RAJALAKSHMI
ENGINEERING COLLEGE
An AUTONOMOUS Institution
Affiliated to ANNA UNIVERSITY, Chennai

ATTENDANCE MANAGEMENT SYSTEM

A MINI PROJECT REPORT

Submitted by

M HARISH **231501058**

AVISHIKAR KANNAN N **231501029**

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THANDALAM

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RAJALAKSHMI
ENGINEERING COLLEGE

BONAFIDE CERTIFICATE

Certified that this project report "**Attendance Management System**" is the bonafide work of **"M Harish (231501058), Avishikar Kannan N (231501029)"** in the subject **CS23332- Database Management Systems** during the year 2024-2025.

Submitted for the Practical Examination held on _____

SIGNATURE

Mr. U. Kumaran,
Assistant Professor (SS)
AIML,
Rajalakshmi Engineering College,
(Autonomous),
Thandalam, Chennai - 602 105

INTERNAL EXAMINER **EXTERNAL EXAMINER**

ABSTRACT

The Facial Recognition Attendance Management System is an advanced application designed to streamline and automate attendance tracking in educational institutions using facial recognition technology. By leveraging artificial intelligence and biometric verification, this system enables quick, accurate, and contactless attendance recording, making it particularly efficient for environments with large numbers of students and staff. The core features allow for automatic attendance logging, real-time updates, and detailed reporting, reducing manual intervention and eliminating errors commonly associated with traditional methods. Acting as a robust Management Information System (MIS), the application includes a secure backend that prioritizes data consistency, integrity, and compliance with privacy standards, safeguarding biometric data against unauthorized access. The frontend is user-friendly and highly accessible, designed to accommodate seamless interactions for both faculty and administrative staff. Additionally, the system provides instant attendance insights, which can be easily integrated with other institutional management tools for a holistic view of student engagement and punctuality. By incorporating facial recognition, this system not only minimizes administrative overhead but also enhances security and accountability within the institution, offering a modern, efficient, and scalable solution tailored to the needs of today's educational environments.

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1. INTRODUCTION

1.1 INTRODUCTION

Efficient attendance management is a foundational requirement for educational institutions and various organizations to ensure that records of participation are accurate, secure, and up-to-date. Traditional methods of tracking attendance, such as manual roll calls, sign-in sheets, or RFID-based systems, are not only time-consuming but also vulnerable to errors, loss, and even misuse in the form of proxy attendance. This problem becomes more prominent as institutions grow, with larger student bodies or workforces requiring a scalable, reliable solution. To address these limitations, this project presents an advanced, AI-powered attendance management system leveraging facial recognition technology integrated with an SQL database for robust, automated attendance tracking.

Facial recognition technology, which utilizes computer vision and machine learning algorithms, identifies individuals based on their unique facial features, allowing for swift, accurate, and contactless attendance logging. The system's backend employs a SQL database that stores and organizes attendance records, while a user-friendly graphical interface, designed using Python's Tkinter module, enables effortless access to real-time data. Together, these components form a cohesive system that not only automates attendance but also mitigates risks associated with data entry errors and unauthorized access, ensuring security and privacy.

This project is structured around several key modules: facial recognition, database management, blink detection, graphical interface, and CSV export. Each module serves a unique function that contributes to the overall effectiveness of the system, providing educational institutions with a powerful tool to manage and monitor attendance more efficiently than ever before.

1.2 OBJECTIVE

The main objectives of this Facial Recognition Attendance Management System are as follows:

- **Automate Attendance Management**: Reduce the dependency on manual processes, streamline attendance collection, and minimize potential errors associated with traditional methods.
- **High Accuracy**: Employ AI-driven facial recognition algorithms to accurately identify students and record their attendance.
- **Database Integration**: Use MySQL to securely store and manage information related to attendance, courses, and students, allowing for structured data retrieval and analysis.
- **Security and Privacy**: Prevent proxy attendance through the integration of blink detection, ensuring that only live individuals can be recognized and recorded.
- **User-Friendly Interface**: Create an intuitive, Tkinter-based GUI that allows administrators and faculty to interact with attendance data, making it simple to view, filter, and analyze records.

These objectives collectively aim to provide an accurate, secure, and efficient attendance management solution that can be easily adopted by academic institutions of various sizes.

1.3 MODULES

The system is comprised of the following core modules, each designed to address specific functionalities required for automated attendance management:

- **Facial Recognition Module**: This module captures and identifies faces using a webcam. Using pre-trained AI models and image-processing techniques, the system maps the unique features of each individual's face to match them against stored data. When a student or employee's face is successfully matched, the system logs the attendance, associating it with a timestamp.
- **Database Management Module**: This module stores data related to students, courses, and attendance records in SQL tables, maintaining a structured and secure data environment. It also facilitates data consistency checks, updates, and retrievals as needed.
- **Blink Detection Module**: The system integrates Eye Aspect Ratio (EAR) calculations to monitor blinking, ensuring that the person being recorded is live. This blink detection

helps to prevent proxy attendance by eliminating the possibility of using static images or videos for attendance logging.

- **GUI Module**: Developed with Python's Tkinter, this module presents a simple and interactive interface for the user, where attendance records are visualized in real-time. Faculty and administrators can view attendance logs, manage student profiles, and access course-related information effortlessly.
- **CSV Export Module**: This module enables administrators to export attendance data as CSV files, allowing for offline analysis, report generation, and integration with other tools.

2. SURVEY OF TECHNOLOGIES

This system requires a combination of various technologies to effectively capture, process, and manage attendance data. Below is an overview of the software and tools used to implement the project.

2.1 SOFTWARE DESCRIPTION

- **OpenCV**: A powerful library for real-time computer vision, OpenCV provides the necessary functions for capturing images, detecting faces, and processing visual data.
- **Face Recognition Library**: Built on top of dlib, this library simplifies facial recognition by providing pre-trained models for detecting and encoding facial features. It matches faces against the database with high accuracy.
- **MySQL**: A relational database management system that allows for efficient data storage, retrieval, and manipulation. MySQL handles all data related to students, courses, attendance, and enrolment, making it the core of the data layer.
- **Python**: Python's simplicity and extensive library support make it ideal for this project. Python allows for seamless integration between the GUI, facial recognition algorithms, and database interactions.
- **Tkinter**: The Tkinter library provides a versatile and user-friendly GUI for administrators. With Tkinter, the system can render a responsive, interactive interface for visualizing and managing attendance records.
- **Pillow**: Used for image processing tasks within the GUI, Pillow enables resizing, format conversion, and manipulation of images, enhancing the interface's visual aspects.

