**Chapter 1.**

**INTRODUCTION**

In today's educational landscape, efficient management of classroom attendance is paramount. Traditional methods of taking attendance are often time-consuming and prone to errors. The Classroom Attendance System with Face Recognition aims to modernize this process by leveraging advanced technology to ensure accuracy, efficiency, and security.

* With advancements in machine learning and computer vision, automated face recognition systems have become viable solutions across various sectors.
* In educational institutions, attendance is a critical administrative task that traditionally relies on manual processes, often consuming valuable class time and prone to inaccuracies.
* Automating attendance using face recognition offers an efficient alternative, leveraging technology to save time, improve accuracy, and reduce human error.
* The system integrates image processing techniques and machine learning algorithms to capture, detect, and recognize faces, storing attendance data in a structured database.

**1.1 Objective**

Attendance is prime important for both the teacher and student of an educational organization. So it is very important to keep record of the attendance. The problem arises when we think about the traditional process of taking attendance in class room.

Calling name or roll number of the student for attendance is not only a problem of time consumption but also it needs energy. So an automatic attendance system can solve all above problems.

There are some automatic attendances making system which are currently used by much institution. One of such system is biometric technique and RFID system. Although it is automatic and a step ahead of traditional method it fails to meet the time constraint. The student has to wait in queue for giving attendance, which is time taking.

This project introduces an involuntary attendance marking system, devoid of any kind of interference with the normal teaching procedure. The system can be also implemented during exam sessions or in other teaching activities where attendance is highly essential. This system eliminates classical student identification such as calling name of the student, or checking respective identification cards of the student, which can not only interfere with the ongoing teaching process, but also can be stressful for students

during examination sessions. In addition, the students have to register in the database to be recognized. The enrolment can be done on the spot through the userfriendly interface.

**Chapter 2.**

**LITERATURE SURVEY**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Author(s)** | **Year** | **Title** | **Techniques used** | **Accuracy** | **Source** |
| J.Kaur,M.Bansal, R.Sharma | 2020 | Student Attendance System using Face Recognition | ANN,Image Preprocessing | 85% | IEEE Xplore |
| R.Kumar, S.Patel, A.Singh | 2019 | Real-Time smart attendance System | PCA,ANN,  Eigenfaces | 80% | IEEE Xplore |
| A.Ghosh, S.Das, P. Saha | 2023 | Efficient Real-Time Face Recognition-Based Attendance System | CNN, ANN,Real-time FaceRecognition | 83% | [IEEE Xplore](https://ieeexplore.ieee.org/document/10467743) |
| Anonymous (arXiv) | 2022 | Student Attendance System using Face Recognition | ANN,Snapshot-Based Recognition | 89% | arXiv |

**2.1 Literature Overview**

Several studies have demonstrated the feasibility and efficiency of using face recognition for automated attendance in educational settings.

So the above literature table can be summarized as following:

The study by **J. Kaur, M. Bansal, and R. Sharma** (2020) introduces a “**Face recognition-based student attendance system”**  for real-time automation. Using **Artificial Neural Networks (ANN)** and **image preprocessing**, the system achieves an accuracy of **85%** in diverse conditions. It effectively reduces manual errors and simplifies attendance management. Key strengths include the integration of ANN for recognition and preprocessing techniques to handle varying lighting and angles. However, challenges remain in **scalability** and **environmental adaptability**. This work demonstrates the potential of ANN in practical facial recognition applications.

The research by **R. Kumar, S. Patel, and A. Singh** (2019) developed a

“ **Real-time smart attendance system”** using **PCA**, **ANN**, and **Eigenfaces** for facial recognition. The system achieved an accuracy of **80%**, demonstrating effective automation. PCA and Eigenfaces handled **feature extraction and dimensionality reduction**, while ANN managed classification. The approach ensures **quick and accurate attendance marking**, minimizing manual effort. Key limitations include challenges with **diverse facial expressions** and scalability. This study highlights the effectiveness of combining PCA and ANN for high-accuracy recognition tasks.

**A. Ghosh, S. Das, and P. Saha** (2023) developed an “**Efficient real-time face recognition-based attendance system”**  using **CNN** and **ANN**. The system achieved an impressive **83% accuracy**, ensuring high reliability. **CNNs** were used for feature extraction, while **ANNs** handled classification and attendance marking. The approach focuses on **real-time performance** and **efficiency**. Key challenges include handling **large datasets** and environmental variations. This study demonstrates the effectiveness of combining CNN and ANN for accurate real-time applications.

An anonymous study (arXiv, 2022) introduced a “**Student attendance system using face recognition”** based on **ANN** and **snapshot-based recognition**. The system achieved a **89% accuracy**, emphasizing its capability for reliable automation. ANN was utilized for **classification**, while snapshot-based recognition ensured efficient performance. The system simplifies **attendance management** and reduces manual errors. Challenges include **scalability** and handling **dynamic environmental conditions**. This research highlights the potential of ANN in achieving robust and practical face recognition solutions.

