पास जा सकता है, जो तस्वीरें लेना शुरू कर देगी और उनकी तुलना योग्य डेटासेट से करेगी। लैपटॉप का वेब कैमरा और HOG के एल्गोरिदम। छवि को निम्नानुसार संसाधित किया जाता है: सबसे पहले, चेहरों को हार कैस्केड क्लासिफायर का उपयोग करके पहचाना जाता है, फिर चेहरों को एलबीपीएच (स्थानीय बाइनरी पैटर्न हिस्टोग्राम) एल्गोरिदम का उपयोग करके पहचाना जाता है, हिस्टोग्राम डेटा को एक स्थापित डेटासेट के खिलाफ जांचा जाता है, और डिवाइस स्वचालित रूप से उपस्थिति को लेबल करता है। एक एक्सेल शीट विकसित की जाती है, और इसे संबंधित कक्षा प्रशिक्षक की जानकारी के साथ हर घंटे अपडेट किया जाता है।

GRAPHICAL ABSTRACT



ABBREVIATIONS

S.NO.	Abbreviations	FullForms
1.	CV	Computer Vision
2.	KNN	K NEAREST NEIGHBOUR
3.	RGB	Red Green Blue
4.	ROI	Region of Interest
5.	FPS	Frame per second
6.	pk	Pickle
7.	PCA	Principal component Analysis
8.	AI	Artificial Intelligence
9.	HOG	Histogram of Gradients
10.	DCNN	Deep Conventional Neural Network
11.	RCNN	Region Conventional Neural Network
12.	PyTorch	Python Torch
13.	TF	Tensforflow
14.	Np	Numpy

CHAPTER 1
INTRODUCTION

1.1. Identification of Clients

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 user- friendly interface.

1.2. Identification of Problem

Traditional student attendance marking techniques are often plagued with problems. The face recognition student attendance system emphasizes its simplicity by eliminating traditional student attendance marking techniques such as calling student names or checking respective identification cards. These methods not only disrupt the teaching process but also cause distractions for students during exam sessions. Apart from calling names, attendance sheets are passed around the classroom during lecture sessions. Lecture classes, especially those with a large number of students, may find it difficult to have the attendance sheet being passed around the class efficiently. Thus, the face recognition attendance system is proposed to replace the manual signing of the presence of students, which is burdensome and causes students to get distracted in order to sign for their attendance. Furthermore, the face recognition-based automated student attendance system can overcome the problem of fraudulent approaches, and lecturers do not have to count the number of students several times to ensure their presence.

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

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

1.3. Identification of Tasks

- Data Preprocessing: A critical task involves preprocessing the gesture data to ensure its quality and compatibility with deep learning models. This includes tasks such as normalization, filtering, and augmentation to standardize the data and enhance model performance.

- Feature Extraction and Representation: Extracting relevant features from raw gesture data is vital. This task involves selecting and transforming data attributes that best encapsulate the gesture dynamics, encompassing spatial and temporal aspects. Effective feature representation is fundamental for the subsequent stages of model learning.

- Model Selection and Architecture Design: Selecting appropriate deep learning architectures (like CNNs, RNNs, or hybrids) is pivotal. This task includes designing or choosing models capable of learning intricate gesture patterns while accommodating variations and complexities within the data.

- Model Training and Optimization: Training deep learning models involves feeding them with labelled data and optimizing their parameters to achieve optimal performance. This task encompasses training on large datasets, fine-tuning hyperparameters, regularization, and implementing optimization techniques to enhance model generalization.

- Evaluation and Performance Metrics: Evaluating model performance is crucial. This task involves employing various performance metrics (accuracy, precision, recall, etc.) and validation techniques (cross-validation, train-test splits) to assess the model's effectiveness in recognizing diverse gestures.

- Continual Improvement and Adaptation: Continual improvement of models is necessary to adapt to evolving gesture patterns and environmental variations. This task involves updating models, exploring novel techniques, and incorporating feedback loops to enhance their adaptability and accuracy over time.

- Robustness to Environmental Variations: Building models that can handle variations in lighting, background noise, or different environments is crucial for real-world applicability of gesture recognition systems.

- User Experience and Interface Design: Designing user-friendly interfaces that integrate gesture recognition seamlessly into applications, considering user feedback and usability for a positive user experience.

- Handling Temporal Aspects: Using time-series analysis or temporal convolutions to capture gesture sequences and understand their chronological dependencies in the data

1.4 Timeline

Fig 1.4 - Timeline

1.4.2. Member-wise Distribution of Work

Table 1.1 Contribution table

S.no.	Name	UID	Task
1.	Anshika Singh	21BCS8162	○ Data Preprocessing ○ Documentation. ○ Writing Research Paper
2.	Akhilesh Kumar	20BCS9907	○ Documentation. ○ Training And Evaluating Deep Learning Model. ○ Collection Of Data

3.	Simranjeet Kaur	20BCS5199	o Dataset Selection and collection. o Documentation. o Evaluation of results.
4.	Shubham Kumar	21BCS8135	o Documentation.
5.	Anshul Saxena	20BCS9538	o Researching Novel Techniques. o Documentation o Algorithm Analysis.

1.5 Organization of Project

- Chapter 1 –

  This chapter introduces the application of facial recognition technology in attendance systems. It highlights the significance of accurate facial recognition in attendance tracking across various domains and discusses the complexities involved in interpreting facial features for identification purposes. Additionally, it outlines the essential tasks required for efficient facial recognition in attendance systems, including data preprocessing, feature extraction, model selection, and training processes.
- Chapter 2 –

  This chapter delves into the historical timeline and evolution of facial recognition methodologies within the context of attendance systems. It explores the initial instances, key milestones, seminal works, and technological advancements that have shaped the field of facial recognition for attendance tracking
- Chapter 3 –

  This section details the design flow, flowchart, and comprehensive block diagrams illustrating the implementation of various machine learning and deep learning algorithms for a facial recognition-based attendance system. It showcases the process of integrating these algorithms into the attendance system and evaluates their accuracy.
- Chapter 4 –

This chapter presents the outcomes of the performance evaluation of the facial recognition-based attendance system. It assesses the system's effectiveness in identifying individuals, the accuracy of attendance records, and overall system performance in tracking attendance.

- Chapter 5 –

  The final chapter summarizes the key concepts derived from the analysis of the facial recognition-based attendance system. It offers suggestions and recommendations for future developments and enhancements in facial recognition technology for attendance tracking purposes.

CHAPTER 2

LITERATURE REVIEW/BACKGROUND STUDY

2.1. Timeline of the reported problem

Following is a timeline of known issues with facial recognition technologies for attendance and suggested fixes:

Early Adoption and Accuracy Issues (2010-2015)

Problem: Early facial recognition systems for attendance experienced accuracy problems, particularly in low-light situations or when people were wearing glasses, hats, or displayed distinct facial expressions.

Suggested Fixes:

Research and development initiatives aimed at enhancing accuracy through improved algorithms, hardware, and software optimizations.

Bias and Privacy Issues (2016-2018)

Problem: There have been reports of facial recognition systems being biased, especially towards women and those with darker skin tones. Additionally, privacy concerns arose as the technology was introduced in public areas without consent.

Suggested Fixes:

Enforcing stronger laws and improving training data to lessen bias.

Implementing stricter privacy controls and informing individuals about data collection practices.

Restrictions and Inspection (2019-Present)

Problem: Due to concerns about privacy, accuracy, and civil liberties, a number of towns and organizations, including San Francisco and some universities, have prohibited the use of facial recognition for attendance.

Suggested Fixes:

- Continued discussions and debates over laws and the ethical use of facial recognition systems.

- Industry leaders promoting transparency and guidelines for appropriate use.
- Increased scrutiny and oversight of facial recognition implementations.

2021–2022: Ethical Facial Recognition Advances

Problem: Despite difficulties, facial recognition technology advanced, improving accuracy and finding use in numerous industries.

Solutions Put Forth:

• Organizations created and implemented ethical AI and responsible use policies.

• Some systems had more robust privacy safeguards and user-controlled data access.

Evolving Ethical Frameworks and Accountability, 2023-Present

Problem: The increased use of facial recognition technology raises concerns about privacy, bias, and accountability.

Solutions Put Forth:

• Developing and implementing ethical guidelines and regulations for facial recognition technology.

• Establishing clear accountability mechanisms for facial recognition systems.

• Increasing transparency and public awareness about facial recognition technology.

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].

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 Detector

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.

2.2. Proposed solutions

Facial image recognition has seen significant advancements over the years, and several techniques and algorithms have been used for this purpose.

Here are some existing solutions and techniques that have been used for facial image recognition:

1. Haar Cascades: Haar Cascades are a machine learning object detection method used to identify objects in images or video. They have been used for basic facial detection.

2. Histogram of Oriented Gradients (HOG): HOG is a feature descriptor used for object detection. While it was initially designed for pedestrian detection, it can also be used for facial detection.

3. Deep Convolutional Neural Networks (CNNs): CNNs have revolutionized facial image recognition. Models like VGG, ResNet, and Inception have been fine-tuned and used for tasks like face detection, face recognition, and emotion recognition. For example, Facebook's DeepFace and Google's FaceNet are based on CNNs.

4. Region-based Convolutional Neural Networks (R-CNN): R-CNN and its variants (Fast R-CNN, Faster R-CNN, Mask R-CNN) are primarily used for object detection but can be adapted for facial detection within images.

5. OpenCV: OpenCV is an open-source computer vision library that provides tools and functions for facial detection and recognition using various methods, including Haar Cascades and deep learning-based approaches.

6. Dlib: Dlib is a C++ library often used for facial landmark detection and facial recognition. Itemploys a combination of shape prediction and HOG features.

7. Facial Recognition APIs: Companies like Amazon, Microsoft, and Google offer facial recognition APIs that use deep learning models to provide facial detection and recognition capabilities.

8. DeepFace: DeepFace is a deep learning framework developed by Facebook that utilizes CNNs for facial recognition tasks. It can identify faces in images and verify whether two faces belong to the same person.

9. Face++: Face++ is a cloud-based facial recognition platform that offers a wide range of facial analysis services, including detection, recognition, and emotion analysis.

10. PyTorch and TensorFlow: These popular deep learning frameworks provide pre-trained models and tools for facial recognition tasks, allowing developers to build custom solutions.

11. FacialRecognitionSDKs: Various software development kits (SDKs) and libraries are available for developers to integrate facial recognition capabilities into their applications. These often leverage deep learning models for accuracy.

12. Deep Fake Detection: With the rise of deepfake technology, there is ongoing research and development in creating solutions to detect manipulated facial images and videos. Some of these solutions use CNNs and other deep learning techniques.

13. Privacy and Ethical Considerations: Given privacy concerns and ethical issues associated with Facial recognition technology, there is also ongoing research in to developing privacy-preserving methods and ensuring responsible use of facial recognition systems. It's important to note that the field of facial image recognition is continuously evolving, and new techniques and models are being developed regularly. Additionally, the use of facial recognition technology is subject to legal and ethical regulations in many regions, so it's essential to consider these factors when implementing such solutions.

2.3. Bibliometric analysis

Handbook of Face Recognition by Stan Z. Li and Anil K. Jain:

- This Comprehensive resource covers all aspects of automated face detection and recognition systems.
- It explores concepts, methods and algorithms related to face detection, tracking, alignment, feature extraction, and recognition.
- The book also addressed issues related to evaluation, systems, security, and applications, making it an essential reference for experts in the field.

