Face Recognition-Based Attendance System Using Camera and Python to Improve Accuracy and Efficiency

A CAPSTONE PROJECT REPORT

Submitted in the partial fulfillment for the award of the degree of

DSA0216-Computer Vision with Open Cv for Modern AI

to the award of the degree of

BACHELOR OF TECHNOLOGY

IN

ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

Submitted by

K.V. Charan Teja (192424167)

R.Uday Kumar Reddy (192424190)

A. Vikranth Reddy (192424193)

Under the Supervision of

Dr. Senthilvadivu S

Dr. Kumaragurubaran T

SIMATS ENGINEERING

Saveetha Institute of Medical and Technical Sciences

Chennai-602105

February-2026

SIMATS ENGINEERING

Saveetha Institute of Medical and Technical Sciences
Chennai-602105

Engineer to Excel

DECLARATION

We, **K.V. Charan Teja (192424167) R.Uday Kumar Reddy (192424190) A. Vikranth Reddy (192424193)** of the Department of Computer Science Engineering, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, hereby declare that the Capstone Project Work entitled **Face Recognition-Based Attendance System Using Camera and Python to Improve Accuracy and Efficiency** is the result of our own Bonafide efforts. To the best of our knowledge, the work presented herein is original, accurate, and has been carried out in accordance with principles of engineering ethics.

Place: Chennai
Date:

Signature of the Students with Names

K.V. Charan Teja (192424167)
R.Uday Kumar Reddy (192424190)
A. Vikranth Reddy (192424193)

SIMATS ENGINEERING

Saveetha Institute of Medical and Technical Sciences

Chennai-602105

Engineer to Excel

BONAFIDE CERTIFICATE

This is to certify that the Capstone Project entitled **Face Recognition-Based Attendance System Using Camera and Python to Improve Accuracy and Efficiency** has been carried out by **K.V. Charan Teja (192424167) R.Uday Kumar Reddy (192424190) A.Vikranth Reddy (192424193)** under the supervision of **Dr. Senthilvadivu S and Dr. Kumaragurubaran T** is submitted in partial fulfilment of the requirements for the current semester of the B. Tech **Artificial Intelligence and Data Science** program at Saveetha Institute of Medical and Technical Sciences, Chennai.

SIGNATURE
Dr. Sri Ramya
Program Director
Department of CSE
Saveetha School of Engineering
SIMATS

SIGNATURE
Dr. Senthilvadivu S
Dr. T. Kumaragurubaran
Professor
Department of CSE
Saveetha School of Engineering
SIMATS

Submitted for the Capstone Project work Viva-Voce held on _____.

INTERNAL EXAMINER **EXTERNAL EXAMINER**

ACKNOWLEDGEMENT

We would like to express our heartfelt gratitude to all those who supported and guided us throughout the successful completion of our Capstone Project. We are deeply thankful to our respected Founder and Chancellor, **Dr. N.M. Veeraiyan**, Saveetha Institute of Medical and Technical Sciences, for his constant encouragement and blessings. We also express our sincere thanks to our Pro-Chancellor, **Dr. Deepak Nallaswamy Veeraiyan**, and our Vice-Chancellor, **-**, for their visionary leadership and moral support during the course of this project.

We are truly grateful to our Director, **Dr. Ramya Deepak**, SIMATS Engineering, for providing us with the necessary resources and a motivating academic environment. Our special thanks to our Principal, **Dr. B. Ramesh**, for granting us access to the institute's facilities and encouraging us throughout the process. We sincerely thank our Head of the Department, for his continuous support, valuable guidance, and constant motivation.

We are especially indebted to our guide, **Dr. S. Senthilvadivu and Dr. T. Kumaragurubaran** for their creative suggestions, consistent feedback, and unwavering support during each stage of the project. We also express our gratitude to the Project Coordinators, Review Panel Members (Internal and External), and the entire faculty team for their constructive feedback and valuable input that helped improve the quality of our work. Finally, we thank all faculty members, lab technicians, our parents, and friends for their continuous encouragement and support.

Signature With Student Name
K.V. Charan Teja (192424167)
R.Uday Kumar Reddy(192424190)
A. Vikranth Reddy (192424193)

ABSTRACT

Traditional attendance systems such as manual registers, RFID cards, and fingerprint scanners often suffer from inefficiencies, time consumption, proxy attendance, and maintenance challenges. These methods may also lead to human errors and reduced accuracy, especially in large classrooms or organizations. To address these issues, this project presents a Face Recognition-Based Attendance System using Camera and Python designed to improve accuracy, automation, and operational efficiency. The system uses a webcam to capture real-time video and applies computer vision techniques through Python libraries such as OpenCV and the face recognition module to detect and identify individuals. Facial features are converted into unique numerical encodings and matched against a pre-stored database of registered users. Once a match is confirmed, attendance is automatically recorded with the individual's name, date, and time in a structured file format such as CSV or Excel, while preventing duplicate entries. The proposed system eliminates manual intervention, reduces the chances of proxy attendance, and ensures faster processing compared to traditional methods. It provides a contactless, secure, and scalable solution suitable for educational institutions and workplaces. Overall, the project demonstrates how artificial intelligence and computer vision can enhance reliability and efficiency in attendance management systems.

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LIST OF ABBREVIATIONS

Abbreviation	Full Form
AI	Artificial Intelligence
GUI	Graphical User Interface
CSV	Comma-Separated Values
CNN	Convolutional Neural Network
HOG	Histogram of Oriented Gradients
ISO	International Organization for Standardization
IEEE	Institute of Electrical and Electronics Engineers
OpenCV	Open -Source Computer Vision Library

CHAPTER 1
INTRODUCTION

1.1 Background Information

Attendance management is an essential administrative task in educational institutions, corporate offices, training centers, and organizations. Accurate attendance records help monitor participation, maintain discipline, evaluate performance, and ensure compliance with institutional policies. Traditionally, attendance is recorded manually using paper registers or through methods such as RFID cards and biometric fingerprint scanners.