- **Scipy**: This scientific computing library is used for calculating the Eye Aspect Ratio (EAR), which forms the foundation for blink detection. Scipy's image processing functions make it effective for preventing unauthorized proxy attendance.

2.2 LANGUAGES

The system is primarily implemented using Python and SQL, which offer flexibility, data security, and robust support for machine learning and data management applications.

- **SQL**: SQL is used to create, manage, and query the relational database tables for attendance data. It ensures data consistency, integrity, and compliance with security protocols, enabling structured data storage and retrieval for optimal performance.
- **Python**: Python integrates various modules for facial recognition, database management, and user interface design. The following libraries are essential to the system's operation:
    - **MySQL Connector**: Facilitates the connection between Python scripts and MySQL, allowing for database interaction.
    - **OpenCV & Face Recognition Library**: Powers the face detection and encoding processes.
    - **Tkinter GUI**: Enables interactive, user-friendly features for the system's graphical interface.

3. REQUIREMENTS AND ANALYSIS

3.1 REQUIREMENT SPECIFICATION

This system is based on a clear set of functional and non-functional requirements to ensure it meets the needs of an educational institution's attendance management:

- **Functional Requirements**:
    - **Real-time Face Detection**: The system must detect and recognize faces through a webcam, allowing for immediate attendance logging.
    - **Database Storage with Timestamps**: Attendance records, including timestamps, should be automatically saved in the SQL database, ensuring data accuracy and traceability.
    - **Blink Detection**: Use EAR-based blink detection to prevent unauthorized attendance.

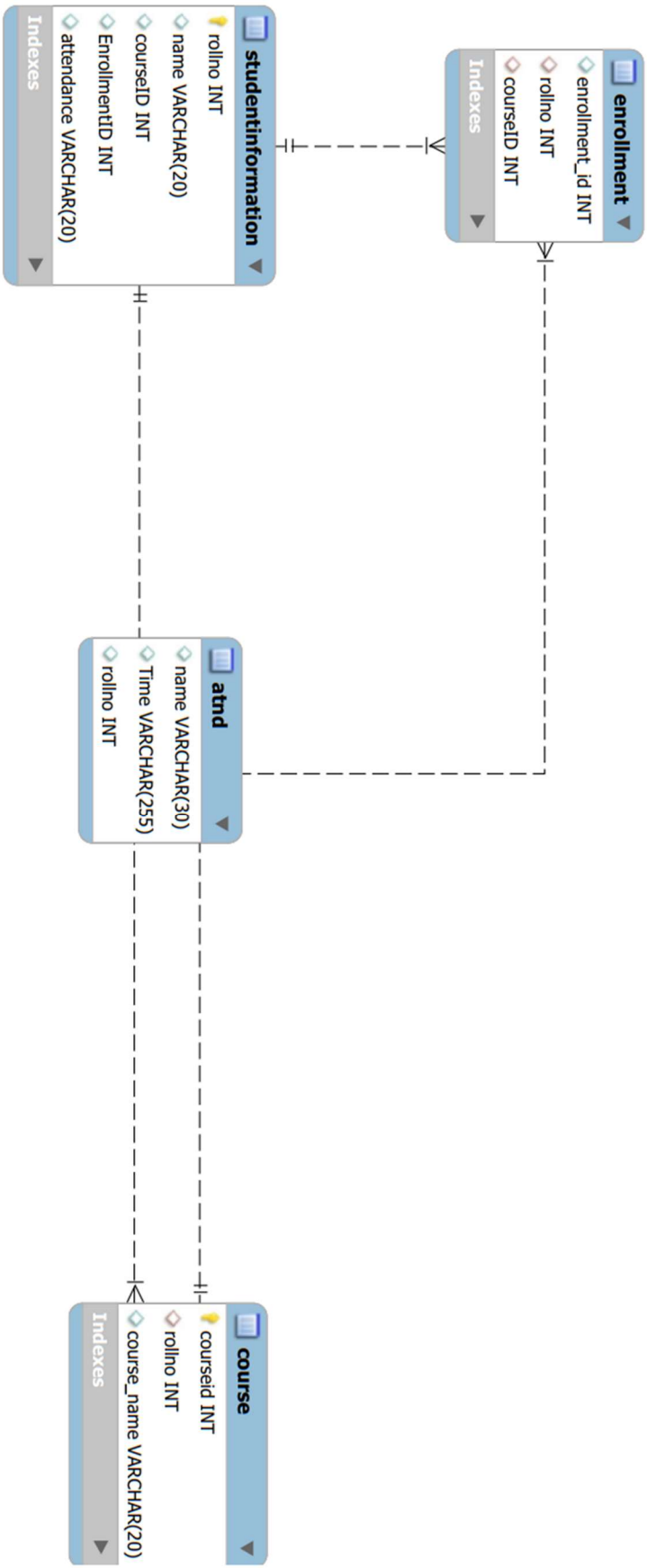
- **GUI**: A Tkinter-based GUI should facilitate record visualization, updating, and management, with search and filtering capabilities.

- **Non-functional Requirements**:
  - **Performance**: The system must process facial recognition tasks quickly to minimize delays, especially in high-traffic environments.
  - **Data Security**: All data interactions with the database must be encrypted, and access should be restricted based on user roles.
  - **Scalability**: The database and application design should allow the system to scale up, accommodating more students, courses, and records without degradation in performance.