A review on Face recognition Systems: Recent approaches and challenges by Muhtabir O. Oloyede, Gerhard P. Hancke, and Hermanus C. Myburgh:

- Published in the journal "Multimedia Tools and Applications" in 2020.
- Provides a critical review of face recognition systems, highlighting challenges faced by researchers in the field.
- Dicusses various approaches and techniques proposed in the literature to address these challenges.
- Analyzes existing techniques and datasets used for evaluating face recognition systems and suggests future research directions.

Face Recognition: A Review by Anh Tuan Tran, Jatuporn Toy Leksut, Tal Hassner, and Gerard Medional:

- Published in the journal "Pattern Recognition" 2020.
- Presents a comprehensive review of face recognition techniques, covering both traditional and deep learning-based approaches.

- Discusses various aspects of face recognition, including data acquisition, preprocessing, feature extraction, matching, and evaluation.
- Provides an overview of the state-of-art in face recognition and identifies future research directions.
- Explore the effectiveness of face recognition systems and questions the need for collecting large datasets.
- Process an approach to increase training data sizes by synthesizing facial images rather than manual collection.
- Tests the approach on benchmarks like LFW, IJB-A (verification and identification), and Janus CS21, achieving performance comparable to systems trained on massive datasets.

Development of Face Recognition-Based Attendance System by Okechukwu M. Chukwude, Nazmat T. Surajudeen-Bakinde, Sikiru O. Zakariyya, Joy B. Ogunsakin, Jimoh Akanni, Sunday A. Olayanju, and Frederick O. Ehiagwina:

- Describes the development of RollCall, a web application using facial recognition technology for managing attendance records at the University of Ilorin in Nigeria.
- Allows lecturers to create courses, record attendance, and enables students to upload their facial data, enroll in courses, and view their attendance records.
- Implements facial recognition using Python, OpenCV, and Sci-kit Learn, providing a user-friendly solution for attendance management in an educational setting.

2.4. Review Summary

Handbook of Face Recognition:

- Comprehensive resource for automated face detection and recognition systems.
- Covers a wide range of concepts, methods, and algorithms.
- Addresses face detection, tracking, alignment, feature extraction, and recognition.
- Discusses evaluation, system development, security, and practical applications.

- Serves as an essential reference for experts and newcomers in the field.

"A Review on Face Recognition Systems: Recent Approaches and Challenges":

- Provides a critical review of face recognition systems.
- Discusses challenges faced by researchers in the field.
- Analyzes various approaches and techniques proposed in the literature.
- Evaluates existing techniques and datasets used for system evaluation.
- Highlights future research directions in face recognition.

"Do We Really Need to Collect Millions of Faces for Effective Face Recognition?":

- Challenges the need for collecting vast amounts of facial data for training.
- Proposes a practical approach to increasing training data size through data synthesis.
- Tests the approach on benchmarks, demonstrating comparable performance to systems trained on extensive datasets.

"Development of Face Recognition-Based Attendance System":

- Describes the development of the RollCall web application.
- Utilizes facial recognition technology for attendance management in an educational setting.
- Empowers lecturers and students to streamline attendance tracking.
- Implements facial recognition using Python, OpenCV, and Sci-kit Learn.

These findings collectively showcase the breadth and depth of research and practical applications in the field of face recognition, from comprehensive references and critical reviews to innovative approaches and real-world implementations.

2.5. Problem Definition

Traditional methods of attendance tracking, such as roll calling, often suffer from unnoticed and skipped instances. This paper addresses the increasing interest in automated face recognition, driven by concerns over public security, the need for identity verification, and applications in multimedia data management and digital entertainment.

By reducing physical contact in public and workspaces, pandemics like Covid-19 may be effectively handled. There has been a huge surge in demand for the use of contactless technology since the epidemic. The industry has realized the advantages of face recognition and the use of attendance systems. Workplaces and multi-tenant workplaces may significantly minimize the frequency of interaction between persons, hence reducing the danger of viral transmission

2.6. Goals/Objectives

When setting goals and objectives for a facial recognition system for attendance, it's important to make them narrow, specific, measurable, achievable, relevant, and time-bound (SMART). Here are some goals and objectives for such a project:

1. Develop a Robust Face Detection Algorithm:
   - Create a face detection algorithm that accurately identifies faces in images.
   - Achieve a detection accuracy rate of at least 95% on benchmark datasets.
2. Implement a Real-time Attendance Tracking System:
   - Develop a real-time attendance tracking system that utilizes facial recognition.
   - Ensure the system can process attendance for a class of 30 students within 5 minutes.
3. Achieve High Recognition Accuracy:
   - Train the facial recognition model to recognize enrolled students with an accuracy rate of at least 98%.
   - Continuously improve the recognition accuracy through iterative model updates.
4. Ensure Scalability:
   - Design the system to handle attendance tracking for multiple courses and classes.
   - Ensure the system can accommodate a growing number of students and courses.
5. Enhance Security and Privacy:
   - Implement privacy protection measures, such as data encryption and secure storage of facial data.
   - Ensure the system complies with relevant privacy regulations.

6. User-Friendly Interface:

- Create a user-friendly interface for both instructors and students.
- Ensure that instructors can easily access attendance records and students can check their attendance status.

7. Minimize False Positives and Negatives:

- Continuously fine-tune the system to reduce false positives (e.g., marking absent students as present) and false negatives (e.g., failing to recognize enrolled students).

8. Evaluate System Reliability:

- Conduct comprehensive testing to evaluate the system's reliability and performance under various conditions.
- Ensure the system meets the specified requirements and objectives.

9. Optimize System Resource Usage:

- Develop the system to operate efficiently on hardware resources (CPU and memory).
- Optimize the system's speed and resource consumption for real-time operation.

10. Documentation and Reporting:

- Maintain comprehensive documentation of system architecture, algorithms, and code.
- Provide regular progress reports to stakeholders and address any issues or concerns.

11. User Training and Support:

- Offer training sessions for instructors and students on how to use the system effectively.
- Establish a support system for addressing user queries and issues promptly.

12. Cost-Effective Implementation:

- Manage project costs efficiently to ensure the implementation remains within budget.
- Evaluate and select cost-effective hardware and software components.

By setting these specific goals and objectives, you can create a clear roadmap for the development and implementation of a facial recognition system for attendance that is both effective and accountable.

The primary goal of our Facial Recognition Attendance System project is to design, implement, and deploy an advanced solution that enhances efficiency, accuracy, and security in attendance tracking within educational or organizational settings. To achieve this overarching goal, a set of comprehensive objectives has been outlined. These objectives include the development of a scalable facial recognition algorithm, seamless integration with existing attendance infrastructure, real-time processing capabilities, and the enhancement of security and privacy measures. Additionally, the project aims to research and select suitable facial recognition technology, design and develop the facial recognition model, create user-friendly interfaces, and implement connectors for integration. The emphasis is on addressing real-time processing needs, ensuring compatibility, optimizing system performance, and addressing security and privacy concerns. Rigorous testing, user training, and ongoing evaluation are integral components, with a focus on scalability and future upgrades to ensure the system's longevity and adaptability to evolving technological and user requirements. Through these objectives, the project aspires to deliver a robust, user-friendly, and future-ready Facial Recognition Attendance System.

CHAPTER 3
DESIGN FLOW/PROCESS

3.1. Evaluation & Selection of Specifications/Features

A Facial Recognition-Based Attendance System using Deep Learning typically includes various features and characteristics to effectively and accurately track attendance. Here are some of the key elements and considerations:

1. Facial Recognition Technology:

- The core of the system is deep learning-based facial recognition algorithms.
- This technology identifies and verifies individuals based on their facial features.

2. User-Friendly Interface:

- Provide a user-friendly interface for both instructors and students.
- Ensure that instructors can easily access attendance records and students can check their attendance status.

3. Enhanced Security and Privacy:

- Implement privacy protection measures, such as data encryption and secure storage of facial data.
- Ensure the system complies with relevant privacy regulations.

4. Maintenance and Support:

- Ongoing maintenance and support are critical to ensure the system functions correctly and stays up to date with the latest advancements in deep learning and security.

5. Cost Considerations:

- Carefully evaluate the costs associated with implementing and maintaining the system, including hardware, software, and operational costs.

6. Remote Access:

- Implement remote access capabilities for authorized administrators or personnel.

- This feature enables administrators to access and control the system's functionalities and data through a network, typically via the Internet.

7. User Training and Support:

- Offer training sessions for instructors and students on how to use the system effectively.

8. Data Collection: The system captures facial data from individuals in real-time. This data can be collected through cameras or other image-capturing devices. The system uses the collected data both during enrollment, where individuals' faces are registered as reference templates, and in real-time recognition, where the system continuously captures and analyzes facial features to identify individuals.

9. Reporting and Analytics:

The system often provides reporting and analytical tools for administrators to gain insights into attendance patterns. These tools contribute to a data-driven approach to attendance tracking and management.

10. Real-time Processing

The system processes facial data in real-time, enabling quick and accurate identification. Real-time processing enhances security and efficiency, ensuring that access control or attendance tracking is both fast and reliable.

11. Backup and Redundancy:

To ensure system reliability, it may include backup mechanisms and redundancy for critical components. Backup and redundancy mechanisms are implemented in the system to ensure its reliability and availability. This redundancy is crucial for maintaining system continuity, particularly in applications where uninterrupted attendance tracking or access control is essential, such as in high-security environments or critical infrastructure.

The Facial Recognition Attendance System is meticulously designed to streamline attendance tracking within educational or organizational settings, emphasizing efficiency, accuracy, and user-friendly interactions. At its core, the system comprises key components, including a sophisticated Facial Recognition Module employing deep learning algorithms for face detection and identification. During the user enrollment process, administrators capture and store unique facial features, seamlessly integrating them with existing attendance databases through connectors or APIs. The real-time processing engine ensures swift and accurate comparisons between live facial images and stored data during attendance tracking. The user interface provides administrators with comprehensive functionalities, from enrollment to monitoring and reporting. Security and privacy measures, such as encryption and data anonymization, safeguard sensitive information, aligning with regulatory standards. Rigorous testing, user training, and ongoing evaluation contribute to system optimization. Designed with scalability and future upgrades in mind, the system is poised to adapt to evolving technological and user requirements, offering a robust, efficient, and secure solution for attendance management.

3.2. Design Constraints

Certainly, here are the important constraints in a Facial Recognition-Based Attendance System:

1. **Data Privacy and Compliance:** This focuses on the need to protect individuals' facial data and adhere to privacy regulations. The system must operate in a way that respects privacy laws and individual rights.
2. **Costs:** These are financial constraints related to the expenses associated with implementing and maintaining the system, which can include both initial and ongoing costs.
3. **Hardware Requirements:** Systems require high-quality cameras and hardware that can process large amounts of data quickly.
4. **Ethical Considerations:** Facial recognition-based attendance systems raise ethical concerns around privacy and surveillance. Therefore, it is important to ensure that the system is implemented in a way that respects individual privacy rights.
5. **Data Quality and Quantity:** The quality and quantity of available facial data for training deep learning models. Insufficient or low-quality data may impact the system's recognition accuracy.