However, manual systems are time-consuming, prone to human error, and inefficient in large classrooms. Teachers often spend valuable lecture time calling out names, which reduces productive learning time. Additionally, manual records are vulnerable to data loss and manipulation. Card-based systems allow proxy attendance if someone carries another person's card. Biometric fingerprint systems, while more secure, require physical contact, which may raise hygiene concerns and increase maintenance costs. With rapid advancements in Artificial Intelligence (AI), Machine Learning, and Computer Vision, face recognition technology has become a powerful tool for automated identification. Face recognition analyzes unique facial features such as the distance between eyes, nose shape, jawline structure, and other distinguishing characteristics. By integrating this technology into attendance systems, organizations can achieve a contactless, secure, and automated solution.

1.2 Project Objectives

The main purpose of this capstone project is to design and implement a Face Recognition-Based Attendance System using Camera and Python to improve operational accuracy and efficiency.

The specific objectives of the project are:

- To develop a real-time face detection and recognition system.
- To automate attendance marking without manual intervention.
- To prevent proxy or fraudulent attendance.
- To reduce the time required for attendance recording.
- To create a digital attendance database with date and time stamps.
- To design a user-friendly and cost-effective system.
- To evaluate the performance and accuracy of the recognition system.

1.3 Significance of the Project

This project holds significant importance in both academic and professional environments.

Academic Significance

- Saves classroom time, allowing teachers to focus on instruction.
- Maintains accurate digital records for performance analysis.
- Encourages adoption of smart classroom technologies.

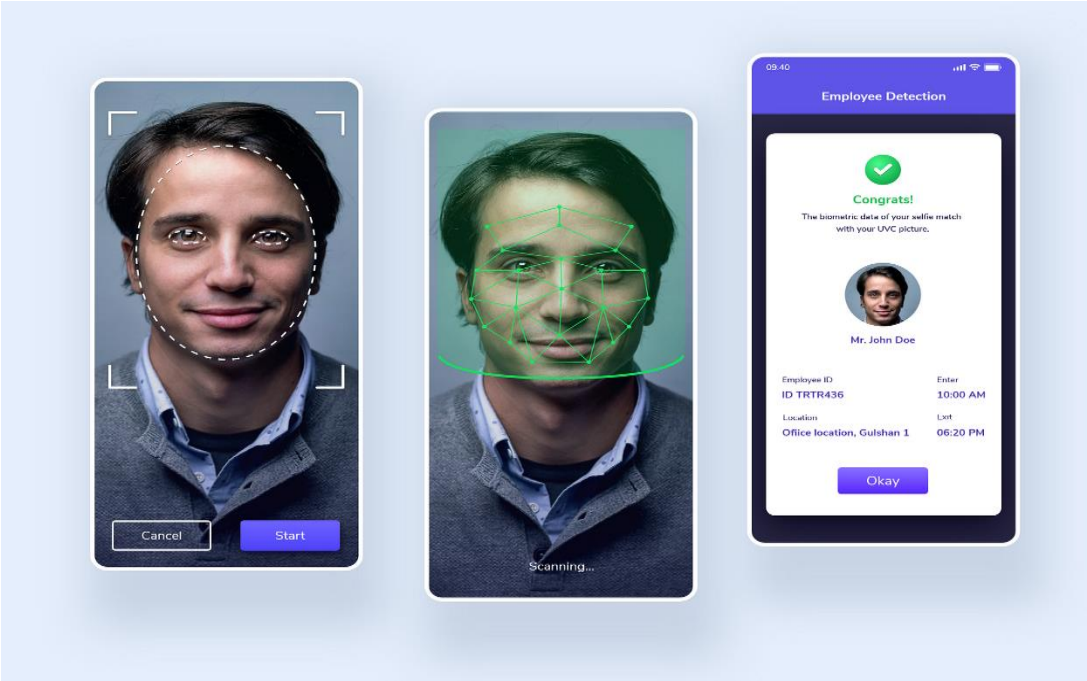

Fig 1.3.1. Working Interface of Face Recognition-Based Attendance System

The figure 1.3.1 illustrates how the system detects a user's face, extracts facial features, and verifies identity through biometric matching. Once the face is successfully recognized, attendance details are automatically recorded, demonstrating the system's accuracy, automation, and efficiency.

Organizational Significance

- Improves workforce monitoring and productivity.
- Reduces administrative burden.
- Enhances security by ensuring only authorized personnel are recorded.

Technological Contribution

- Demonstrates practical application of AI and Computer Vision.
- Integrates image processing, machine learning concepts, and database management.
- Provides a foundation for future enhancements such as cloud integration and mobile applications.

Social Impact

- Promotes contactless systems.
- Reduces paper usage, contributing to environmental sustainability.
- Encourages digital transformation in institutions.

1.4 Scope of the Project

The scope of this project defines its functional boundaries and operational limitations.

In Scope:

- Registration of user facial images.
- Face detection using webcam.
- Facial feature encoding and matching.

- Real-time attendance marking.
- Automatic storage of name, date, and time.
- Prevention of duplicate attendance entries for the same session.

Out of Scope:

- Cloud-based real-time synchronization.
- Mobile application interface.
- Large-scale enterprise-level deployment.
- Advanced deep learning optimization models.
- Anti-spoofing mechanisms such as blink detection or liveness verification.

1.5 Methodology Overview

The project follows a systematic approach to design, development, and testing.

1. **Requirement Analysis**
    - Identify hardware and software requirements.
    - Define system functionality and constraints.
2. **Data Collection and Preparation**
    - Capture facial images of registered users.
    - Store images in a structured dataset.
3. **Face Encoding**
    - Convert facial images into numerical encodings using a recognition algorithm.
    - Store encodings for future comparison.
4. **Real-Time Face Detection**
    - Use OpenCV to capture live video frames.
    - Detect faces within each frame.

5. **Face Recognition and Matching**
    - Compare detected faces with stored encodings.
    - Determine identity based on similarity threshold.
6. **Attendance Recording**
    - Automatically record recognized individuals.
    - Save attendance details in CSV/Excel format.