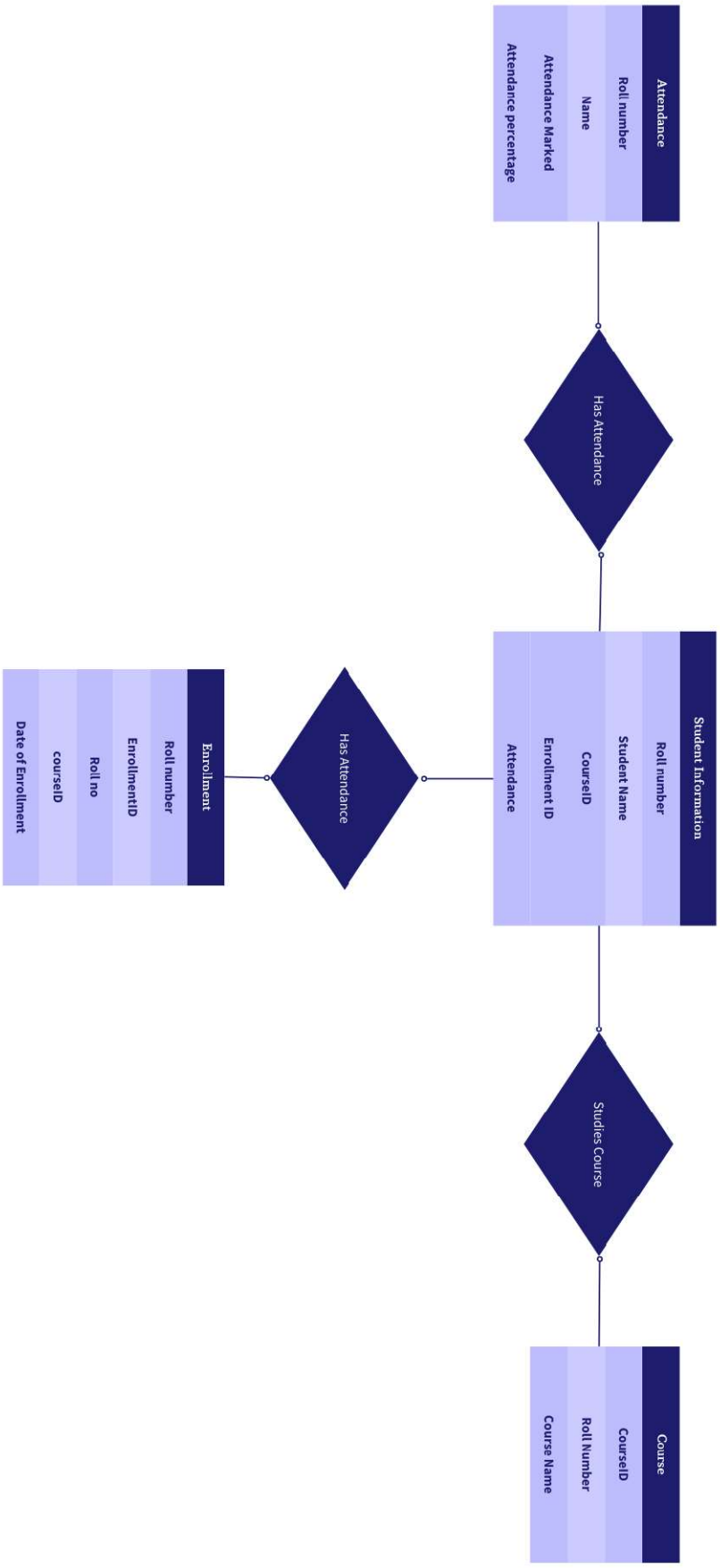
3.2 HARDWARE AND SOFTWARE REQUIREMENTS

- **Hardware Requirements**:
  - A computer running Windows 10/Linux with at least 4 GB RAM and 500 GB storage capacity.
  - A high-resolution webcam to capture real-time images with clarity.
- **Software Requirements**:
  - **Python 3.x** for development.
  - **MySQL Server** for database management and storage.
  - **Python Libraries**: mysql-connector, opencv-python, face_recognition, scipy, tkinter, and Pillow for system functionality and seamless module integration.