6. **Timeline Constraints:** Project schedules must adhere to specific deadlines. These timelines can be constrained by factors such as deployment schedules, regulatory requirements, or academic terms in educational institutions.
7. **Privacy Concerns:** Facial recognition-based attendance systems collect biometric data, which is sensitive information. Therefore, it is important to ensure that the data is stored securely and that access to it is restricted.
8. **User Training and Acceptance:** The need to provide user training and conduct acceptance testing to ensure that users are comfortable and knowledgeable about the system's usage.

3.3. Analysis and Feature finalization subject to constraints

In the development of a Facial Recognition-Based Attendance System, ananalys is of its features is paramount to ensure that it meets the specific needs and requirements of the project. This system incorporates a range of advanced features, including face detection, recognition, real-time data collection and processing, secure data storage, liveness detection, and robust privacy measures to protect individuals' rights. Furthermore, it provides options for customization, reporting, and analytics tools, as well as seamless integration with access control systems. These features collectively define the system's capabilities and functionality, making it a powerful tool for attendance management.

Constraint Identification:

However, when designing and finalizing these features, one must take into account various constraints that may impact the project's development and implementation. These constraints span a wide spectrum, encompassing budget limitations, timeline restrictions, resource availability, data quality and quantity, hardware and software compatibility, regulatory compliance, ethical considerations, stakeholder expectations, and the need for rigorous testing and user training.

Addressing Budget Constraints:

Budget constraints necessitate careful allocation of resources. The project must make cost-effective choices in terms of hardware and software, ensuring that expenses align with the available budget while maintaining the desired level of functionality and performance.

Meeting Timeline Constraints:

To meet timeline constraints, effective project planning and management are crucial. This involves setting realistic milestones, prioritizing tasks, and implementing efficient project management strategies to ensure that project timelines are met without delays.

Leveraging Resource Availability:

Resource availability is another significant factor. The availability of skilled personnel, computing resources, and high-quality datasets can impose constraints on the project.

Enhancing Data Quality and Quantity:

Data quality and quantity constraints require deliberate measures. To address these constraints, the project should strive to access high-quality facial datasets and implement data augmentation techniques to enhance the model's accuracy and robustness.

Ensuring Hardware and Software Compatibility:

The constraints related to hardware and software compatibility necessitate careful component selection. The chosen hardware components should be compatible with the selected software frameworks, ensuring seamless integration and optimal performance while adhering to budget constraints.

Regulatory Compliance and Ethical Considerations:

Regulatory constraints require the development of robust data security measures, informed consent procedures, and clear data retention policies to comply with data privacy regulations. Ethical considerations entail the establishment of ethical guidelines for system usage and the mitigation of biases in recognition accuracy.

Managing Stakeholder Expectations:

Addressing stakeholder expectations is essential. The project should maintain open lines of communication with stakeholders, manage their expectations, and incorporate their feedback into system design and functionality.

Ensuring Testing and Validation:

Rigorous testing and validation procedures are critical. These must be subject to tight timelines, necessitating the development of meticulous test protocols and the implementation of automated testing processes to expedite the project and ensure the system's accuracy and compliance.

In conclusion, the finalization of the Facial Recognition-Based Attendance System's features, while considering these constraints, is vital to create a system that is technically sound, cost-effective, ethical, compliant with legal requirements, and capable of meeting stakeholder expectations and needs.

In the development of a Facial Recognition-Based Attendance System, a thorough analysis of its features is crucial to ensure alignment with the specific needs and requirements of the project. This system integrates advanced functionalities, such as face detection, recognition, real-time data processing, secure data storage, liveness detection, and robust privacy measures. Additionally, it offers customization options, reporting tools, analytics features, and seamless integration with access control systems, collectively positioning it as a powerful tool for attendance management.

However, during the design and finalization of these features, it becomes imperative to consider various constraints that might impact the project's development and implementation. These constraints encompass budget limitations, timeline restrictions, resource availability, data quality and quantity, hardware and software compatibility, regulatory compliance, ethical considerations, stakeholder expectations, and the imperative need for rigorous testing and user training.

Addressing these constraints involves careful decision-making and strategic planning. Budget constraints necessitate the allocation of resources in a cost-effective manner, balancing functionality and performance within financial boundaries. Meeting timeline constraints requires effective project planning, realistic milestone setting, and efficient project management strategies. Resource availability, including skilled personnel and quality datasets, is identified as a critical factor influencing project success.

To enhance data quality and quantity, deliberate measures, such as accessing high-quality facial datasets and implementing data augmentation techniques, are proposed. The selection of hardware components compatible with chosen software frameworks is emphasized to ensure seamless integration while adhering to budget constraints. Regulatory compliance demands robust data security measures, informed consent procedures, and ethical considerations to mitigate biases in recognition accuracy.

Managing stakeholder expectations and maintaining open communication channels are essential elements to address stakeholder-related constraints. Rigorous testing and validation procedures, subject to tight timelines, are identified as critical for ensuring system accuracy and compliance with defined constraints. In conclusion, the finalization of the Facial Recognition-Based Attendance System's features, while navigating these constraints, is pivotal to creating a system that is technically sound, cost-effective, ethical, legally compliant, and capable of meeting the diverse expectations and need of stakeholders.

3.4. Design Flow

Application Launch: To begin, the average user runs the attendance-tracking programme on their computer. Initialization of the webcam for real-time video capturing: The application initialises the webcam.

Face Detection: As the webcam captures video frames, the system processes each frame to detect faces using the Haar Cascade classifier. When a face is detected, the system highlights and identifies it.

User Interaction: The general user interacts with the system using the computer keyboard. Specifically, they press a designated key, often ’o,’ to initiate the attendance-taking process.

Timestamp Generation: Upon pressing the ’o’ key, the system generates a timestamp that records the current date and time. This timestamp is essential for organizing attendance records.

Image Capture: The system captures an image of the user’s face as they take attendance. This image is typically stored temporarily and may be displayed to the user for verification.

Feedback: The system may use speech synthesis (text-to- speech) to vocally announce the successful attendance update and provide feedback.

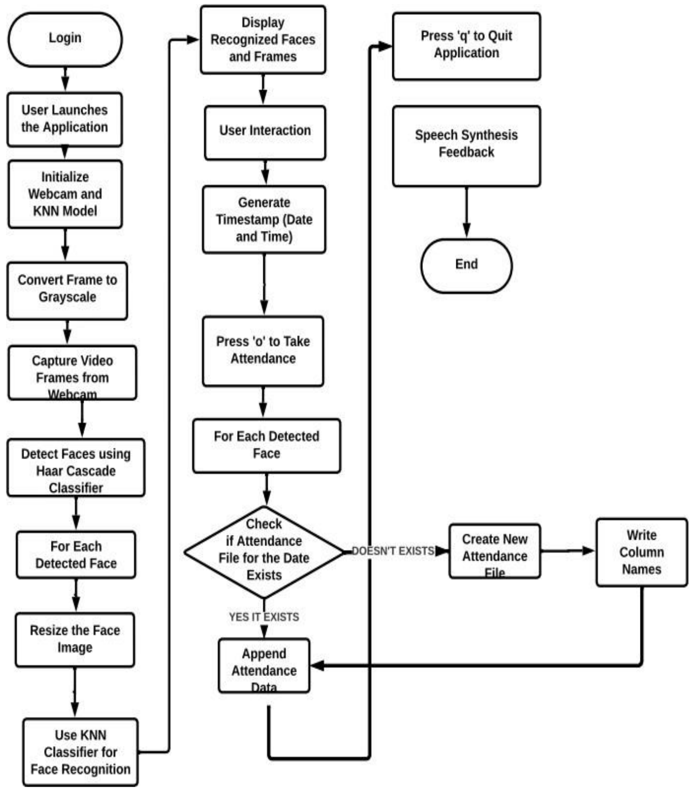


Figure 3.1: Design Flow

Data storage: In the background, the system keeps track of each person's attendance and saves their photographs for later

Use: According to the auto-refresh settings, the count variable effectively keeps track of how frequently the programme has updated, and the displayed messages adjust accordingly. This can be helpful for developing interactive and dynamic Streamlit apps that regularly change their content.

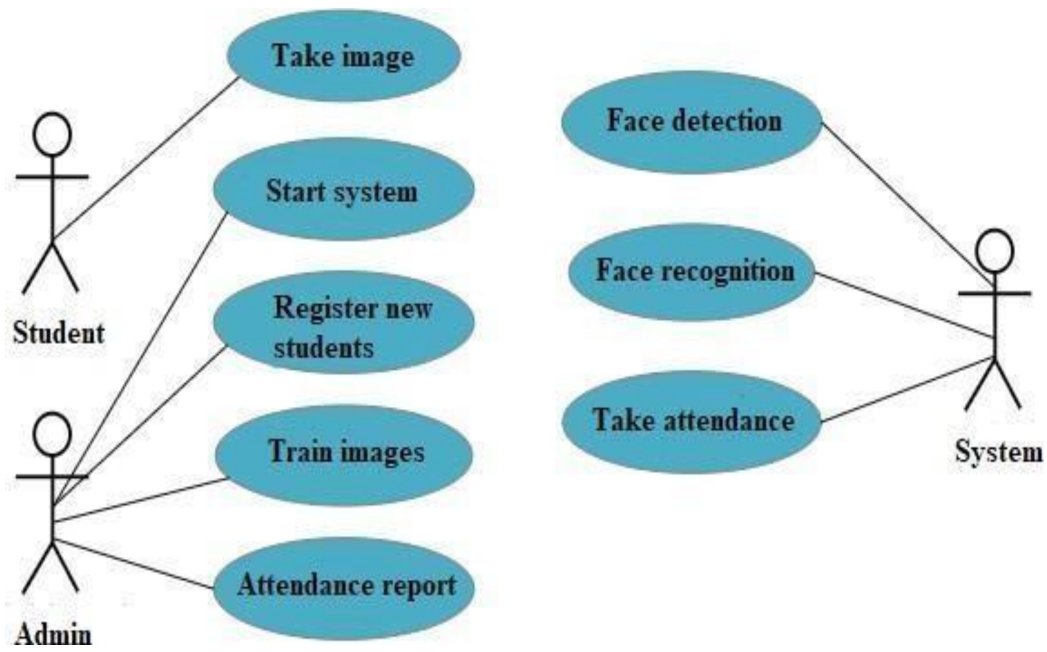


Fig 3.2: Use case Diagram

Use Case Diagram:

The benefit of use case diagrams is mostly based on communication between the request team and the user group. A use case specification document should cover the following areas:

- Actors - participating in and interacting in this use case
- Preconditions - must be met for the use case to work.
- Unconditional - defines the various states in which the system is expected to be after it is executed. The Use Case diagram lists the basic events that will occur when the system is executed. It includes all the primary actions that the system must perform.
- Triggers - Events or actions that initiate the use case. These could be specific user actions, system events, or external stimuli.
- Exceptional Conditions - Explicitly stating how the system should handle exceptional or error conditions that might occur during the execution of the use case.
- Security Considerations - Details on security measures and protocols relevant to the use case, especially concerning sensitive data or critical system functions.

