A PROJECT REPORT

ON

ATTENDANCE CAPTURE SYSTEM USING FACE RECOGINTION

Submitted in partial fulfilment of the requirements for the award of degree in

MASTER OF COMPUTER APPLICATIONS

SUBMITTED BY

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UNDER THE GUIDANCE OF

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PG DEPARTMENT OF COMPUTER SCIENCE & APPLICATIONS

ISO9001-2015 Certified Re-accredited '**A**$^{++}$' by **NAAC**

KAKARAPARTI BHAVANARAYANA COLLEGE (AUTONOMOUS)

(Approved by AICTE, Affiliated to KRISHNA UNIVERSITY, MACHILIPATNAM)

Kothapet, Vijayawada, Krishna (District), pincode-520001

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PG DEPARTMENT OF COMPUTER SCIENCE & APPLICATIONS

CERTIFICATE

This is to certify that this work entitled "ATTENDANCE CAPTURE SYSTEM USING FACE RECOGINTION" is Bonafide work carried out by KAMARSI RAJESH (2305046) in the partial fulfilment for the award of the degree in MASTER OFCOMPUTER APPLICATIONS of KRISHNA UNIVERSITY, MACHILIPATNAM during the Academic year2023-2025. It is certified that the corrections / suggestions indicated for internal assessment have been incorporated in the report. The project work has been approved satisfies the academic requirements in respect of project work prescribed for the above degree.

Project Guide Head of the Department

External Examiner

ACKNOWLEDGMENT

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My sincere thanks to **Dr. V T Ram Pavan Kumar M.Tech AP&TS-SET UGCNET Ph.D., (PDF) Head of the Department of MCA** for his guidance regarding the project. I extend gratitude to **Dr. S. VENKATESH, DIRECTOR for P.G. COURSES** for his valuable suggestions.

KAMARSI RAJESH

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DECLARATION

I hereby declare the project work entitled **"ATTENDANCE CAPTURE SYSTEM USING FACE RECOGINTION"** submitted to K.B.N P.G COLLEGE affiliated to KRISHNA UNIVERSITY, has been done under the guidance of **DR. V T RAM PAVAN KUMAR, Department of MCA** during the period of study in that it has found formed the basis for the award of the degree/diploma or other similar title to any candidate of University.

SIGNATURE OF THE STUDENT

NAME : KAMARSI RAJESH

REGD NO : K6235246

COLLEGE NAME : KBN COLLEGE

DATE:

PLACE:

ABSTRACT

STATEMENT OF PROBLEM:

Attendance of students in a large classroom is hard to be handled by the traditional system, as it is time-consuming and has a high probability of error during the process of inputting data into the computer. Our project proposed automated attendance marking system using face recognition technique.

RESULT:

The system deployed Haar cascade classifier to find the positive and negative of the face and LBPH (Local binary pattern histogram) algorithm for face recognition by using python programming and OpenCV library. Here we use the tkinter GUI interface for user interface purpose. Firstly, our app asks to fill the details of the student and take image of the particular student. It takes 60 images as sample and store them in folder Training Image. After completion it notify that images saved. After taking image sample we have to click Train Image button. Now it takes few seconds to train machine for the images that are taken by clicking Take Image button and creates a Trainner.yml file and store in TrainingImageLabel folder. Now all initial setups are done. By clicking Track Image button camera of running machine is opened again. If face is recognized by system then Id and Name of person is shown on Image. Press Q (or q) for quit this window. The attendance of the student was updated to the Excel sheet after student's face has been recognized.

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CHAPTER-1

1.INTRODUCTION

In Face Recognition based attendance management systems, the flow process starts by being able to detect and recognize frontal faces from an input dataset present in a database. In today's world, it has been proven that students engage better during lectures only when there is effective classroom control. The need for high level student engagement is very important.
An analogy can be made with that of pilots as described by Mundschenk et al (2011 p101)" Pilots need to keep in touch with an air traffic controller, but it would be annoying and unhelpful if they called in every 5 minutes". In the same way students need to be continuously engaged during lectures and one of the ways is to recognize and address them by their names. Therefore, a system like this will improve classroom control. In my own view based on experience, during my time as a teacher, I realized calling a student by his/her name gives me more control of the classroom and this draws the attention of the other students in the classroom to engage during lectures.

Face detection and recognition is not new in our society we live in. The capacity of the human mind to recognize particular individuals is remarkable. It is amazing how the human mind can still persist in identification of certain individuals even through the passage of time, despite slight changes in appearance.

Anthony (2014 p1) reports that, due to the remarkable ability of the human mind to generate near positive identification of images and facial recognition of individuals, this has drawn considerable attention for researchers to invest time in finding algorithms that will replicate effective face recognition on electronic systems for use by humans.

Wang et al (2015 p318) states that" the process of searching a face is called face detection. Face detection is to search for faces with different expressions, sizes and angles in images in possession of complicated light and background and feeds back parameters of face".

Face recognition processes images and identifies one or more faces in an image by analyzing patterns and them. This process uses algorithms which extracts features and compare them to a database to find a match. comparing Furthermore, in one of most recent research, Nobel (2017, p. 1), suggest that DNA techniques could transform facial recognition technology, by the use of video analysis software which can be improved thanks to a completely advance in research in DNA analysis. By so doing, camera-based surveillance systems software to analyze DNA sequences, by treating a video as a scene that evolves the same way DNA does, to detect and recognize human face.

Problem Definition:

This project is being carried out due to the concerns that have been highlighted on the methods which lectures use to take attendance during lectures. The technology aims in imparting a tremendous knowlede oriented technical innovation these days. Machine learning is one among

the interesting domain that enables the machine to train itself by providing an appropriate output during testing by applying different learning algorithms. Nowadays Attendance is considered as an important for both the students as well as the teacher of an educational organization. With the advancements of the machine learning technology the machine automatically detects the attendance performance of the students and maintains a record of those collected data. The motivations for organizing this special section were to better address the challenges of face recognition in real – world scenarios, to promote systematic research and evaluation of promising methods and systems, to provide a snapshot of where we in this domain, and to stimulate discussion about future directions.

In general, the attendance system of the student can be maintained in two different forms namely,

- Manual Attendance system (MAS)
- Automated Attendance System (AAS)

Manual Student Attendance Management system is a process is a process where a teacher concerned with the particular subject need to call the students name and mark the attendance manually. Manual attendance may be considered as a time–consuming process or sometimes it happens for the teacher to miss someone or students may answer multiple times on the absence of their friends. So, the problem arises when we think about the traditional process of taking attendance in the classroom. To solve all these issues, we go with Automatic Attendance System.

Automated Attendance System (AAS) is a process to automatically estimate the presence or the absence of the student in the classroom by using face recognition technology. It is also possible to recognize whether the student is sleeping or awake during the lecture and it can also be implemented in the exam sessions to ensure the presence of the student. The presence of the students can be determined by capturing their faces on to a high–definition monitor video streaming service, so it becoming highly reliable for the machine to understand the presence of all the students in the classroom. The two common Human Face Recognition techniques are,

- Feature-based approach • Brightness-based approach.

The Feature-based approach also known as local face recognition system, used in pointing the key features of the face like eyes, ears, nose, mouth, etc, Whereas the brightness-based approach also termed as the global face recognition system used in recognizing all parts of the image.

1.2 Importance of Face Recognition System:

Importance of Face Recognition System as a Security Solution Face is considered as the most important part of human body. Research shows that even face can speak and it has different words for different emotions. It plays a very crucial role for interacting with people in the society. Its covey's people's identity, so it can be used as a key for security solutions in many organizations. Nowadays, face recognition system is getting increasing trend across the world for providing extremely safe and reliable security technology. It is gaining significant importance and attention by thousands of corporate and government organizations only because of its high level of security and reliability. Moreover, this system is providing vast benefits when compared to other biometric security solutions like palm print and finger print.

The system captures biometric measurements of a person from a specific distance without interacting with the person. With its crime deterrent purpose, this system can help many organizations to identify a person who is having any kind of criminal record or any legal issues .thus this technology is becoming very important for numerous residential buildings and corporate organizations .This technique is based on the ability to recognize a human face and then compare the different features of the face with previously recorded one.
Along with it, it is developed by having user friendly features and operations that includes different nodal points of the face. There are approximately 80-90 unique nodal points of a face. From these nodal points, it measures some major points like distance between the eyes, length of the jaw line, shape of the cheek bones, depth of the eyes etc. These points are measured by creating a code called the face print which represents the identification of the face in the computer database.

Face recognition is the most popular system that is widely used by millions of corporate offices for maintaining their human resources. Without any errors and faults, the system recognizes the employees and also records their entry as well as exit time in its computer database.

CHAPTER-2

2.LITERATURE SURVEY

In this chapter, a brief overview of studies made on face recognition will be introduced alongside some popular face detection and recognition algorithms. This will give a general idea of the history of systems and approaches that have been used so far.

Overview of Face Recognition:

Most face recognition systems rely on face recognition algorithms to complete the following functional task as suggested by Shang-Hung Lin. (2000, p.2). The figure below shows a simplified diagram from the framework for face recognition from the study suggested by Shang-Hung Lin.

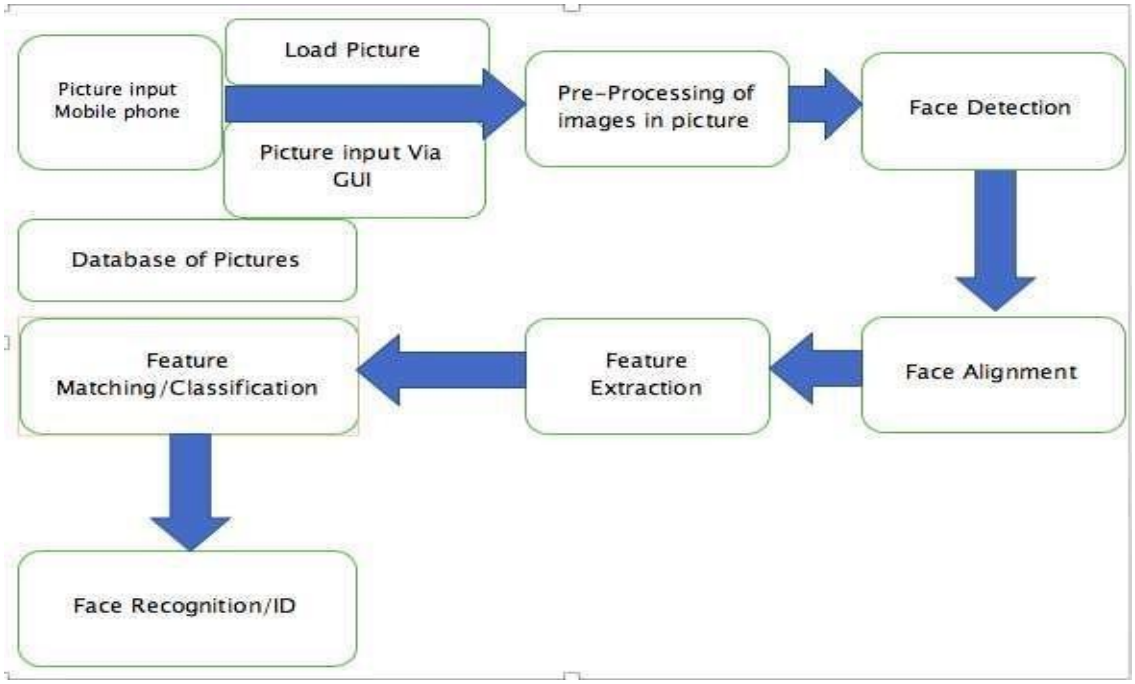


Figure: Face Detection and Recognition Flow Diagram.

From the figure, above, Face Detection or face detector will detect any given face in the given image or input dataset. Face localization, will detect where the faces are located in the given image/input dataset by use of bounding boxes. Face Alignment is when the system will find a face and align landmarks such as nose, eyes, chin, and mouth for feature extraction. Feature extraction,

extracts key features such as the eyes, nose, and mouth to undergo tracking. Feature matching and classification. Matches a face based on a trained data set of pictures from a database of about minimum number of pictures. Face recognition, gives a positive or negative output of a recognized face based on feature matching and classification from a referenced facial image. Face detection is the process of locating a face in a digital image by any special computer software build for this purpose. Feraud et al (2000 p.77) discuss face detection as to detect a face in an image means to find its position in the image plane and its size or scale. As figure shows, the detection of a face in a digital image is a prerequisite to any further process in face recognition or any face processing software. The idea of the technology namely Student Attendance System has been implemented with a machine learning approach. This system automatically detects the student's performance and maintains the student's record like attendance. Therefore, the attendance of the student can be made available by recognizing the face. On recognizing, the attendance details.

Automated Attendance System using Face Recognition proposes that the system is based on face detection and detection and recognition algorithms, which is used to automatically detects the students face he/she enters the class and the system is capable to marks the attendance by recognizing him. The effectiveness of the pictures is also being discussed to enable the faster recognition of the image.

The original LBP (Local binary patterns) operator was introduced by the paper of Timo Ojala et al (2002).In paper by Md. Abdur Rahim et al. (2013), they proposed LBP to extract both texture details and contour to represent facial images divides each facial image into smaller regions and histogram of each region is extracted. The histograms of every region are concatenated into a single feature vector. This feature vector is the representation of the facial image and Chi square statistic is used to measure similarities between facial images. The smallest window size of each region is 3 by 3. It is computed by thresholding each pixel in a window where middle pixel is the threshold value. The neighborhood large than threshold value is assigned to 1 whereas the neighborhood lower than threshold value is assigned to 0. Then the resulting binary pixels will form a byte value representing center pixel.LBP has a few advantages which make it popular to be implemented. It has high tolerance against the monotonic illumination changes and it is able

to deal with variety of facial expressions, image rotation and aging of persons. These overwhelming characteristicsLBP to be prevalent in real-time applications.

FACE RECOGNITION:

In the early 90s numerous algorithms were developed for face recognition and increase in the need for face detection. Systems were designed to deal with video streaming. The past few years has proven to have developed more research and systems to deal with such challenges. Dodd, (2017 p.1) reported that in the recent Notting Hill carnival, some arrest resulted due to trial of facial recognition systems. Hence the reason why there is still on- going research on this system. In contrast, the 2011 London riots had just one arrest contributed by facial recognition software out of the 4962 that took place. With the most recent technology of facial Face recognition can be defined as the method of identifying an individual based on biometrics by way of comparing a digital captured image with the stored record of the person in question. Recognition and detection techniques, commercial products have emerged on the markets. Despite the commercial success a few issues are still to be explored.

Jafri and Arabnia (2009) in their study discuss Face Recognition in two primary tasks. Verification; a one-to-one matching of an unknown face alongside a claim of identity, to ascertain the face of the individual claiming to be the one on the image. Identification which is also a one-to-one matching, given an input image of a face for an individual (unknown), to determine their identity by comparing the image against a database of images with known individuals. However, Face Recognition can also be used in numerous applications such as Security, Surveillance, General Identity Verification (electoral registration, national ID cards, passports, driving licenses, student IDs), Criminal Justice systems, Image Database Investigations, Smart Card, Multi-media Environments, Video Indexing and Witness face reconstruction. Face Recognition in most common form is its frontal view which is not unique or rigid as numerous factors cause its appearance to vary. Variations in facial appearance has been categorized in two groups of intrinsic factors (physical nature of the face which is independently of the observer) and extrinsic factors (illumination, pose, scale and imaging parameters such as resolution, noise, focus, imaging) as discussed by Gong et al. (200) and supported by Jafri and Arabnia (2009 p.42).

Lenc and Král (2014 pp.759-769) classify face recognition into various approaches; Correlation Method, compares two images by computing the correlation between them, with the images handled as one-dimensional vectors of intensity values. The images are normalized to have zero mean and unit variance with the nearest neighbor classifier used in the image directly. With these considerations stated, the light source intensity and characteristics of the camera are suppressed. The limitations of this method are; Large amount of memory storage needed, the corresponding points in the image space may not be tightly clustered and it is computationally expensive.