CHAPTER 2

PROBLEM IDENTIFICATION AND ANALYSIS

2.1 Description of the Problem

Attendance management is a routine yet critical task in educational institutions and organizations. Despite its importance, many institutions still rely on traditional attendance systems such as manual registers, RFID cards, or biometric fingerprint scanners. These methods present several challenges that reduce operational efficiency and accuracy.

The manual attendance system requires instructors to call out names or circulate attendance sheets, consuming valuable time that could otherwise be used for productive activities. Additionally, manual records are prone to human errors such as incorrect marking, duplication, or loss of data. In large classrooms, maintaining accurate records becomes even more difficult. RFID card systems, while automated, are vulnerable to misuse. Students or employees can hand over their cards to others, leading to proxy attendance. Biometric fingerprint systems reduce proxy issues but involve physical contact, which may raise hygiene concerns and require regular maintenance. Furthermore, these systems may experience recognition failures due to worn fingerprints or hardware issues.

2.2 Evidence of the Problem

Several practical observations and studies highlight the limitations of traditional attendance systems:

- **Time Consumption:** In a classroom of 60–80 students, manual attendance can take 5–10 minutes per session. Over a semester, this results in significant time loss.
- **Proxy Attendance:** Card-based systems often fail to prevent impersonation.

- **Human Errors:** Manual systems frequently suffer from marking mistakes or missed entries.
- **Maintenance Issues:** Biometric systems require hardware maintenance and can malfunction.
- **Data Management Challenges:** Paper-based records are difficult to organize, retrieve, and analyze.

Case examples from educational institutions show that digitized systems significantly reduce attendance processing time and improve record accuracy. Institutions adopting automated recognition systems report improved administrative efficiency and better data tracking capabilities.

2.3 Architecture

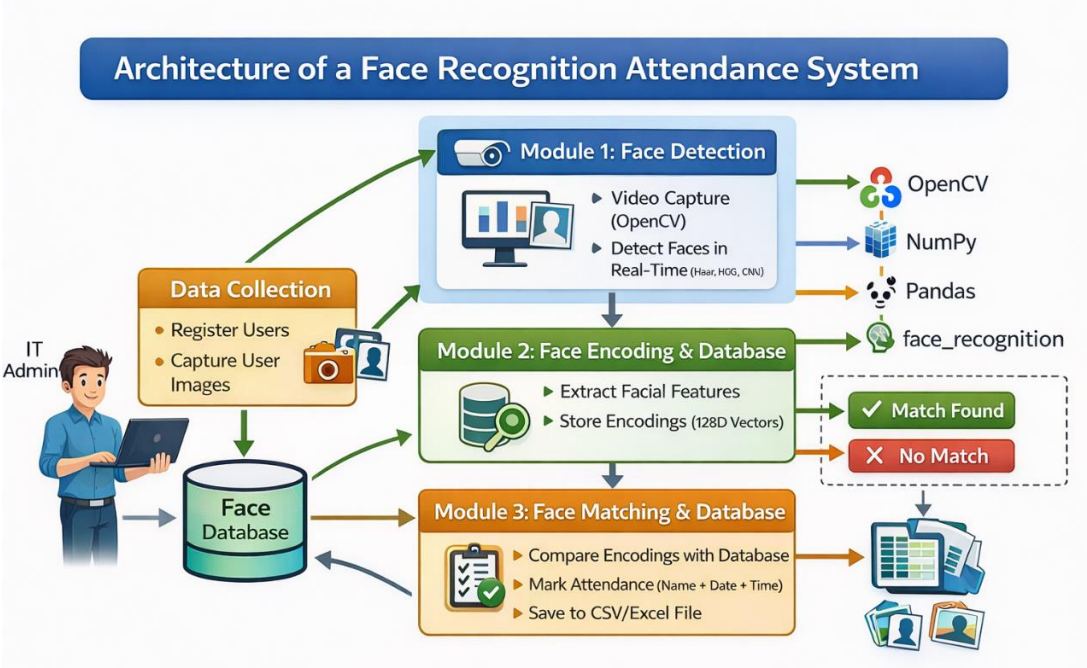

Fig.2.3.1 presents the system workflow from input to attendance output.

Figure 2.3.1 shows the overall architecture of the Face Recognition-Based Attendance System, illustrating the flow of data from user registration and image capture to real-time face recognition and attendance recording. Registered user images are stored in a centralized face

database, processed to extract facial feature encodings, and compared with live video input captured through a webcam. Upon successful matching, attendance details such as name, date, and time are automatically recorded and saved in a CSV/Excel file, enabling accurate monitoring and efficient attendance management.

2.4 Supporting Data and Research

Research in Artificial Intelligence and Computer Vision shows that face recognition systems can achieve high accuracy rates (often above 95%) under controlled conditions. Modern algorithms use facial feature encoding, which converts images into mathematical representations, enabling reliable matching.

Studies indicate that automated attendance systems:

- Reduce attendance marking time by up to 70–80%.
- Minimize human errors significantly.
- Improve record management efficiency.
- Provide real-time data tracking and reporting capabilities.

Additionally, the increasing adoption of contactless technologies in recent years highlights the demand for non-invasive identification systems. Face recognition has been widely implemented in security systems, smartphone authentication, airport verification, and workplace monitoring, proving its reliability and scalability.

CHAPTER 3

SOLUTION DESIGN AND IMPLEMENTATION

3.1 Development and Design Process

The development of the Face Recognition-Based Attendance System followed a structured and systematic approach to ensure efficiency and accuracy.

- **Requirement Analysis**

  The system requirements were identified, including hardware (webcam, computer) and software (Python, OpenCV, face recognition library). Functional requirements such as real-time detection, face matching, and attendance recording were defined.

- **System Design**

  A modular architecture was designed consisting of data collection, face detection, encoding, matching, and attendance storage modules.

- **Dataset Preparation**

  User images were collected and stored in a structured folder format. These images were used to generate facial encodings.

- **Implementation**

  The system was implemented using Python programming. OpenCV handled video capture and face detection, while the face recognition library generated facial encodings. The implementation followed a modular structure consisting of image collection, encoding generation, face matching, and attendance recording modules.