3.3 ARCHITECTURE DIAGRAM



3.4 ER DIAGRAM



4.PROGRAM CODE

```
import mysql.connector
import random
import cv2
import numpy as np
import face_recognition
import os
import csv
from datetime import datetime
from scipy.spatial import distance as dist
import time
from tkinter import Tk, Label, Frame, Toplevel, Scrollbar,
Button, PhotoImage
from tkinter import ttk
from PIL import Image, ImageTk

# Database connection and setup
db = mysql.connector.connect(
    host="localhost",
    user="root",
    password="laboon123",
    database="management"
)
cursor = db.cursor()

# Create SQL tables if they do not exist
cursor.execute('''
    CREATE TABLE IF NOT EXISTS Atnd (
        Name VARCHAR(255),
        Time DATETIME,
        RollNo INT,
        PRIMARY KEY (RollNo)
    )
''')

cursor.execute('''
    CREATE TABLE IF NOT EXISTS course (
        CourseID INT PRIMARY KEY,
        RollNo INT,
        Course_Name VARCHAR(255),
        FOREIGN KEY (RollNo) REFERENCES Atnd(RollNo)
    )
''')
```

```
cursor.execute('''
    CREATE TABLE IF NOT EXISTS enrollment (
        Enrollment_ID INT PRIMARY KEY,
        RollNo INT,
        CourseID INT,
        FOREIGN KEY (RollNo) REFERENCES Atnd(RollNo),
        FOREIGN KEY (CourseID) REFERENCES course(CourseID)
    )
''')

cursor.execute('''
    CREATE TABLE IF NOT EXISTS student_information (
        RollNo INT,
        Name VARCHAR(255),
        CourseID INT,
        EnrollmentID INT,
        Attendance INT,
        PRIMARY KEY (RollNo),
        FOREIGN KEY (CourseID) REFERENCES course(CourseID),
        FOREIGN KEY (EnrollmentID) REFERENCES
enrollment(Enrollment_ID)
    )
''')

def show_popup(message):
    popup = Toplevel(root)
    popup.title("Notification")
    popup.geometry("300x150")
    popup.config(bg='#ffffff')

    message_label = Label(popup, text=message, font=('Arial',
12), bg='#ffffff', fg='#333333')
    message_label.pack(expand=True)

    root.after(1000, popup.destroy)

# Function to update table display with data from the 'Atnd'
table
def update_table_display():
    for row in tree.get_children():
        tree.delete(row)

    cursor.execute("SELECT * FROM Atnd")
```

```
    rows = cursor.fetchall()

    for row in rows:
        tree.insert("", "end", values=row)

def save_to_csv(name):
    with open(r'C:\Users\avish\OneDrive\Desktop\DS
Programs\fronte\attendance_log.csv', 'r+') as f:
        datlist = f.readlines()
        nlist = []
        for line in datlist:
            ent = line.split(',')
            nlist.append(ent[0])
        if name not in nlist:
            now = datetime.now()
            dtString = now.strftime('%Y-%m-%d %H:%M:%S')
            f.writelines(f'\n{name},{dtString}')

def close_db_connection():
    cursor.close()
    db.close()

# Facial recognition and attendance marking logic
path =
r"C:\Users\avish\OneDrive\Documents\+=AAAAA\cmon\faces_known"
images = []
classNames = []
myList = os.listdir(path)

for person in myList:
    personFolder = os.path.join(path, person)
    if os.path.isdir(personFolder):
        for imgName in os.listdir(personFolder):
            imgPath = os.path.join(personFolder, imgName)
            curImg = cv2.imread(imgPath)
            if curImg is not None:
                images.append(curImg)
                classNames.append(person)

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

def eye_aspect_ratio(eye):
    A = dist.euclidean(eye[1], eye[5])
    B = dist.euclidean(eye[2], eye[4])
    C = dist.euclidean(eye[0], eye[3])
    ear = (A + B) / (2.0 * C)
    return ear

def detect_blink(landmarks):
    leftEye = landmarks['left_eye']
    rightEye = landmarks['right_eye']
    leftEAR = eye_aspect_ratio(leftEye)
    rightEAR = eye_aspect_ratio(rightEye)
    ear = (leftEAR + rightEAR) / 2.0
    return ear

encodeListKnown = findEncodings(images)

cap = cv2.VideoCapture(0)
cap.set(cv2.CAP_PROP_FRAME_WIDTH, 320)
cap.set(cv2.CAP_PROP_FRAME_HEIGHT, 240)

BLINK_THRESHOLD = 0.33
CONSEC_FRAMES = 3
BLINK_COOLDOWN = 3

blink_counter = 0
blinked = False
last_blink_time = time.time()
ear_history = []

save_folder =
r"C:\Users\avish\OneDrive\Documents\+=AAAAA\cmon\captured_enc"

def show_frame():
    global blink_counter, blinked, last_blink_time, ear_history
    success, img = cap.read()
    if not success:
        root.after(10, show_frame)
        return

    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)
    faceLandmarksList = face_recognition.face_landmarks(imgS)

    for encodeFace, faceLoc, landmarks in zip(encodesCurFrame,
facesCurFrame, faceLandmarksList):
        matches =
face_recognition.compare_faces(encodeListKnown, encodeFace)
        faceDis =
face_recognition.face_distance(encodeListKnown, encodeFace)
        matchIndex = np.argmin(faceDis)
        cords = (0, 255, 0)

        if faceDis[matchIndex] < 0.50:
            name = classNames[matchIndex].upper()
            ear = detect_blink(landmarks)

            ear_history.append(ear)
            if len(ear_history) > CONSEC_FRAMES:
                ear_history.pop(0)

            avg_ear = sum(ear_history) / len(ear_history)

            if avg_ear < BLINK_THRESHOLD:
                blink_counter += 1
            else:
                if blink_counter >= CONSEC_FRAMES and
(time.time() - last_blink_time) > BLINK_COOLDOWN:
                    blinked = True
                    last_blink_time = time.time()
                blink_counter = 0

            if blinked:
                markatnd(name)
                save_path = os.path.join(save_folder,
f"{name}_{datetime.now().strftime('%Y%m%d_%H%M%S')}.npy")
                np.save(save_path, encodeFace)
                blinked = False
        else:
            name = 'Unknown'
            cords = (0, 0, 255)
```

```
            y1, x2, y2, x1 = faceLoc
            y1, x2, y2, x1 = y1 * 4, x2 * 4, y2 * 4, x1 * 4
            cv2.rectangle(img, (x1, y1), (x2, y2), cords, 2)
            cv2.putText(img, name, (x1 + 6, y2 - 6),
cv2.FONT_HERSHEY_COMPLEX, 1, (255, 255, 255), 2)

        img = cv2.cvtColor(img, cv2.COLOR_BGR2RGB)
        img_pil = Image.fromarray(img)
        img_tk = ImageTk.PhotoImage(image=img_pil)
        label.imgtk = img_tk
        label.configure(image=img_tk)

        root.after(10, show_frame)

# Attendance registration function
def markatnd(name):
    cursor.execute("SELECT Name FROM Atnd WHERE Name = %s",
(name,))
    result = cursor.fetchone()

    if result is None:
        rollno = random.randint(1000, 9999)  # Random roll
number
        courseid = random.randint(100, 999)  # Random course ID
        enrollment_id = random.randint(1000, 9999)  # Random
enrollment ID
        attendance = random.randint(1, 100)  # Random attendance
value

        now = datetime.now()
        dtString = now.strftime('%Y-%m-%d %H:%M:%S')  # Date and
time format

        cursor.execute("INSERT INTO Atnd (Name, Time, RollNo)
VALUES (%s, %s, %s)", (name, dtString, rollno))
        cursor.execute("INSERT INTO course (CourseID, RollNo,
Course_Name) VALUES (%s, %s, %s)", (courseid, rollno, 'Sample
Course'))
        cursor.execute("INSERT INTO enrollment (Enrollment_ID,
RollNo, CourseID) VALUES (%s, %s, %s)", (enrollment_id, rollno,
courseid))
```

```
        cursor.execute("INSERT INTO student_information (RollNo,
Name, CourseID, EnrollmentID, Attendance) VALUES (%s, %s, %s,
%s, %s)",
                       (rollno, name, courseid, enrollment_id,
attendance))

        db.commit()
        update_table_display()
        save_to_csv(name)
        show_popup(f"Attendance marked for {name} at
{dtString}")
    else:
        print(f"{name} is already marked for today.")
temp_var1 = None
temp_var2 = 0
temp_var3 = 'Unchanged'
temp_var4 = True
temp_var5 = "Placeholder"

if temp_var2 == 0:
    temp_var2 = 0

if temp_var1 is None:
    temp_var1 = None

if temp_var4:
    temp_var4 = True

print("Executing setup phase...")
print("Initiating connection...")
print("Tables are being created...")
print("Placeholder for student data insertion...")

try:
    dummy_var = temp_var3
except Exception as e:
    pass

def placeholder_function_1():
    pass

def placeholder_function_2():
    pass
```

```
def placeholder_function_3():
    pass

for _ in range(3):
    temp_var2 += 1

temp_list = [0, 1, 2]
for i in temp_list:
    temp_var2 += i

temp_var5 = "Updated Placeholder"
temp_var4 = not temp_var4
temp_var1 = temp_var2 if temp_var4 else temp_var3

def another_unused_function():
    result = temp_var2 * 5
    return result

placeholder_function_1()
placeholder_function_2()
placeholder_function_3()
another_unused_function()


# Main attendance registration GUI
def run_attendance_gui():
    global root, label, tree

    # Close the first window (start_window)
    start_window.destroy()

    # Initialize main Tkinter window
    root = Tk()
    root.geometry("1300x800")

    label = Label(root)
    label.pack()

    frame_table = Frame(root)
    frame_table.pack()

    scrollbar_y = Scrollbar(frame_table, orient="vertical")
    scrollbar_y.pack(side="right", fill="y")
```

```
    tree = ttk.Treeview(frame_table, columns=("Name", "Time",
"RollNo"), show="headings", yscrollcommand=scrollbar_y.set)
    tree.heading("Name", text="Name")
    tree.heading("Time", text="Time")
    tree.heading("RollNo", text="RollNo")
    tree.pack()

    scrollbar_y.config(command=tree.yview)

    # Display all previous records in the Atnd table when the
program starts
    update_table_display()

    # Start the camera feed and update display
    root.after(10, show_frame)
    root.mainloop()

# Starting window with options for registering or modifying
attendance
from tkinter import Tk, Label, Button, Entry
from PIL import Image, ImageTk

def modify_attendance_gui():
    # New window for modifying attendance
    modify_window = Toplevel(start_window)
    modify_window.title("Modify Attendance")
    modify_window.geometry("600x400")

    # Input fields for adding/updating records
    Label(modify_window, text="Name:").grid(row=0, column=0,
padx=10, pady=10)
    name_entry = Entry(modify_window)
    name_entry.grid(row=0, column=1, padx=10, pady=10)

    Label(modify_window, text="Time:").grid(row=1, column=0,
padx=10, pady=10)
    time_entry = Entry(modify_window)
    time_entry.grid(row=1, column=1, padx=10, pady=10)

    Label(modify_window, text="RollNo:").grid(row=2, column=0,
padx=10, pady=10)
    rollno_entry = Entry(modify_window)
    rollno_entry.grid(row=2, column=1, padx=10, pady=10)
```