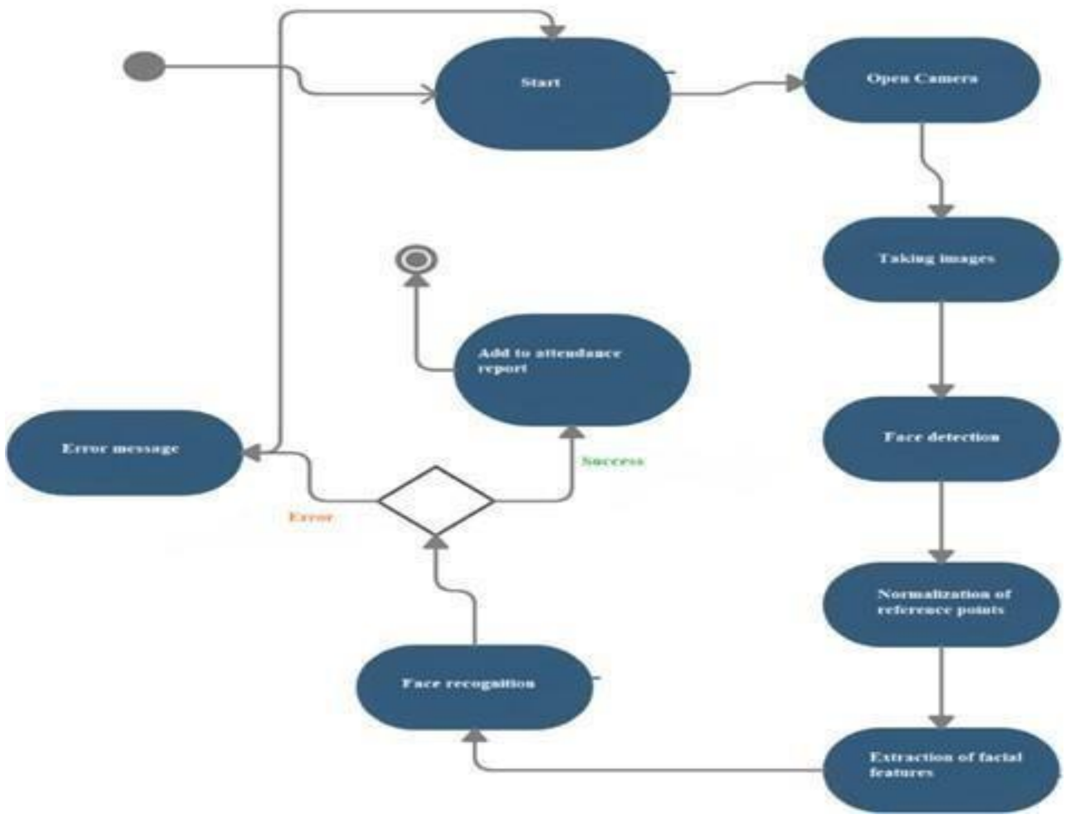


Figure 3.3: Activity Diagram

Activity diagram:

The activity diagram for how the system works in the facial features registration section, the processes which are performed before the presence marking process takes place. After going through the defined steps face image recognition can be performed successfully and, in this case, the assigned student is added to the presence preservation report otherwise, the error message is displayed on the screen, and the reason why it is not executed with order process success.

Start/Initial Node: This marks the beginning of the activity diagram for facial features registration.

Input Gathering:

Capture facial features: This step involves capturing the necessary facial data required for recognition. It may include processes like taking pictures or scanning facial features.

Data validation: Verification of the captured data to ensure its accuracy and completeness.

Facial Recognition Process:

Image preprocessing: Any necessary image adjustments or enhancements to prepare the facial data for recognition.

Feature extraction: Identifying key facial features from the captured data.

Matching algorithm: Utilizing a matching algorithm (such as neural networks or other recognition methods) to compare extracted features with stored data.

Recognition decision: Determining whether the facial features match an existing record in the system.

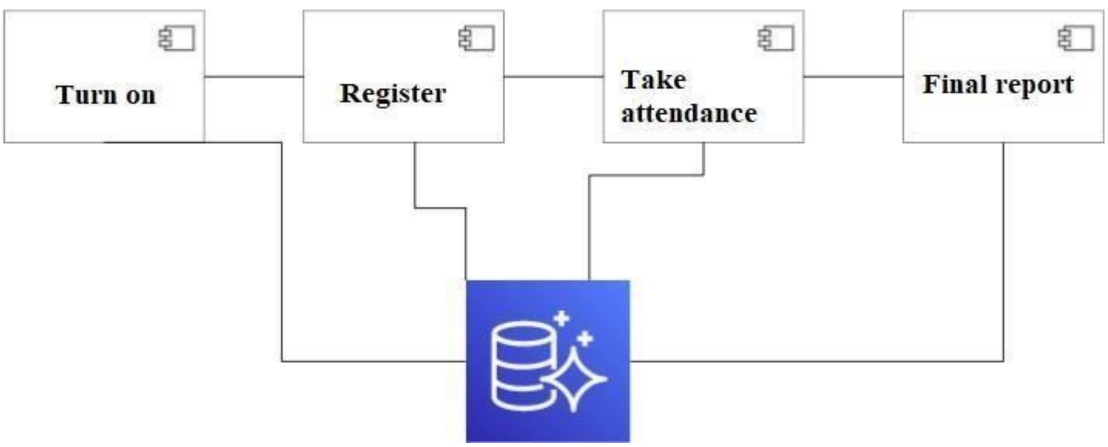


Figure 3.4: Component Diagram

Component Diagram:

Component Diagram represents the implementation perspective of a system. Therefore, the components in a component diagram are reflected by grouping different designs of system elements, such as system classes. Firstly, the component must be replaceable, and secondly, the component must provide interfaces to enable other elements to interact and provide the services provided by the component.

3.5. Design Selection:

Selecting the right design for a facial recognition system with deep learning involves several considerations. Here's a detailed explanation of the design selection process:

1. Define Objectives: Clearly outline the goals and objectives of the facial recognition system. Understand the specific requirements, such as attendance tracking, access control, or security enhancement.

2. System Requirements: Identify the key system requirements, including accuracy, speed, scalability, and adaptability to different environments. Consider whether real-time processing is essential and the level of accuracy required for your application.

3. Deep Learning Models: Choose an appropriate deep learning model for facial recognition. Convolutional Neural Networks (CNNs) are commonly used for image-related tasks, and architectures like VGG, ResNet, or MobileNet may be considered based on the trade-offs between accuracy and computational efficiency.

4. Dataset Preparation: Collect a diverse and representative dataset for training the facial recognition model. Ensure that the dataset includes a variety of facial expressions, poses, lighting conditions, and demographics to enhance the model's robustness.

5. Data Preprocessing: Implement preprocessing techniques, such as face alignment, normalization, and augmentation, to enhance the quality and diversity of the training data. This helps the model generalize well to different scenarios.

6. Transfer Learning: Leverage transfer learning if you have limited labeled data. Pre-trained models on large datasets (e.g., ImageNet) can be fine-tuned for facial recognition tasks, saving computational resources and time.

7. Model Training: Train the selected deep learning model using the prepared dataset. Fine-tune the hyperparameters, monitor performance metrics, and employ techniques like regularization to avoid overfitting.

8. Hardware Considerations: Choose appropriate hardware based on the computational requirements of the deep learning model. Graphics Processing Units (GPUs) are commonly used to accelerate training and inference processes.
9. Integration with RFID: If integrating with RFID, ensure seamless communication between the facial recognition system and RFID technology. Design the system to capture facial data and RFID signals efficiently for accurate attendance tracking.
10. Privacy and Ethical Considerations: Address privacy concerns by implementing measures such as anonymization of data, encryption, and compliance with data protection regulations. Ensure that your facial recognition system adheres to ethical standards.
11. User Interface (UI) Design: Design an intuitive user interface for interaction with the facial recognition system. Consider ease of use, feedback mechanisms, and accessibility to ensure user acceptance.
12. Scalability: Design the system to be scalable, allowing for the addition of more users, devices, or locations. Consider the impact on performance as the system grows.
13. Security Measures: Implement security measures to protect against potential attacks, such as adversarial attacks on the facial recognition system. Regularly update the system to patch vulnerabilities.
14. Monitoring and Maintenance: Set up a system for continuous monitoring and maintenance. Regularly update the deep learning model with new data, monitor system performance, and address any issues promptly.

CHAPTER 4

RESULTS ANALYSIS AND VALIDATION

4.1. Implementation of solution

4.1.1 Analysis

The application of deep learning in facial recognition for attendance systems demands a comprehensive evaluation to gauge its effectiveness, efficiency, and impact on achieving attendance recording goals. A qualitative assessment of each stage of the process is pivotal for successful implementation.

The effectiveness of this system hinges on the analysis of collected data, assessing differences and representations therein. The pivotal role of facial features in accurate recognition underscores the necessity to meticulously review and exclude extraneous facial areas. Creating discernible patterns during resizing and normalization, along with comparing facial images, forms the bedrock of this evaluation. Understanding key patterns through thorough data analysis becomes imperative.

The chosen deep learning model, typically a convolutional neural network (CNN), undergoes scrutiny for its efficacy in capturing subtle facial nuances. Its performance in simulating facial recognition and ensuring accuracy in attendance recording stands as a critical metric in this analysis. Evaluating the model's training process involves assessing the amalgamation of speed and stability. Additionally, the efficacy of planning and data augmentation techniques in enhancing recognition accuracy requires thorough evaluation.

4.1.2 Software Implementation

15. **OpenCV:** We rely on OpenCV 3, a Python 3 dependency, for our image processing needs. OpenCV is a powerful library equipped with numerous image processing functions, making it incredibly handy. It simplifies complex tasks, often delivering desired results without the need for extensive coding. This library is versatile, working seamlessly across different platforms, and is freely available for use, governed by the open-source BSD license. It offers a wide array

of functions that support various image processing tasks, providing extensive capabilities for image manipulation and analysis.

Example of some supported functions are given below:

- **Derivation:** Gradient/Laplacian computing, contours delimitation
- **Hough transforms:** Lines, segments, circles, and geometrical shapes detection
- **Histograms:** Computing, equalization, and object localization with back projection algorithm
- **Segmentation:** Thresholding, distance transform, foreground/background detection, watershed segmentation
- **Filtering:** Linear and nonlinear filters, morphological operations
- **Cascade detectors:** detection of face, eye, car plates**.**

4.2 Results

Below are the implementation screenshots:

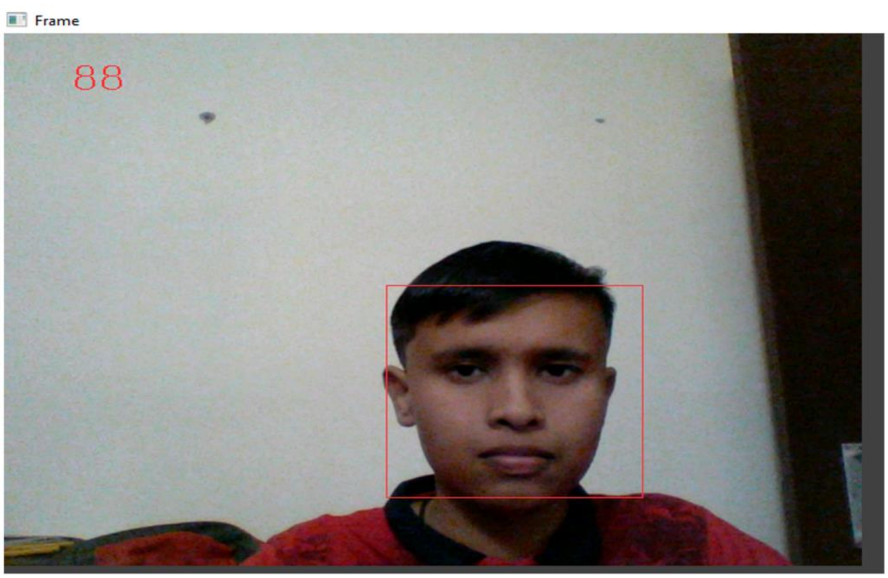


Fig 4.1 – Face Detection

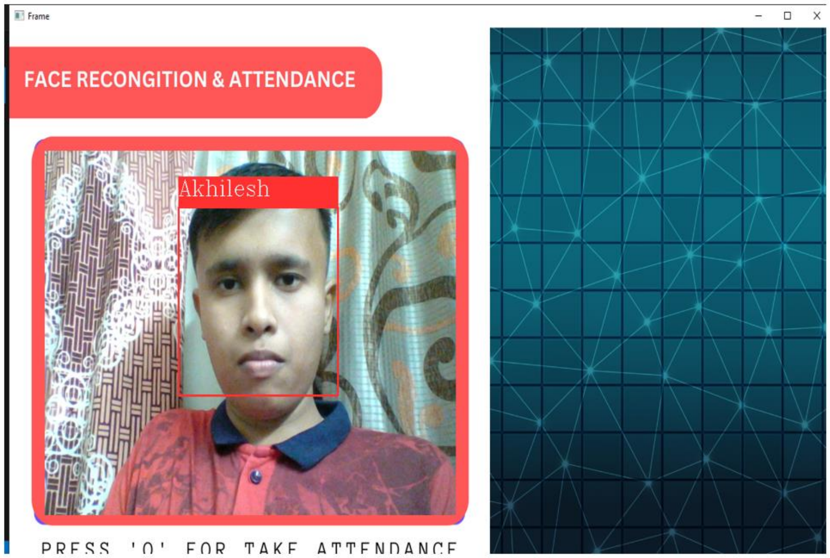


Fig 4.2 – Attendance marking

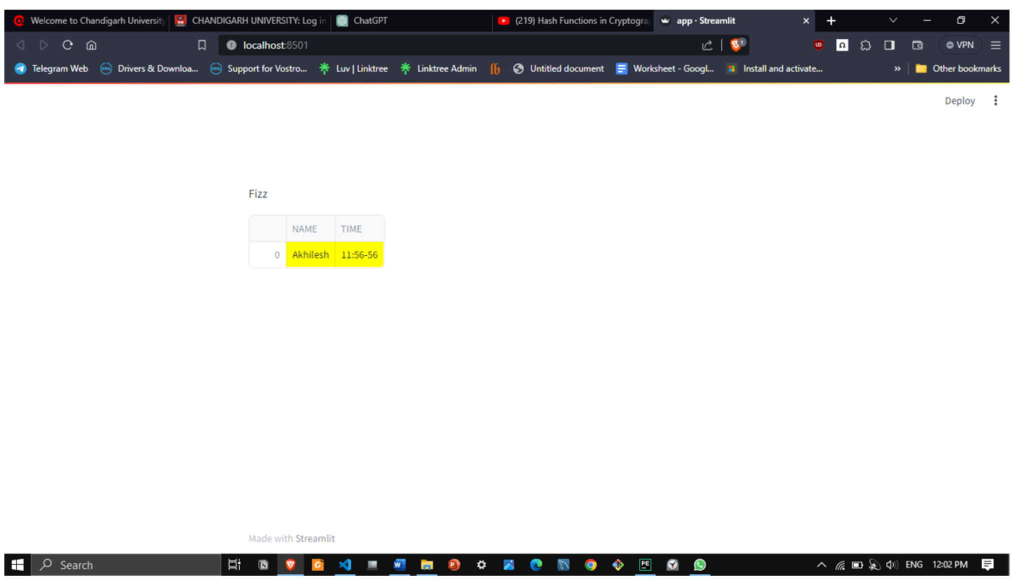


Fig 4.3 – Streamlit dashboard

4.3 Testing

The testing phase in our face recognition-based attendance system employs facial evolution, regression, and deep learning methodologies. This phase stands as a critical checkpoint, ensuring the robustness and generalizability of our design. We implement a rigorous testing protocol that spans diverse scenarios and datasets to validate the system's performance.

Evaluation of our training program is comprehensive, assessing competitive speed, stability, and overall model performance throughout the training period. Learning curve analyses offer insights into the model's adaptability to varying data and its ability to expand effectively. Back testing procedures are crucial for identifying and resolving issues related to overfitting, underfitting, or convergence, thereby enhancing the training process.

Quantitative evaluation metrics like mean square error (MSE) and accuracy are systematically applied to measure the model's prediction performance. These metrics gauge the realism of the model's output, providing a nuanced understanding of how well it simulates facial evolution and degradation.

Currently, quality assessments are underway to evaluate the model's accuracy concerning age and facial image deterioration. User research and opinions are integrated to formulate recommendations, ensuring a comprehensive understanding of system integrity and alignment with user expectations.

Our evaluation process incorporates ethical considerations, prioritizing confidentiality, consent, and ethical compliance. Protocols are meticulously designed to address ethical concerns, with test results serving as indicators of solution integrity.

The testing phase not only validates success but also gauges the effectiveness of our system. It opens avenues for development and improvement, leveraging insights gained from testing iterations to foster a feedback loop for continuous enhancement. This iterative approach ensures that our solutions not only meet existing standards but also remain adaptable to evolving challenges and technologies.

Ultimately, the testing phase serves as a cornerstone in establishing the reliability, validity, and ethical framework of our deep learning-based face recognition system for attendance tracking.

CHAPTER 5

CONCLUSION AND FUTURE WORK

5.1. Conclusion

The central objective of this system is to implement a resilient class attendance management mechanism by employing cutting-edge facial recognition techniques. The envisioned system is poised to demonstrate exceptional proficiency in capturing attendance data accurately through the utilization of advanced face identification methods. Its operational prowess lies in the seamless integration of real-time face detection facilitated by a webcam, coupled with precise face recognition algorithms. Upon the successful recognition of a student's face, the system seamlessly proceeds to record their attendance, guaranteeing that attendance records are not only meticulously documented but also promptly updated.

In crafting this technological solution, the emphasis is on harnessing the individuality inherent in facial features to create a robust identification system. By doing so, the system ensures a high degree of precision in attendance tracking, minimizing the possibility of errors or discrepancies. This innovation aims to streamline the conventional attendance recording processes prevalent in educational institutions, offering a more efficient and foolproof alternative.

The proposed system's real-time face detection component, powered by webcam technology, exemplifies its commitment to immediacy and responsiveness. This feature not only enhances the speed of attendance capture but also adds a layer of adaptability to various classroom environments. The subsequent step, which involves the intricate process of face recognition, further underscores the system's technological sophistication. Through the meticulous analysis of facial characteristics, the system distinguishes each student uniquely, creating a secure and reliable method for attendance monitoring.

Furthermore, the system's efficiency extends to the backend, where it ensures that attendance records are not just captured but promptly integrated into the overarching record-keeping infrastructure. This commitment to timely updates adds an element of dynamism to the attendance management process, facilitating quick access to accurate attendance data for educators and administrators alike.

In essence, this innovative system represents a leap forward in class attendance management, harnessing advanced facial recognition technologies to establish a foolproof, efficient, and responsive mechanism for recording and updating attendance records in educational settings.

5.2. Future work

- Future work could focus on refining the accuracy of face recognition algorithms to ensure even higher precision in identifying and verifying individuals, reducing the chances of false positives or negatives.
- Integration with additional biometric modalities, such as fingerprint or iris recognition, could enhance the robustness of the system, providing alternative means of identification and reducing dependency on facial recognition alone.
- Developing adaptive learning algorithms that continuously improve with more data, ensuring the system becomes more adept at recognizing faces under varying conditions, including different lighting, angles, and facial expressions.
- Implementing real-time analytics to provide insights into attendance patterns, such as identifying trends, irregularities, and possible areas of improvement for educators and administrators.
- Exploring the integration of behavioral biometrics, such as gait analysis or keystroke dynamics, to add an extra layer of security and uniqueness to the identification process.
- Incorporating privacy-preserving measures, like differential privacy or secure multiparty computation, to address concerns related to data security and privacy, especially in educational environments.
- Designing the system to be easily scalable to accommodate varying class sizes, multiple classrooms, and potentially even different educational institutions with diverse infrastructure setups.

- Developing user-friendly interfaces for both educators and students to facilitate easy adoption and interaction with the attendance system, promoting a positive user experience.
- Seamless integration with existing student management systems to automate attendance tracking, grading, and other administrative tasks, reducing manual efforts and potential errors.
- Creating mobile applications that allow students to check their attendance records, receive notifications, and provide feedback, fostering a more engaged and informed student body.
- Investing in ongoing research to stay abreast of the latest advancements in facial recognition technology, artificial intelligence, and biometrics, ensuring the system remains at the forefront of innovation.
- Ensuring the system is accessible to individuals with diverse physical characteristics, including different skin tones, facial features, and disabilities, to prevent biases and promote inclusivity in attendance tracking.

Future work on a Facial Recognition Attendance System holds immense potential for further refinement and innovation. One avenue for advancement is the continuous improvement of the underlying facial recognition algorithms. Research efforts can focus on enhancing the accuracy and efficiency of recognition processes, especially under challenging conditions such as low lighting or varying facial expressions. Incorporating advanced machine learning techniques, including reinforcement learning and unsupervised learning, could contribute to more robust and adaptive facial recognition models.

Moreover, future developments might explore the integration of additional biometric modalities to augment facial recognition, potentially improving the system's overall reliability. Fusion with technologies such as fingerprint or iris recognition could offer a multi-modal approach, addressing limitations associated with individual biometric methods and enhancing the system's overall performance.

In terms of user interaction and experience, future work can delve into refining the system's user interfaces. Intuitive and accessible interfaces, coupled with user-friendly enrollment processes, could contribute to increased user acceptance and satisfaction. Exploring augmented reality or interactive visualizations within the user interface might also enhance the overall user experience.

Security and privacy considerations remain paramount, and future efforts should focus on developing more sophisticated anti-spoofing techniques to counter facial recognition vulnerabilities. Additionally, exploring privacy-preserving mechanisms, such as federated learning or on-device processing, can address concerns related to data security and privacy compliance.

The scalability of Facial Recognition Attendance Systems is another aspect ripe for future exploration. Research can delve into developing systems capable of handling large-scale deployments, accommodating diverse user populations and varied environmental conditions. Moreover, investigations into edge computing and decentralized architectures could optimize system performance, reducing dependencies on centralized servers.

Collaboration with regulatory bodies and policymakers will be crucial for future work on Facial Recognition Attendance Systems. Addressing legal and ethical concerns, establishing clear guidelines for system usage, and ensuring compliance with evolving data protection regulations will be integral to the system's long-term viability.

In conclusion, the future trajectory of Facial Recognition Attendance Systems involves a holistic approach that encompasses algorithmic advancements, user interface enhancements, security and privacy considerations, scalability improvements, and collaboration with regulatory frameworks. By addressing these aspects, future iterations of the system have the potential to redefine attendance management with heightened accuracy, efficiency, and ethical considerations.