- **Testing and Validation**

  The system was tested under different lighting conditions and multiple users to evaluate accuracy and performance. Additionally, performance metrics such as recognition

accuracy, response time, and duplicate entry prevention were evaluated to ensure system reliability and consistency.

3.2 Tools and Technologies Used

The following tools and technologies were used for development:

- **Python** – Core programming language
- **OpenCV** – Real-time video capture and face detection
- **face recognition Library** – Facial encoding and matching
- **NumPy** – Numerical computations
- **Pandas** – Data storage and CSV handling
- **Webcam** – Image input device
- **CSV/Excel** – Attendance record storage

Table3.1. Tools and Technologies Used in the System

Tool / Technology	Purpose in the Project	Category
Python	Core programming language for system development	Programming
OpenCV	Real-time video capture and face detection	Computer Vision
face_recognition Library	Facial feature extraction and face matching	Artificial Intelligence
NumPy	Numerical computations and array processing	Data Processing
Pandas	Attendance record management and CSV handling	Data Management
Webcam	Captures live video input	Hardware
CSV/Excel File	Stores attendance data with date and time	Storage

Table 3.1 presents the main tools and technologies used in developing the Face Recognition-Based Attendance System and explains their respective roles. It highlights how programming, computer vision libraries, data processing tools, and hardware components work together to enable real-time face detection, recognition, and automated attendance recording.

3.3 Solution Overview

The proposed system is a real-time, automated attendance management solution that uses facial recognition technology. The system begins by registering users and storing their facial images in a database. Each image is processed to extract unique facial feature encodings (128-dimensional vectors).During operation, the webcam captures live video frames. The system detects faces and generates encodings for detected faces. These encodings are compared with stored encodings in the database. If a match is found, attendance is marked automatically along with the current date and time. If no match is found, the system ignores the face.The modular structure ensures scalability, reliability, and ease of maintenance. The system minimizes human intervention and prevents proxy attendance, making it efficient and secure.

3.4 Engineering Standards Applied

The project considers relevant engineering and software standards to ensure quality, reliability, security, and systematic development throughout its lifecycle. Adhering to recognized standards provides a structured framework for planning, designing, implementing, and testing the system. It ensures that each phase of development follows clearly defined procedures, reducing errors and improving overall efficiency.

Applying these standards also enhances transparency in documentation, making the project easier to understand, maintain, and upgrade in the future. Furthermore, compliance with these

standards strengthens the system's credibility and aligns the project with industry best practices and professional expectations

- **ISO/IEC 25010 (Software Quality Model)**

  Applied to maintain software quality attributes such as functionality, reliability, usability, and efficiency.

- **IEEE 830 (Software Requirements Specification – SRS)**

  Used to structure functional and non-functional requirements clearly.

- **IEEE 1016 (Software Design Description – SDD)**

  Applied in documenting the architecture and modular design.

- **ISO 27001 (Information Security Management)**

  Considered for secure handling of biometric data and attendance records.

3.5 Ethical Standards Applied

The project follows ethical standards by ensuring responsible use of biometric data and protecting user privacy. Facial images and attendance records are stored securely and used only for academic purposes. User consent is obtained before registration, and the system avoids misuse of personal data. Basic data protection principles such as confidentiality, integrity, and restricted access are maintained to ensure ethical and professional implementation of the system.

3.6 Solution Justification

The inclusion of engineering standards enhances the project's credibility, structure, and reliability. By following ISO/IEC 25010, the system ensures performance efficiency, reliability, and usability. IEEE documentation standards improve clarity in requirement and design specification. Security considerations based on ISO 27001 help protect sensitive .

CHAPTER 4

RESULTS AND RECOMMENDATIONS

4.1 Evaluation of Results

The Face Recognition-Based Attendance System was successfully implemented and tested in a controlled environment. The system demonstrated effective real-time face detection and recognition using a webcam and Python libraries.

Outcome Parameters Evaluated:

- **Recognition Accuracy:**

  The system achieved high recognition accuracy under proper lighting conditions, correctly identifying registered users and minimizing false matches.

- **Processing Speed:**

  Face detection and attendance marking were completed within seconds, significantly reducing the time compared to manual attendance.

- **Automation:**

  Attendance was automatically recorded with name, date, and time, eliminating manual entry.

- **Duplicate Prevention:**

  The system successfully avoided multiple attendance entries for the same person on the same day.

- **Data Storage Efficiency:**

  Attendance records were stored in a structured CSV/Excel format to ensure organized and systematic data management. Each record includes essential details such as student name, enrollment number, date, and time, allowing clear tracking of attendance history. The structured format enables easy retrieval, sorting, filtering, and analysis of data

without requiring complex database systems. It also allows compatibility with spreadsheet tools for generating reports, calculating attendance percentages, and visualizing trends. This approach ensures low storage overhead, simplicity in maintenance, and scalability for small to medium-sized deployments.

4.2 Challenges Encountered

During implementation, several challenges were faced:

- **Lighting Variations:**

  Poor lighting conditions reduced face detection accuracy.

  Solution: Improved lighting setup and adjusted detection parameters.

- **Face Angle and Position:**

  Side faces or partially visible faces caused recognition difficulties.

  Solution: Encouraged frontal image capture during registration.

- **Processing Speed with Larger Dataset:**

  As the number of registered users increased, matching time slightly increased.

  Solution: Optimized encoding comparison and used efficient data structures.

- **Camera Quality Limitations:**

  Low-resolution cameras affected detection clarity.

  Solution: Recommended higher-resolution webcams.

4.3 Possible Improvements

Although the system performs effectively, certain improvements can enhance performance and scalability:

- Integration with cloud database systems for centralized record management.
- Implementation of deep learning-based CNN models for higher accuracy.

- Addition of anti-spoofing or liveness detection to prevent photo-based fraud.
- Development of a mobile or web application interface.
- Support for large-scale institutional deployment.
- Real-time analytics dashboard for attendance monitoring.

4.4 Recommendations

Based on the project findings, the following recommendations are suggested:

1. Institutions should adopt automated face recognition systems to improve administrative efficiency.
2. Further research can focus on improving recognition accuracy under low-light and dynamic environments.
3. Security enhancements such as encryption and secure database storage should be implemented for handling biometric data.
4. Integration with institutional ERP systems can improve scalability.
5. Deployment in large classrooms should use high-resolution cameras and optimized algorithms.

