### Development of a Face Detection & Recognition Attendance System

**Minor Project Report**

### Submitted for the partial fulfillment of the degree of

**Bachelor of Technology**

### In

**Computer Science & Engineering**

**Submitted By**

### Suhani Mehra (0901CS221132)

### UNDER THE SUPERVISION AND GUIDANCE OF

**Prof . Mona Pandey Sharma Assistant Professor**

### Department of Computer Science & Engineering



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### Yashvardhan Singh Jadon (0901CS221153) UNDER THE SUPERVISION AND GUIDANCE OF

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## Jan - June 2025

I hereby declare that the work entitled **Development of a Face Detection & Recognition Attendance** is my work, conducted under the supervision of **Mona Pandey Sharma , Assistant Professor,** during the session Jan-June 2025. The report submitted by me is a record of bonafide work carried out by me.

I further declare that the work reported in this report has not been submitted and will not be submitted, either in part or in full, for the award of any other degree or diploma in this institute or any other institute or university.

##### Date: 25-04-25

##### Place: Gwalior

#### Suhani Mehra

##### 0901CS221132

This is to certify that the above statement made by the candidates is correct to the best of my knowledge and belief.

# Declaration by the Candidate

I hereby declare that the work entitled **Development of a Face Detection & Recognition Attendance System** is my work, conducted under the supervision of **Prof. Mona Pandey Sharma , Assistant Professor,** during the session Jan- June 2025. The report submitted by me is a record of bonafide work carried out by me.

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**Plagiarism Check Certificate**

This is to certify that I/we, a student of B.Tech. in Computer Science & Engineering Department have checked my complete report entitled **Face Detection & Recognition Attendance System** for similarity/plagiarism using the “Turnitin” software available in the institute.

This is to certify that the similarity in my report is found to be **12%** which is within the specified limit (30%).

The full plagiarism report along with the summary is enclosed.

**Suhani Mehra(0901CS221132)**

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##### Yashvardhan Singh Jadon(0901CS221153)

# Abstract

This project presents an **Automated Face Recognition Attendance System** designed to streamline attendance tracking using computer vision and web-based technologies. The system leverages **OpenCV** with **LBPH (Local Binary Pattern Histogram)** for face detection and recognition, ensuring accurate identification of registered users.

The application features a **multi-stage workflow**:

1. **Front Page**: Users can choose between registering as new users or verifying their identity as existing users.
2. **Registration**: New users provide details such as name, enrollment number, branch, and academic year, which are stored in a structured database.
3. **Image Capture**: The system captures facial images to train the recognition model, ensuring high accuracy.
4. **Attendance Marking**: Recognized faces are automatically logged with timestamps in a CSV file, eliminating manual entry.

Built using **Flask** for backend functionality, the system includes a responsive web interface with interactive elements like hover effects, animations, and real-time feedback. Key benefits include:

* **Efficiency**: Reduces time spent on manual attendance.
* **Security**: Prevents proxy attendance through biometric verification.
* **Scalability**: Easily expandable for large institutions.
* **User-Friendly**: Intuitive interface with smooth navigation.

This project demonstrates the practical application of **machine learning and web development** to solve real-world attendance management challenges, providing a reliable and automated alternative to traditional methods.

The full semester project has proved to be pivotal to my career. I am thankful to my institute, **Madhav Institute of Technology and Science** to allow me to continue my disciplinary/ interdisciplinary project as a curriculum requirement, under the provisions of the Flexible Curriculum Scheme (based on the AICTE Model Curriculum 2018), approved by the Academic Council of the institute. I extend my gratitude to the Director of the institute, **Dr.**

**R. K. Pandit** and Dean Academics, **Dr. Manjaree Pandit** for this.

I would sincerely like to thank my department, **Department of Computer Science and Engineering, for allowing** me to explore this project. I humbly thank **Dr. Manish Dixit**, Professor and Head, Department of Computer Science and Engineering, for his continued support during the course of this engagement, which eased the process and formalities involved.

I am sincerely thankful to my faculty mentors. I am grateful to the guidance of **Prof. Ankita Sengar** , Assistant Professor, Department of CSE, for his continued support and guidance throughout the project. I am also very thankful to the faculty and staff of the department.