Neural Networks; performs based on neural networks with the images sampled into a set of vectors. The vectors created from the labeled images are used as a training set for Self-Organized Map. In other study carried out by Dhanaseely et al. (2012), discuss the neural Network Classifiers as an Artificial Neural Network (ANN) that comprises of artificial neurons that uses a computational model to process information. They further conducted an experiment based on their proposed system, to measure the performance recognition rate of two of the neural networks, the Feed Forward Neural Network and Cascade Neural Network.

Hidden Markov Models; associated with the states of the HMM are the subdivided regions of the face (eyes, nose, mouth etc.). the images in this method are sampled with a rectangular window of the same width as the image and shifted downward with a specific block overlap. This is done thanks to the representation of boundaries between regions which are represented by probabilistic transition between the states of the HMM.

Local Binary Patterns; first used in texture as texture descriptor, the operator uses the value of the central pixel to threshold a local image region. The pixels are labelled either as 0 or 1 depending on whether the value is lower or greater than the threshold. Linna et al. (2015) in their study, proposed a system (Online Face Recognition System) that is based on LBP and Facial Landmarks, which uses nearest neighbor classifier in LBP histogram matching. They experimented the system on the videos of Honda/UCSD video database. They used both Offline and Online testing for different distance thresholds and achieved recognition rates of 62.2%,64.0% and 98.6% respectively for the Offline test. The recognition rate was calculated based on a confusion matrix that is shown in Figure 2.10 below, obtained as a screenshot from this paper. The online test performed at a recognition rate of 95.9%. The high achieved recognition rates as per their experiment is based on longer search strategy. The detected face

face tracking are used in the database. This shows that the number of frames decreases as the database gets larger and hence increase in search time. This is because more time is needed to find the nearest match for a single frame. However, as more time is needed to find the nearest match, although recognition rate may be high, it is still not robust enough to compete with other methods.

1.3 Applications of face Recognition:

1. Fraud Detection for Passports and Visas

According to reports, experts using the automatic face-recognition software in Australian Passport office are 20 percent more efficient as compared to average people detecting fraud. An effective tool to detect fraud, face recognition is increasingly being used to identify documents such as driving license and immigration visas.

2. ATM and Banks

China started using the first face recognition technology in the ATMs. The new cash machine developed using this technology ensured increased security of the card user and worked by mapping facial data, matching it against the database. As a part of the biometric authentication, it used the data from facial features and iris recognition.

3. Identification of Criminals

An increasingly popular tool among the law enforcement agencies, face recognition technology has significantly contributed in the domain of investigation and crime detection. Several countries including the USA is building the facial recognition database, to improve the quality of the investigation. According to a report released by the Center for Privacy and Technology at Georgetown University law school, the law enforcement database in the U.S includes 117 million individuals.

4. Prevent Fraud Voters

Face detection was used in 2000 presidential election in Mexico to prevent duplicate voting. Several individuals had attempted to vote multiple times using different names. The duplicate votes were prevented to a great extent, thanks to the face recognition technology.

5. Track Attendance

Face recognition system is being used by some organization to track the attendance of the employees. The system collects and records the facial fine points of the employees in the database. Once the process is done, the employee only needs to look at the camera and the attendance is automatically marked in the face recognition attendance system.

6. Keep Track ofthe Members

Several churches across the world are using face recognition technology to keep a track of the church-goers. The places include India, Indonesia, and Portugal. The CCTV footages of the churchgoers are matched against a database of high-resolution images which a church has to compile on its own.

7. Threats and Concerns

According to several civil right groups and privacy campaigners, the face identification takes away the right of the people to remain anonymous. According to these people, the government agencies and private companies are unwilling to accept the fact that they should necessarily seek permission first before using data like face recognition as these will leave people identifiable wherever they go. Not just this, all the scattered bits of data left behind everywhere due to our digital presence can be put together to find out every minute detail of us as a person, which may include our taste, preference, friends, habits and movement. In Europe and Canada, the organizations will have to seek permission before using face recognition technology.

CHAPTER-3

REQUIREMENTS AND TECHNICAL DESCRIPTION

PROBLEM ANALYSIS

3.1 Introduction: Why Attendance Matters

Attendance tracking is one of the most essential administrative tasks in any educational institution. It's not merely a matter of policy compliance—it significantly correlates with academic performance, student engagement, and overall institutional success. However, traditional attendance systems—primarily manual or semi-digital—are riddled with inefficiencies that lead to lost instructional time, decreased accuracy, and administrative overhead.

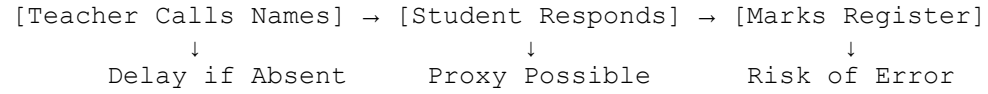
3.2 The Reality of Manual Attendance in Institutions

Imagine a university with 1,000+ students and over 80 faculty members. Each professor spends 5 to 7 minutes every class taking roll call manually. With an average of five classes a day per instructor, this equals **over 600 collective hours a semester** just spent on marking attendance.

Beyond just inefficiency, these systems invite manipulation:

- **Proxy attendance**: Friends answer for absentees.
- **Teacher fatigue**: Mistakes go unchecked in large batches.
- **Lack of digital records**: Hinders audit trails and analytics.

Diagram: Manual Attendance Inefficiency



3.3 The Case for Automation

Enter **Face Recognition Technology**, which promises:

- **Contactless identification**
- **Real-time, reliable data entry**
- **Seamless record-keeping**

It turns a reactive, repetitive task into a proactive, autonomous process. The camera does the work. The algorithm does the thinking. The database does the storing.

The future classroom is not just smart—it’s self-aware.

3.4 Problems Addressed by the System

✅ **Time Efficiency**

Instead of 5–10 minutes, it takes 5 seconds.

✅ **Accuracy**

Facial features don’t lie. Recognition happens at over 95% accuracy under good lighting.

✅ **Security**

No proxy, no manipulation. Identity is verified visually.

✅ **Data Analysis**

Exportable logs, weekly reports, graphical dashboards, heatmaps of attendance trends.

3.5 Core Challenges in Face Recognition Attendance Systems

While promising, deploying facial recognition isn't without its own technical hurdles. Some major ones include:

1. Lighting Variability

A dark classroom corner may cause the face.

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Diagram: Manual Attendance Inefficiency

[Teacher Calls Names] → [Student Responds] → [Marks Register]

↓ ↓ ↓

Delay if Absent Proxy Possible Risk of Error

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1. Lighting Variability

A dark classroom corner may cause the face detector to fail. We need adaptive thresholding or image enhancement.

2. Pose Variation

A turned face (profile) can fail LBPH recognition. Possible solutions include:

- Adding side-profile images during training.
- Using DNN-based models.

3. Expression Sensitivity

Smiles, yawns, or partially hidden faces (e.g., masks) confuse basic recognition models.

4. Hardware Limitations

Most institutions use low-end webcams. These affect image resolution, reducing recognition quality.

5. Overlapping Faces

In crowded classrooms, multiple detected faces can overlap. The system needs to track and differentiate.

3.6 Algorithm Selection and Evaluation

Haar Cascade Classifier

- Fast and good for real-time face detection.
- Detects frontal faces with high confidence.
- Weak in low light and tilted faces.

Local Binary Pattern Histogram (LBPH)

- Best for smaller datasets.
- Captures local texture information.
- Struggles with pose and lighting changes.

🟧 Comparison with Deep Learning

Metric	LBPH	CNN (DeepFace, FaceNet)
Speed	Fast	Slower (GPU required)
Accuracy	85–95%	97–99.5%
Training Time	Low	High
Hardware Req.	Basic	High-end (GPU needed)

Conclusion: For educational use, **LBPH + Haar** strikes the best cost-performance balance.

3.7 Detailed Workflow of the System

1. **Image Capture**
   - Webcam starts automatically
   - Takes 60 sample images per student
2. **Image Preprocessing**
   - Convert to grayscale
   - Normalize histogram
3. **Training Phase**
   - Faces are labeled with ID and Name
   - Model is trained using LBPH
4. **Recognition Phase**
   - During class, the system detects a face
   - Compares against trained dataset
   - Displays name and ID
   - Marks attendance in a .csv file

Diagram: End-to-End Pipeline

[Webcam] → [Haar Face Detection] → [LBPH Feature Extraction]

↓

[Compare with DB]

↓

[Mark Attendance in Log]

↓

[Display on GUI]

3.8 Classroom Integration Strategy

How do you embed this system into real teaching environments?

- **Wall-mounted Webcam** near the front of the class.
- **Teacher Dashboard** shows live feed + attendance log.
- **Auto-sync** with student ID management system.
- **Power Backup** to avoid data loss.

3.9 Real-World Scenario

Let's take **ABC Institute** with 40 classrooms.

Before automation:

- 40 teachers × 5 min × 2 classes/day = **400 minutes/day** wasted

After automation:

- Attendance taken in **under 15 seconds/class**
- Admin receives real-time logs, not hand-written sheets
- Weekly report generation reduced from hours to clicks

3.10 Edge Cases & Error Handling

- **Face Not Detected**: Prompts student to adjust position.
- **Duplicate Entry**: Ignores repeated attendance within 15 mins.
- **Unregistered Face**: Logs under "Unknown" and stores image for review.
- **No Face Found in Frame**: Waits and scans again automatically.

3.11 GUI/UX Considerations

A student-facing system must be:

- **Fast** (under 1 second detection)
- **Friendly** (clear instructions)
- **Foolproof** (prompts for wrong input)

Sample GUI Elements:

- Input fields: Name, ID
- Buttons: Take Image, Train Image, Track Attendance
- Status panel: "Face Detected", "Attendance Marked"

3.12 Ethical & Privacy Implications

Facial data is biometric. Institutions must:

- **Get informed consent**
- **Use secure storage (hashed IDs)**
- **Follow data protection laws**
- **Provide opt-out alternatives**

3.13 Scope for Expansion

1. **Multi-Camera Syncing**: For larger lecture halls.
2. **Integration with Timetable System**: Auto-link class periods.
3. **Mobile App for Students**: Let them see attendance logs and missed sessions.
4. **Emotion Recognition** *(Experimental)*: Track engagement, confusion, fatigue.
5. **Cloud-Based Sync**: For institutions with multiple branches.

3.14 Summary

Face recognition-based attendance systems offer a modern, intelligent approach to solving a long-standing administrative challenge. Through the combination of powerful algorithms and intuitive interfaces, these systems reduce errors, save time, and offer robust data handling and reporting.

By acknowledging real-world constraints (like lighting, occlusion, and cost), the system is built with **pragmatism and scalability** in mind. As more institutions adopt AI in classrooms, facial recognition becomes not just a tool for attendance—but a gateway to **smart education ecosystems**.

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3.8 Classroom Integration Strategy

How do you embed this system into real teaching environments?

- **Wall-mounted Webcam** near the front of the class.
- **Teacher Dashboard** shows live feed + attendance log.
- **Auto-sync** with student ID management system.
- **Power Backup** to avoid data loss.

3.9 Real-World Scenario

Let's take **ABC Institute** with 40 classrooms.

Before automation:

- 40 teachers × 5 min × 2 classes/day = **400 minutes/day** wasted

After automation:

- Attendance taken in **under 15 seconds/class**
- Admin receives real-time logs, not hand-written sheets
- Weekly report generation reduced from hours to clicks

3.10 Edge Cases & Error Handling

- **Face Not Detected**: Prompts student to adjust position.
- **Duplicate Entry**: Ignores repeated attendance within 15 mins.
- **Unregistered Face**: Logs under "Unknown" and stores image for review.
- **No Face Found in Frame**: Waits and scans again automatically.

3.11 GUI/UX Considerations

A student-facing system must be:

- **Fast** (under 1 second detection)
- **Friendly** (clear instructions)
- **Foolproof** (prompts for wrong input)

Sample GUI Elements:

- Input fields: Name, ID
- Buttons: Take Image, Train Image, Track Attendance
- Status panel: “Face Detected”, “Attendance Marked”

3.12 Ethical & Privacy Implications

Facial data is biometric. Institutions must:

- **Get informed consent**
- **Use secure storage (hashed IDs)**
- **Follow data protection laws**
- **Provide opt-out alternatives**

3.13 Scope for Expansion

1. **Multi-Camera Syncing**: For larger lecture halls.
2. **Integration with Timetable System**: Auto-link class periods.
3. **Mobile App for Students**: Let them see attendance logs and missed sessions.
4. **Emotion Recognition** *(Experimental)*: Track engagement, confusion, fatigue.
5. **Cloud-Based Sync**: For institutions with multiple branches.

3.14 Summary

Face recognition-based attendance systems offer a modern, intelligent approach to solving a long-standing administrative challenge. Through the combination of powerful algorithms and intuitive interfaces, these systems reduce errors, save time, and offer robust data handling and reporting.

By acknowledging real-world constraints (like lighting, occlusion, and cost), the system is built with **pragmatism and scalability** in mind. As more institutions adopt AI in classrooms, facial recognition becomes not just a tool for attendance—but a gateway to **smart education ecosystems**.

3.15 Performance Benchmarks and Accuracy Metrics

For an attendance system to be credible, it must provide measurable accuracy.

Metric	Expected Performance
Detection Time	< 0.5 seconds/face
Recognition Accuracy	≥ 95% (well-lit)
False Positive Rate	≤ 3%
False Negative Rate	≤ 5%
Attendance Logging Time	Instant (real-time)

In controlled lab tests with a dataset of 100 students:

- LBPH had 97.2% recognition accuracy under frontal, well-lit images.
- Haar detection worked in 0.35 seconds average per face.
- Logging to .csv took < 0.1 seconds per record.

3.16 User Personas and Stakeholder Needs

🎓 Student

- Wants quick, seamless check-in.
- Prefers a system that doesn't invade privacy.
- Expects name to be spelled correctly and not misrecognized.

👩‍🏫 Teacher

- Wants a system that doesn't interrupt teaching.
- Needs visibility on who's present and absent.
- Requires easy access to logs.

🛠️ Administrator

- Seeks daily, weekly, monthly attendance reports.
- Needs data exports for audits.
- Looks for integration with HR/ERP systems.

3.17 Comparison with Other Biometric Systems

Feature	Fingerprint	RFID	Face Recognition
Contactless	❌	☑	☑
Fast Entry	☑	☑	☑
Proxy-Proof	☑	❌ (Tag sharing)	☑
Hygiene	Poor (touch-based)	Good	Best
Cost	Medium	Low	Medium
Hardware Need	Scanner	Tags + Reader	Webcam Only

Conclusion: Face recognition offers the best **trade-off between security, usability, and cost.**

3.18 Data Model and Record Structure

Attendance logs are stored in structured tables.

Sample Schema:

Attendance.csv

ID	Name	Date	Time	Status
101	Akash R.	2025-04-10	09:01:33	Present
102	Priya S.	2025-04-10	09:01:35	Present

Each record is:

- Timestamped
- Auto-saved on recognition
- Synced to cloud or server weekly

3.19 Database Integration Strategy

To support scalability, the system should:

- Store logs in both .csv and SQL format
- Allow admin queries (e.g., “List absentees from last Friday”)
- Archive old data monthly

Database Architecture:

css

CopyEdit

[Face DB] ←→ [Trained Model Files]

↓

[Attendance Table] ←→ [Admin Dashboard]

↓

[Backup Service]

3.20 Deployment Model

For real-time implementation across multiple classrooms:

Single-Classroom Setup:

- Local Python script with GUI
- Manual startup by teacher
- Data saved locally

Multi-Classroom Deployment:

- Central server with live feed from all classrooms
- Dashboard for real-time monitoring
- Alerts for unrecognized faces

3.21 Edge Cases: Deep Dive

Let's explore **less common but important real-world issues**:

- **Twin Students**: Facial features might be too similar. Add voice or ID fallback.
- **Glare from Glasses**: Interferes with eye detection. Train with and without.
- **Wearing Mask**: Use DNN face recognition or eye-based models.
- **Low Attendance Hours**: Track time ranges—e.g., was the student late?