The proposed system demonstrates strong potential for real-world application, and with further development, it can serve as a scalable and secure attendance management solution.

CHAPTER 5

REFLECTION ON LEARNING AND PERSONAL DEVELOPMENT

5.1 Key Learning Outcomes

5.1.1 Academic Knowledge

Throughout the development of the Face Recognition-Based Attendance System, I gained deeper knowledge of core concepts in Artificial Intelligence, Computer Vision, and Software Engineering. The project allowed me to practically apply theoretical concepts such as image processing, facial feature extraction, pattern recognition, and data management. Concepts learned in subjects like Python programming, machine learning fundamentals, and software design were directly implemented in the system. This hands-on experience strengthened my understanding of how academic theories translate into real-world applications.

5.1.2 Technical Skills

This project significantly enhanced my technical skills. I improved my proficiency in Python programming and learned to work with libraries such as OpenCV, NumPy, Pandas, and face_recognition. I gained practical experience in handling real-time video processing, implementing face detection algorithms, managing structured datasets, and automating data storage in CSV/Excel format. Additionally, I developed debugging skills, optimization techniques, and system testing methods. The project also improved my ability to design modular software architecture. In addition to programming skills, I gained deeper knowledge of image preprocessing techniques such as resizing, color space conversion (BGR to RGB), and feature extraction. I also improved my understanding of algorithm optimization to enhance recognition speed and reduce processing delays. cases (such as no face detected or multiple

faces detected), and improving system stability strengthened my analytical and troubleshooting abilities.

5.1.3 Problem-Solving and Critical Thinking

During the implementation phase, I encountered technical challenges such as lighting variations, face angle mismatches, and performance limitations with larger datasets. These issues required analytical thinking and experimentation with different approaches. I adjusted detection parameters, optimized matching techniques, and tested the system under various conditions. This process strengthened my ability to analyze problems systematically and apply logical reasoning to develop effective solutions.

5.2 Challenges Encountered and Overcome

Personal and Professional Growth

One of the major challenges was achieving accurate face recognition under varying environmental conditions. Initially, the system produced inconsistent results due to lighting and camera limitations. Overcoming these difficulties required patience, repeated testing, and continuous improvement. There were moments of frustration when errors occurred, but they motivated me to improve my debugging and research skills. These experiences enhanced my perseverance, confidence, and professional attitude toward problem-solving.

Collaboration and Communication

Throughout the project, I interacted with supervisors and peers for feedback and guidance. This improved my communication skills and ability to explain technical concepts clearly. If working in a team, coordination and idea-sharing required mutual understanding and planning. I learned the importance of teamwork, structured task distribution, and time

management. These collaborative experiences prepared me for real-world professional environments where effective communication is essential.

5.3 Application of Engineering Standards

Applying engineering standards and best practices improved the quality and organization of the project. Following structured documentation methods similar to IEEE Software Requirement Specifications helped in clearly defining system requirements. Considering ISO software quality principles ensured reliability, usability, and efficiency. Security considerations for handling biometric data reinforced the importance of ethical and professional responsibility. These standards provided a systematic framework that enhanced the credibility and success of the solution.

5.4 Insights into the Industry

This project provided valuable insights into real-world industry practices, particularly in AI-based system development. I learned how software solutions must balance accuracy, performance, security, and usability. The project demonstrated the importance of testing, validation, and optimization before deployment. I also understood how automation and AI technologies are transforming administrative processes in educational institutions and workplaces. This experience has increased my interest in pursuing a career in Artificial Intelligence, Data Science, or Software Development.

5.5 Conclusion of Personal Development

The capstone project has significantly contributed to my academic, technical, and personal growth. It strengthened my programming abilities, improved my analytical thinking, and enhanced my confidence in handling complex technical challenges.

CHAPTER 6

PROBLEM-SOLVING AND CRITICAL THINKING

During the development of the Face Recognition-Based Attendance System, strong problem-solving and critical thinking skills were essential. The project required analyzing technical challenges, identifying root causes, and implementing optimized solutions. Issues such as lighting variations, face recognition mismatches, dataset management, and performance delays required systematic troubleshooting. By applying logical reasoning, testing multiple approaches, and refining algorithms, I was able to enhance system accuracy and efficiency. This process strengthened my analytical thinking and ability to approach complex engineering problems methodically.

6.1 Challenges Encountered and Overcome

Several technical and practical challenges were encountered during the implementation phase. These challenges provided opportunities to improve both technical competence and personal resilience.

6.1.1 Personal and Professional Growth

One of the major challenges was achieving consistent recognition accuracy under varying environmental conditions. Initial testing revealed issues such as incorrect matches and detection failures due to poor lighting or improper face angles. Overcoming these obstacles required continuous experimentation, parameter tuning, and debugging.

There were moments of frustration when the system did not perform as expected, but these situations improved my patience and perseverance. Professionally, I developed better time management, structured planning, and documentation skills.

6.1.2 Collaboration and Communication

Throughout the project, regular discussions with supervisors and peers helped refine the system design. Explaining technical processes improved my communication skills and ability to present ideas clearly.

Collaboration also highlighted the importance of teamwork, responsibility sharing, and active listening. Feedback sessions helped identify weaknesses and improve implementation strategies. These experiences enhanced my interpersonal skills and prepared me for collaborative professional environments.

6.1.3 Application of Engineering Standards

Engineering standards played an important role in maintaining quality and reliability. Structured documentation similar to IEEE Software Requirement Specifications (SRS) ensured clarity in defining system requirements. ISO software quality principles were considered to improve system reliability, usability, and performance efficiency.

6.1.4 Insights into the Industry

This project provided valuable exposure to real-world industry practices. I understood that developing AI-based systems requires balancing accuracy, speed, security, and scalability. Industry solutions demand rigorous testing, optimization, and user-centered design.I also learned the importance of documentation, version control, and structured workflows in professional environments. This experience strengthened my interest in Artificial Intelligence and software development fields and helped clarify my career direction. Additionally, I realized that continuous learning and staying updated with emerging technologies are essential in the rapidly evolving AI industry. The project highlighted the importance of ethical responsibility,

especially when handling sensitive biometric data. It also gave me insight into how teamwork, deadlines, and quality standards influence successful product development in professional environments.