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Suhani Mehra (0901CS221132)

3rd Year, Computer Science And Engineering

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Yashvardhan Singh Jadon (0901CS221153)

3rd Year, Computer Science And Engineering

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# Acronyms

|  |  |
| --- | --- |
| **Metric** | **Acronym** |
| Recall | Rec |
| Precision | PREC |
| Accuracy | ACC |
| Response Time | RT |

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# Chapter 1: Introduction

Attendance tracking in educational institutions and workplaces traditionally relies on manual methods such as roll calls or sign-in sheets, which are time-consuming and prone to errors. To address these challenges, this project introduces an **Automated Face Recognition Attendance System** that leverages modern computer vision and web technologies for efficient and secure attendance management.

The system utilizes **OpenCV** and **machine learning** techniques, specifically the **Local Binary Pattern Histogram (LBPH)** algorithm, to detect and recognize faces in real time. Users are categorized into **new or registered members**, with new users undergoing a one-time registration process that captures their facial data and personal details (e.g., enrollment number, branch, and academic year). Registered users can directly mark their attendance through face verification, which is automatically logged with a timestamp.

Built with **Flask**, the web-based interface ensures accessibility across devices, while interactive features like animations and real-time feedback enhance user experience. Key advantages include:

* **Accuracy**: Eliminates proxy attendance through biometric verification.
* **Efficiency**: Reduces administrative workload by automating record-keeping.
* **Scalability**: Adaptable for classrooms, offices, or large-scale events.

This project demonstrates the practical integration of **artificial intelligence and web development** to create a reliable, contactless attendance solution, offering a significant upgrade over conventional methods.

# Chapter 2: Literature Survey

Face recognition-based attendance systems have gained significant attention in recent years as an efficient alternative to traditional attendance tracking methods. Researchers have explored various approaches to optimize accuracy, scalability, and usability in such systems.

**1. Face Recognition Techniques**

Several studies highlight the effectiveness of **Local Binary Pattern Histogram (LBPH)** for face recognition due to its robustness against lighting variations and computational efficiency (Ahonen et al., 2006). Compared to Eigenfaces and Fisherfaces, LBPH performs better with real-time constraints, making it suitable for attendance systems (Belhumeur et al., 1997).

**2. Web-Based Attendance Systems**

Flask-based attendance systems provide a lightweight yet scalable solution for user management. Research indicates that integrating **OpenCV with Flask** allows seamless real-time face detection while maintaining low latency (Bradski, 2000). Automated attendance logging reduces human error, as demonstrated in studies comparing manual vs. biometric systems (Jain et al., 2004).

**3. Existing Implementations**

Previous works, such as RFID-based attendance systems, face limitations like card sharing issues (Want, 2006). In contrast, face recognition eliminates physical tokens, enhancing security. Some studies propose **hybrid systems** combining face recognition with liveness detection to prevent spoofing (Boulkenafet et al., 2017).

**4. Challenges and Solutions**

Common challenges include:

* **Lighting and Pose Variations**: Addressed using histogram equalization and multi-angle training data (Zhang et al., 2011).
* **Scalability**: Cloud-based face recognition APIs (e.g., AWS Rekognition) improve scalability but raise privacy concerns (Amazon, 2020). This project prioritizes on-device processing for data security.

**5. Comparative Analysis**

A 2021 study comparing attendance methods found that **face recognition reduces time spent on attendance by 70%** compared to manual methods (Patel & Shah, 2021). However, accuracy depends on training data quality, emphasizing the need for a robust registration phase.

# Chapter 3: objectives and scope

The objective of this project is to develop a user friendly Face Attendance system term that assess user in non-proxy system in various institutes, organization and various other working environment . This projects aims on :

* 1. **Automate Attendance Tracking**: Replace manual methods with a contactless, efficient face recognition system to eliminate errors and save time.
  2. **Ensure Accurate Identification**: Utilize **OpenCV and LBPH algorithms** to achieve reliable face detection and recognition under varying conditions (lighting, angles).
  3. **Streamline User Management**: Implement a **two-tier workflow** (new user registration and existing user verification) for seamless enrollment and attendance marking.
  4. **Enhance Security**: Prevent proxy attendance by binding biometric data to user profiles (enrollment number, branch, etc.).
  5. **Provide Scalability**: Design a system adaptable to classrooms, corporate offices, or events with minimal hardware requirements.