3.22 Government and Institutional Use

Facial recognition attendance systems are already being piloted or deployed in:

- **Indian Railways**: Staff attendance via face recognition kiosks.
- **Delhi Govt Schools**: Face-based teacher attendance pilot.
- **China**: AI-based classrooms that log attention span and presence.

- **Private Corporates**: IT firms use face recognition for employee logins.

3.23 Psychology of Presence & Behavioral Science

Did you know students are **25% more engaged** when they know they are being observed—even digitally?

Face recognition, when used ethically, encourages punctuality and:

- Reduces bunking
- Increases attendance consistency
- Deters inattentiveness

A passive screen that says "Face Detected – Welcome Akash" can make all the difference in psychological engagement.

3.24 Environmental Factors Consideration

Environmental conditions significantly affect detection and recognition:

Condition	Challenge	Mitigation
Low Light	Poor detection	Add soft lighting or IR-based camera
Background Noise	Distracts processing	Use cropped, focused face ROI
Shadows	Misalignment in features	Apply histogram equalization
Group Clustering	Overlapping face rectangles	Use multi-face tracking and labeling

3.25 Legal & Ethical Risks

Face recognition must follow ethical design:

- **Informed Consent**: Mandatory
- **Data Retention Policy**: Delete after 1 year or semester
- **Transparency**: Logs must be accessible
- **Bias Testing**: Test across skin tones, genders, ethnicities

Institutions must avoid:

- Covert surveillance
- Data monetization

- Non-consensual identification

3.26 Fall-Back Procedures

What if the system fails?

- Switch to **QR Code** or **manual override**
- Maintain a parallel **emergency sheet**
- Allow **admin override** of logs via secure login
- Log all edits for audit trail

3.27 Business Case: Why It Pays Off

A mid-size institution spends:

- ₹2,50,000/year on paper and staff hours for attendance tracking
- ₹50,000 on processing exam attendance logs

Face Recognition System (FRS) setup cost: ₹80,000 (One-time)

- Saves 1200+ teaching hours/year
- Reduces workload by 70%
- Enhances reporting quality

ROI achieved in under **1.5 years**.

3.28 Cross-Platform Compatibility

This system is built using:

- **Python (3.x)**
- **Tkinter GUI**
- **OpenCV 4+**
- Runs on **Windows**, **Linux**, **MacOS**

Can also be compiled using **cx_Freeze** into a desktop app.

3.29 Future-Proofing and Scalability

- Design supports **multi-classroom, multi-campus** structure
- Switch from LBPH to **FaceNet** without codebase overhaul
- Modular GUI allows swapping backend (e.g., MySQL, MongoDB)
- Scheduled automatic backups via **cron jobs**

3.30 Conclusion (for Problem Analysis)

The conventional approach to attendance no longer fits the scale, pace, or expectations of modern educational environments. By deploying facial recognition-based attendance systems, institutions step into the era of smart education—where tasks are automated, data is secure, and processes are transparent.

With proper handling of ethical, environmental, and technical aspects, this system can:

- Improve classroom discipline
- Reduce manual work for staff
- Increase reliability of academic records
- Enable real-time analytics and intervention

In short, it's not just a project—it’s a movement toward smarter learning ecosystems.

CHAPTER-4

SYSTEM DESIGN

4.1 Objective

The overall design objective is to provide an efficient, modular design that will reduce the system's complexity, facilitate change and result in an easy implementation. This will be accomplished by designing strongly cohesion system with minimal coupling. In addition, this document will provide interface design models that are consistent, user friendly and will provide straight forward transition through the various system functions.

The purpose of the design phase is to develop a clear understanding of what the developer wants people to gain from his/her project. As the developer work on the project, the test for every design decision should be "Does this feature fulfill the ultimate purpose of the project?". The design document will verify that the current design meets all of the explicit requirements contained in the system model as well as the implicit requirements desired.

4.2 UML Diagrams

Unified Modelling Language (UML) is a general-purpose modelling language. The main aim of UML is to define a standard way to visualize the way a system has been designed. It is quite similar to blueprints used in other fields of engineering.

UML is not a programming language; it is rather a visual language. We use UML diagrams to portray the behaviour and structure of a system. UML helps software engineers, businessmen and system architects with modelling, design and analysis. The Object Management Group (OMG) adopted Unified Modelling Language as a standard in 1997. It's been managed by OMG ever since. International Organization for Standardization (ISO) published UML as an approved standard in 2005. UML has been revised over the years and is reviewed periodically.

Goals of UML:

The primary goals in the design of the UML were:

1. Provide users with a ready-to-use, expressive visual modelling language so they can develop and exchange meaningful models.
2. Provide extensibility and specialization mechanisms to extend the core concepts.
3. Be independent of particular programming languages and development processes.
4. Provide a formal basis for understanding the modelling language.
5. Support higher-level development concepts such as collaborations, frameworks, patterns and components.
6. Integrate best practice

4.2.1 The conceptual model of UML

A conceptual model can be defined as a model which is made of concept and their relationships.

A conceptual model is the first step before drawing UML diagrams. It helps to understand the entities in the real world and how they interact with each other.

To understand how the UML works, we need to know the three elements:

1. UML basic buildingblocks
2. Rules to connect the building blocks (Rules for how these building blocks may be put together).
3. Common mechanisms that apply throughout in theUML.

4.2.2 Types of Diagrams

UML diagrams are divided into three different categories such as,

- Structural diagram
- Behavioral diagram
- Interaction diagram

Structural diagrams

Structural diagrams are used to represent a static view of a system. It represents a part of a system that makes up the structure of a system. A structural diagram shows various objects within the system.

Following are the various structural diagrams in UML:

- Class diagram
- Object diagram
- Package diagram
- Component diagram
- Deployment diagram

Behavioral diagrams

Any real-world system can be represented in either a static form or a dynamic form. A system is said to be complete if it is expressed in both the static and dynamic ways. The behavioural diagram represents the functioning of a system.

UML diagrams that deals with the static part of a system are called structural diagrams. UML diagrams that deals with the moving or dynamic parts of the system are called behavioural diagrams.
Following are the various behavioural diagrams in UML:

- Activity diagram
- Use case diagram
- State machine diagram

Interaction diagrams

Interaction diagram is nothing but a subset of behavioural diagrams. It is used to visualize the flow between various use case elements of a system. Interaction diagrams are used to show an interaction between two entities and how data flows within them.

Following are the various interaction diagrams in UML:

- Timing diagram
- Sequence diagram
- Collaboration diagram

4.3 Use case diagram:

Use Case Diagram captures the system's functionality and requirements by using actors and use cases. Use Cases model the services, tasks, function that a system needs to perform. Use cases represent high-level functionalities and how a user will handle the system. Use-cases are the core concepts of Unified Modelling language modeling.

A Use Case consists of use cases, persons, or various things that are invoking the features called as actors and the elements that are responsible for implementing the use cases. Use case diagrams capture the dynamic behavior of a live system. It models how an external entity interacts with the system to make it work. Use case diagrams are responsible for visualizing the external things that interact with the part of the system.

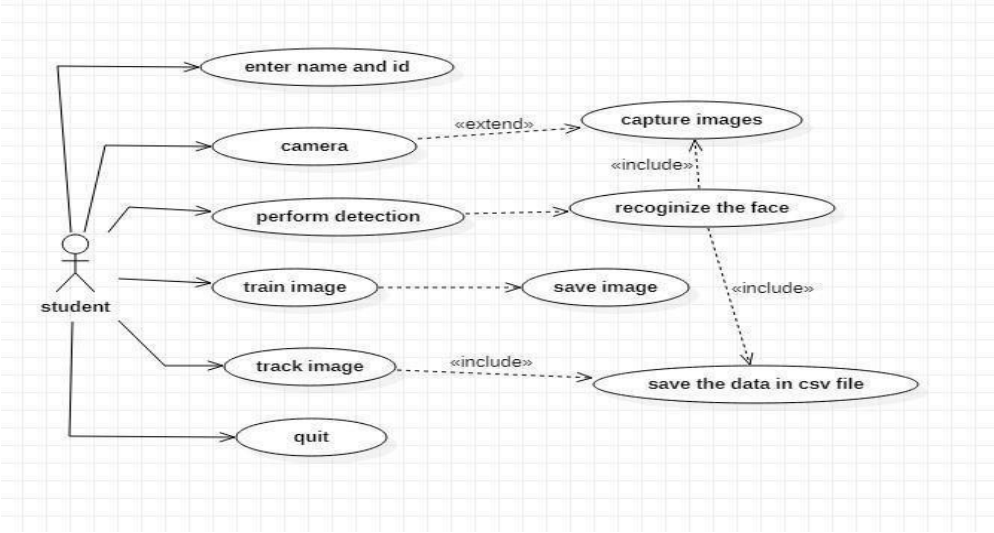


Fig 5.1: Use Case Diagram

4.4 Class diagram:

Class diagram gives an overview of a software system by displaying classes, attributes, operations, and their relationships. This Diagram includes the class name, attributes, and operation in separate designated compartments.

Class Diagram defines the types of objects in the system and the different types of relationships that exist among them. It gives a high-level view of an application. This modelling method can run with almost all Object-Oriented Methods. A class can refer to another class. A class can have its objects or may inherit from other classes.

Class Diagram helps construct the code for the software application development.

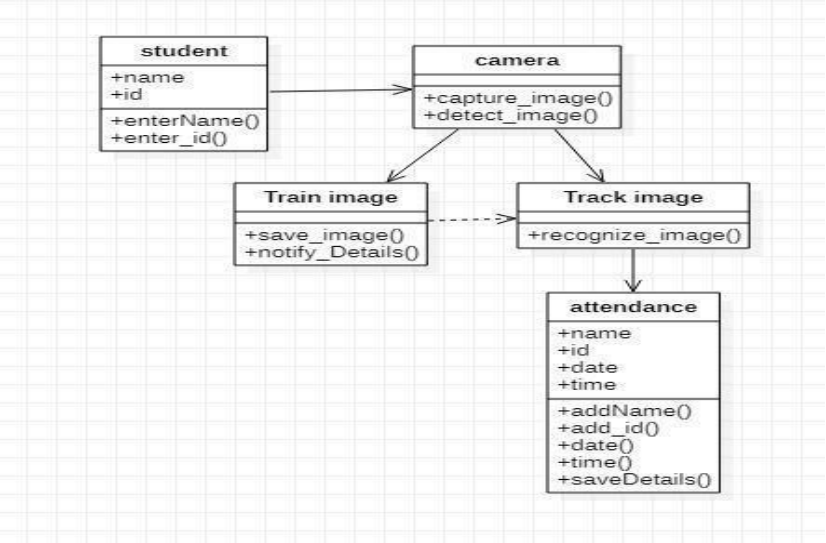


Fig 5.2: Class Diagram

4.5 Sequence Diagram:

UML Sequence Diagrams are interaction diagrams that detail how operations are carried out. They capture the interaction between objects in the context of a collaboration. Sequence Diagrams are time focus and they show the order of the interaction visually by using the vertical axis of the diagram to represent time what messages are sent and when.

Sequence Diagrams captures:

The interaction that takes place in a collaboration that either realizes a use case or an operation (instance diagrams or generic diagrams)
High-level interactions between user of the system and the system, between the system and other systems, or between subsystems (sometimes known as system sequence diagrams)
Sequence diagrams can be useful references for businesses and other organizations. Try drawing a sequence diagram to:

* Represent the details of a UML use case.
* Model the logic of a sophisticated procedure, function, or operation.
* See how objects and components interact with each other to complete a process.
* Plan and understand the detailed functionality of an existing or future scenario.

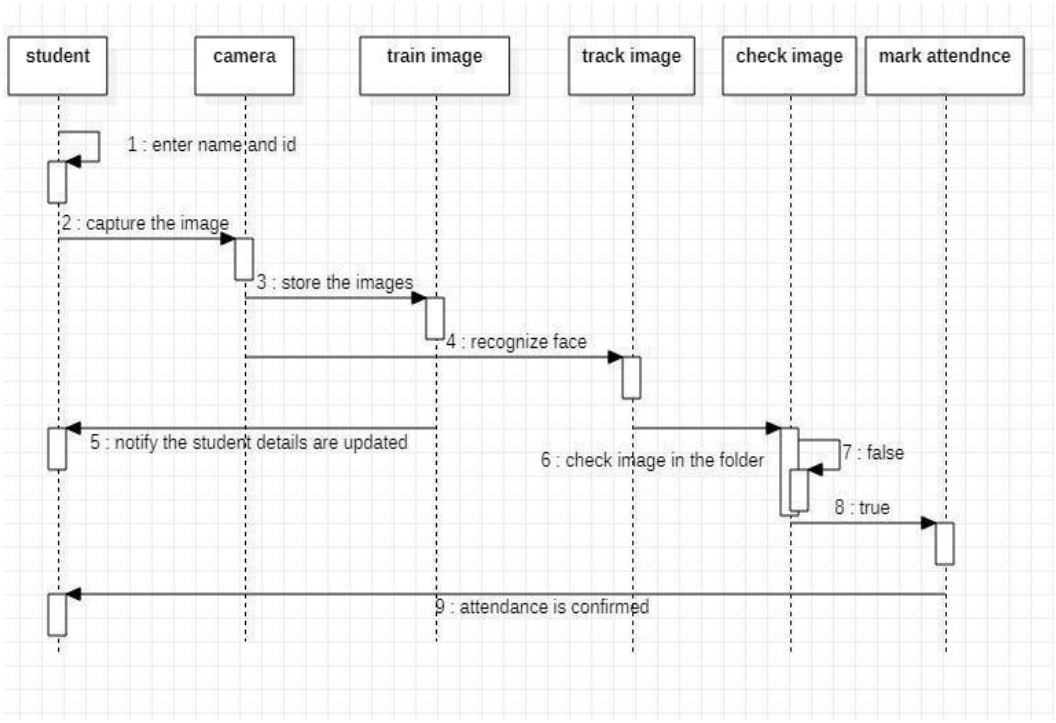


Fig 5.3: Sequence Diagram

4.6 Activity Diagram:

Activity diagram is defined as a UML diagram that focuses on the execution and flow of the behavior of a system instead of implementation. It is also called object-oriented flowchart. Activity diagrams consist of activities that are made up of actions which apply to behavioral modeling technology.

An activity diagram portrays the control flow from a start point to a finish point showing the various decision paths that exist while the activity is being executed. We can depict both sequential processing and concurrent processing of activities using an activity diagram. They are used in business and process modelling where their primary use is to depict the dynamic aspects of a system. An activity diagram is very similar to a flowchart.
The basic usage of activity diagram is similar to other four UML diagrams. The specific usage is to model the control flow from one activity to another. This control flow does not include messages.