REFERENCES

[1] Turk, M., & Pentland, A. (1991). "Face recognition using eigenfaces." Proceedings CVPR '91: Computer Vision and Pattern Recognition.

[2] Viola, P., & Jones, M. (2004). "Robust Real-Time Face Detection." International Journal of Computer Vision, 57(2), 137-154.

[3] Zhang, L., Zhang, D., & Chen, S. (2010). "A Survey of Recent Advances in Face Detection." Microsoft Research Technical Report, MSR-TR-2010-66.

[4] Zhao, W., Chellappa, R., Phillips, P. J., & Rosenfeld, A. (2003). "Face recognition: A literature survey." ACM Computing Surveys (CSUR), 35(4), 399-458.

[5] Turk, M. A., & Pentland, A. P. (1991). "Eigenfaces for recognition." Journal of cognitive neuroscience, 3(1), 71-86.

[6] Tan, X., & Triggs, B. (2010). "Enhanced local texture feature sets for face recognition under difficult lighting conditions." IEEE Transactions on Image Processing, 19(6), 1635-1650.

[7] Hjelmas, E., & Low, B. K. (2001). "Face detection: A survey." Computer Vision and Image Understanding, 83(3), 236-274.

[8] Phillips, P. J., Moon, H., Rizvi, S. A., & Rauss, P. J. (2000). "The FERET evaluation methodology for face-recognition algorithms." IEEE Transactions on Pattern Analysis and Machine Intelligence, 22(10), 1090-1104.

[9] Zhang, Z., Luo, P., Loy, C. C., & Tang, X. (2016). "Joint face detection and alignment using multitask cascaded convolutional networks." IEEE Signal Processing Letters, 23(10), 1499-1503.

[10] Khan, M. H., Wahab, N., & Goh, N. (2019). "An Automated Attendance Management System Using Face Recognition." 2019 IEEE 21st International Conference on High-Performance Computing and Communications; IEEE 17th International Conference on Smart City; IEEE 5th International Conference on Data Science and Systems (HPCC/SmartCity/DSS), Zhangjiajie, China, pp. 1813-1818.

[11] Chan, C. H., Kittler, J., & Poh, N. (2009). "PCA-MLDA: A new approach for face recognition." IEEE Transactions on Information Forensics and Security, 4(4), 765-778.

[14] Martinez, A. M., & Kak, A. C. (2001). "PCA versus LDA." IEEE Transactions on Pattern Analysis and Machine Intelligence, 23(2), 228-233.

[15] Liu, C., Shum, H. Y., & Zhang, C. (2001). "A two-step approach to hallucinating faces: Global parametric model and local nonparametric model." In CVPR 2001. Proceedings of the 2001 IEEE Computer Society Conference on Computer Vision and Pattern Recognition. CVPR 2001 (Vol. 1, pp. I-I).

[16] Hu, J., Lu, J., & Tan, Y. P. (2004). "Discriminative multilinear principal component analysis for face recognition with face alignment." Pattern Recognition, 37(10), 2013-2024.

[17] Ratha, N. K., Senior, A., & Bolle, R. M. (2001). "Enhancing security and privacy in biometrics-based authentication systems." IBM Systems Journal, 40(3), 614-634.

[18] Kong, W. K., Zhang, D., Kamel, M., & Zhang, L. (2005). "A survey of palmprint recognition." Pattern Recognition, 42(7), 1408-1418.

[19] Jain, A. K., Ross, A., & Nandakumar, K. (2016). "Introduction to biometrics." Springer.

[20] Klare, B. F., Burge, M. J., Klontz, J. C., Vorder Bruegge, R. W., & Jain, A. K. (2012). "Face recognition performance: Role of demographic information." IEEE Transactions on Information Forensics and Security, 7(6), 1789-1801.

[21] Yang, M. H., Kriegman, D. J., & Ahuja, N. (2002). "Detecting faces in images: A survey." IEEE Transactions on Pattern Analysis and Machine Intelligence, 24(1), 34-58.

[22] Zhang, D., & Jain, A. K. (2004). "Evaluation of face recognition systems under occlusion conditions." In International Conference on Pattern Recognition (Vol. 2, pp. 223-226). IEEE.

[23] Abiantun, R. (2019). "Face Recognition based Attendance Management System." International Journal of Scientific & Technology Research, 8(10), 2456-2165.

[24] Wang, X., & Han, T. X. (2007). "An HMM-based approach for face recognition." IEEE Transactions on Image Processing, 16(10), 2624-2633.

[25] Wang, S., & Sung, E. (2001). "Face recognition using LDA-based algorithms." IEEE Transactions on Neural Networks, 12(4), 696-710.

[26] Zhou, S., Chellappa, R., Moghaddam, B., & Atick, J. (2003). "Exploiting non-negative matrix factorization for signal classification." IEEE Transactions on Pattern Analysis and Machine Intelligence, 27(11), 1680-1684.

[27] Zhao, W., Chellappa, R., Krishnaswamy, A., & Rosenfeld, A. (1998). "Face recognition: A convolutional neural-network approach." IEEE Transactions on Neural Networks, 8(1), 98-113.

[28] Abate, A. F., Nappi, M., & Riccio, D. (2007). "A fully automated technique for human face recognition in uncontrolled conditions." Pattern Recognition Letters, 28(8), 965-975.

[29] Kong, W. K., & Zhang, D. (2003). "Accurate face localization in complex scenes." Pattern Recognition, 36(6), 1389-1400.

[30] Wu, X., He, R., Sun, Z., & Tan, T. (2017). "A light CNN for deep face representation with noisy labels." IEEE Transactions on Information Forensics and Security, 13(11), 2884-2896.

[31] Cao, Q., Shen, L., Xie, W., Parkhi, O. M., & Zisserman, A. (2018). "VGGFace2: A dataset for recognizing faces across pose and age."

[32] Mian, A. S., Mohamed, S., & Baker, T. (2007). "Face recognition using 2D and 3D facial data." IEEE Transactions on Pattern Analysis and Machine Intelligence, 29(6), 603-618.

[33] Turk, M., & Pentland, A. (1991). "Face recognition using eigenfaces." Proceedings CVPR '91: Computer Vision and Pattern Recognition, 586-591.

[34] Yan, J., Lei, Z., Yi, D., & Li, S. Z. (2014). "Learn discriminative biometric features from quality distorted face images." IEEE Transactions on Information Forensics and Security, 9(3), 425-438.

[35] Kumar, A., & Zhang, D. (2011). "Ordinal measures for iris recognition." IEEE Transactions on Pattern Analysis and Machine Intelligence, 33(10), 2082-2098.

[36] Jain, A. K., Ross, A., & Prabhakar, S. (2004). "An introduction to biometric recognition." IEEE Transactions on Circuits and Systems for Video Technology, 14(1), 4-20.

[37] Zafeiriou, S., Kollias, D., & Tzimiropoulos, G. (2015). "Texture and shape deformable models in 3D face recognition." IEEE Transactions on Pattern Analysis and Machine Intelligence, 37(10), 1929-1941.

[38] Phillips, P. J., Flynn, P. J., Scruggs, T., Bowyer, K. W., Chang, J., Hoffman, K.,... & Weimer, S. (2005). "Overview of the face recognition grand challenge." In 2005 IEEE Computer Society Conference on Computer Vision and Pattern Recognition (CVPR'05) (Vol. 1, pp. 947-954). IEEE.

[39] Sirovich, L., & Kirby, M. (1987). "Low-dimensional procedure for the characterization of human faces." Journal of the Optical Society of America A, 4(3), 519-524.

[40] Parkhi, O. M., Vedaldi, A., & Zisserman, A. (2015). "Deep face recognition." In BMVC (Vol. 1, No. 3, p. 6).

[41] Li, H., Hua, G., Lin, Z., & Davis, L. S. (2013). "Discriminative multimodal feature fusion for RGB-D object recognition." In 2013 IEEE International Conference on Computer Vision (ICCV) (pp. 541-548). IEEE.

[42] Raghavendra, R., & Raja, K. B. (2017). "Deep learning for facial expression recognition: A step closer to human level performance." In 2017 IEEE International Conference on Systems, Man, and Cybernetics (SMC) (pp. 1846-1851). IEEE.

[43] Yang, L., Jin, R., Sukthankar, R., & Jurie, F. (2012). "Unsupervised learning of discriminative texture representation for image segmentation." IEEE Transactions on Pattern Analysis and Machine Intelligence, 34(9), 1690-1702.

[44] Su, Y., Shan, S., Chen, X., & Gao, W. (2009). "Hierarchical ensemble of global and local classifiers for face recognition." IEEE Transactions on Image Processing, 18(8), 1885-1896.

[45] LeCun, Y., Bengio, Y., & Hinton, G. (2015). "Deep learning." Nature, 521(7553), 436-444.

[46] Yan, J., Zhang, Z., Lei, Z., & Li, S. Z. (2013). "Learn to combine modalities in multi-modal biometric verification." IEEE Transactions on Pattern Analysis and Machine Intelligence, 35(4), 917-932.

[47] Simonyan, K., & Zisserman, A. (2014). "Very deep convolutional networks for large-scale image recognition." arXiv preprint arXiv:1409.1556.

[48] Li, H., Lin, Z., Shen, X., Brandt, J., & Hua, G. (2017). "Eigen-PEP for video face recognition." In 2017 IEEE International Conference on Computer Vision (ICCV) (pp. 1023-1032). IEEE.

[49] Nair, V., & Hinton, G. E. (2010). "Rectified linear units improve restricted boltzmann machines." In Proceedings of the 27th International Conference on Machine Learning (ICML-10) (pp. 807-814).

[50] Ding, C., & Tao, D. (2015). "Robust face recognition via multimodal deep face representation." IEEE Transactions on Multimedia, 17(11), 2049-2058.

[51] Yi, D., Lei, Z., Liao, S., & Li, S. Z. (2014). "Learning face representation from scratch." arXiv preprint arXiv:1411.7923.

[52] Ojala, T., Pietikainen, M., & Maenpaa, T. (2002). "Multiresolution gray-scale and rotation invariant texture classification with local binary patterns." IEEE Transactions on Pattern Analysis and Machine Intelligence, 24(7), 971-987.

[53] Yang, M. H., & Ahuja, N. (2000). "Gaussian mixture model for human skin color and its applications in image and video databases." In Proceedings IEEE International Conference on Image Processing (Vol. 2, pp. 447-450). IEEE.

[54] Taigman, Y., Yang, M., Ranzato, M., & Wolf, L. (2014). "DeepFace: Closing the gap to human-level performance in face verification." In Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (pp. 1701-1708).

[55] Chen, L., Zhang, Z., & Wang, D. (2017). "Single image super-resolution based on multi-scale competitive convolutional neural networks." IEEE Transactions on Multimedia, 19(12), 2737-2748.

[56] Lu, J., Wang, G., Deng, W., Moulin, P., & Zhou, J. (2015). "Attribute-guided face generation using conditional generative adversarial networks." arXiv preprint arXiv:1708.00939.

[57] Zhang, Z., Luo, P., Loy, C. C., & Tang, X. (2015). "Learning deep representation for face alignment with auxiliary attributes." IEEE Transactions on Pattern Analysis and Machine Intelligence, 38(5), 918-930.

[58] Yu, J., & Deng, W. (2015). "Discriminative multimetric learning for face verification in the wild." IEEE Transactions on Image Processing, 24(1), 595-606.