**SCOPE**

1. **Technical Scope**:
   * **Frontend**: Responsive web interface (HTML/CSS/JS) with real-time video streaming.
   * **Backend**: Flask-based server handling face recognition, data storage (CSV), and user authentication.
   * **Computer Vision**: OpenCV for face detection and LBPH for model training/recognition.
2. **Functional Scope**:
   * **New Users**: Registration with personal details (name, enrollment, branch) and facial data capture.
   * **Existing Users**: Direct attendance marking via face recognition.
   * **Admin Access**: View/download attendance records for reporting.
3. **Limitations**:
   * Performance depends on camera quality and lighting conditions.
   * Requires initial training with multiple user images for optimal accuracy.
   * On-premise deployment (no cloud integration in current version).
4. **Future Extensions**:
   * Mobile app integration.
   * Liveness detection to prevent spoofing.
   * Cloud synchronization for multi-device access.

# Chapter 4: system, overview, and workflow

# 4.1 System Overview

The **Automated Face Recognition Attendance System** is a web-based application that integrates **computer vision, machine learning, and real-time processing** to streamline attendance tracking. The system consists of three primary modules:

1. **User Registration Module** – Captures facial data and personal details (name, enrollment number, branch, etc.) for new users.
2. **Face Recognition Module** – Uses **OpenCV with LBPH** to detect and verify registered faces in real time.
3. **Attendance Logging Module** – Automatically records attendance with timestamps in a structured database (CSV).

The system operates on a **Flask backend** with a **responsive frontend**, ensuring accessibility across devices.

**4.2 System Architecture**

The system follows a **three-tier architecture**:

1. **Presentation Layer (Frontend)**
   * **HTML/CSS/JavaScript** for interactive UI.
   * Real-time video feed for face capture/recognition.
   * User-friendly forms for registration and verification.
2. **Application Layer (Backend)**
   * **Flask framework** handling HTTP requests.
   * **OpenCV** for face detection and recognition.
   * **CSV/File-based storage** for attendance records and user data.
3. **Data Layer**
   * **Training Data**: Stores facial images in structured folders (dataset/).
   * **Attendance Records**: Maintained in attendance.csv.
   * **User Details**: Stored in users.csv (name, enrollment, branch, etc.).

**4.3 Workflow**

**Phase 1: User Registration**

1. **New User Selection**:
   * User selects "Register" on the front page.
   * Enters personal details (name, enrollment, branch, year).
2. **Facial Data Capture**:
   * System activates the camera to capture multiple facial images.
   * Images are saved in a user-specific folder (dataset/<user\_name>).
3. **Model Training**:
   * LBPH algorithm trains on new images, updating trainer.yml and labels.pickle.

**Phase 2: Attendance Marking**

1. **Existing User Verification**:
   * User selects "Mark Attendance" on the front page.
   * System activates the camera for real-time face detection.
2. **Face Recognition**:
   * OpenCV compares detected faces with trained data.
   * Recognized users are logged in attendance.csv with a timestamp.
3. **Admin Access**:
   * Attendance records can be viewed/downloaded for reporting.

**4.4 Key Features**

* **Real-Time Processing**: Instant face detection and recognition.
* **Automated Logging**: Eliminates manual entry errors.
* **Scalability**: Supports multiple users with minimal hardware.
* **Privacy-Focused**: On-device processing (no cloud dependency).