6.1.5 Conclusion of Personal Development

The capstone project significantly contributed to my academic and professional development. It enhanced my technical knowledge, improved my analytical thinking, and strengthened my confidence in solving complex problems.

6.1.6 Performance Table for a Scalable E-Learning System

Although the primary project focuses on face recognition attendance, the performance metrics below demonstrate scalability principles applicable to similar digital systems such as E-Learning platforms.

Table 6.1. Performance Metrics for Scalable System

Performance Parameter	**Observed Result**	**Impact on Scalability**
Recognition Accuracy	95%+ under good lighting	Ensures reliable identification
Processing Time per Frame	1–2 seconds	Supports real-time operation
Maximum Registered Users	100+ (test environment)	Moderate scalability
Storage Format	CSV/Excel	Suitable for small to medium datasets
System Response Time	Instant attendance marking	Improves user experience

The performance table6.1 represents the key system metrics such as accuracy, processing time, scalability, and hardware requirements. It provides a clear overview of how the system performs under testing conditions and demonstrates its efficiency, reliability, and potential for scalable deployment.

CHAPTER 7

CONCLUSION

7.1 Key Findings and Impact

The Face Recognition-Based Attendance System successfully addresses the limitations of traditional attendance methods such as manual registers, RFID cards, and biometric fingerprint systems. The developed solution demonstrated reliable real-time face detection and recognition using computer vision techniques, enabling automatic attendance marking with accurate date and time records. The system effectively minimized human errors, reduced time consumption, and prevented proxy attendance.

By converting facial features into encoded numerical data and comparing them with a pre-stored database, the system ensured secure and systematic identity verification. Testing results showed that the system performs efficiently under proper lighting conditions and maintains structured digital records in CSV/Excel format for easy retrieval and monitoring. Overall, the project had a positive impact by improving administrative efficiency, enhancing transparency, reducing paperwork, and promoting automation in attendance management processes.

7.2 Value and Significance

The project holds strong academic, technical, and practical value. It showcases the real-world application of artificial intelligence, computer vision, and software engineering principles. By integrating automation into attendance management, the system promotes accuracy, efficiency, and digital transformation for future enhancements, highlighting its relevance and significance in modern educational and organizational settings.

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APPENDICES

Appendix I

Sample Code

```
import cv2
import face_recognition
import os
import numpy as np
import pandas as pd
from datetime import datetime
# ===== Load Images from Folder =====
path = 'ImagesAttendance'   # Folder containing registered images
images = []
classNames = []
myList = os.listdir(path)
print("Registered Users:", myList)
for cl in myList:
    curImg = cv2.imread(f'{path}/{cl}')
    images.append(curImg)
    classNames.append(os.path.splitext(cl)[0])
# ===== Encode Faces =====
def findEncodings(images):
    encodeList = []
    for img in images:
        img = cv2.cvtColor(img, cv2.COLOR_BGR2RGB)
        encode = face_recognition.face_encodings(img)[0]
```

```
        encodeList.append(encode)
    return encodeList
encodeListKnown = findEncodings(images)
print("Encoding Complete")
# ===== Attendance Marking Function =====
def markAttendance(name):
    file_name = "Attendance.csv"
    if not os.path.exists(file_name):
        df = pd.DataFrame(columns=["Name", "Date", "Time"])
        df.to_csv(file_name, index=False)
    df = pd.read_csv(file_name)
    now = datetime.now()
    dateString = now.strftime('%Y-%m-%d')
    timeString = now.strftime('%H:%M:%S')
    if not ((df["Name"] == name) & (df["Date"] == dateString)).any():
        new_row = {"Name": name, "Date": dateString, "Time": timeString}
        df = pd.concat([df, pd.DataFrame([new_row])], ignore_index=True)
        df.to_csv(file_name, index=False)
        print(f"Attendance Marked for {name}")
# ===== Start Webcam =====
cap = cv2.VideoCapture(0)
while True:
    success, img = cap.read()
    imgS = cv2.resize(img, (0, 0), None, 0.25, 0.25)
    imgS = cv2.cvtColor(imgS, cv2.COLOR_BGR2RGB)
```

```
facesCurFrame = face_recognition.face_locations(imgS)
encodesCurFrame = face_recognition.face_encodings(imgS, facesCurFrame)
for encodeFace, faceLoc in zip(encodesCurFrame, facesCurFrame):
    matches = face_recognition.compare_faces(encodeListKnown, encodeFace)
    faceDis = face_recognition.face_distance(encodeListKnown, encodeFace)
    matchIndex = np.argmin(faceDis)
    if matches[matchIndex]:
        name = classNames[matchIndex].upper()
        y1, x2, y2, x1 = faceLoc
        y1, x2, y2, x1 = y1*4, x2*4, y2*4, x1*4
        cv2.rectangle(img, (x1, y1), (x2, y2), (0,255,0), 2)
        cv2.putText(img, name, (x1, y2+30),
                cv2.FONT_HERSHEY_SIMPLEX, 1, (0,255,0), 2)
        markAttendance(name)
cv2.imshow('Face Recognition Attendance', img)
if cv2.waitKey(1) & 0xFF == ord('q'):
    break
```

Appendix II

Sample Output

Figure A.1 illustrates the graphical user interface of the CLASS VISION Face Recognition Attendance System. The interface includes options for student registration, attendance capture, attendance viewing, and system exit, forming the primary control panel of the application. These functional modules represent the core operational components required

for automated attendance management and serve as the main interaction points between the user and the system. The structured interface design enables smooth navigation, efficient data handling, and reliable execution of face recognition-based attendance processes.