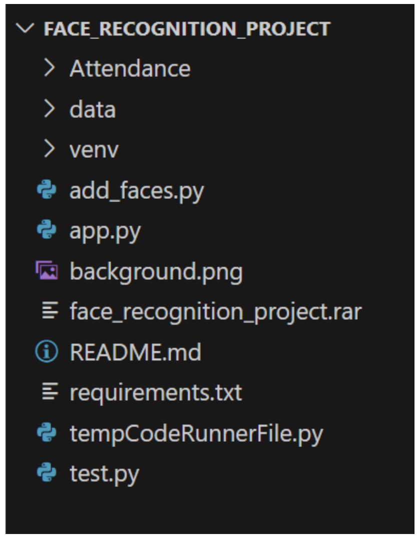
[59] Parkhi, O. M., Simonyan, K., Vedaldi, A., & Zisserman, A. (2015). "Deep face recognition." British Machine Vision Conference.

[60] Liao, S., Li, S. Z., & Zhao, G. (2017). "Efficient convolutional sparse coding." IEEE Transactions on Neural Networks and Learning Systems, 29(2), 303-313.

APPENDIX

Code Implementation:

All our code is written in Python language. First here is our project directory structure and files.



test.py

All the work will be done here, Detect the face ,recognize the faces and takeattendance.

```
from sklearn.neighbors import KNeighborsClassifier
import cv2
import pickle
import numpy as np
import os
import csv
import time
from datetime import datetime

from win32com.client import Dispatch

def speak(str1):
    speak=Dispatch(("SAPI.SpVoice"))
    speak.Speak(str1)

video=cv2.VideoCapture(0)
facedetect=cv2.CascadeClassifier('data/haarcascade_frontalface_default.xml')

with open('data/names.pkl', 'rb') as w:
    LABELS=pickle.load(w)
```

```python
with open('data/faces_data.pkl', 'rb') as f:
    FACES=pickle.load(f)

print('Shape of Faces matrix --> ', FACES.shape)

knn=KNeighborsClassifier(n_neighbors=5)
knn.fit(FACES, LABELS)

imgBackground=cv2.imread("background.png")

COL_NAMES = ['NAME', 'TIME']

while True:
    ret,frame=video.read()
    gray=cv2.cvtColor(frame, cv2.COLOR_BGR2GRAY)
    faces=facedetect.detectMultiScale(gray, 1.3 ,5)
    for (x,y,w,h) in faces:
        crop_img=frame[y:y+h, x:x+w, :]
        resized_img=cv2.resize(crop_img, (50,50)).flatten().reshape(1,-1)
        output=knn.predict(resized_img)
        ts=time.time()
        date=datetime.fromtimestamp(ts).strftime("%d-%m-%Y")
        timestamp=datetime.fromtimestamp(ts).strftime("%H:%M-%S")
        exist=os.path.isfile("Attendance/Attendance_" + date + ".csv")
        cv2.rectangle(frame, (x,y), (x+w, y+h), (0,0,255), 1)
        cv2.rectangle(frame,(x,y),(x+w,y+h),(50,50,255),2)
        cv2.rectangle(frame,(x,y-40),(x+w,y),(50,50,255),-1)
        cv2.putText(frame, str(output[0]), (x,y-15), cv2.FONT_HERSHEY_COMPLEX, 1,
(255,255,255), 1)
        cv2.rectangle(frame, (x,y), (x+w, y+h), (50,50,255), 1)
        attendance=[str(output[0]), str(timestamp)]
    imgBackground[162:162 + 480, 55:55 + 640] = frame
    cv2.imshow("Frame",imgBackground)
    k=cv2.waitKey(1)
    if k==ord('o'):
        speak("Attendance Taken..")
        time.sleep(5)
        if exist:
            with open("Attendance/Attendance_" + date + ".csv", "+a") as csvfile:
                writer=csv.writer(csvfile)
                writer.writerow(attendance)
            csvfile.close()
        else:
            with open("Attendance/Attendance_" + date + ".csv", "+a") as csvfile:
                writer=csv.writer(csvfile)
```

```
                writer.writerow(COL_NAMES)
                writer.writerow(attendance)
            csvfile.close()
    if k==ord('q'):
        break
video.release()
cv2.destroyAllWindows()
```

app.py

using app.py, we can see the marked attendance

```
import streamlit as st
import pandas as pd
import time
from datetime import datetime

ts=time.time()
date=datetime.fromtimestamp(ts).strftime("%d-%m-%Y")
timestamp=datetime.fromtimestamp(ts).strftime("%H:%M-%S")

from streamlit_autorefresh import st_autorefresh

count = st_autorefresh(interval=2000, limit=100, key="fizzbuzzcounter")

if count == 0:
    st.write("Count is zero")
elif count % 3 == 0 and count % 5 == 0:
    st.write("FizzBuzz")
elif count % 3 == 0:
    st.write("Fizz")
elif count % 5 == 0:
    st.write("Buzz")
else:
    st.write(f"Count: {count}")

df=pd.read_csv("Attendance/Attendance_" + date + ".csv")

st.dataframe(df.style.highlight_max(axis=0))
```

add_face.py

This capture_image.py will collect the data set of a student and add his/her name in the StudentsDetails.csv

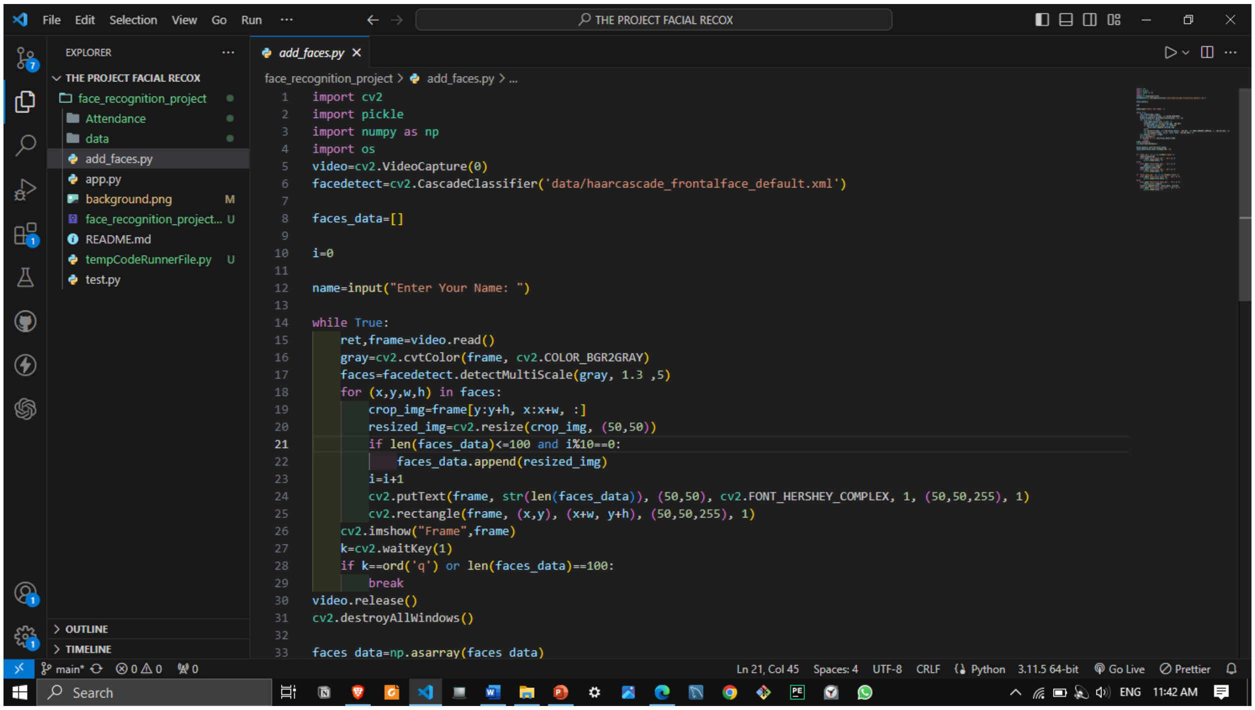
```
import cv2
import pickle
```

```
import numpy as np
import os
video=cv2.VideoCapture(0)
facedetect=cv2.CascadeClassifier('data/haarcascade_frontalface_default.xml')

faces_data=[]

i=0

name=input("Enter Your Name: ")

while True:
    ret,frame=video.read()
    gray=cv2.cvtColor(frame, cv2.COLOR_BGR2GRAY)
    faces=facedetect.detectMultiScale(gray, 1.3 ,5)
    for (x,y,w,h) in faces:
        crop_img=frame[y:y+h, x:x+w, :]
        resized_img=cv2.resize(crop_img, (50,50))
        if len(faces_data)<=100 and i%10==0:
            faces_data.append(resized_img)
        i=i+1
        cv2.putText(frame, str(len(faces_data)), (50,50),
cv2.FONT_HERSHEY_COMPLEX, 1, (50,50,255), 1)
        cv2.rectangle(frame, (x,y), (x+w, y+h), (50,50,255), 1)
    cv2.imshow("Frame",frame)
    k=cv2.waitKey(1)
    if k==ord('q') or len(faces_data)==100:
        break
video.release()
cv2.destroyAllWindows()

faces_data=np.asarray(faces_data)
faces_data=faces_data.reshape(100, -1)

if 'names.pkl' not in os.listdir('data/'):
    names=[name]*100
    with open('data/names.pkl', 'wb') as f:
        pickle.dump(names, f)
else:
    with open('data/names.pkl', 'rb') as f:
        names=pickle.load(f)
    names=names+[name]*100
    with open('data/names.pkl', 'wb') as f:
        pickle.dump(names, f)
```

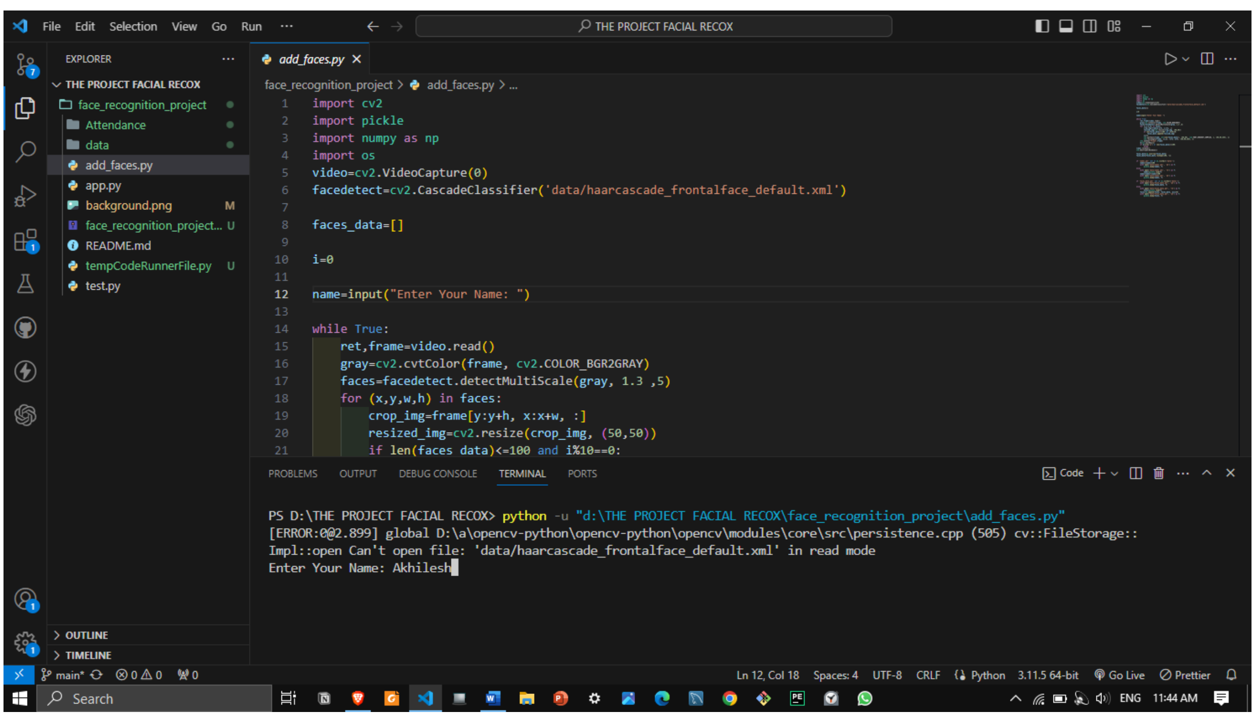
```python
if 'faces_data.pkl' not in os.listdir('data/'):
    with open('data/faces_data.pkl', 'wb') as f:
        pickle.dump(faces_data, f)
else:
    with open('data/faces_data.pkl', 'rb') as f:
        faces=pickle.load(f)
    faces=np.append(faces, faces_data, axis=0)
    with open('data/faces_data.pkl', 'wb') as f:
        pickle.dump(faces, f)
```