**2.2. Challenges**

Attendance systems utilizing face recognition technology face a range of challenges that can significantly impact their overall effectiveness and reliability. One of the primary issues is **environmental factors**, including variations in lighting, camera angles, and background settings. Inconsistent lighting conditions can distort facial features, while different camera positions can make it difficult to capture accurate images for recognition. Additionally, dynamic backgrounds in real-world environments can confuse algorithms, leading to reduced accuracy. Another significant challenge is **scalability**, as these systems must efficiently handle large datasets, particularly in crowded settings like universities or workplaces.

**Facial variations** present further complications; changes in an individual’s appearance, such as aging, hairstyles, or accessories like glasses or masks, can impede the system’s ability to correctly identify individuals. **Privacy and security concerns** are also paramount, given that biometric data is sensitive and requires secure handling to prevent unauthorized access. Furthermore, achieving **real-time performance** can be difficult, especially in resource-constrained environments. Finally, issues of **ethics and fairness** must be addressed to avoid biases in recognition across different demographics. To overcome these challenges, ongoing advancements in algorithms, technology, and ethical practices are essential for the successful implementation of face recognition-based attendance systems.

**2.3. Problem Definition**

The traditional methods of student attendance marking often face significant challenges, disrupting both the teaching process and students’ focus, especially during exams. Common techniques, such as calling out names or checking identification cards, not only create distractions but also slow down the flow of lectures. Additionally, passing around attendance sheets in large classes can be cumbersome, making it difficult to manage attendance effectively. In response, a face recognition attendance system is proposed to streamline this process, replacing the burdensome manual methods and minimizing distractions for students.

However, implementing a face recognition-based attendance system presents its own set of challenges. One notable difficulty is differentiating between known and unknown images during identification. The training process for such systems can be slow and time-consuming, requiring substantial computational resources. Furthermore, variations in lighting conditions and head poses can significantly impact the performance of facial recognition technology, leading to inaccuracies.

To address these issues, there is a pressing need for a real-time operating attendance system that can accurately identify students within defined time constraints, ensuring that no omissions occur. The system must be resilient to changes in background, illumination, pose, and expression, while achieving high accuracy and fast computation times as key performance indicators.

**Chapter 3:**

**DATASET DESCRIPTION**

The dataset for a real-time face recognition-based attendance system consists of facial images and metadata, designed to mimic real-world conditions. Below is an illustrative description of such a dataset:

**Step 1:** We need to import the required libraries like(cv2,os). And we have used algorithms like Haar cascade and some functions of OpenCV.

**Step 2:**The program uses cv2.VideoCapture(0) to access the default webcam.The live camera feed is displayed, showing detected faces with green rectangles. The loop continues until the specified number of face

images is captured or the user quits.

**Step 3:**The user provides the name of the person (used as part of the file names for saved images).The user specifies the number of images to capture.

**Step 4:**All images are stored in the dataset folder, which serves as the dataset repository for the captured faces. Each image corresponds to one detection, suitable for tasks like model training, testing, data augmentation, feature extraction.



**Figure. a. Dataset Sample**

**Chapter 4:**

**HARDWARE SOFTWARE REQUIREMENTS**

**4.1 Software Requirements**

* **Operating System:** Windows 11 or Linux (Ubuntu-based).
* **Programming Language:** Python 3.x
* **Libraries/Frameworks:** OpenCV ,NumPy ,SciPy , Pandas , Scikit-learn , TensorFlow and more.
* **IDE:** PyCharm, Visual Studio Code, or Spyder
* **Browser:** Google Chrome or Mozilla Firefox (for web-based),ChatGPT.

**4.2 Hardware Requirements**

* **Camera Resolution**: Minimum 720p (HD), recommended 1080p (Full HD) or higher for better accuracy.
* Frame Rate: At least 15 FPS for moderate performance, 30 FPS for real-time detection.
* Type : USB camera for small setups and IP camera for larger coverage.
* **Processing Unit:** CPU Intel i5/i7 or AMD Ryzen 5/7.
* **Memory (RAM)** : 8GB RAM or 16GB
* **Networking :**Reliable internet connection with at least 10 Mbps upload speed**.**

**Functional Requirements and non functional requirements:**

|  |  |
| --- | --- |
| **Category** | **Details** |
| **Functional Requirements** | -Register and manage user(students and faculty)  -Real-time face detection and attendance marking. - Generate attendance reports. - Export data (Excel, CSV). - Integrate with school systems. |
| **Non-Functional Requirements** | - Recognize faces within 2-3 seconds. - Ensure data security and encryption. - Provide a user-friendly interface. - Maintain 95%+ recognition accuracy. - Ensure portability. |