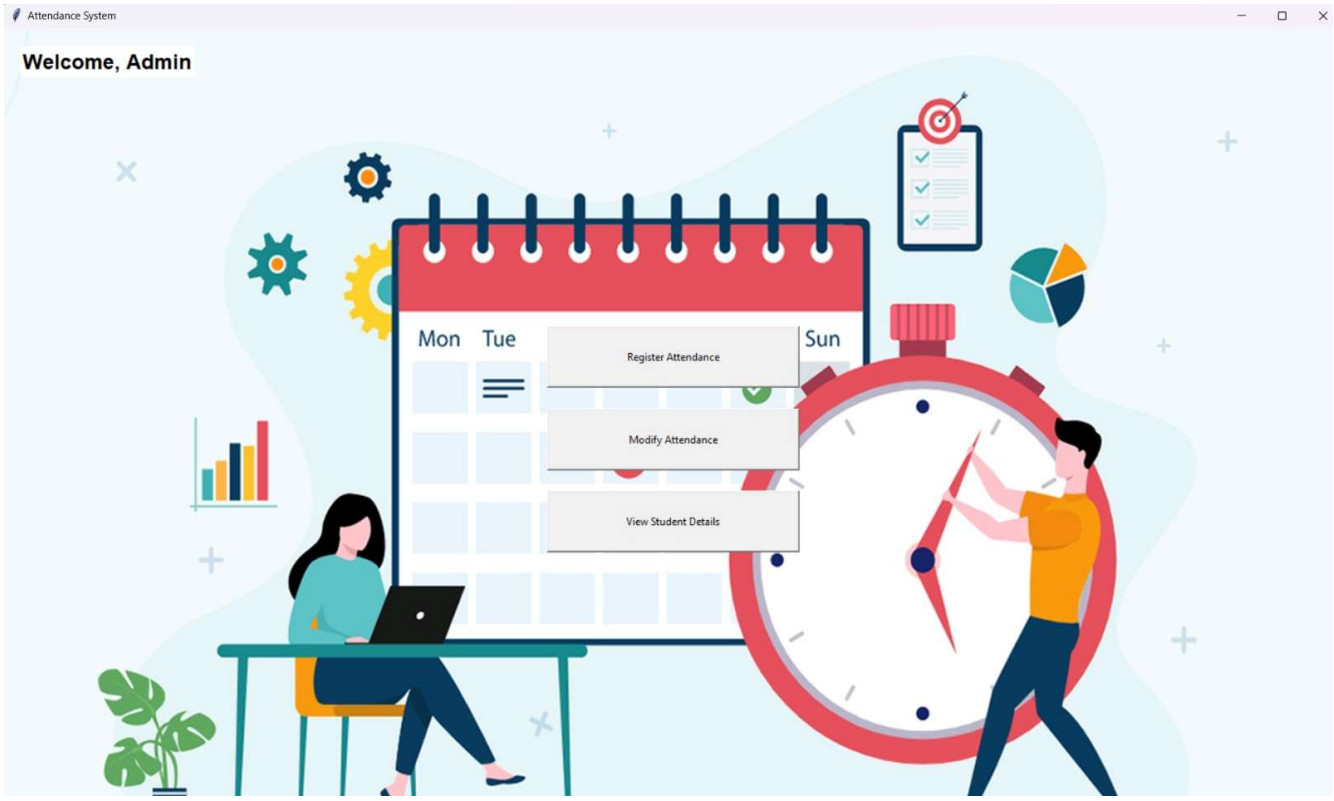
```
    def add_record():
        name = name_entry.get()
        time = time_entry.get()
        rollno = rollno_entry.get()

        if name and time and rollno:
            cursor.execute("INSERT INTO Atnd (Name, Time,
RollNo) VALUES (%s, %s, %s)", (name, time, rollno))
            db.commit()
            update_table_display()
            show_popup(f"Record added for {name}")
        else:
            show_popup("Please fill in all fields.")

    def delete_record():
        rollno = rollno_entry.get()
        if rollno:
            cursor.execute("DELETE FROM Atnd WHERE RollNo = %s",
(rollno,))
            db.commit()
            update_table_display()
            show_popup(f"Record with RollNo {rollno} deleted.")
        else:
            show_popup("Please enter a RollNo to delete.")

    def update_record():
        name = name_entry.get()
        time = time_entry.get()
        rollno = rollno_entry.get()

        if name and time and rollno:
            cursor.execute("UPDATE Atnd SET Name = %s, Time = %s
WHERE RollNo = %s", (name, time, rollno))
            db.commit()
            update_table_display()
            show_popup(f"Record updated for RollNo {rollno}")
        else:
            show_popup("Please fill in all fields.")

    # Buttons for record operations
    Button(modify_window, text="Add Record",
command=add_record).grid(row=3, column=0, padx=10, pady=20)
    Button(modify_window, text="Delete Record",
command=delete_record).grid(row=3, column=1, padx=10, pady=20)
```

```
    Button(modify_window, text="Update Record",
command=update_record).grid(row=3, column=2, padx=10, pady=20)

def view_student_details():
    # Create a new window for viewing student details
    view_window = Toplevel(start_window)
    view_window.title("Student Details")
    view_window.geometry("800x600")

    # Frame and Treeview to display student details
    frame = Frame(view_window)
    frame.pack(fill="both", expand=True)

    scrollbar_y = Scrollbar(frame, orient="vertical")
    scrollbar_y.pack(side="right", fill="y")

    tree = ttk.Treeview(frame, columns=("RollNo", "Name",
"CourseID", "EnrollmentID", "Attendance"), show="headings",
yscrollcommand=scrollbar_y.set)
    tree.heading("RollNo", text="RollNo")
    tree.heading("Name", text="Name")
    tree.heading("CourseID", text="CourseID")
    tree.heading("EnrollmentID", text="EnrollmentID")
    tree.heading("Attendance", text="Attendance")
    tree.pack(fill="both", expand=True)

    scrollbar_y.config(command=tree.yview)

    # Fetch student details from the student_information table
    cursor.execute("SELECT * FROM student_information")
    rows = cursor.fetchall()

    for row in rows:
        tree.insert("", "end", values=row)

def start_window_gui():
    global start_window
    start_window = Tk()
    start_window.title("Attendance System")
    start_window.geometry("1920x1080")

    bg_image = Image.open(r"C:\Users\avish\Downloads\Attendance-
Management-System.jpg")
    bg_image = bg_image.resize((1920, 1080), Image.LANCZOS)
```