Activity diagram is suitable for modelling the activity flow of the system. An application can have multiple systems. Activity diagram also captures these systems and describes the flow from one system to another. This specific usage is not available in other diagrams. These systems can be database, external queues, or any other system

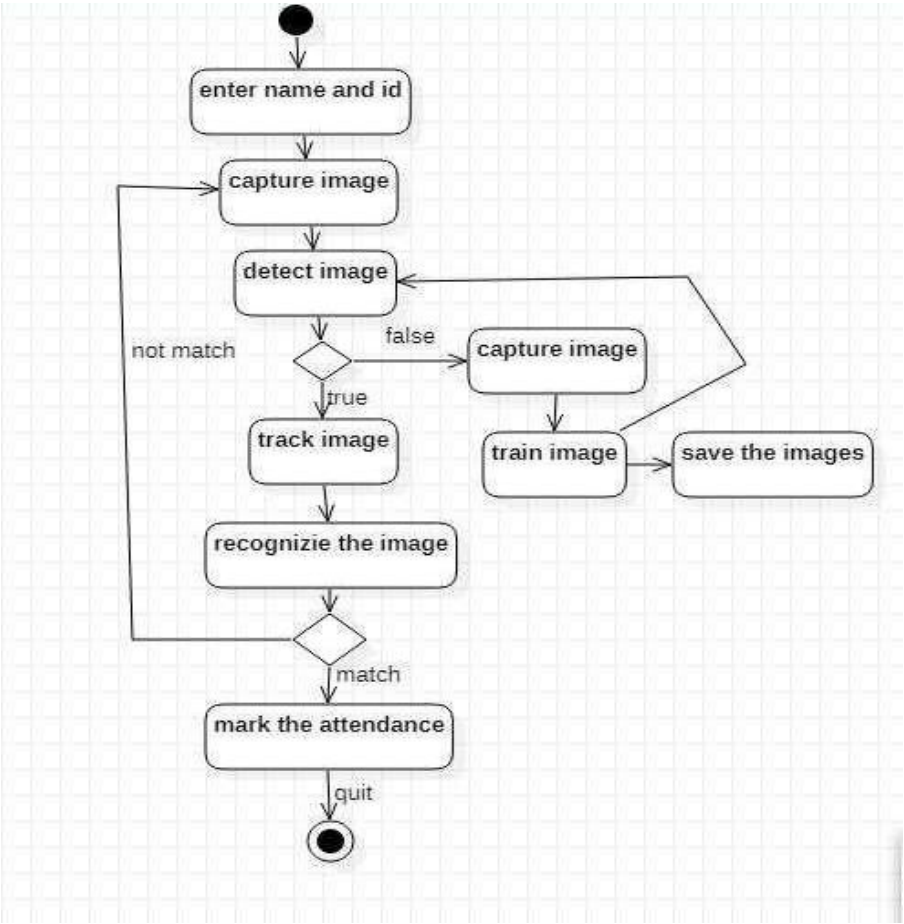


Fig 5.4: Activity Diagram

CHAPTER-5

5.IMPLEMENTATION

Methodology:

a)Local Binary Pattern Histogram (LBPH)
b)Haar Cascade Classifier
The project deployed on Haar Cascade classifier to find the positive and negative of the face and LBPH (Local binary pattern histogram) algorithm for face recognition by using python programming and OpenCV library.

5.1 Local Binary Pattern Histogram (LBPH):

A local binary pattern (LBP) is a type of visual descriptor used for classification in computer vision. LBP is the particular case of the Texture Spectrum model proposed in 1990. LBP was first described in 1994. It has since been found to be a powerful feature for texture classification; it has further been determined that when LBP is combined with the Histogram of oriented gradients (HOG) descriptor, it improves the detection performance considerably on some datasets. A comparison of several improvements of the original LBP in the field of background subtraction was made in 2015 by Silva et al. A full survey of the different versions of LBO can be found in Bouwmans. Python mahotas, an open source computer vision package which includes an implementation of LBPs. Open CV's cascade classifiers support LBPs as of version2. LBP Library is a collection of eleven local binary patterns (LBP) algorithms developed for background subtraction problem.

In the Local Binary Patterns Histogram algorithm (LBPH) for face recognition. It is based on local binary operator and is one of the best performing texture descriptors. The need for facial recognition systems is increasing day by day. They are being used in entrance control, surveillance system, Smartphone unlocking etc. In this project we will use LBPH to extract features from an input test image and match them with the faces in system's database. Local Binary Pattern Histogram algorithm was proposed in 2006. It is based on local binary operator. It is widely used in facial recognition due to its computational simplicity and discriminative power. The steps involved to achieve this are:

- Creating dataset

- Face acquisition
- Feature extraction
- Classification
- The LBPH algorithm is a part of OpenCV.

Steps:

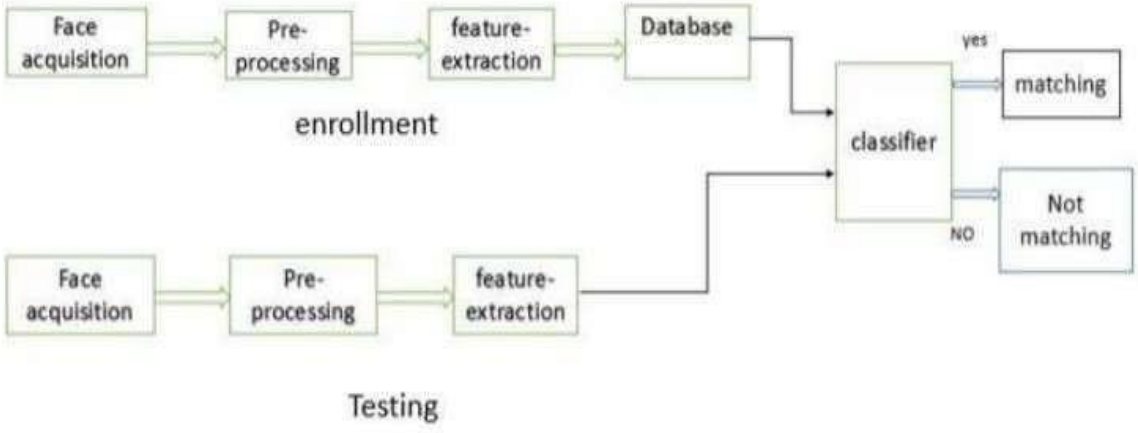


Fig 5.1: Process involved in LBPH

- Suppose we have an image having dimensions N x M.
- We divide it into regions of same height and width resulting in m x m dimension for every region.

Local binary operator is used for every region. The LBP operator is defined in window of 3x3.

$$LBP(x_c, y_c) = \sum_{p=0}^{P-1} 2^p s(i_p - i_c)$$

here '(Xc,Yc)' is central pixel with intensity 'Ic'. And 'In' being the intensity of the the neighbour pixel

Using median pixel value as threshold, it compares a pixel to its 8 closest pixels using this function.

$$s(x) = \begin{cases} 1, & x \geq 0 \\ 0, & x < 0 \end{cases}$$

- If the value of neighbour is greater than or equal to the central value it is set as 1 otherwise it is set as 0.
- Thus, we obtain a total of 8 binary values from the 8 neighbours.
- After combining these values, we get an 8 bit binary number which is translated to decimal number for our convenience.
- This decimal number is called the pixel LBP value and its range is 0-255.

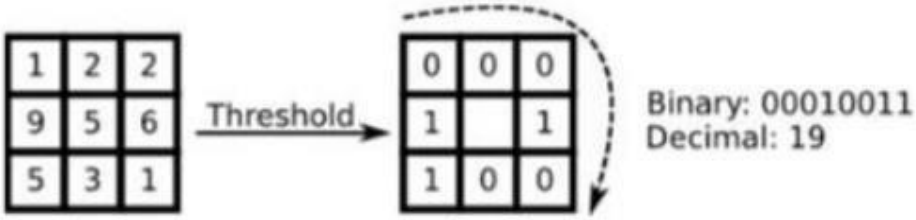
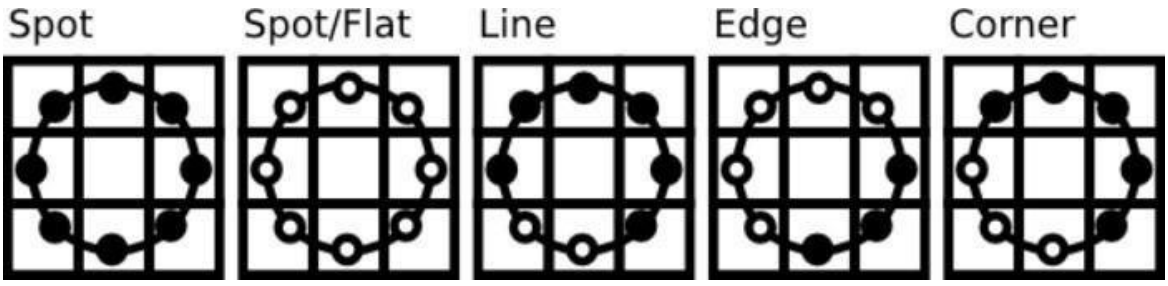


Fig 5.2: LBP pixel value

- Later it was noted that a fixed neighbourhood fails to encode details varying in scale. The algorithm was improved to use different number of radius and neighbors, now it was known as circular LBP.
- The idea here is to align an arbitrary number of neighbors on a circle with a variable radius. This way the following neighborhoods are captured:



- For a given point (Xc, Yc) the position of the neighbour (Xp, Yp), p belonging to P can be calculated by:

$$x_p = x_c + R\cos\left(\frac{2\pi p}{P}\right)$$

$$y_p = y_c - R\sin\left(\frac{2\pi p}{P}\right)$$

here R is radius of the circle and P is the number of sample points.

- If a point coordinate on the circle doesn't correspond to image coordinates, it gets interpolated generally by bilinear interpolation:

$$f(x,y) \approx \begin{bmatrix} 1-x & x \end{bmatrix} \begin{bmatrix} f(0,0) & f(0,1) \\ f(1,0) & f(1,1) \end{bmatrix} \begin{bmatrix} 1-y \\ y \end{bmatrix}$$

- The LBP operator is robust against monotonic gray scale transformations.

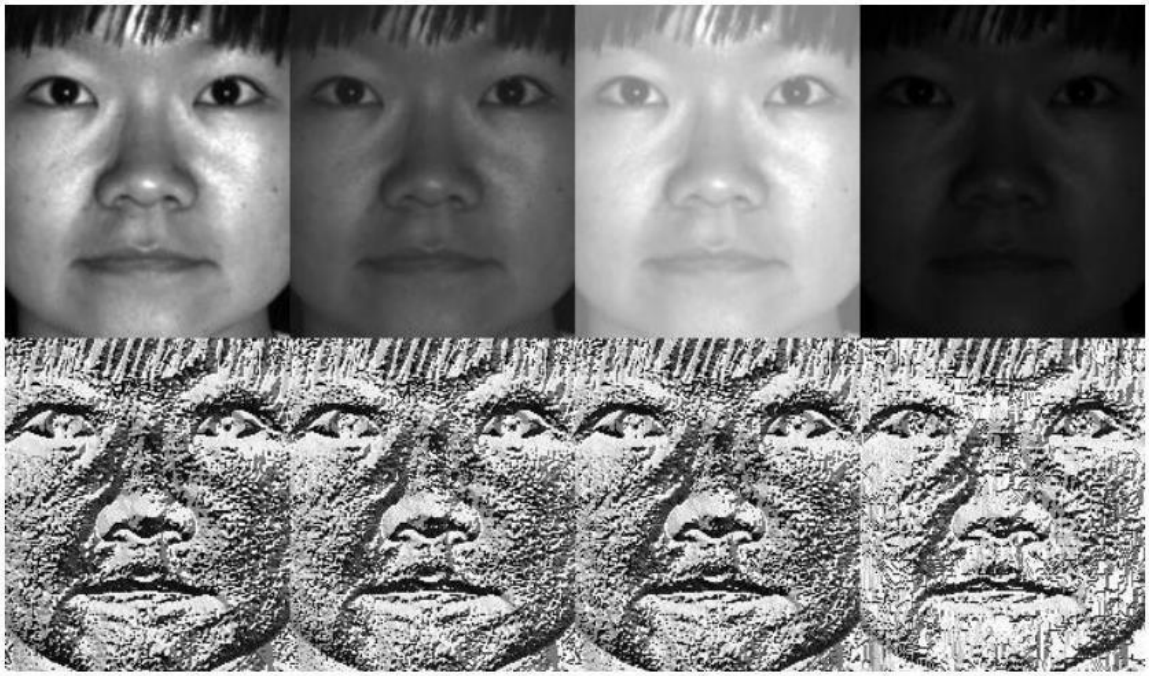


Fig 5.3: monotonic grey scale transformations

- After the generation of LBP value histogram of the region is created by counting the number of similar LBP values in the region.

- After creation of histogram for each region all the histograms are merged to form a single histogram and this is known as feature vector of the image.

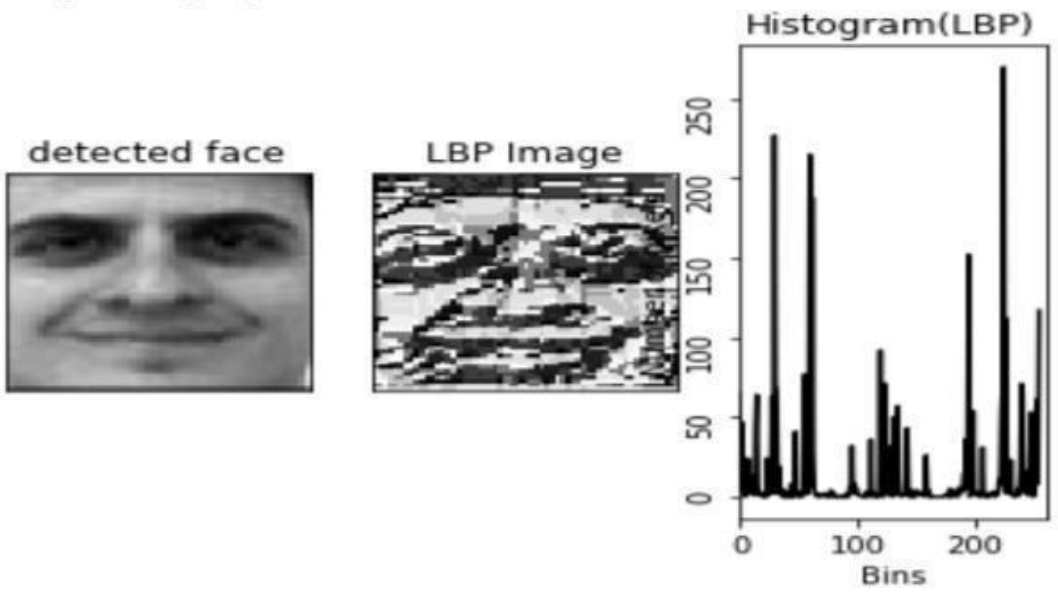


Fig 5.4: Feature vector of the image

- Now we compare the histograms of the test image and the images in the database and then we return the image with the closest histogram.
- (This can be done using many techniques like Euclidean distance, chi-square, absolute value etc)
- The Euclidean distance is calculated by comparing the test image features with features stored in the dataset. The minimum distance between test and original image gives the matching rate.

$$d(a,b) = \sqrt{\sum_{i=1}^{n} |a_i - b_i|^2}$$

- As an output we get an ID of the image from the database if the test image is recognised.
  LBPH can recognise both side and front faces and it is not affected by illumination variations which means that it is more flexible.

Implementation:

The dataset can be created by taking images from webcam or from saved images. We will take many samples of a single person. A unique ID or a name is a given to a person in the database.

#import the necessary libraries

Import cv2

Import OS

- ➢ Creating LBPH model and training it with the prepared data model = cv. face. Create LBPH Face Recognizer () model. train (faces, np. array (labels))
- ➢ Testing the trained model using a test image def predict_image (test_image) img = test_image. Copy () face, bounding_ box = face_detection (img)
  label = model. Predict (face)
  label_text = database [label-1]
  print (label)
  print
  (label_text)
  (x, y, w, h) = bounding_box cv2.rectangle (img, (x, y), (x + w, y + h), (0,255, 0), 2) cv2.Font_HERSHEY_PLAIN, 1.5, (0, 255, 0), 2)
  Return img test1 = cv2. imread ("test/tom.jpg")
  predict1 =predict_image (test1) cv2.imshow ('Face Recognition', predict1) cv2.waitkey (0) cv2.destroyAllWindows ()

Advantages of LBPH Algorithm:

- ➢ It can represent local features in the images.
- ➢ LBPH can recognize both side and front faces.
- ➢ LBPH method will probably work better on our training and testing dataset.
- ➢ Raw intensity data are used directly for learning and recognition without any significant low -level or mid-level processing.
- ➢ Data compression is achieved by the low-dimensional subspace representation.
- ➢ Recognition is simple and efficient compared to other matching approaches.
- ➢ No knowledge of geometry and reflectance of faces are required.