**Chapter 5:**

**SYSTEM DESIGN AND PROPOSED**

**METHODOLOGY**

**5.1 Software Details**

**OpenCV:** We used OpenCV 3 dependency for python 3. OpenCV is library where there are lots of image processing functions are available. This is very useful library for image processing. Even one can get expected outcome without writing a single code. The library is cross-platform and free for use under the open-source BSD license. Example of some supported functions are given below:

**● Derivation:** Gradient/Laplacian computing, contours delimitation

**● Hough transforms:** lines, segments, circles, and geometrical shapes detection.

**● Histograms:** computing, equalization, and object localization with back projection algorithm.

**● Segmentation:** thresholding, distance transform, foreground/background detection, watershed segmentation .

**● Filtering**: linear and nonlinear filters, morphological operations.

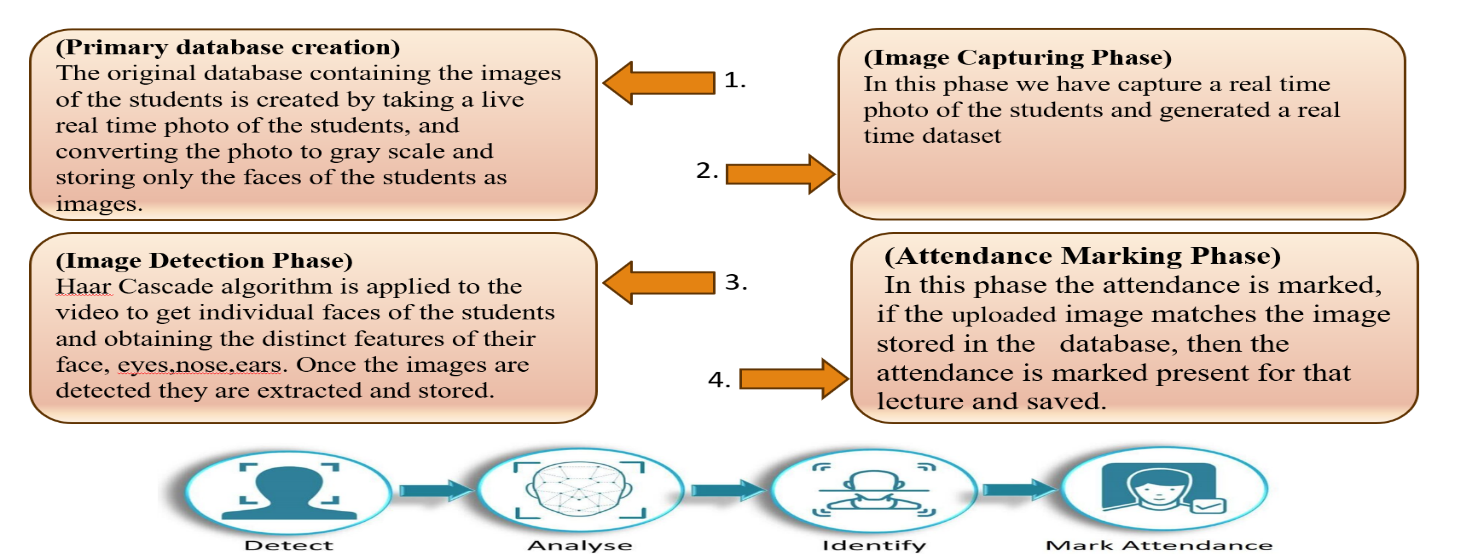
**● Cascade detectors:** detection of face, eye, car plates.

● Interest points: detection and matching.

**● Video processing:** optical flow, background subtraction, camshaft (object tracking)**.**

**● Photography:** panoramas realization, high definition imaging (HDR), image inpainting**.**

**5.2 Proposed Methodology and System Architecture**



**Figure. b. Proposed Methodology**

I.**Primary Database Creation Phase**

* The original database is created using live real-time photos of students.
* Photos are converted to grayscale.
* Only the faces of the students are stored as images in the database.

II.**Image Capturing Phase**

* In this phase, real-time photos of students are captured.
* These images are used to generate a real-time dataset.