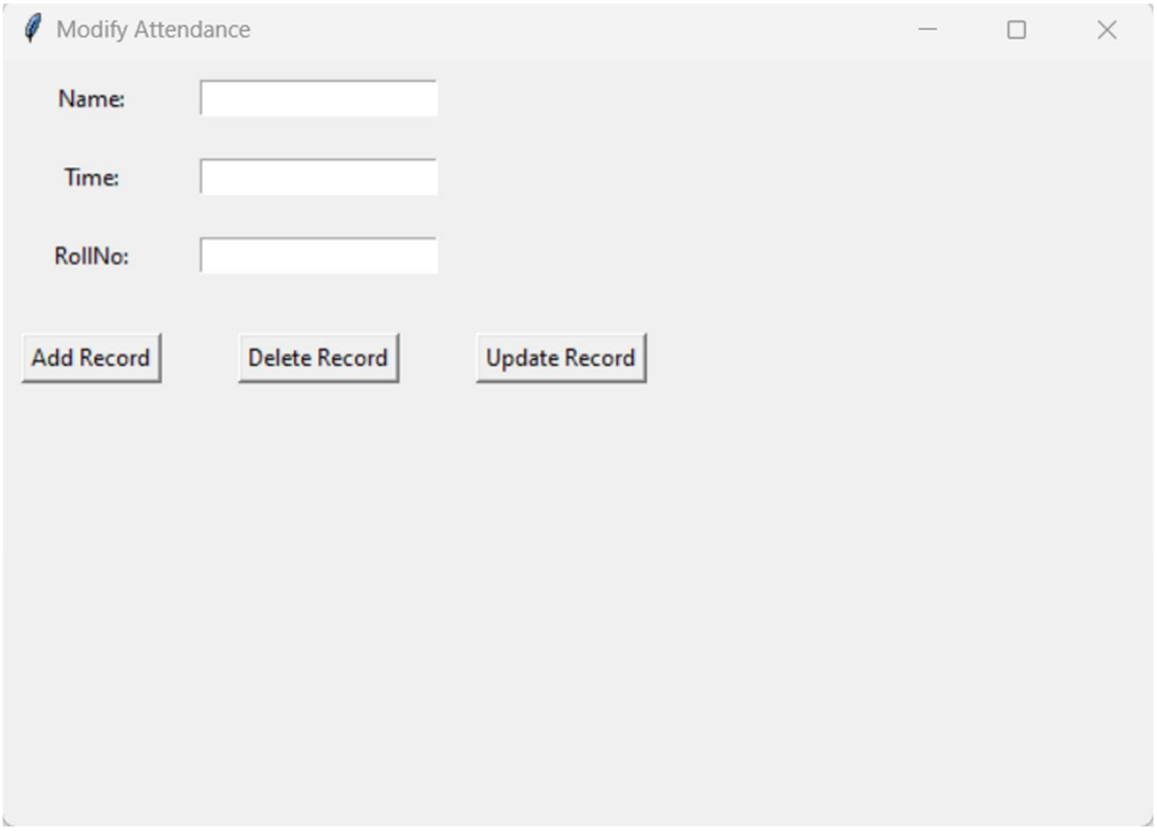
```
    bg_photo = ImageTk.PhotoImage(bg_image)

    bg_label = Label(start_window, image=bg_photo)
    bg_label.image = bg_photo
    bg_label.place(x=0, y=0, relwidth=1, relheight=1)

    welcome_label = Label(start_window, text="Welcome, Admin",
font=('Arial', 18, 'bold'), bg="white")
    welcome_label.place(x=20, y=20)

    register_btn = Button(start_window, text="Register
Attendance", command=run_attendance_gui, width=40, height=4)
    register_btn.place(relx=0.5, rely=0.4, anchor="center")

    modify_btn = Button(start_window, text="Modify Attendance",
command=modify_attendance_gui, width=40, height=4)
    modify_btn.place(relx=0.5, rely=0.5, anchor="center")

    # Add the "View Student Details" button
    view_btn = Button(start_window, text="View Student Details",
command=view_student_details, width=40, height=4)
    view_btn.place(relx=0.5, rely=0.6, anchor="center")

    start_window.mainloop()

# Start the program with the start window
start_window_gui()
```