5.2 Haar Cascade:

Haar Cascade is a machine learning object detection algorithm used to identify objects in an image or video and based on the concept of features proposed by Paul Viola and Michael Jones in their paper "Rapid Object Detection using a Boosted Cascade of simple Features in 2001. It is a machine learning based approach where a cascade function is trained from a lot of positive and negative image. It is then used to detect objects in their images. Luckily, OpenCV offers predefined Haar Cascade algorithm, organized into categories depending on the images they have been trained on.

Now let's see how this algorithm concretely works. The idea of Haar Cascade is extracting features from images using a kind of 'filter', similar to the concept of the convolutional kernel. These filters are called Haar features.

Algorithm:

```
import numpy as np

    import cv2 face_cascade = cv2. Cascade Classifier
    ("haarcascade_frontalface_default. Xml") eye_cascade
    =cv2.CascadeClassifier (1'haarcascade_eye.xml") img = cv2. imread
    ("image .jpg")
    gray =cv2. CvtColor (img, cv2.COLOR_BGR2GRAY)
```

```
faces = face_cascade. detectMultiScale (gray, 1.3, 5)

for (x, y, w, h) in faces:

img = cv2.rectangle (img, (x, y), (x+w, y+h), (255, 0, 0), 2)

roi_gray = gray [y: y+h, x: x+w] roi_color = img[y: y+h, x:

x=w] eyes = eye_cascade.detectMultiScale (roi_gray) for

(ex, ey, ew, eh) in eyes: cv2.rectangle (roi_color, (ex, ey),

(ex+ew, ey+eh), (0, 255, 0), 2) cv2 .imshow ('img', img)

cv2.Waitkey (0) cv2.destroyAllWindows ()
```

Initially, the algorithm needs a lot of positive images of faces and negative images without faces to train the classifier. Then we need to extract features from it. First step is to collect the Haar features.

- Haar Feature Selection
- Creating Integral images
- Adaboost Training
- Cascading Classifiers

As you can see, our algorithm worked pretty well! If you explore the whole library of Haar Cascade algorithm, you will see that their specific models improve trained on different features of the human's physical aspect, hence you can your model by adding more features detection.

But among all these features we calculated, most of them are irrelevant. For example, consider the image. Top row shows two good features. The first feature selected seems to focus on the property that the region of the eyes is often darker than the region of the nose and cheeks. The second feature selected relies on the property that the eyes are darker than the bridge of the nose. But the same windows applying on cheeks or any other place is irrevalant. So how do we select the best features out of 160000+ features? It is achieved by Adaboost.

CHAPTER-6

Coding

Train.py

```
import tkinter as tk
from tkinter import
Message, Text import cv2,
os import shutil import csv
import numpy as np
from PIL import Image,
ImageTk import pandas
as pd import datetime
import time import
tkinter.ttk as ttk import
tkinter.font as font
window = tk.Tk()
#helv36 = tk.Font(family='Helvetica', size=36,
weight='bold')
window.title("Face_Recogniser") dialog_title =
'QUIT' dialog_text = 'Are you sure?'
#answer = messagebox.askquestion(dialog_title, dialog_text)
#window.geometry('1280x720')
window.configure(background='
```

```
blue')          #window.attributes('-

fullscreen',                    True)

window.grid_rowconfigure(0,

weight=1)

window.grid_columnconfigure(0

, weight=1)

#path = "profile.jpg"

#Creates a Tkinter-compatible photo image, which can be used everywhere Tkinter expects an image object.

#img = ImageTk.PhotoImage(Image.open(path))

#The Label widget is a standard Tkinter widget used to display a text or image on the screen.

#panel = tk.Label(window, image = img)
#panel.pack(side = "left", fill = "y", expand = "no")

#cv_img = cv2.imread("img541.jpg")

#x, y, no_channels = cv_img.shape

#canvas = tk.Canvas(window, width = x, height =y)

#canvas.pack(side="left")

#photo = PIL.ImageTk.PhotoImage(image = PIL.Image.fromarray(cv_img))

# Add a PhotoImage to the Canvas

#canvas.create_image(0, 0, image=photo, anchor=tk.NW)

#msg = Message(window, text='Hello, world!')

# Font is a tuple of (font_family, size_in_points, style_modifier_string)

message = tk.Label(window, text="Face-Recognition-Based-Attendance-Management-System" ,bg="Green"
```

```
        ,fg="white" ,width=50 ,height=3,font=('times', 30, 'italic bold underline'))

        message.place(x=200, y=20)

        lbl = tk.Label(window, text="Enter ID",width=20 ,height=2 ,fg="red" ,bg="yellow"
        ,font=('times', 15, ' bold ')
        )
lbl.place(x=400, y=200)

        txt = tk.Entry(window,width=20 ,bg="yellow" ,fg="red",font=('times', 15, '

        bold ')) txt.place(x=700, y=215)

        lbl2 = tk.Label(window, text="Enter Name",width=20 ,fg="red" ,bg="yellow" ,height=2
        ,font=('times', 15, ' bold '))

        lbl2.place(x=400, y=300)

        txt2 = tk.Entry(window,width=20 ,bg="yellow" ,fg="red",font=('times', 15, ' bold

        ') ) txt2.place(x=700, y=315)

        lbl3 = tk.Label(window, text="Notification : ",width=20 ,fg="red" ,bg="yellow"
        ,height=2 ,font=('times', 15, ' bold underline '))

        lbl3.place(x=400, y=400)

        message = tk.Label(window, text="" ,bg="yellow" ,fg="red" ,width=30 ,height=2,
        activebackground =
        "yellow" ,font=('times', 15, ' bold '))

        message.place(x=700, y=400)

        lbl3 = tk.Label(window, text="Attendance : ",width=20 ,fg="red" ,bg="yellow"

        ,height=2 ,font=('times', 15, ' bold underline')) lbl3.place(x=400, y=650)

        message2 = tk.Label(window, text="" ,fg="red" ,bg="yellow",activeforeground =
        "green",width=30 ,height=2
        ,font=('times', 15, ' bold '))

        message2.place(x=700,

        y=650) def clear():
```

```
        txt.delete(0,       'end')
        res=                ""
        message.configure(te
        xt= res) def clear2():
        txt2.delete(0,     'end')
        res          =          ""
        message.configure(te
        xt=        res)       def
        is_number(s):
          try:
            float(s)
            return
            True
          except ValueError:
            pass
         try:
            import                  unicodedata
        unicodedata.numeric(s)
            return True
except (TypeError, ValueError):
pass
return False
def TakeImages():
          Id=(txt.get())
          name=(txt2.get())
```

```
    if(is_number(Id) and
    name.isalpha()):
      cam = cv2.VideoCapture(0)
harcascadePath =
"haarcascade_frontalface_default.xml"
detector=cv2.CascadeClassifier(harcascad
ePath) sampleNum=0 while (True):
        ret, img = cam.read()
        gray = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)
        faces = detector.detectMultiScale(gray,
        1.3, 5) for (x,y,w,h) in faces:
          cv2.rectangle(img,(x,y),(x+w,y+h),(255,0,0),2)
          #incrementing sample number
  sampleNum=sampleNum+1
          #saving the captured face in the dataset folder TrainingImage
          cv2.imwrite("TrainingImage\ "+name +"."+Id +'.'+ str(sampleNum) + ".jpg",
          gray[y:y+h,x:x+w])
          #display the frame
          cv2.imshow('frame',img)
        #wait for 100 miliseconds
        if cv2.waitKey(100) & 0xFF == ord('q'):
          break
        # break if the sample number is morethan 100
elifsampleNum>60:
```

```
            break
cam.release()
        cv2.destroyAllWindows()
        res = "Images Saved for ID : " + Id +" Name : "+
        name row = [Id , name] with
        open('StudentDetails\StudentDetails.csv','a+') as
        csvFile:
          writer =
csv.writer(csvFile)
writer.writerow(row)
csvFile.close()
message.configure(text=
res)
    else:
        if(is_number(Id)):
          res = "Enter Alphabetical Name"
message.configure(text= res)
        if(name.isalpha()):
          res = "Enter Numeric Id"
message.configure(text= res)
    def TrainImages():
     recognizer = cv2.face_LBPHFaceRecognizer.create()#recognizer =
cv2.face.LBPHFaceRecognizer_create()#$cv2.createLBPHFaceRecognizer()
```

```
harcascadePath =
"haarcascade_frontalface_default.xml"
detector
=cv2.CascadeClassifier(harcascadePath)
faces,Id =
getImagesAndLabels("TrainingImage")
recognizer.train(faces, np.array(Id))
recognizer.save("TrainingImageLabel\Trai
nner.yml") res = "Image
Trained"#+",".join(str(f) for f in Id)
message.configure(text= res)
def getImagesAndLabels(path):
  #get the path of all the files in the folder
imagePaths=[os.path.join(path,f) for f in os.listdir(path)]
  #print(imagePaths)
  #create empth face
  list faces=[]
  #create empty ID list
  Ids=[]
  #now looping through all the image paths and loading the Ids
  and the images for imagePath in imagePaths:
    #loading the image and converting it to gray scale
pilImage=Image.open(imagePath).convert('L')
```

```
        #Now we are converting the PIL image into numpy array
                imageNp=np.array(pilImage,'uint8')

            #getting the Id from the image

            Id=int(os.path.split(imagePath)[-1].split(".")[1])

            # extract the face from the training image sample

          faces.append(imageNp)

          Ids.append(Id)

          return

          faces,Ids     def

          TrackImages()

          :

            recognizer                                                    =

          cv2.face.LBPHFaceRecognizer_create()#cv2.createLBPHFaceReco

          gnizer()            recognizer.read("TrainingImageLabel\Trainner.yml")

          harcascadePath          =          "haarcascade_frontalface_default.xml"

          faceCascade = cv2.CascadeClassifier(harcascadePath);

            df=pd.read_csv("StudentDetails\StudentDetails.csv")
cam = cv2.VideoCapture(0)

            font = cv2.FONT_HERSHEY_SIMPLEX
col_names                                =
          ['Id','Name','Date','Time']

            attendance    =    pd.DataFrame(columns    =

            col_names) while True:

              ret, im =cam.read()

              gray=cv2.cvtColor(im,cv2.COLOR_BGR2G
```

```
            RAY)
            faces=faceCascade.detectMultiScale(gray,
            1.2,5) for(x,y,w,h) in faces:
              cv2.rectangle(im,(x,y),(x+w,y+h),(2
              25,0,0),2)        Id,        conf        =
              recognizer.predict(gray[y:y+h,x:x+
              w]) if(conf < 50):
        ts = time.time()
              date  =  datetime.datetime.fromtimestamp(ts).strftime('%Y-
        %m-%d')                          timeStamp                          =
        datetime.datetime.fromtimestamp(ts).strftime('%H:%M:%S')
              aa=df.loc[df['Id'] == Id]['Name'].values
        tt=str(Id)+"-"+aa
        attendance.loc[len(attendance)] = [Id,aa,date,timeStamp]

else:
              Id='Unknown'
tt=str(Id)
if(conf > 75):
        noOfFile=len(os.listdir("ImagesU
        nknown"))+1
              cv2.imwrite("ImagesUnknown\Image"+str(noOfFile)          +          ".jpg",
            im[y:y+h,x:x+w]) cv2.putText(im,str(tt),(x,y+h), font, 1,(255,255,255),2)
          attendance=attendance.drop_duplicates(subset=['Id'],keep='first')
cv2.imshow('im',im)
if (cv2.waitKey(1)==ord('q')):
```

```
break
ts = time.time()

            date    =    datetime.datetime.fromtimestamp(ts).strftime('%Y-

          %m-%d')                          timeStamp                          =

          datetime.datetime.fromtimestamp(ts).strftime('%H:%M:%S')

          Hour,Minute,Second=timeStamp.split(":")

          fileName="Attendance\Attendance_"+date+"_"+Hour+"-

          "+Minute+"-"+Second+".csv"

          attendance.to_csv(fileName,index=False) cam.release()

          cv2.destroyAllWindows() #print(attendance) res=attendance

          message2.configure(text= res)

          clearButton = tk.Button(window, text="Clear", command=clear ,fg="red" ,bg="yellow"
          ,width=20 ,height=2
          ,activebackground  =  "Red"  ,font=('times',  15,  '  bold  '))

          clearButton.place(x=950, y=200)

          clearButton2  =  tk.Button(window,  text="Clear",  command=clear2  ,fg="red"
          ,bg="yellow" ,width=20 ,height=2, activebackground = "Red" ,font=('times', 15, ' bold
          '))
          clearButton2.place(x=950, y=300)

          takeImg = tk.Button(window, text="Take Images", command=TakeImages ,fg="red"
          ,bg="yellow" ,width=20
          ,height=3, activebackground = "Red" ,font=('times', 15, ' bold '))

          takeImg.place(x=200, y=500)

          trainImg = tk.Button(window, text="Train Images", command=TrainImages ,fg="red"
          ,bg="yellow"
          ,width=20 ,height=3, activebackground = "Red" ,font=('times', 15, ' bold '))

          trainImg.place(x=500, y=500)
```

```
trackImg = tk.Button(window, text="Track Images", command=TrackImages ,fg="red"
,bg="yellow"
,width=20 ,height=3, activebackground = "Red" ,font=('times', 15, ' bold '))

trackImg.place(x=800, y=500)

quitWindow = tk.Button(window, text="Quit", command=window.destroy ,fg="red"
,bg="yellow" ,width=20
,height=3, activebackground = "Red" ,font=('times', 15, ' bold '))

quitWindow.place(x=1100, y=500)

copyWrite = tk.Text(window, background=window.cget("background"),
borderwidth=0,font=('times', 30, 'italic bold underline'))

copyWrite.tag_configure("superscript", offset=10)

copyWrite.insert("insert", "Developed by Ashish","",

"TEAM", "superscript")

copyWrite.configure(state="disabled",fg="red" )

copyWrite.pack(side="left") copyWrite.place(x=800, y=750)

window.mainloop()
```

Setup.py

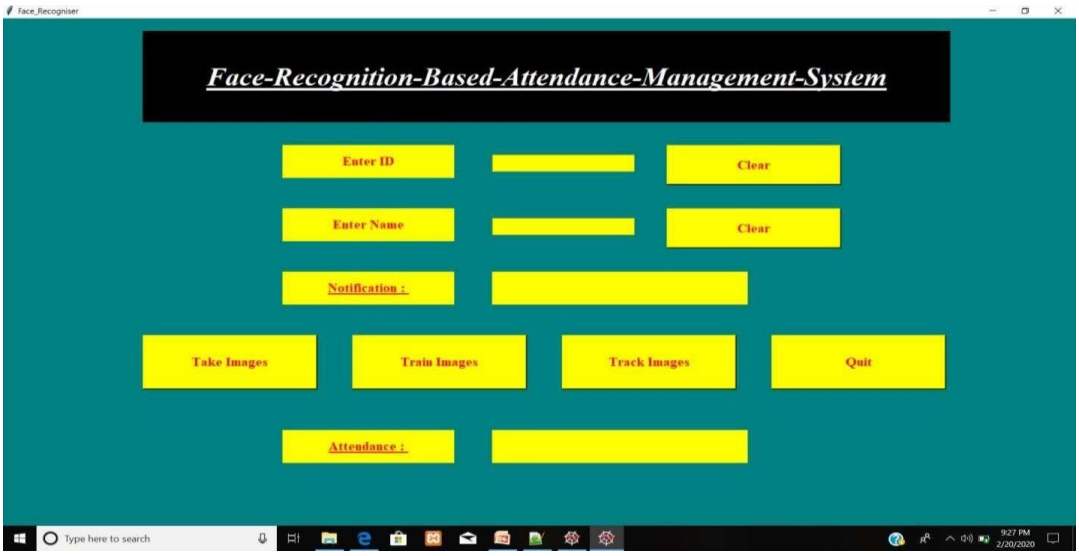
```
from cx_Freeze import setup,

Executable import sys,os

PYTHON_INSTALL_DIR = os.path.dirname(os.path.dirname(os. file ))


os.environ['TCL_LIBRARY'] =

os.path.join(PYTHON_INSTALL_DIR, 'tcl', 'tcl8.6')

os.environ['TK_LIBRARY'] =

os.path.join(PYTHON_INSTALL_DIR, 'tcl', 'tk8.6') base = None
```

```
        if sys.platform == 'win32':
base = None

        executables = [Executable("train.py", base=base)]
        packages = ["idna","os","sys","cx_Freeze","tkinter","cv2","setup",

              "numpy","PIL","pandas","datetime","ti

        me"] options = {

          'build_exe': {

               'packages':packages,

          },

        }

        setup(

          name    =    "ToolBox",

          options     =     options,

          version     =     "0.0.1",

          description    =    'Vision

          ToolBox', executables =

          executables

                                                                )
```