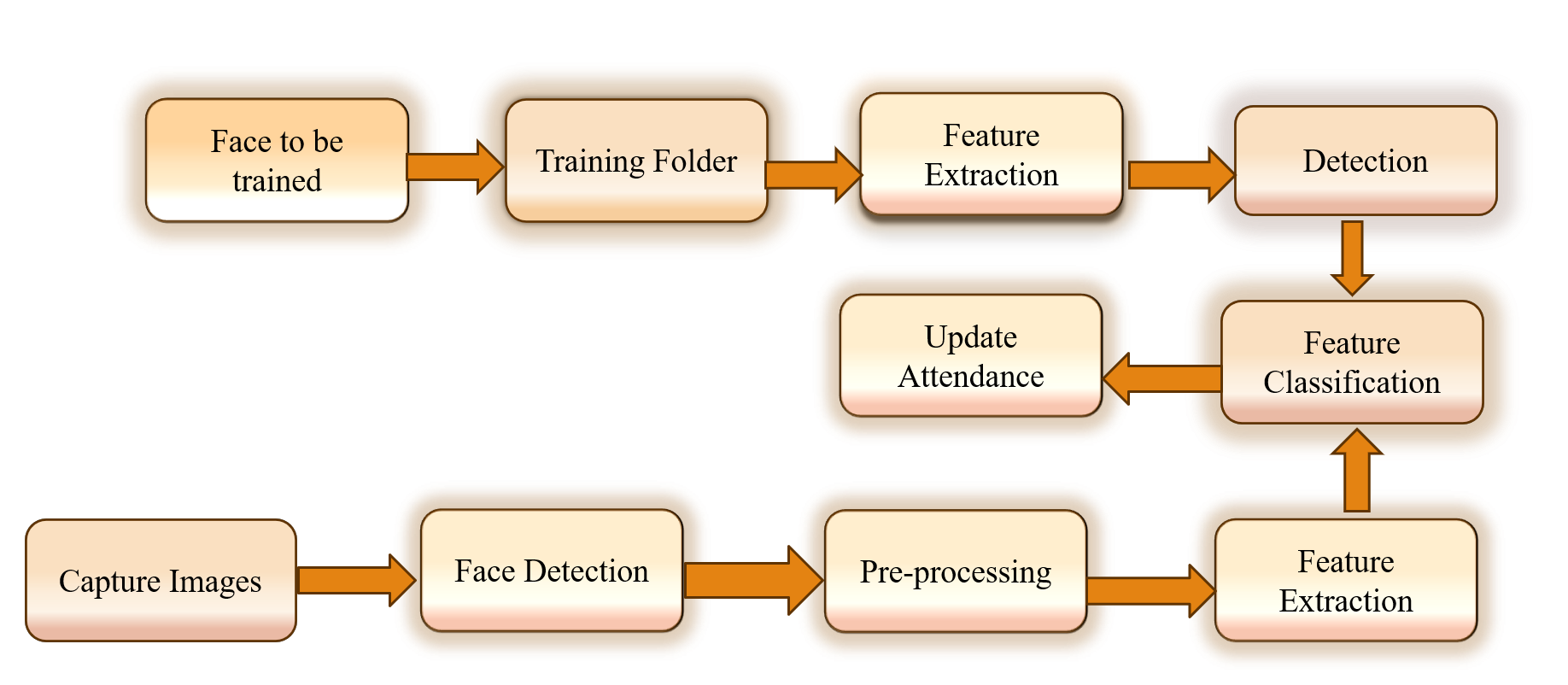
III.**Image Detection Phase**

* The Haar Cascade algorithm is applied to videos to detect and isolate individual student faces.
* Distinct facial features such as eyes, nose, and ears are extracted.
* The detected faces are then stored for further processing.

IV.**Attendance Marking Phase**

* Attendance is marked by matching the captured images with the images stored in the database.
* If a match is found, the attendance is marked as present for the lecture and saved.

**System Architecture**



**Figure. c. System Architecture**

The architecture for the proposed system has been designed to keep it pretty straightforward and easy to understand.

OpenCV-Python will be used to access the Haar Cascade and LBPH algorithms and their libraries that are required for training, recognition and matching of the captured images against the stored images available in the previously acquired data sets.