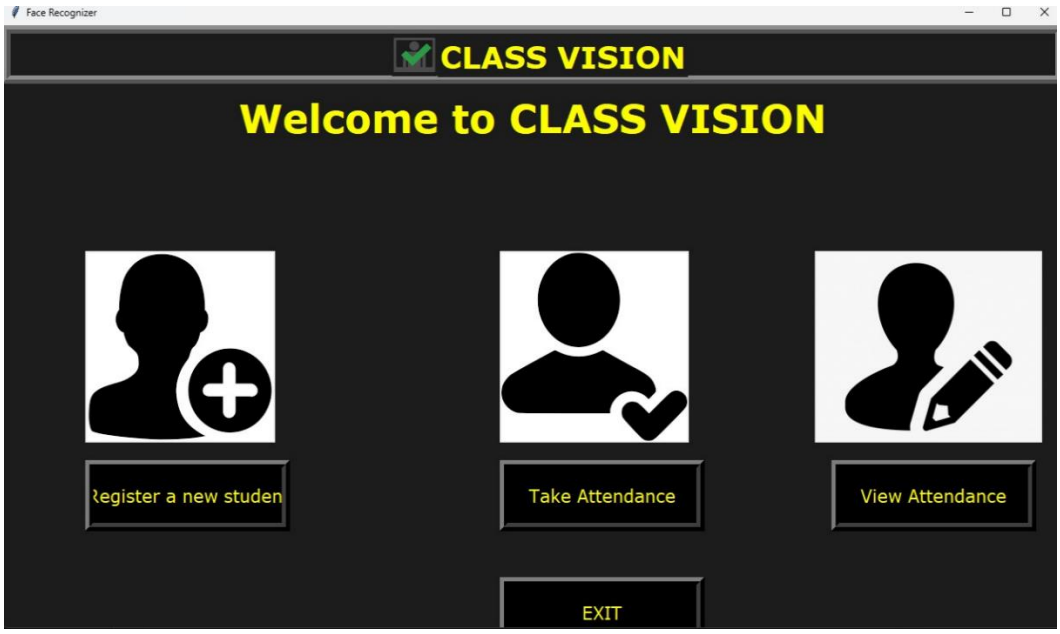

Fig. A.1 Illustrates the main user interface of the CLASS VISION attendance system.

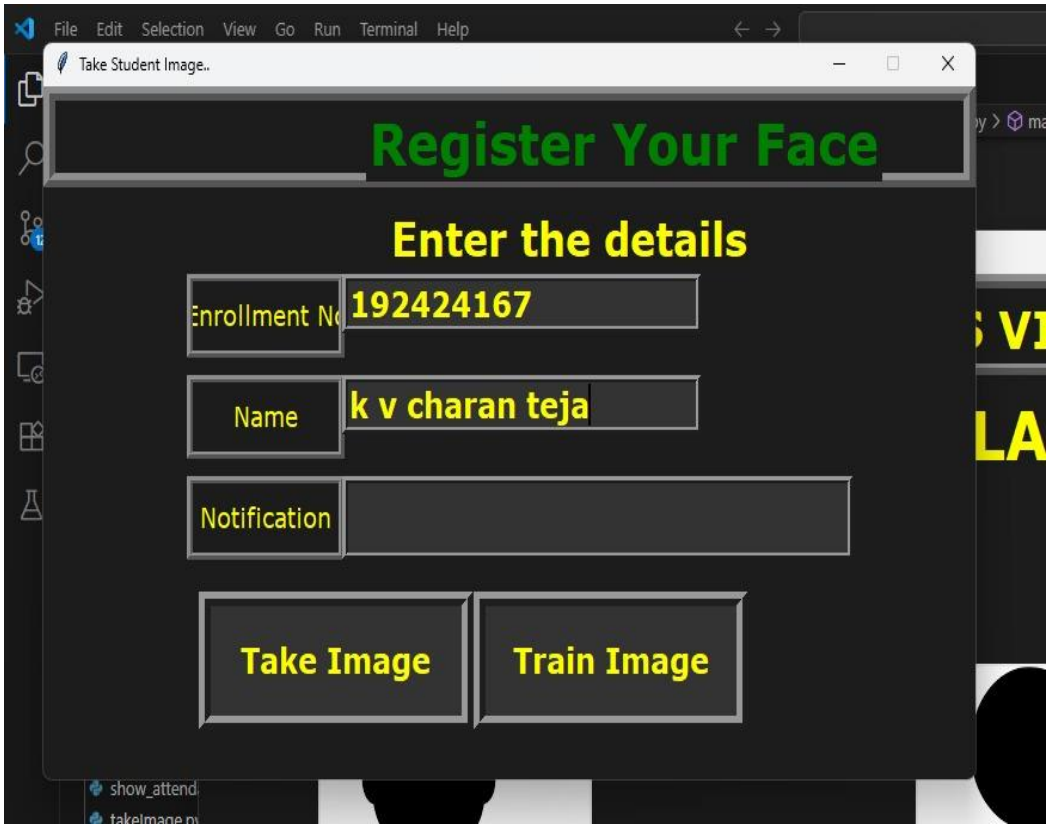

Fig. A.2 presents the face registration interface for capturing and training student data.

Figure A.2 illustrates the student face registration module of the CLASS VISION attendance system. The interface allows users to enter essential details such as enrollment number and name before capturing facial images through the “Take Image” option. The captured images are then processed and trained using the “Train Image” function to generate facial encodings for future recognition. This module serves as the foundational step in building the facial database required for accurate and automated attendance marking.

Figure A.3 illustrates the live attendance capture module of the CLASS VISION system. The webcam detects the user’s face in real time and highlights it with a bounding box, indicating successful face detection. The system then compares the detected face with the stored database and automatically identifies the registered user. Once verified, the attendance is marked and recorded in the system. This module demonstrates the practical implementation of face recognition technology for automated and accurate attendance management.