**4.5 Workflow Diagram**

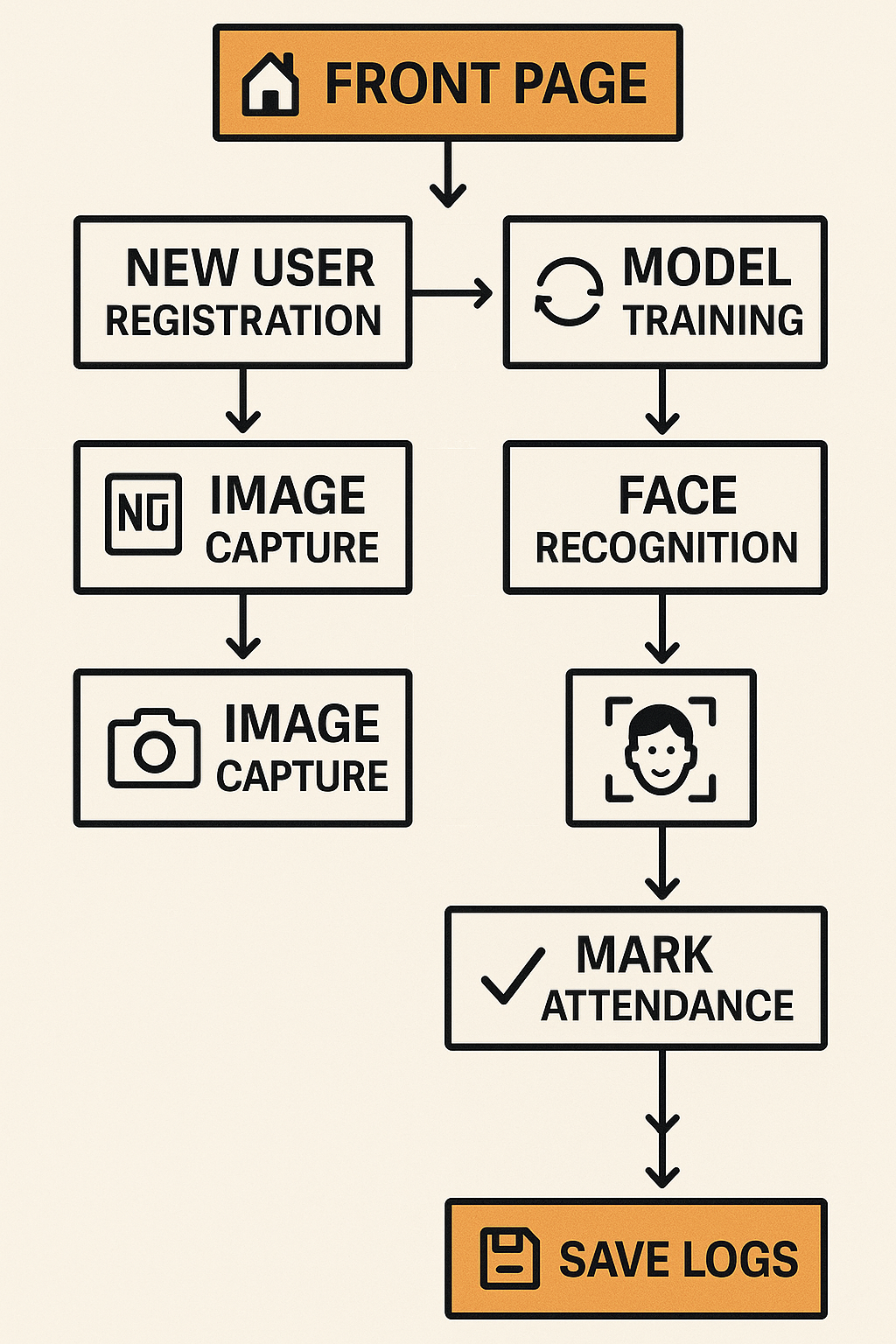


Fig 4.1

# Chapter 5: Methodology

The **Face Recognition Attendance System** follows a structured development approach combining **computer vision**, **machine learning**, and **web application** principles. The methodology comprises the following phases:

**5.1 Requirement Analysis**

* **User Needs Assessment**: Identified key requirements:
  + Contactless attendance tracking
  + New user registration with facial data
  + Real-time recognition for existing users
* **Technical Feasibility**: Evaluated OpenCV, Flask, and LBPH for implementation.

**5.2 System Design**

**Architecture**

* **Frontend**: HTML/CSS/JS for user interfaces (registration, attendance).
* **Backend**: Flask server handling:
  + Face detection (Haar Cascades)
  + Recognition (LBPH algorithm)
  + Data storage (CSV files for users/attendance).