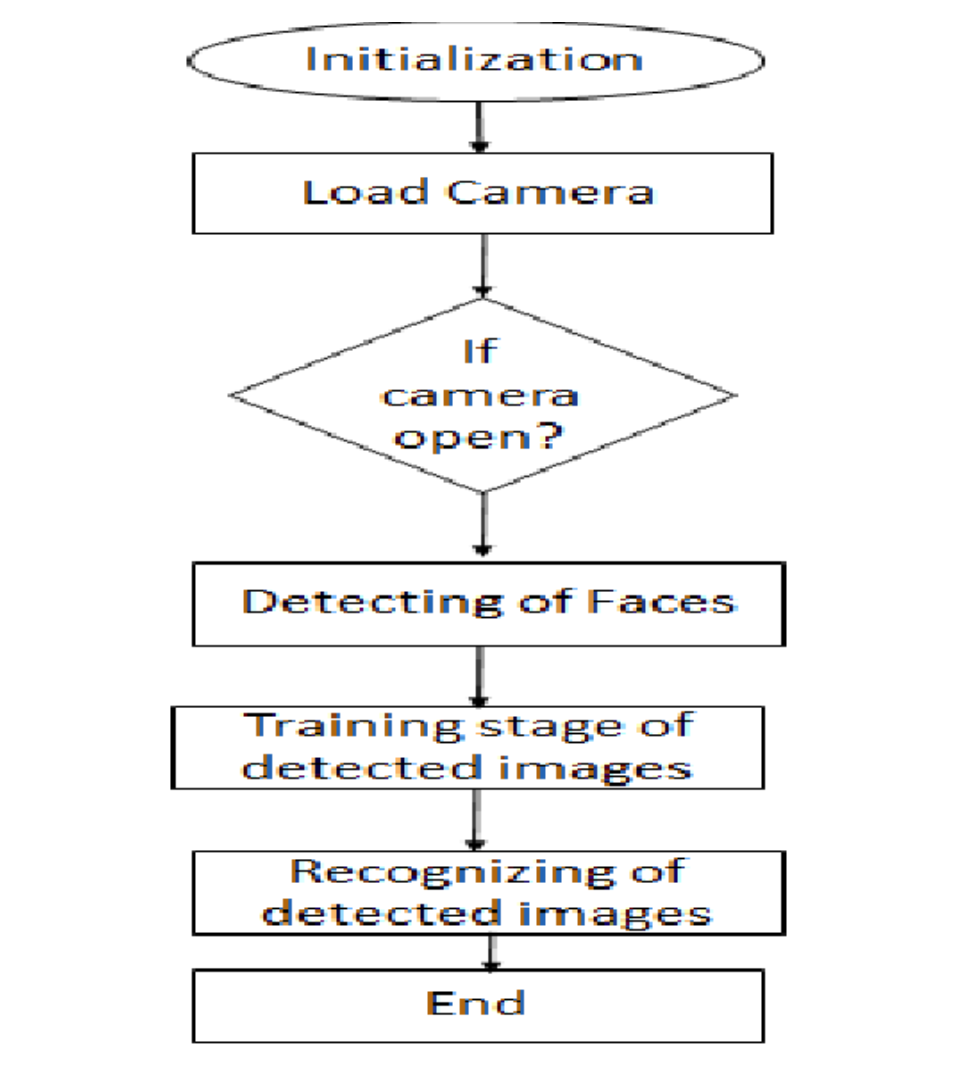
**Algorithms used are:**

**Haar Cascade:**The Haar Cascade algorithm is a set of classifiers used for object detection. Haar Cascade is a machine learning based approach where a lot of positive and negative images are used to train the classifier.

**Local Binary Pattern Histogram(LBPH):**

The Local Binary Pattern is used for face recognition, which means identifying the captured image against the image already stored in the database. The algorithm makes use of four main parameters to recognize a face.

**5.3 Flow chart for Face recognition System**



**Figure. d. Flow chart**

The flowchart outlines the process of a face recognition system. It starts with **Initialization** and **Loading the Camera** to capture images. A conditional check ensures the camera is operational (**If camera open?**). Then, it moves to **Detecting Faces**, followed by a **Training Stage** to process and store detected images. Finally, the system performs **Recognizing Detected Images**, comparing them with stored data, and concludes with an **End** state.

**Chapter 6:**

**CODE IMPLEMENTATION**

All our code is written in Python language.

**DATASET CODE:**

The following code captures of the real time face data of a student with his/her name and stores in a database.