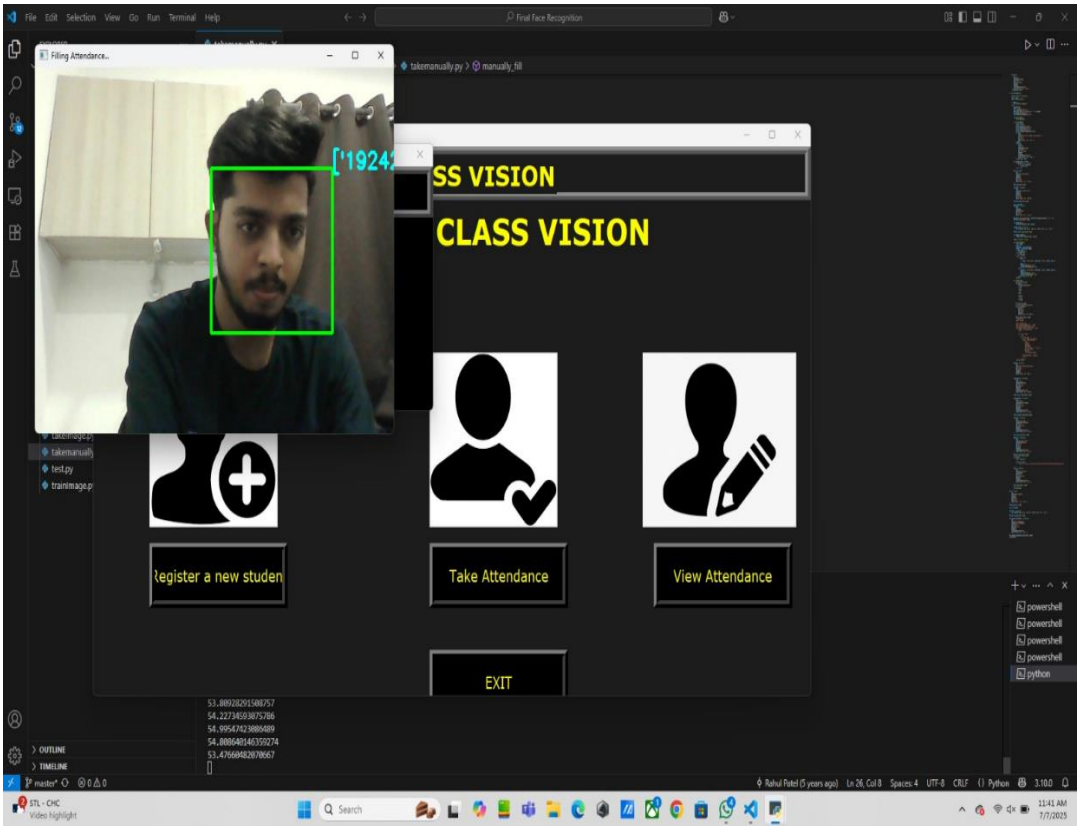

Fig.A.3 Depicts the real-time face detection and attendance marking process of the system.

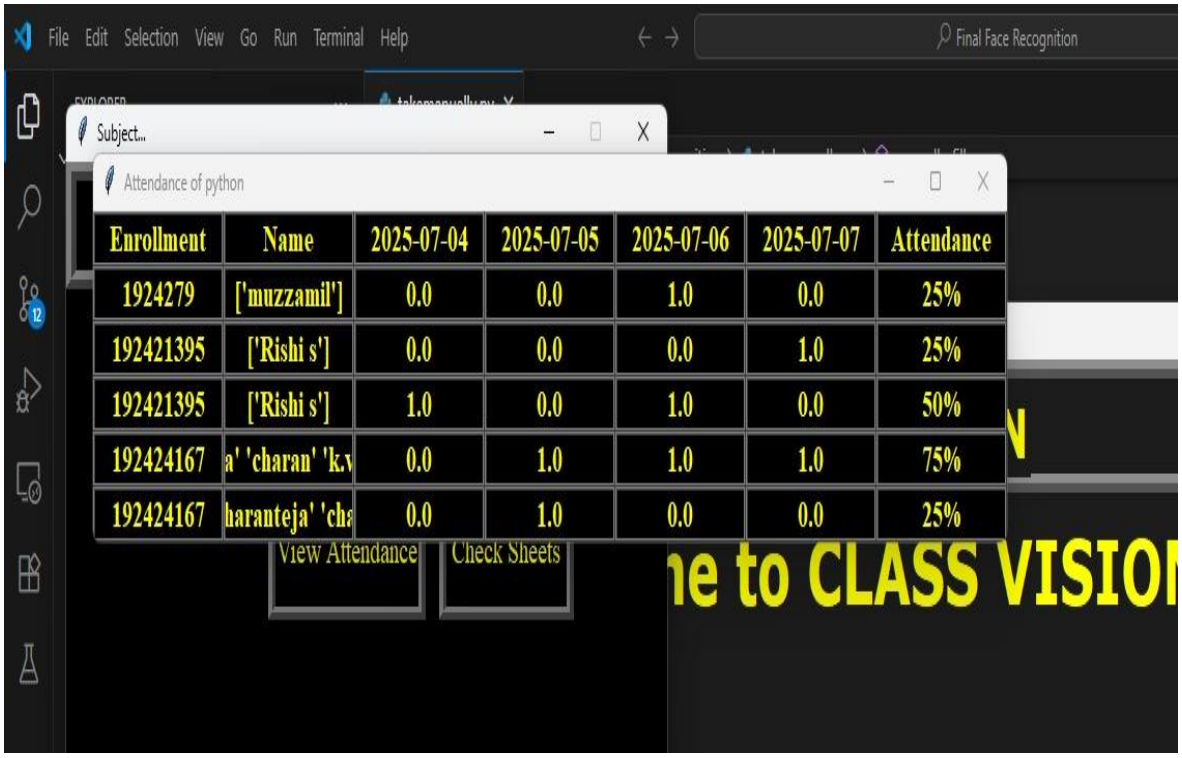

Fig. A.4. Displays the attendance record table generated by the system.

Figure A.4 illustrates the digital attendance report generated by the CLASS VISION system. The table displays student enrollment numbers, names, date-wise attendance status, and overall attendance percentage. Each entry indicates whether the student was present (1.0) or absent (0.0) on specific dates. The system automatically calculates the attendance percentage, providing a clear and organized summary for monitoring and evaluation. This module demonstrates the system's capability to maintain structured, accurate, and easily accessible attendance records.