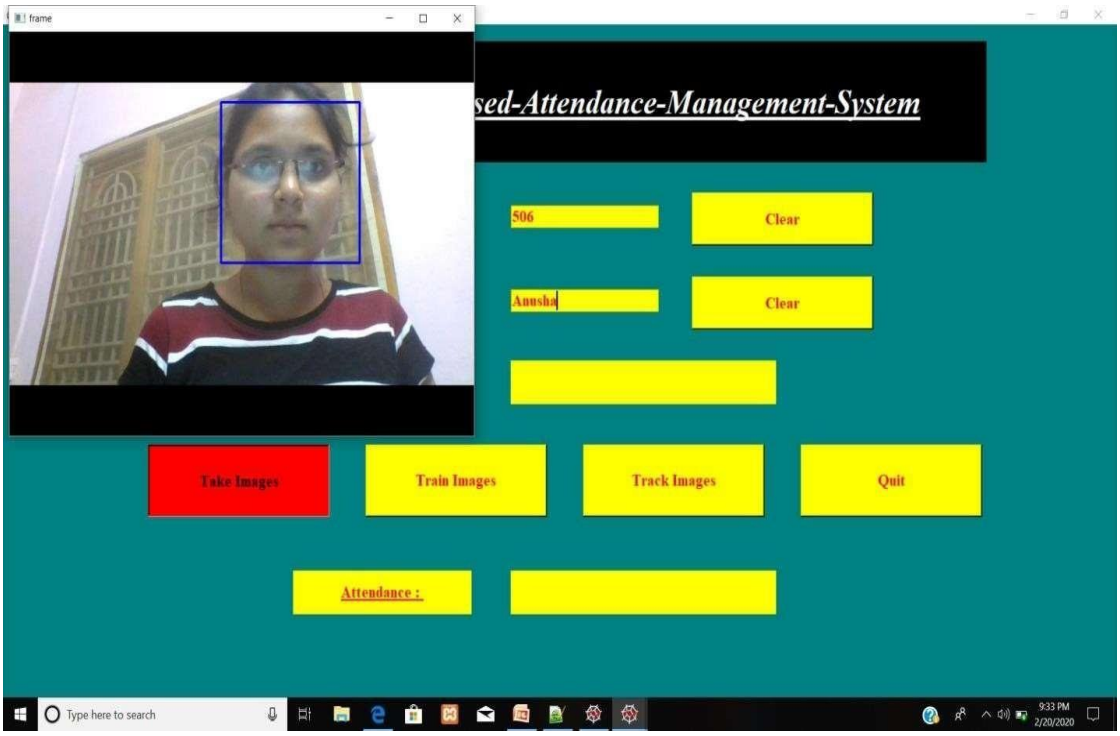
Chapter-7

Screen Shots

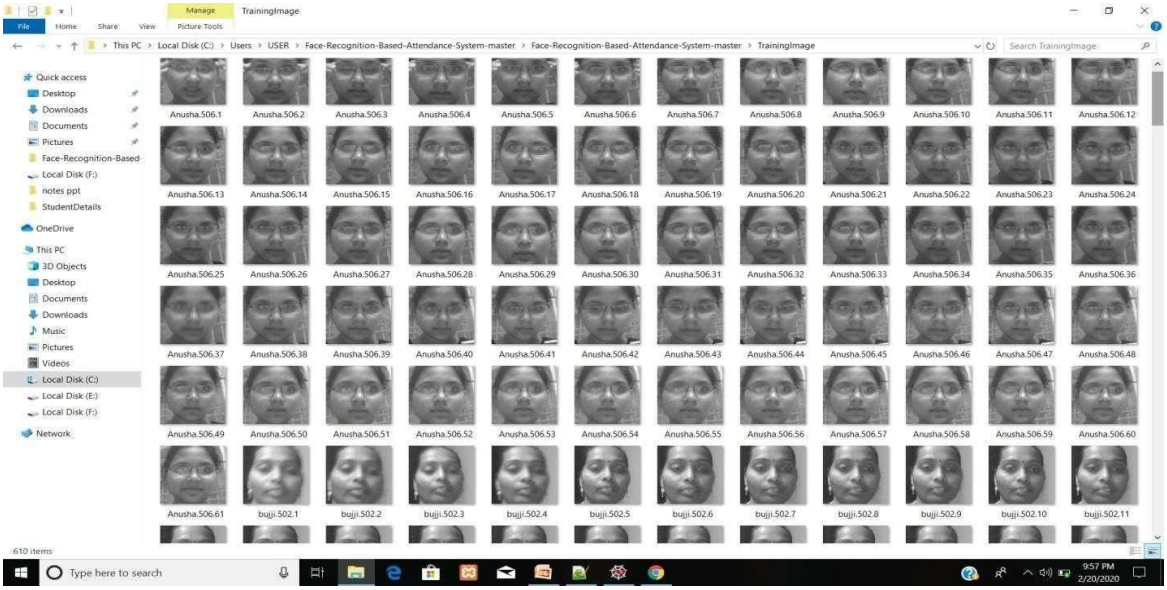
1) Front view (GUI):



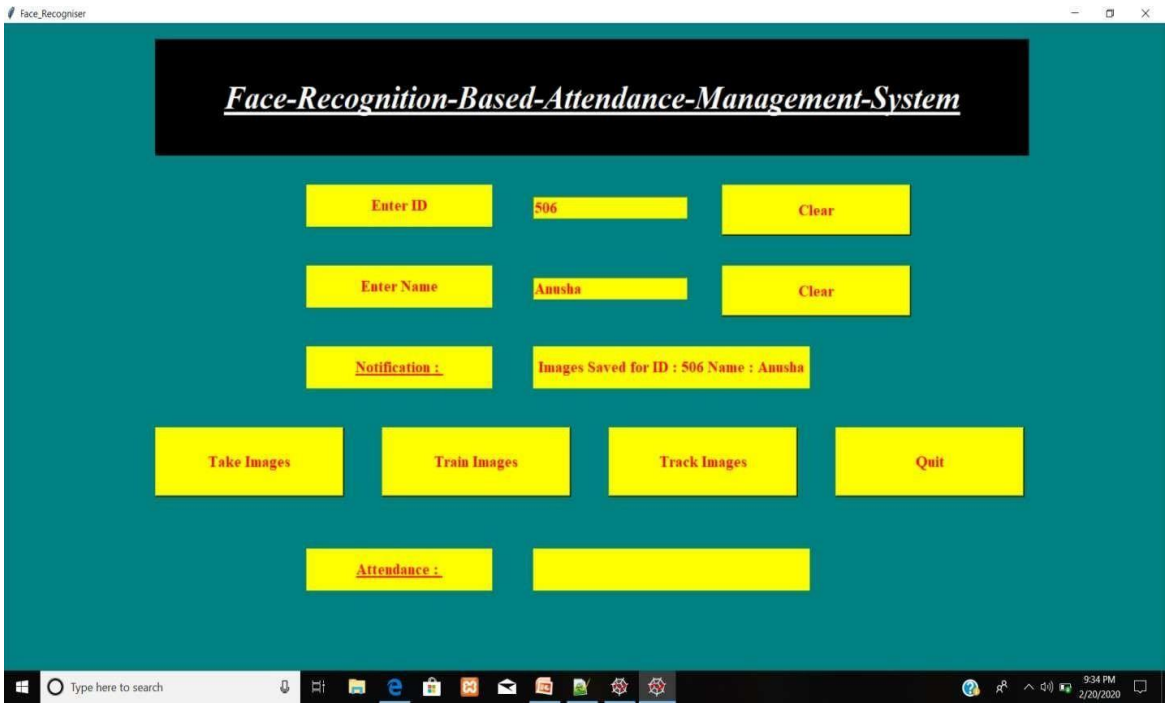
2) Capturing the image of student



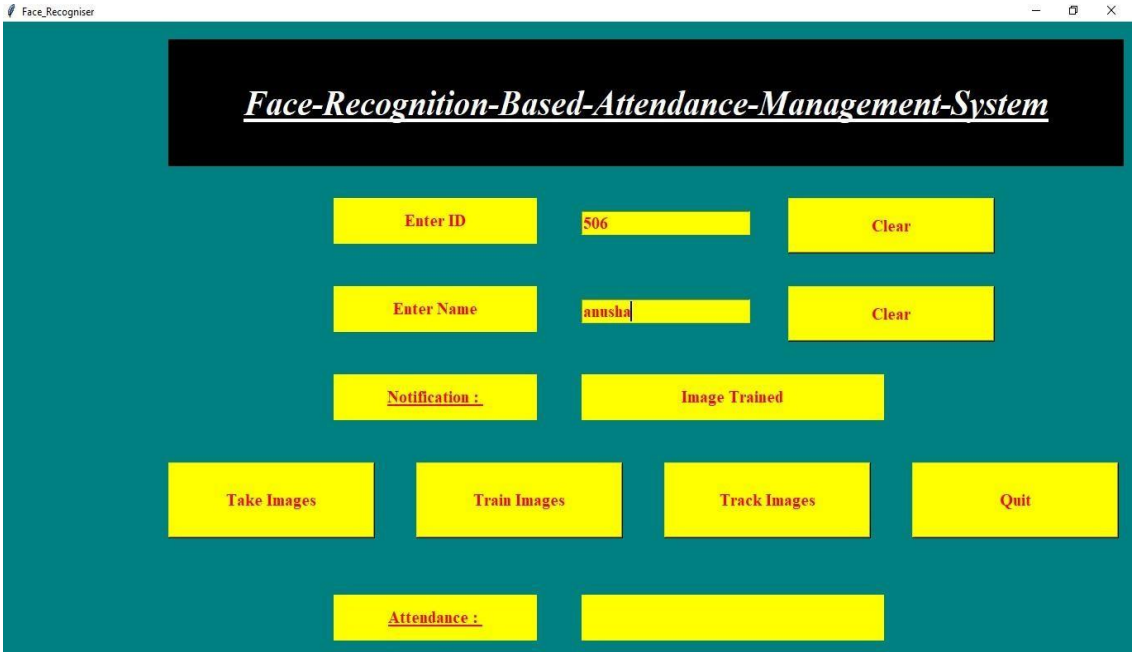
3) After capturing the image. Images are stored in Training Image folder.



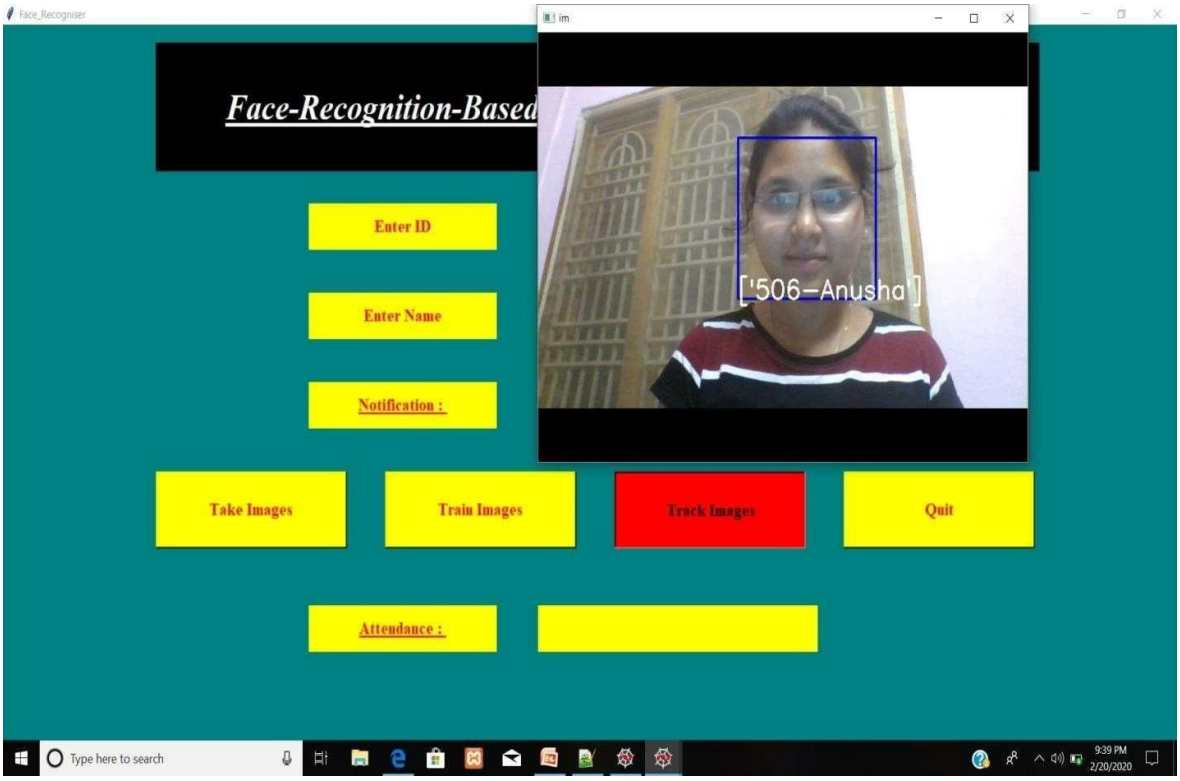
4) After completion of process. It shows the notification i.e., image saved for particular student with id and name



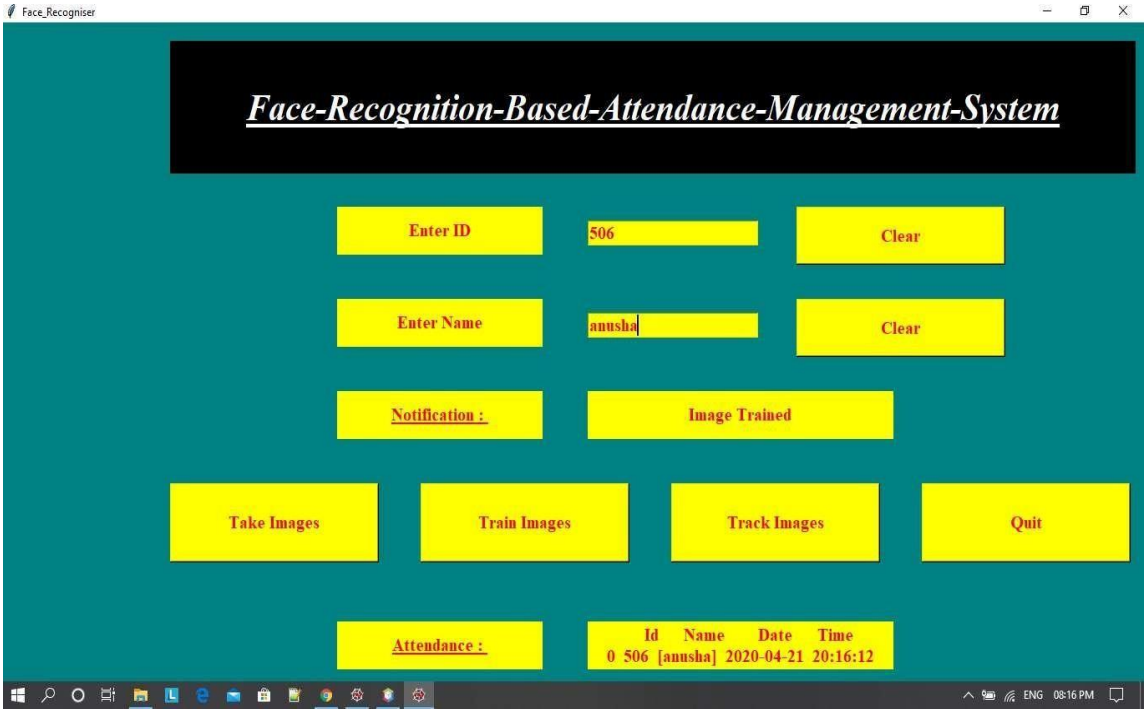
5) Clicking on Train image button, it displays a notification message like “Image Trained”(means images of the detected face)