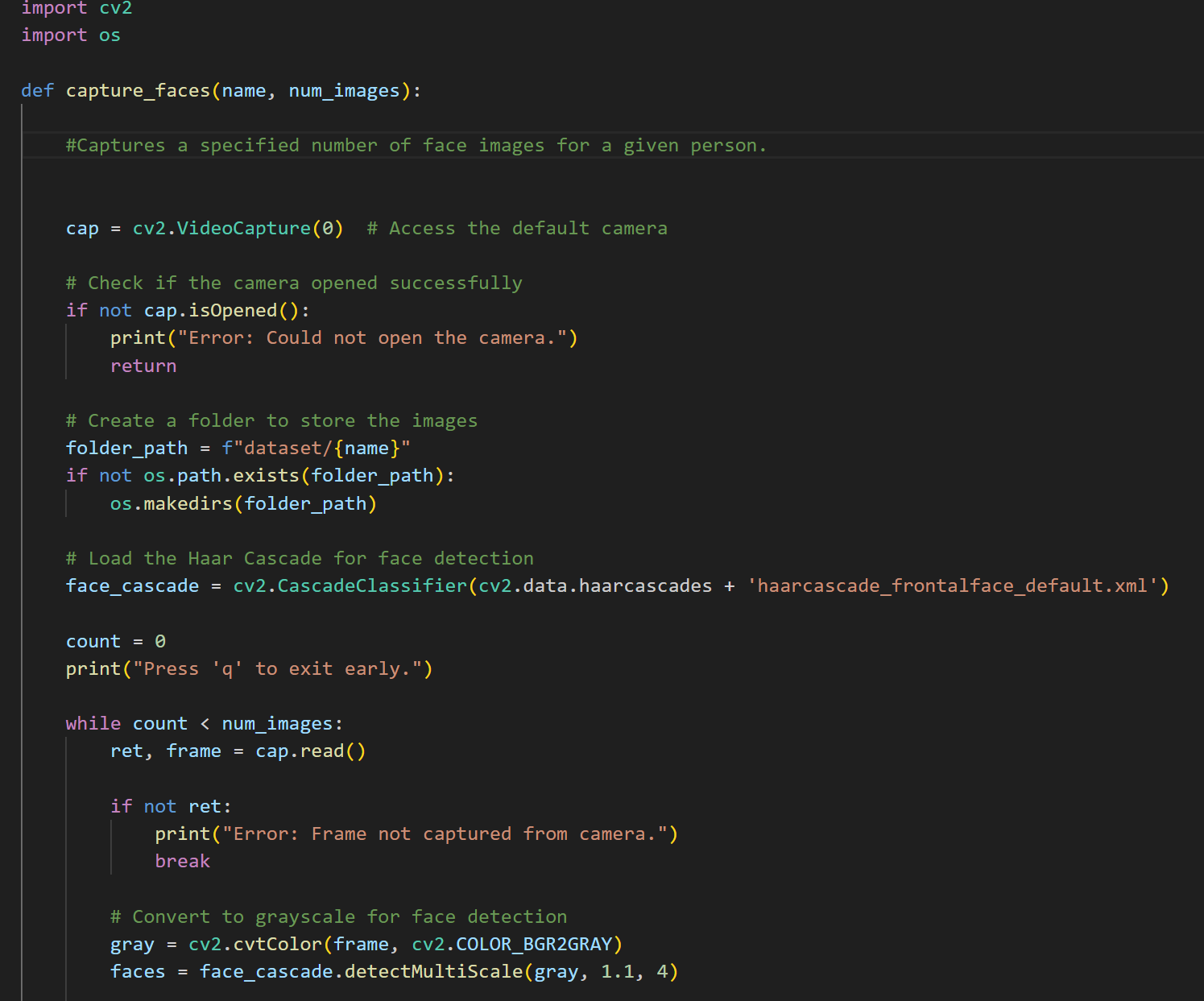
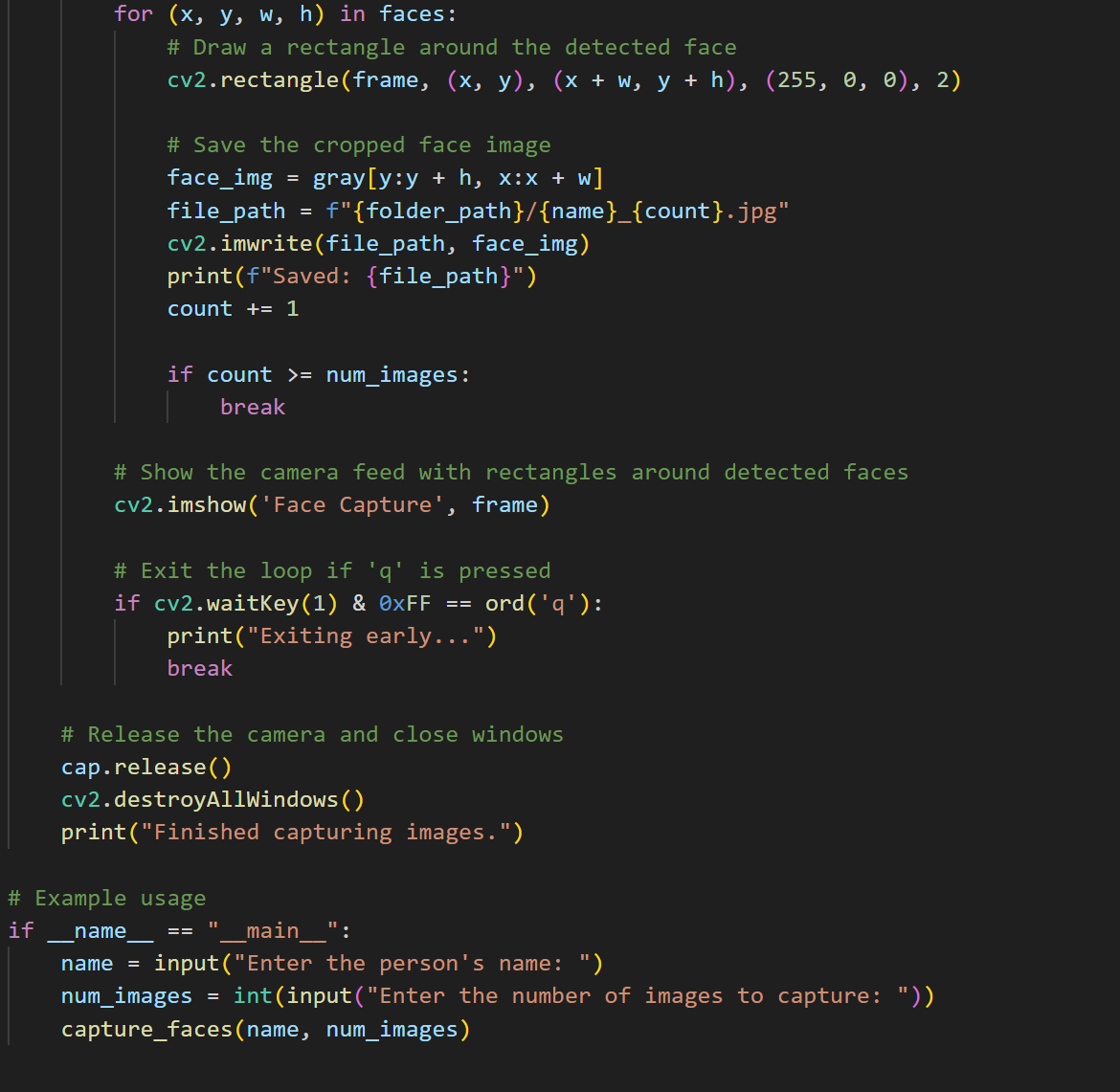