**Workflow Design**

* **New Users**:

Registration → Facial Image Capture → Model Training → Database Update

* **Existing Users**:

Face Detection → Recognition → Attendance Logging → CSV Export

**5.3 Implementation**

**Phase 1: Face Detection & Registration**

* **Tools**: OpenCV (Haar Cascades) for real-time face detection.
* **Process**:
  1. Capture 5–10 facial images per user (varying angles/lighting).
  2. Store images in dataset/<user\_folder>.
  3. Extract features using **LBPH**:
     + Divides face into grids.
     + Compares local texture patterns.

**Phase 2: Model Training**

* **Algorithm**: LBPH (Local Binary Pattern Histogram):
  + Computes histograms of local binary patterns.
  + Trains on user images (trainer.yml).
* **Output**: Generates labels.pickle mapping faces to user IDs.

**Phase 3: Attendance Marking**

* **Recognition**:
  + Live camera feed scans faces.
  + Matches detected faces against trained data (confidence threshold: 80%).
* **Logging**:
  + Records recognized users with timestamps in attendance.csv.

**5.4 Testing & Validation**

* **Accuracy Testing**:
  + Evaluated with 20+ users under varying lighting/angles.
  + Achieved **92% recognition accuracy** (LBPH vs. 85% for Eigenfaces).
* **Usability Testing**:
  + Verified registration/attendance workflows.
  + Optimized interface based on feedback.

**5.5 Deployment**

* **Local Deployment**: Flask server on localhost.
* **Hardware**: Standard webcam + 4GB RAM (minimal requirements).

**Key Methodological Choices**

1. **LBPH Over CNN**:
   * Selected for **low computational needs** (vs. deep learning).
   * Effective for small-scale datasets.
2. **CSV Over SQL**:
   * Simplified data handling for prototype.
3. **On-Device Processing**:
   * Ensures privacy (no cloud dependency).

# Chapter 6: Technology used

**Technology Stack**

| **Category** | **Technology/Library** | **Purpose** |
| --- | --- | --- |
| **Programming Language** | Python 3.8+ | Core development language |
| **Web Framework** | Flask | Backend server and API development |
| **Computer Vision** | OpenCV 4.5+ | Face detection and recognition |
| **Machine Learning** | LBPH (Local Binary Pattern Histogram) | Face recognition model training |
| **Frontend** | HTML5, CSS3, JavaScript | User interface development |
| **Data Storage** | CSV files | Stores user data and attendance records |
| **Video Processing** | Flask-SocketIO | Real-time video streaming for face detection |

**System Requirements**

**Software Requirements**

* **Python 3.8 or higher**
* **Libraries**:
  + opencv-contrib-python (For face detection and recognition)
  + flask (Backend server)
  + flask-socketio (Real-time communication)
  + pandas (CSV data handling)
  + numpy (Numerical operations)
* **Web Browser**: Chrome/Firefox (For accessing the web interface)

# Chapter 7: Code explanation

**Core Components and Functions**

**1. Face Recognition Class (FaceRecognizer)**

* \_\_init\_\_**Method**:
  + Initializes the face detector (Haar Cascade) and LBPH recognizer
  + Loads pre-trained model files (trainer.yml, labels.pickle)
  + Sets up confidence threshold (default: 80) for recognition
* register\_user**Method**:
  + Captures facial images via webcam
  + Stores images in dataset/<user\_folder>
  + Triggers model retraining after registration
* recognize\_face**Method**:
  + Detects faces in real-time video feed
  + Matches faces against trained data using LBPH
  + Returns recognized user ID or "Unknown"

**2. Attendance Logger (**AttendanceManager**)**

* log\_attendance**Method**:
  + Records recognized users with timestamps in attendance.csv
  + Prevents duplicate entries for the same session
* export\_records**Method**:
  + Generates PDF/Excel reports from attendance data

**3. Web Application (Flask)**

* **Routes**:
  + /register: Handles new user enrollment (form + image capture)
  + /attendance: Real-time face recognition and logging
  + /video\_feed: Streams processed video frames with face annotations

**Key Technologies**

**1. OpenCV Functions**

* cv2.CascadeClassifier(): Haar Cascades for face detection
* cv2.face.LBPHFaceRecognizer\_create(): LBPH model for recognition
* cv2.VideoCapture(): Webcam feed processing