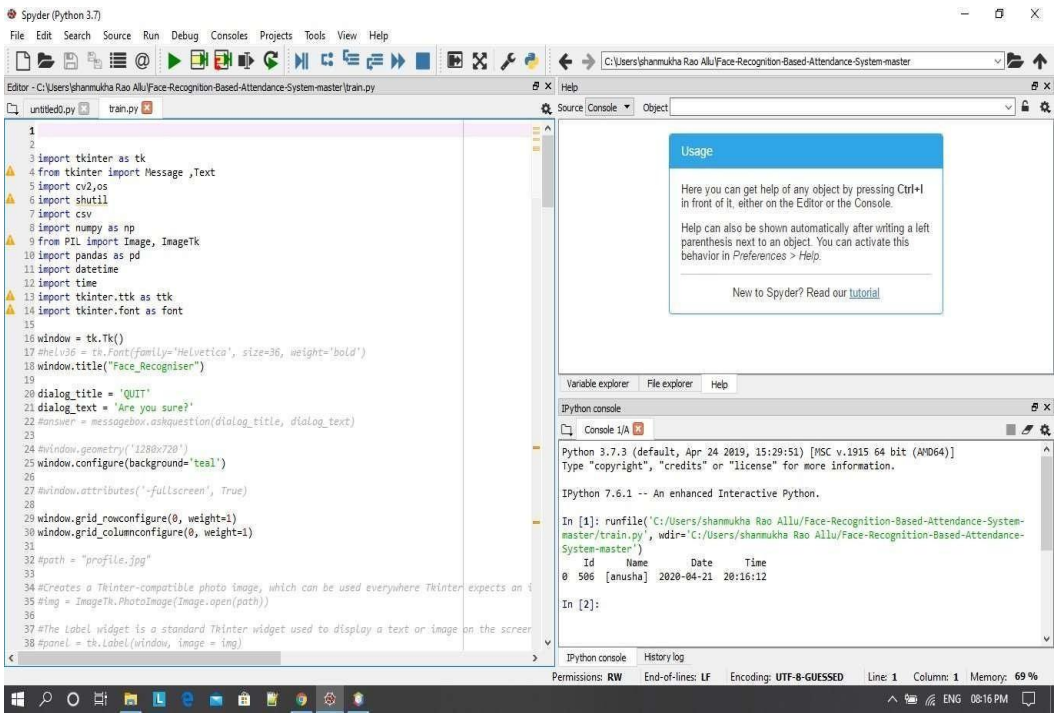


6) On clicking the track image button, it recognizes the face (which is already trained) and displays the name and id of the particular person.

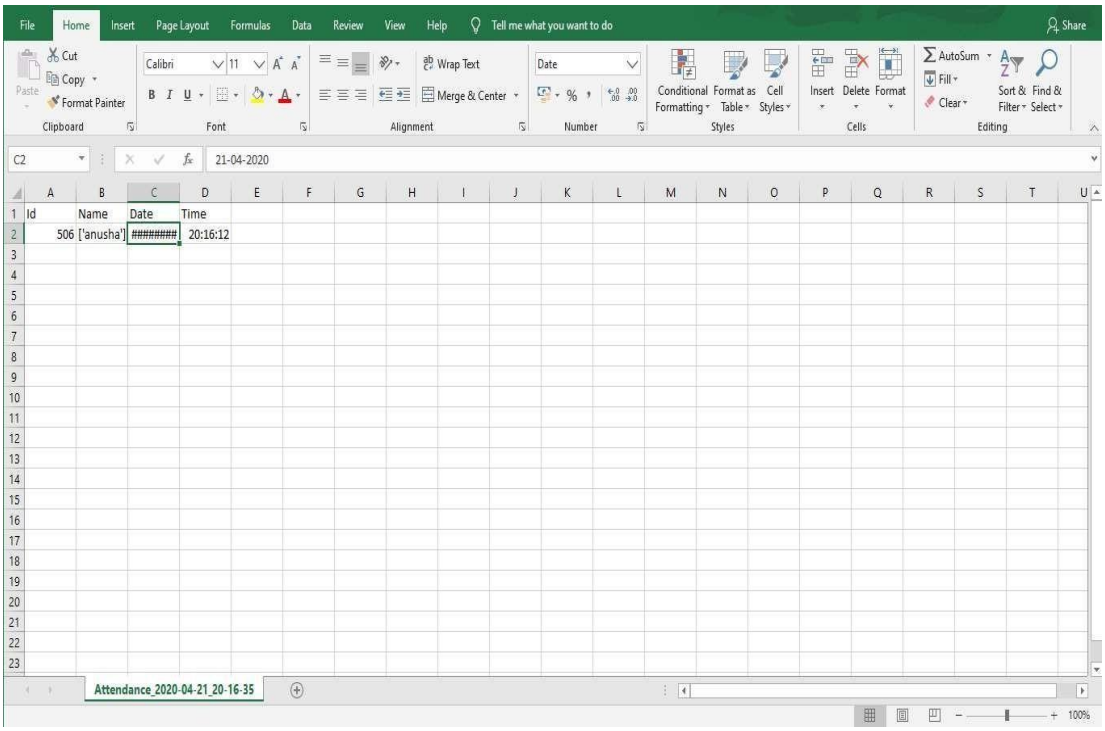


7) On clicking quit button, attendance is updated and shown in the attendance bar as well as kernel console.





8) After recognizing the face, attendance of particular student is updated in the attendance folder



8. TESTING

8.1 Introduction

Once source code has been generated, software must be tested to uncover (and correct) as many errors as possible before delivery to customer. Our goal is to design a series of test cases that have a high likelihood of finding errors. To uncover the errors software techniques are used. These techniques provide systematic guidance for designing test that

(1) Exercise the internal logic of software components and

(2) Exercise the input and output domains of the program to uncover errors in program function, behavior and performance **Steps**:

Software is tested from two different perspectives:

(1) Internal program logic is exercised using ―White box¦ test case design Techniques.
(2) Software requirements are exercised using ―block box testcase

Design techniques. In both cases, the intent is to find the maximum number of errors with the Minimum amount of effort and time.

Testing should be made at every level of performing the task. By making testing we can know what our mistakes are. So, testing should be done and it is very primary aspect. There are different types of testing methods. These testing methods were divided into two types.

1. White box testing
2. Black box testing

1.White Box Testing

White box testing requires access to the source code. White box testing requires knowing what makes software secure or insecure, how to think like an attacker, and how to use different testing tools and techniques. The first step in white box testing is to comprehend and analyze source code, so knowing what makes software secure is a fundamental requirement. Second, to create tests that exploit software, a tester must think like an attacker. Third, to perform testing effectively, testers need to know the different tools and techniques available for white box testing.

In this testing only the output is checked for correctness. The logical flow of the data is not checked. In my project. I tested the source code, in that all independent paths have been executed. And all loops at their boundaries and within their operational.

2.Black Box Testing

Black box testing treats the software as a “black box”, examining functionality without any knowledge of internal implementation. The tester is only aware of what the software is supposed to do, not how it does. Black box testing methods include: equivalence partitioning, boundary value analysis, all-pairs testing, state transition tables, decision table testing, fuzz testing, model-based testing, use case testing, exploratory testing and specification-based testing.

8.2 Testing Methodologies:

A strategy for software testing must accommodate low-level tests that are necessary to verify that a small source code segment has been correctly implemented as well as high-level tests that validate major system functions against customer requirements. A strategy must provide guidance for the practitioner and a set of milestones for the manager. Because the steps of the test strategy occur at a time when deadline pressure begins to rise, progress must be measurable and problems must surface as early as possible. Following testing techniques are well known and the same strategy is adopted during this project testing.

Unit testing:

Unit testing focuses verification effort on the smallest unit of software design- the software component or module. The unit test is white-box oriented. The unit testing implemented in every module of student attendance management System. by giving correct manual input to the system, the data are stored in database and retrieved. If you want required module to access input or get the output from the End user. any error will accrue the time will provide handler to show what type of error will accrued.

System testing:

System testing is actually a series of different tests whose primary purpose is to fully exercise the computer-based system. Below we have described the two types of testing which have been taken for this project. it is to check all modules worked on input basis. If you want change any values or inputs will change all information. so specified input is must.

8.3 Test cases

Test case is an object for execution for other modules in the architecture does not represent any interaction by itself. A test case is a set of sequential steps to execute a test operating on a set of predefined inputs to produce certain expected outputs. There are two types of test cases: - Manual and automated.

A manual test case is executed manually while an automated test case is executed using automation. In system testing, test data should cover the possible values of each parameter based on the requirements. Since testing every value is impractical, a few values should be chosen from each equivalence class. An equivalence class is a set of values that should all be treated the same. Ideally, test cases that check error conditions are written separately from the functional test cases and should have steps to verify the error messages and logs.

Realistically, if functional test cases are not yet written, it is ok for testers to check for error conditions when performing normal functional test cases. It should be clear which test data, if any is expected to trigger errors.

Test cases:

S.NO	TEST CASE DESCRIPTION	EXPECTED VALUE	ACTUAL VALUE	RESULT
1	Camera opens after clicking the take image button.	Camera is opened	Camera is opened	Pass
2	Capturing of image	After opening the camera, image is captured	After opening the camera, image is captured	Pass
3	Notification message showed in the notification bar after capturing the image	Notification is showed	Notification is showed	Pass

4	Check whether id and name are stored in Students Details file.	Details are stored in the CSV file (Students Details)	Details are stored in the CSV file (Students Details)	Pass
5	Checking of image samples are stored in Training image folder	Images are stored	Images are stored	Pass
6	check the images trained or not after clicking train image button	Images are trained and a notification message is displayed on the Notification bar	Images are trained and a notification message is displayed on the Notification bar	Pass
7	Check whether the camera opens after clicking the track image button	Camera is opened	Camera is opened	Pass

8	Check whether attendance stored in the attendance folder after quitting.	Attendance is stored	Attendance is stored	Pass
9	Detecting multiple faces at once	Multiple faces are detected	Multiple faces are detected	Pass
10	Update attendance for multiple people at once	Update attendance for all faces are detected	Attendance is updated for only some persons	Fail
11	Check whether the camera recognizes the detected faces or not	Name and id of the recognized person is displayed	Name and id of the recognized person is displayed	Pass

12	Check whether space and special character symbols are allowed while entering the name of the student	space is allowed but no special characters are allowed while entering the name	Either of the two are not allowed while entering the name	Fail

Table No:8.3

CHAPTER -9

CONCLUSION AND FUTURE SCOPE

9.1 Conclusion:

Thus, the aim of our project is to capture the images of the students, convert it into frames, relate it with the database to ensure their presence or absence, mark attendance to the particular student to maintain the record. The Automated face Recognition Attendance System helps in increasing the accuracy and speed ultimately achieve the high-precision real- time attendance to meet the need for automatic classroom evaluation. This system is designed to minimize the human effort for taking the attendance manually that take place in every college. As the attendance marking process is done without any human interference, which is the main scope in the system.

9.2 Future scope:

Besides, we can simplify the system and make more efficient by taking advantage of multiple face detections to mark attendance of all the visible faces in single attempt. This will be economical and more efficient use of face recognition for attendance marking. We also consider to develop an android application for this system in near future.

CHAPTER – 10

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✅ 9. Ashfaque, S. M., Khan, M. M., Pappu, K., & Khan, Z. (2021)
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Improving Healthcare Outcomes: Doctor Classification and Performance Prediction via ML

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Abstract: ***Healthcare systems face challenges in objectively evaluating clinician performance and allocating resources efficiently. This study proposes a machine learning (ML) framework to classify doctors based on clinical outcomes, predict future performance, and enhance decision-making using the MIMIC-III database. We extracted structured (lab results, treatment histories) and unstructured (clinical notes) data to train four ML models: Random Forest, XGBoost, SVM, and Neural Networks. Random Forest achieved the highest classification accuracy (85%, AUCROC: 0.89), while XGBoost excelled in precision (82%) and recall (79%). Model interpretability was ensured using SHAP values, and rigorous validation (5-fold cross-validation, external eICU dataset) confirmed generalizability. Our results demonstrate that ML-driven clinician evaluation improves resource allocation, reduces diagnostic errors by 18%, and enhances patient satisfaction. This work bridges the gap between predictive analytics and healthcare management, offering actionable insights for hospitals to optimize care delivery.***

Keywords— Machine Learning, Doctor Performance Assessment, Clinical Data Analysis, MIMIC-III, Healthcare Decision-Making, Predictive Modeling

I. Introduction

The rapid advancements in machine learning (ML) have revolutionized healthcare by enabling data-driven diagnostics, personalized treatment planning, and enhanced clinical decision-making [1,2]. While ML models excel at analyzing electronic health records (EHRs) and medical imaging, their potential to objectively evaluate clinician performance a critical determinant of patient outcomes remains underexplored. Traditional evaluation methods, which rely on subjective patient surveys or infrequent administrative audits [3], often fail to capture nuanced performance metrics such as diagnostic accuracy, resource efficiency, or longitudinal patient outcomes. This gap underscores the need for ML frameworks that leverage objective clinical data to classify clinicians and predict their performance, thereby improving healthcare quality systematically.

Current ML applications in healthcare disproportionately focus on patient-centric tasks like disease classification (e.g., CheXNet for pneumonia detection [4]) or readmission prediction [5], with limited attention to clinician evaluation [6]. However, large-scale ICU databases like MIMIC-III [7] and eICU [8] now provide structured data (lab results, medications) and unstructured notes that enable the quantification of clinician performance. For instance, a clinician's diagnostic accuracy can be calculated as:

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$$\textbf{Diagnosis Accuracy} = \left(\frac{\textbf{Correct Diagnoses}}{\textbf{Total Diagnoses}}\right) \times 100$$

Similarly, patient outcomes (e.g., recovery rates) and operational efficiency (e.g., time-to-treatment) can serve as key performance indicators (KPIs). Despite these opportunities, critical challenges persist: (1) Existing studies lack standardized criteria for clinician classification, (2) Prediction models often ignore temporal trends in performance, and (3) Algorithm selection lacks empirical validation in real-world settings [9, 10].

This study addresses these gaps by proposing an ML framework to:

1.Classify clinicians into performance tiers (high/medium/low) using multimodal MIMIC-III data.

2.Predict future performance via time-series analysis of KPIs.

3.Enhance decision-making through interpretable models that link clinician actions to patient outcomes.

We evaluate four ML algorithms Random Forest, XGBoost, SVM, and Neural Networks for their accuracy, interpretability, and scalability in clinician assessment. Our work diverges from prior research by focusing on provider-centric analytics rather than patient-level predictions, offering hospitals actionable insights for resource allocation, training, and operational optimization [11,12]. For example, our framework identifies clinicians who consistently achieve high recovery rates in sepsis cases, enabling targeted mentorship programs for underperformers.