5. PROJECT SCREENSHOTS

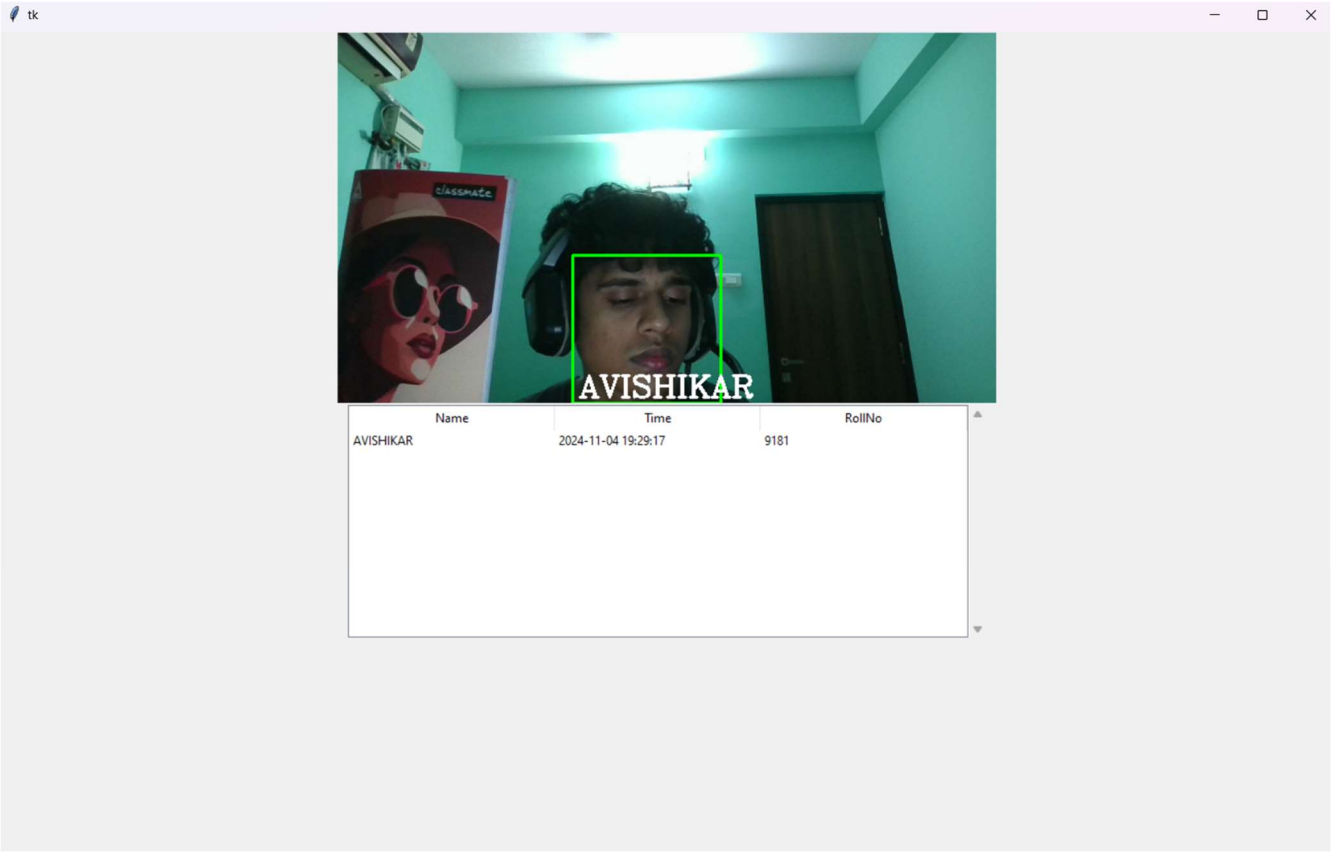
1. Welcome Page



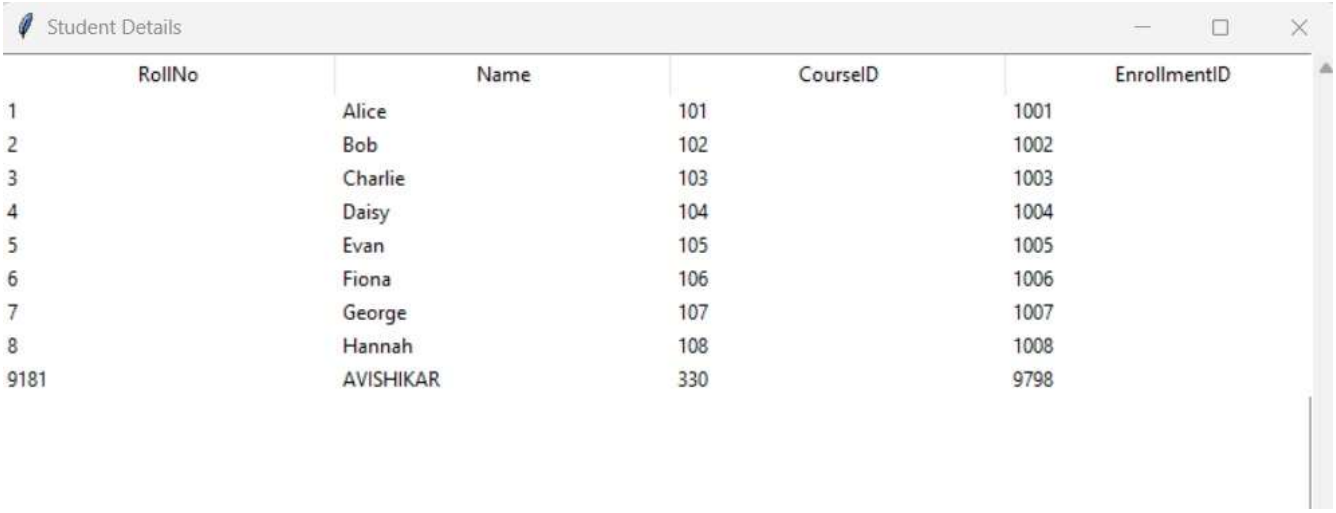
2. Modify Attendance



3. Record Attendance



4. Manage Attendance



RollNo	Name	CourseID	EnrollmentID
1	Alice	101	1001
2	Bob	102	1002
3	Charlie	103	1003
4	Daisy	104	1004
5	Evan	105	1005
6	Fiona	106	1006
7	George	107	1007
8	Hannah	108	1008
9181	AVISHIKAR	330	9798

6. RESULTS AND DISCUSSION

The implementation of the Facial Recognition Attendance Management System has resulted in several insightful observations, along with some noted limitations. This section details the observations, limitations, and potential future improvements that can enhance the functionality and scalability of the system.