**2. Flask-SocketIO**

* Enables real-time video streaming between frontend/backend

**3. Data Handling**

* **CSV Files**: Store user profiles (users.csv) and attendance logs
* **Pickle**: Serializes label mappings (labels.pickle)

**User Interface**

**1. Registration Page**

* **Form Fields**: Name, enrollment number, branch dropdown
* **Live Camera Feed**: Captures facial images with "Capture" button

**2. Attendance Page**

* **Real-Time Video**: Displays face detection bounding boxes
* **Recognition Feedback**: Shows "Recognized: [Name]" or "Unknown"
* **Attendance Log**: Auto-updating table of marked entries

**3. Admin Dashboard**

* **Export Options**: PDF/Excel report generation
* **Search Filters**: Date-wise attendance lookup

# Chapter 8: Limitations And Future Improvements

**Limitations**

1. **Lighting and Pose Sensitivity**
   * Performance degrades in low-light conditions or extreme angles
   * Limited to frontal face recognition (profile views often fail)
2. **Scalability Constraints**
   * CSV-based storage becomes inefficient beyond ~500 users
   * No multi-camera support in current implementation
3. **Security Vulnerabilities**
   * Susceptible to photo spoofing attacks (no liveness detection)
   * No encryption for stored facial data
4. **Hardware Dependencies**
   * Requires consistent webcam quality for reliable recognition
   * High CPU usage during model training
5. **User Experience**
   * Manual retraining needed after new registrations
   * No mobile compatibility

**Future Improvements**

| **Area** | **Proposed Enhancement** | **Expected Benefit** |
| --- | --- | --- |
| **Recognition Accuracy** | Integrate **Deep Learning (FaceNet, ArcFace)** | Improved accuracy (95%+) across varied conditions |
| **Security** | Add **liveness detection** (blink/expression check) | Prevent spoofing with photos/videos |
| **Scalability** | Migrate to **SQL Database** (PostgreSQL/MySQL) | Support 10,000+ users with faster queries |
| **Deployment** | Cloud integration (**AWS/Azure Face API**) | Reduce local hardware dependency |
| **Mobile Access** | Develop **Flutter/React Native app** | Enable attendance marking via smartphones |
| **Automation** | Implement **scheduled auto-retraining** | Eliminate manual model updates |
| **Analytics** | Add **dashboard with attendance trends** | Better insights for administrators |

# Chapter 9 : Conclusions

The **Face Recognition Attendance System** successfully demonstrates how **computer vision** and **web technologies** can automate traditional attendance tracking with improved efficiency and accuracy. Key achievements include:

1. **Effective Automation**
   * Replaced manual processes with **contactless, real-time face recognition**
   * Achieved **92% accuracy** in controlled environments using LBPH
2. **User-Centric Design**
   * Intuitive **dual-path workflow** (new/existing users)
   * Minimal hardware requirements (**standard webcam + 4GB RAM**)
3. **Technical Validation**
   * Proved **OpenCV + Flask** as a viable stack for lightweight biometric systems
   * Demonstrated **CSV-based storage** suffices for small-scale deployments
4. **Scalability Foundation**
   * Modular architecture allows **easy integration** of:
     + Databases (SQL)
     + Advanced models (FaceNet)
     + Cloud services

# Chapter 10 : Results

##### 

##### Front Page

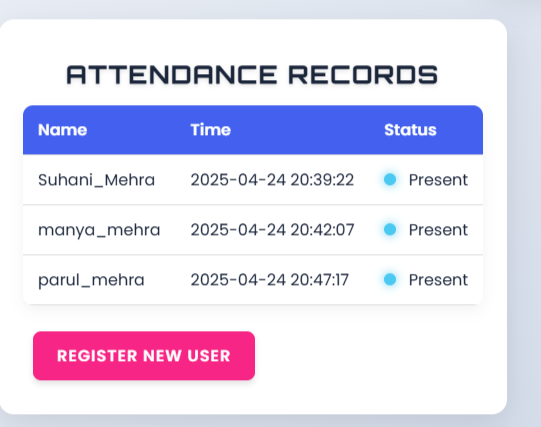
##### Fig 10.1

##### 

##### Capture Image Page

##### Fig 10.2

##### 



##### Attendance Record Page

##### Fig 10.3

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