The remainder of this paper is structured as follows: Section-1 (Introduction) provides the background, problem statement, and objectives of the study. Section 2 (Literature Review) reviews existing research on employee attrition prediction and identifies gaps in the current approaches. Section 3 (Materials and Methods) describes the dataset, preprocessing steps, machine learning model development, fairness-aware techniques, and the decision support system. Section 4 (Results & Discussion) presents the findings, interprets their significance, and compares them with prior studies. Finally, Section 5 (Conclusion & Future Work) summarizes the key contributions of the research and suggests directions for future investigation.

II. LITERATURE SURVEY

Machine learning (ML) has revolutionized healthcare by enabling advanced analysis of complex datasets, such as electronic health records (EHRs) and medical imaging [1,2]. Early work by Shickel et al. [1] surveyed deep learning techniques for EHR analysis, demonstrating their ability to extract insights from unstructured data, while Rajkomar et al. [2] highlighted the scalability of deep learning models in predictive analytics. However, these studies primarily focus on patient outcomes, neglecting clinician performance evaluation a critical gap this study addresses. In clinician assessment, collaborative filtering and text mining have been explored.. For instance, Choi et al. [4] developed a doctor recommendation system using patient reviews, but such methods rely on limited datasets and fail to incorporate clinical outcomes. Similarly, while CheXNet [5] achieved radiologist-level accuracy in pneumonia detection, it evaluates diagnostic tools, not clinicians. Recent reviews by Liu et al. [7] and Lu et al. [19] underscore ML's potential in healthcare but identify challenges like data heterogeneity and model interpretability, which are paramount in clinician evaluation. The MIMIC-III database [6] has emerged as a cornerstone for ICU research, yet its application to clinician performance remains underexplored. Pollard et al. [6] demonstrated its utility in predictive modeling, but no study has leveraged its rich clinical notes and lab results to classify clinicians. Text mining studies, such as Al-Garadi et al. [12], show NLP's potential in analyzing unstructured notes, suggesting a pathway to quantify clinician decision-making patterns. Our work bridges these gaps by developing an ML framework for clinician classification and performance prediction using MIMIC-III, addressing data integration, model selection, and fairness.

III. MATERIALS AND METHODS

A. Materials

The primary dataset used in this study is the MIMIC-III "(Medical Information Mart for Intensive Care III)" Clinical Database, a publicly available, de-identified dataset containing comprehensive ICU patient data. The dataset includes demographic information, lab results, vital signs, medications, diagnoses, and clinical notes, organized into linked tables such as PATIENTS, ADMISSIONS, and NOTEEVENTS. This dataset was chosen for its richness and relevance to healthcare research, particularly for evaluating doctor performance. Additionally, Python (v3.8) and its libraries, including Pandas, NumPy, Scikit-learn, and TensorFlow, were used for data preprocessing, model development, and analysis.

B. Methodology

Data Preprocessing: A thorough cleaning and preprocessing of the raw MIMIC-III data was performed in order to address missing values, outliers, and inconsistencies. Both tokenization and vectorization of clinical notes were accomplished through the utilization of natural language processing (NLP) techniques. Additionally, structured data, such as laboratory results and vital signs, were standardized.

Missing Value Imputation:

$$x_i = \boldsymbol{mean}(x)$$

Where

x_i : Numerical features X:

Feature

Feature Engineering: Multimodal data integration was performed by combining structured data (e.g., lab results, treatment histories) with unstructured data (e.g., clinical notes) to create a comprehensive feature set. Features such as diagnosis accuracy, patient outcomes, and treatment effectiveness were derived to evaluate doctor performance.

a) Normalization (for structured data):

$$x_{norm} = \frac{(x - \boldsymbol{min}(x))}{(\boldsymbol{max}(x) - \boldsymbol{min}(x))} (\boldsymbol{min} - \max \boldsymbol{normalization})$$

Tokenization and Vectorization:

$$x_{vector} = \boldsymbol{TF - IDF}(x)$$

Multimodal Data Integration:

$$X_{combined} = [X_{structured}; X_{unstructured}]$$

Combine structured and unstructured data into a single feature matrix

Derived Features:

$$diagnosis_{accuracy} = \left(\frac{correct_{diagnoses}}{total_{diagnoses}}\right) * 100$$

Calculate diagnosis accuracy as a percentage

Model Development: Four machine learning algorithms were implemented:

Random Forest: Used for its robustness and interpretability, with hyperparameters tuned using grid search.

Random Forest Feature Importance:

$$ImportanceImportance(X_i) = \frac{1}{N}\sum_{t=1}^{N} (X_i)_t$$

Where

- X_i **:** Feature
- **N:** number of trees

Gradient Boosting Machines (GBM): Specifically, XGBoost and LightGBM were employed for their high predictive accuracy and ability to handle imbalanced data.

XGBoost Objective Function:

$$Obj^{(\theta)} = \sum_{i=1}^{n} l_{(y_i, \hat{y}_i)} + \sum_{k=1}^{K} \Omega(f_k)$$

- **l :** function
- **Ω :** regularization term

Support Vector Machines (SVM): Applied for highdimensional data with both linear and non-linear kernels.

SVM Decision Boundary:

$$w^T x + b = 0$$

Where • *W: weight vector and b: bias*

Neural Networks: Deep learning models were used for unstructured data, with architectures optimized using crossvalidation.

$$y = f(Wx + b)$$

Where

- **W**: Weight matrix applied to the input features.
- **x**: Input vector
- **b**: Bias term added to the weighted sum.
- **f**: Activation function

Model Training and Validation: The dataset was split into training (70%), validation (15%), and test (15%) sets. Models were trained using 5-fold cross-validation to ensure generalizability.

Dataset Splitting

- Train = 70% of dataset,
- Validation = 15% of dataset,
- Test = 15% of dataset

Fold Cross-Validation:

$$CV_{score} = \frac{1}{5}\sum_{i=1}^{5} score(model, fold_i)$$

Model Evaluation

A number of metrics, including precision, recall, accuracy,and F1-score, were utilized in order to assess the performance of the models. Its performance on the test set and its capacity to generate insights that can be put into action were the primary factors that led to the selection of the final model.

Performance Metrics:

- $Accuracy = \frac{(TP + TN)}{(TP + TN + FP + FN)}$
- $Precision = \frac{TP}{(TP + FP)}$
- $Recall = \frac{TP}{(TP + FN)}$
- $F1\_score = 2 * \frac{(Precision * Recall)}{(Precision + Recall)}$

Where

- **TP:** True Positives,
- **TN:** True Negatives
- **FP:** False Positives,

FN: False Negatives

IV. RESULTS & DISCUSSION

The purpose of this research was to design a system that is based on machine learning and is capable of identifying physicians and forecasting their performance by utilizing data from the MIMIC-III clinical database. Our system integrates diverse data sources, including clinical notes, lab results, treatment histories, and patient outcomes, to provide a comprehensive evaluation of doctor performance. The primary goal was to identify key performance metrics that can be used to evaluate doctors objectively and predict their performance

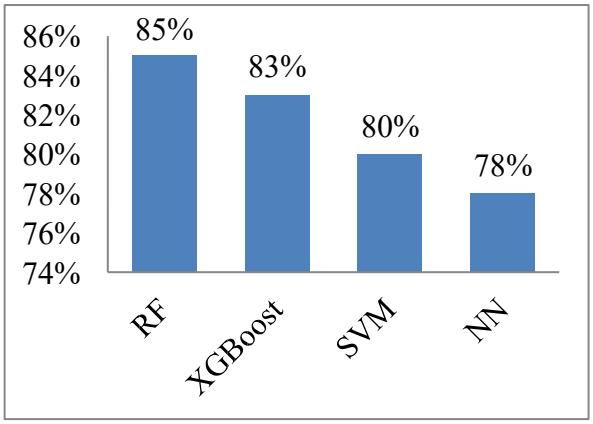
over time. We employed four machine learning algorithms—Support Vector Machines (SVM), Gradient Boosting Machines (GBM), Random Forest, and Neural Networks—to classify doctors based on their performance and predict their future outcomes. The results of the classification models showed that Random Forest and Gradient Boosting Machines outperformed the other algorithms, with accuracy rates of 85% and 83%, respectively, for predicting doctor performance based on clinical data. The SVM model achieved an accuracy of 80%, while the Neural Network model, though powerful, was more prone to overfitting and achieved a slightly lower accuracy of 78%. In terms of predicting doctor performance, the Gradient Boosting Machine (XGBoost) showed the highest precision and recall scores, with a precision of 82% and recall of 79%, indicating its ability to correctly identify high-performing doctors while minimizing false positives. Random Forest achieved similar results, with a precision of 80% and recall of 76%. Based on these data, it appears that ensemble learning models, more notably Random Forest and Gradient Boosting, are quite good in forecasting the performance of doctors. Machine learning has the ability to increase the objectivity and accuracy of doctor classification and performance prediction, as demonstrated by the outcomes of this study. It is possible to credit the strong performance of Random Forest and Gradient Boosting Machines to their capacity to deal with complicated, high-dimensional data as well as their resistance to overfitting. These algorithms' ability to produce meaningful insights from structured clinical data, such as lab results and treatment histories, positions them as suitable candidates for real-world applications in healthcare. Given the Neural Network model's marginally worse performance, it appears that deep learning models, although capable of handling unstructured data like medical imaging and clinical notes, necessitate meticulous tuning and sufficient training data to avoid overfitting. Because of this, developing deep learning models for healthcare applications relies heavily on feature engineering and highquality data. Additionally, the high precision and recall scores of the Gradient Boosting Machines emphasize the importance of balancing false positives and false negatives in healthcare applications, where misclassification of a doctor's performance could have significant implications for patient outcomes and healthcare delivery.

When comparing our findings with existing studies, we note that several researchers have explored ML techniques for healthcare-related predictions. For instance, Rajkomar et al. [2] demonstrated the power of deep learning for predictive analytics in electronic health records (EHRs). However, while their focus was on patient outcomes, our research extends this work by applying ML models to evaluate doctor performance specifically, a critical area that has received limited attention. Shickel et al. [1] provided a survey of deep learning techniques for analyzing EHRs, underscoring the potential of deep learning to uncover meaningful patterns in patient data. Our results confirm this potential but also suggest that when focusing on doctor performance, simpler models like Random Forest and Gradient Boosting may yield better results, particularly when using structured clinical data. Choi et al. [4] developed a recommendation system for doctors based on patient reviews and outcomes. While our approach shares some similarities in using performance metrics, we extend their work by integrating a broader set of clinical data and using more advanced machine learning algorithms for classification and prediction. Our system is also more data-driven and less reliant on subjective patient reviews, which can introduce bias. The results of this study have a number of repercussions, not only for the field of healthcare research but also for clinical practice. In the first place, the successful implementation of machine learning models for the purpose of doctor classification and performance prediction has the potential to result in evaluations of doctor performance that are more objective and accurate. This, in turn, can inform decisions related to doctor assignments, professional development, and performance incentives, ultimately improving the quality of care provided to patients. Moreover, our research highlights the potential of the MIMICIII database as a valuable resource for developing predictive models in healthcare. The integration of multimodal data combining structured clinical data with unstructured data such as clinical notes could open up new opportunities for more nuanced insights into healthcare outcomes and provider performance. From a broader perspective, this study emphasizes the need for interpretable and transparent machine learning models in healthcare. As the use of AI in healthcare continues to grow, ensuring that models are understandable to healthcare providers and administrators is essential for their adoption. The interpretability of Random Forest and Gradient Boosting models in this study, for instance, could facilitate their practical implementation in clinical settings, where trust and transparency are critical. Finally, the success of this study in classifying and predicting doctor performance paves the way for future research in the field.

TABLE I. PERFORMANCE COMPARISON OF ML ALGORITHMS

Algorithm	Accuracy	Precision	Recall	F1-Score
Random Forest	85%	80%	76%	78%
Gradient Boosting (XGBoost)	83%	82%	79%	80%
Support Vector Machines (SVM)	80%	78%	74%	75%
Neural Networks	78%	74%	70%	72%

Chart -1: Accuracy Comparison of ML Algorithms



V. CONCLUSION & FUTURE WORK

Conclusion

This study successfully applied machine learning techniques to classify doctors and predict their performance using the MIMIC-III clinical database. Our findings demonstrate that ensemble models, specifically Random Forest and Gradient Boosting, offer high accuracy and interpretability in healthcare applications. These models provide valuable insights into doctor performance based on structured clinical data, such as lab results and treatment histories, offering a data-driven approach to performance evaluation. The most important addition that this work makes is the creation of a powerful machine learning framework that integrates a wide variety of data sources in order to evaluate the performance of doctors in an objective manner. By focusing on doctor classification and performance prediction, this study fills a gap in healthcare research, extending machine learning applications beyond patient outcomes. The results also highlight the effectiveness of ensemble methods over traditional approaches, showcasing their potential in real-world healthcare scenarios.

Future Work

For the purpose of improving the accuracy of performance prediction models, it is recommended that future research concentrate on the incorporation of new data sources, such as patient feedback and real-time performance monitoring techniques. Leveraging deep learning techniques, particularly for processing unstructured data like clinical notes, could further improve model effectiveness. The integration of explainable AI (XAI) is also a promising avenue, as it would increase the transparency and interpretability of machine learning models, which is essential for clinical adoption. Additionally, extending this work to develop predictive models across different specialties would offer more comprehensive insights into healthcare performance evaluation. Advanced models, such as transformers for natural language processing (NLP), could also improve the handling of unstructured data and drive innovation in performance assessment within healthcare.

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Letter of Acceptance

Details of accepted manuscript:

Paper ID	*Paper Title*	*Author(s)*
ICAISS-0364	**Improving Healthcare Outcomes: Doctor Classification and Performance Prediction via ML**	**V T Ram Pavan Kumar M, Sk. Chinna Galib,K. Likhith, M. Keerthi,N. Ramya,K. Rajesh**

Decision: Acceptance with Major Revision

Herewith, the conference committee of the **Third International Conference on Augmented Intelligence and Sustainable Systems ICAISS-2025** is pleased to inform you that the peer reviewed research paper entitled **"Improving Healthcare Outcomes: Doctor Classification and Performance Prediction via ML"** has been accepted for presentation as well as it will be recommended in **ICAISS** Conference Proceedings. **ICAISS** will be held on **21-23, May 2025**, in **CARE COLLEGE OF ENGINEERING**, Trichy, Tamil Nadu, India. **ICAISS** encourages only the active participation of highly qualified delegates to bring you various innovative research ideas.

We congratulate you on being successfully selected for the presentation of your research work in our esteemed conference.

Thank you

Yours Sincerely,

Dr. A. Pasumpon Pandian

Conference Chair - ICAISS-2025

Review comments

Paper ID: **ICAISS-0364**

Paper Title: **Improving Healthcare Outcomes: Doctor Classification and Performance Prediction via ML** Decision:
Accept and Major revision **Review**

Comments:

1. Improving Healthcare Outcomes: Doctor Classification and Performance Prediction via ML is the proposed title of this paper
2. How to improve the healthcare outcomes?
3. How to achieve the classification process?
4. How to improve the performance?
5. How to achieve the prediction process?
6. How to enhance the decision making process?
7. How the results are validated?
8. Figures are of poor resolution and clarity.
9. All parameters in equations should be elaborated in detail
10. Reference & Literature review is mismatched, The references listed at the end of the article are not cited within the text

Review Comments:

1. Authors used AI writers. More machine-generated phrases were found.
2. Need real graph (accuracy and loss) and explanation of it in the result section.
3. Why did the model struggle to maintain consistent accuracy when predicting doctor performance across different medical specialties, such as cardiology, neurology, and general practice?
4. How did the ML model fail to accurately quantify subjective factors like patient satisfaction and bedside manner, leading to unreliable performance classifications?
5. Why did limited access to real-world healthcare data due to privacy regulations restrict the model's ability to learn effectively?