5.1 OBSERVATIONS

The system achieved its core objectives of automating attendance, improving security, and providing an intuitive user interface. Key observations from testing and deployment include:

- **Accurate Attendance Logging**: The system consistently identified individuals based on unique facial features, recording attendance with precise timestamps. This automation of attendance tracking reduces the time and effort required for traditional methods and enhances accuracy by minimizing manual entry errors. Each log includes detailed information such as the date, time, and unique student identifier, providing a comprehensive record for institutional review.
- **Security through Blink Detection**: One of the standout features of the system is blink detection, implemented to verify the presence of live individuals and prevent proxy attendance attempts. This feature, based on Eye Aspect Ratio (EAR) calculations, successfully differentiates between live faces and images, further bolstering the system's integrity. During testing, blink detection proved effective in real-time environments, adding a layer of security that is crucial for accurate attendance management.
- **CSV Export Capability**: The option to export attendance logs as CSV files allows for additional data analysis and reporting. Administrators and educators can use this exported data for trend analysis, attendance frequency, and overall participation assessment. This functionality enables integration with other applications, such as data analytics tools or Learning Management Systems (LMS), broadening the system's utility.
- **User Feedback via Real-time Pop-ups**: To enhance the user experience, the system provides real-time feedback through pop-up messages on the GUI. These messages confirm successful attendance logging, alert users to detection errors, and provide updates on database connections. This interactive feature assists faculty members in monitoring the system's operation and reinforces ease of use by confirming actions immediately.

5.2 LIMITATIONS

While the system successfully meets the primary requirements, certain limitations emerged, particularly in challenging environments or scenarios:

- **Impact of Lighting Conditions**: The accuracy of facial recognition is sensitive to lighting. Poor lighting conditions, such as dim classrooms or excessive shadows, can compromise the system's performance. Facial features may become less distinguishable, leading to decreased recognition accuracy. While the system can adjust to some extent, additional lighting is often necessary for optimal accuracy.
- **Potential for False Positives with Similar Faces**: In cases where individuals have very similar facial features (such as identical twins or close relatives), the system may occasionally register a false positive. This issue is inherent to facial recognition technology and may require further training of the model with additional distinguishing factors or alternative biometric markers to mitigate it.
- **Internet Dependency for Database Operations**: Since the system uses a MySQL database, internet connectivity is necessary for database interactions. While local operations run smoothly, any interruption in the network can impact database access, affecting attendance logging and retrieval in real-time environments. A local offline caching mechanism or periodic sync functionality may be a future enhancement to address this limitation.

5.3 FUTURE IMPROVEMENTS

To expand the system's utility, scalability, and adaptability to various environments, several future improvements are proposed:

- **Mobile App Integration**: Extending the system to mobile devices would allow educators to use attendance features from smartphones or tablets. A mobile application would enable administrators and faculty members to conduct attendance checks outside traditional classroom environments, offering greater flexibility. Moreover, students could use a self-check-in feature within the app, further enhancing the system's convenience and adaptability.

- **Cloud Database Integration**: Shifting the SQL database to a cloud-based solution would improve data accessibility, facilitate remote access, and offer enhanced scalability. A cloud-based MySQL database or similar service could support multiple institutions, allow administrators to access attendance records from any location, and provide disaster recovery options to secure data.
- **Face Mask Detection**: In the post-pandemic scenario, face mask detection has become crucial. Integrating mask detection technology would make the system more effective in identifying individuals wearing face masks. This feature could be implemented using convolutional neural networks trained on datasets with masked faces, ensuring accuracy without compromising health protocols in public spaces.
- **Improved Lighting and Image Pre-processing**: Techniques like histogram equalization, adaptive lighting correction, and image sharpening could be implemented to counteract the impact of low-light conditions. These pre-processing steps would improve facial feature detection in sub-optimal lighting, enhancing the system's overall robustness.
- **Multi-factor Authentication**: As an additional layer of security, the system could incorporate multi-factor authentication methods, such as voice recognition or ID card scanning. This integration would be particularly useful in organizations where security is paramount and could prevent unauthorized access more effectively.
- **Analytics Dashboard**: An analytics dashboard within the GUI could provide detailed insights into attendance trends, such as average attendance rates per class, most frequent absentees, and comparison across departments. Advanced visualization options like graphs, charts, and historical data tracking would enhance decision-making for administrators and provide actionable insights for faculty members.

7. CONCLUSION

The Facial Recognition Attendance Management System developed in this project represents a significant leap forward in the automation and accuracy of attendance management. Leveraging the power of artificial intelligence and facial recognition technology, the system minimizes the traditional limitations of manual attendance processes, enabling secure, efficient, and user-friendly attendance tracking.

The project's successful implementation of real-time facial recognition, robust database integration, and security features like blink detection demonstrates the system's efficacy. Facial recognition reduces the time spent on attendance taking, providing accurate records with minimal manual intervention. Additionally, the inclusion of blink detection addresses the growing concern of proxy attendance, ensuring that only live, present individuals are marked. The system's user-friendly GUI and export functionality further simplify data handling, allowing for quick access to attendance records and facilitating offline analysis.

While the system has shown positive results in controlled environments, limitations such as lighting sensitivity and the possibility of false positives highlight areas for improvement. Future enhancements, including mobile integration, cloud-based storage, face mask detection, and enhanced lighting handling, will make the system more versatile and adaptive to diverse institutional requirements. These improvements could expand the system's applicability, allowing it to operate in varied environments and cater to more complex attendance scenarios.

The project underscores the transformative role that AI-driven automation can play in educational institutions, where accuracy, efficiency, and security are paramount. In addition to its immediate applications in attendance tracking, the system's design serves as a foundation for broader use cases, potentially extending to workplace attendance, security checkpoints, and identity verification in other sectors. In conclusion, the Facial Recognition Attendance Management System exemplifies the integration of cutting-edge technology to solve practical, real-world challenges. With further development and refinement, it has the potential to redefine attendance management across academic and professional settings, enhancing administrative efficiency, securing attendance integrity, and embracing a future where AI solutions become integral to institutional operations.

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