USER MANUAL

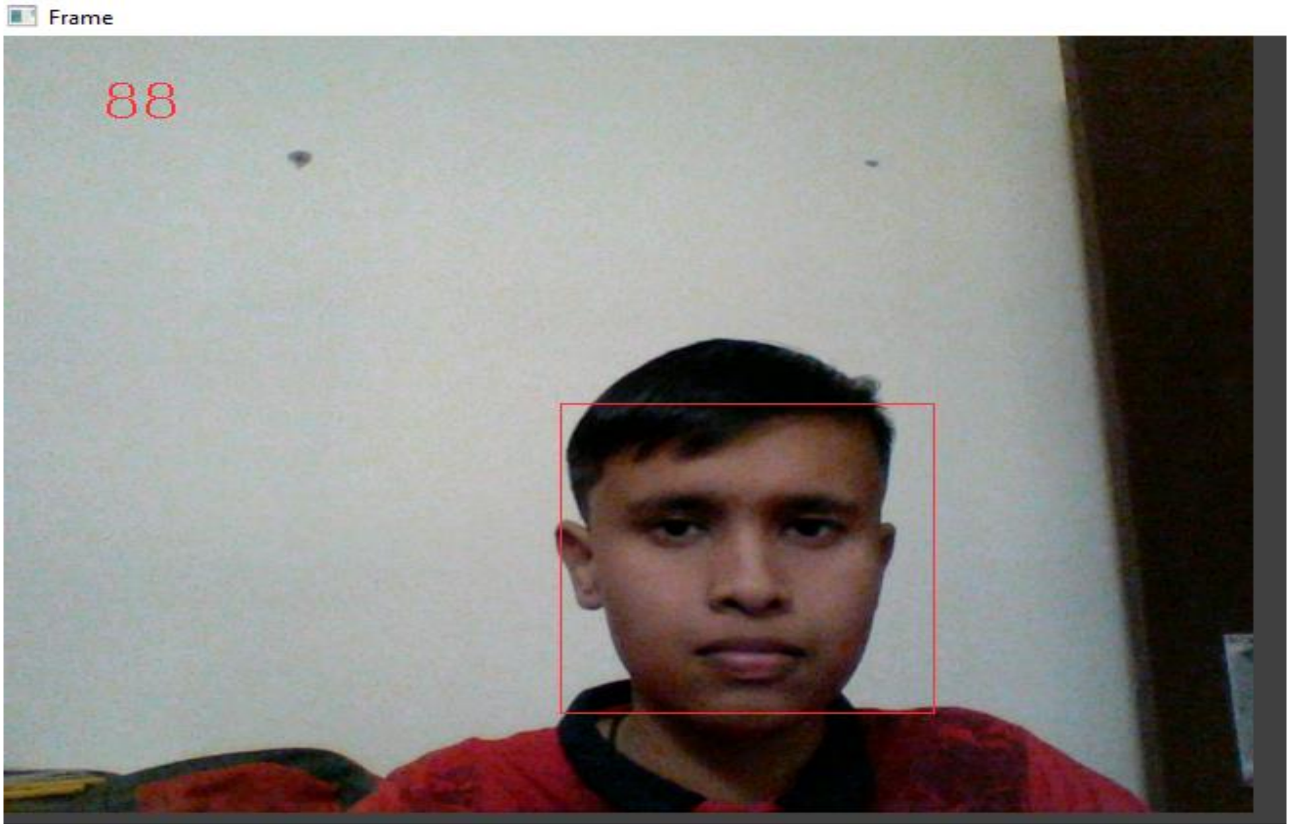
Step:1: open vscode or similar application and open add faces.py to add the face in the database



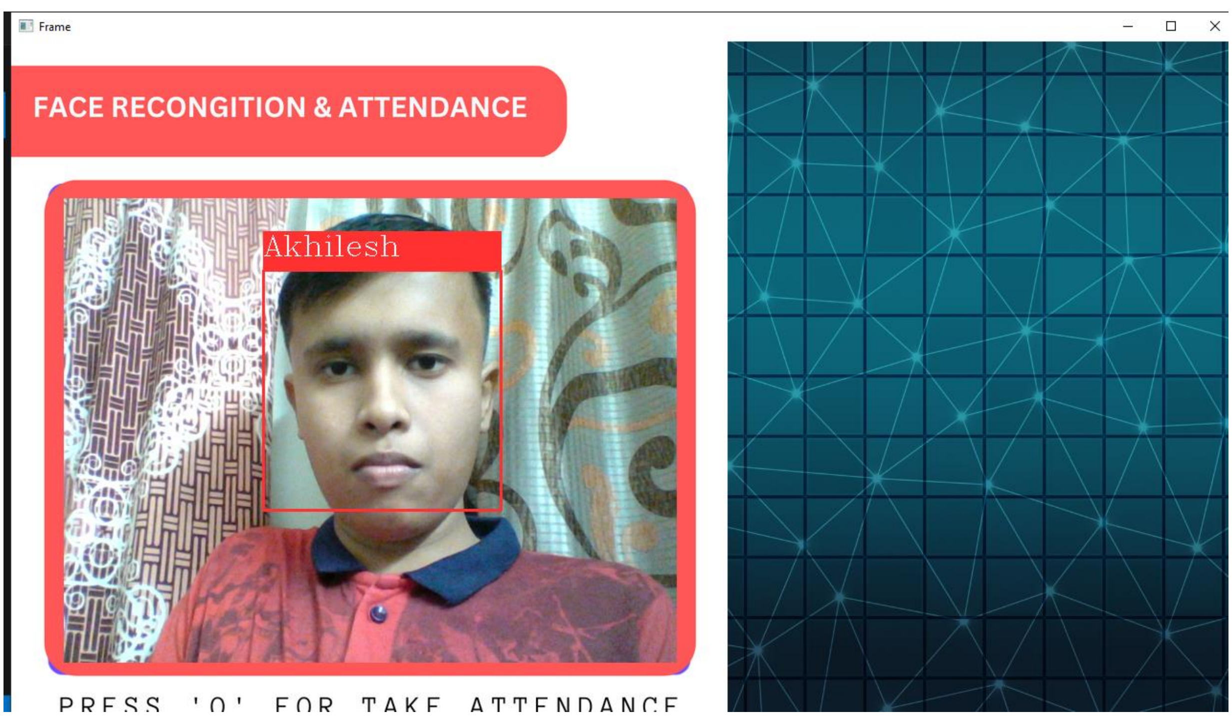
Step:2: Run the addface.py code it will ask you to enter name



It will take 100 images of the person



Step:3: Now open opentest .py code for the recognition of the person and marking of attendance



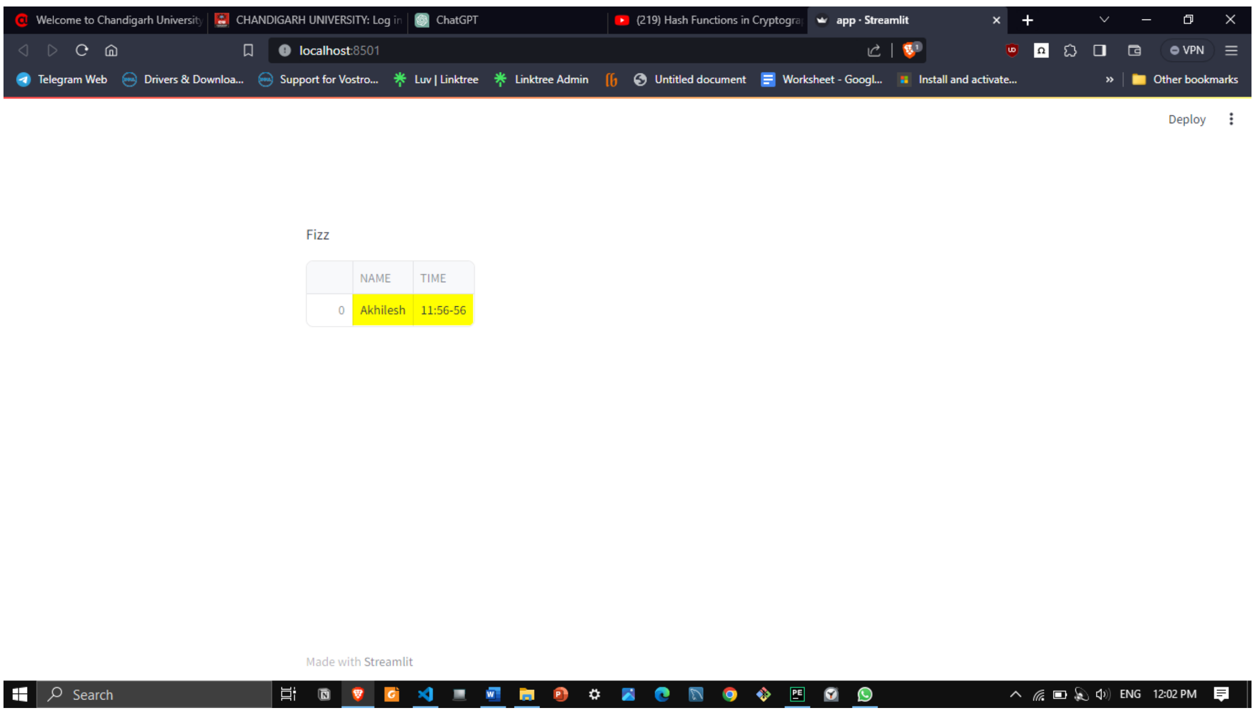
Step:4: then you can press control o to mark your attendance the system will note down your time and store it in the data base

Step:5: Now to check the records open app.py

Step:6: It will provide you the link   You can now view your Streamlit app in your browser.

Local URL: http://localhost:8501

To start the web app where the data of attendance is stored in csv format



So here is how the user can use the application to record attendance via facial recognition system