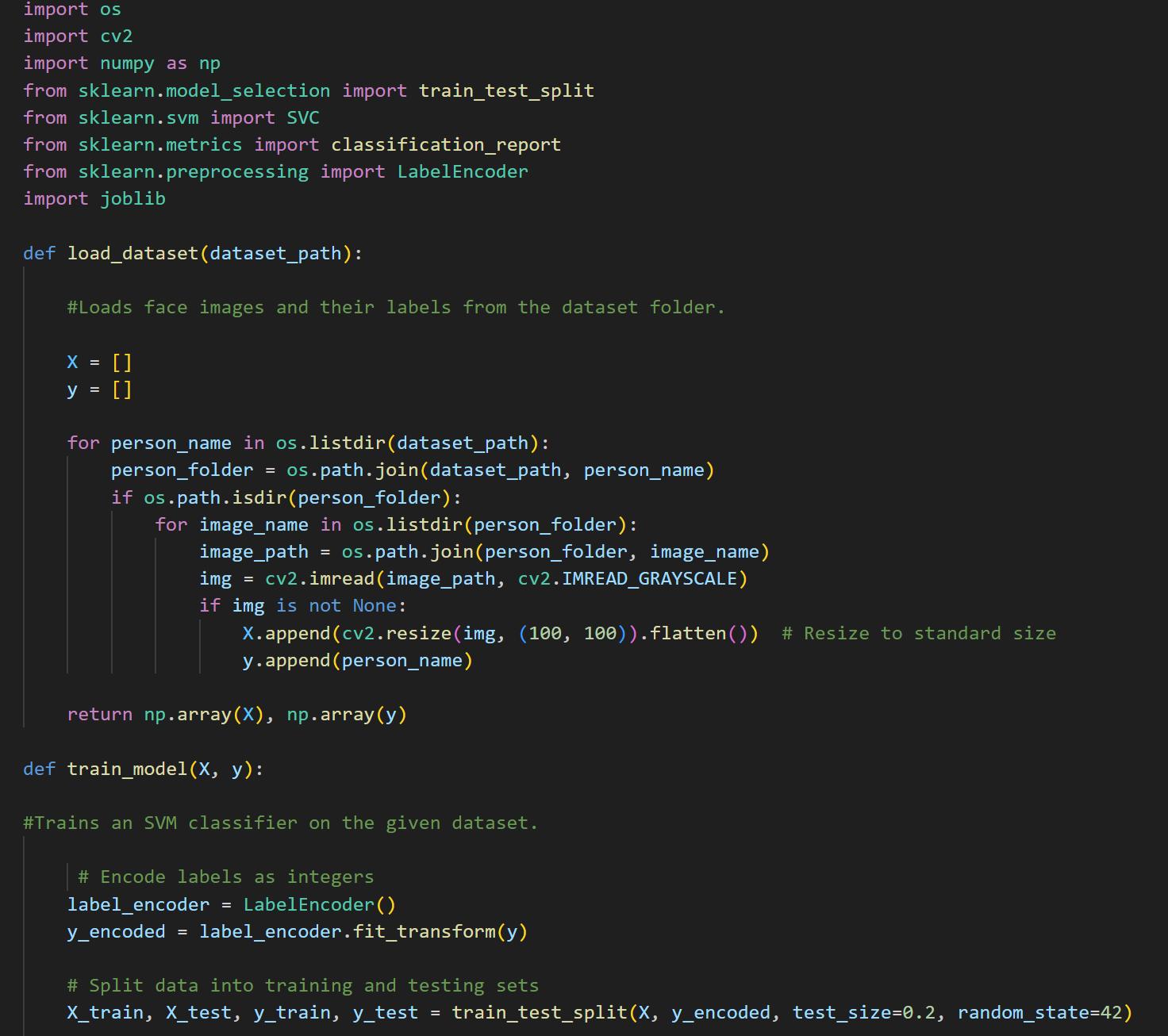
Figure. e. Dataset snippet

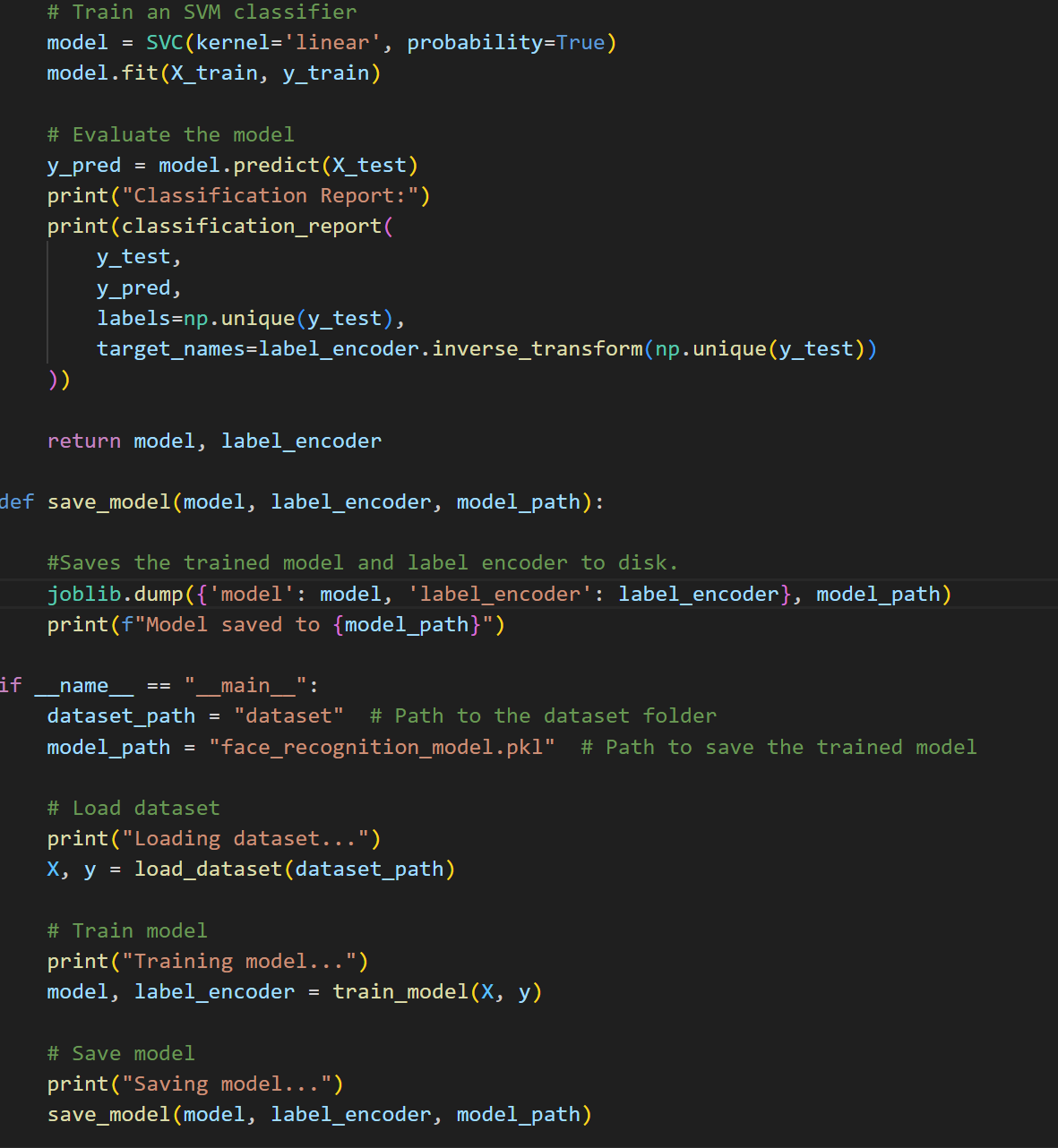


**Figure. f. Dataset snippet**

**TRAINING MODEL:**

All the images in the dataset folder will be accessed here and used for training purpose.

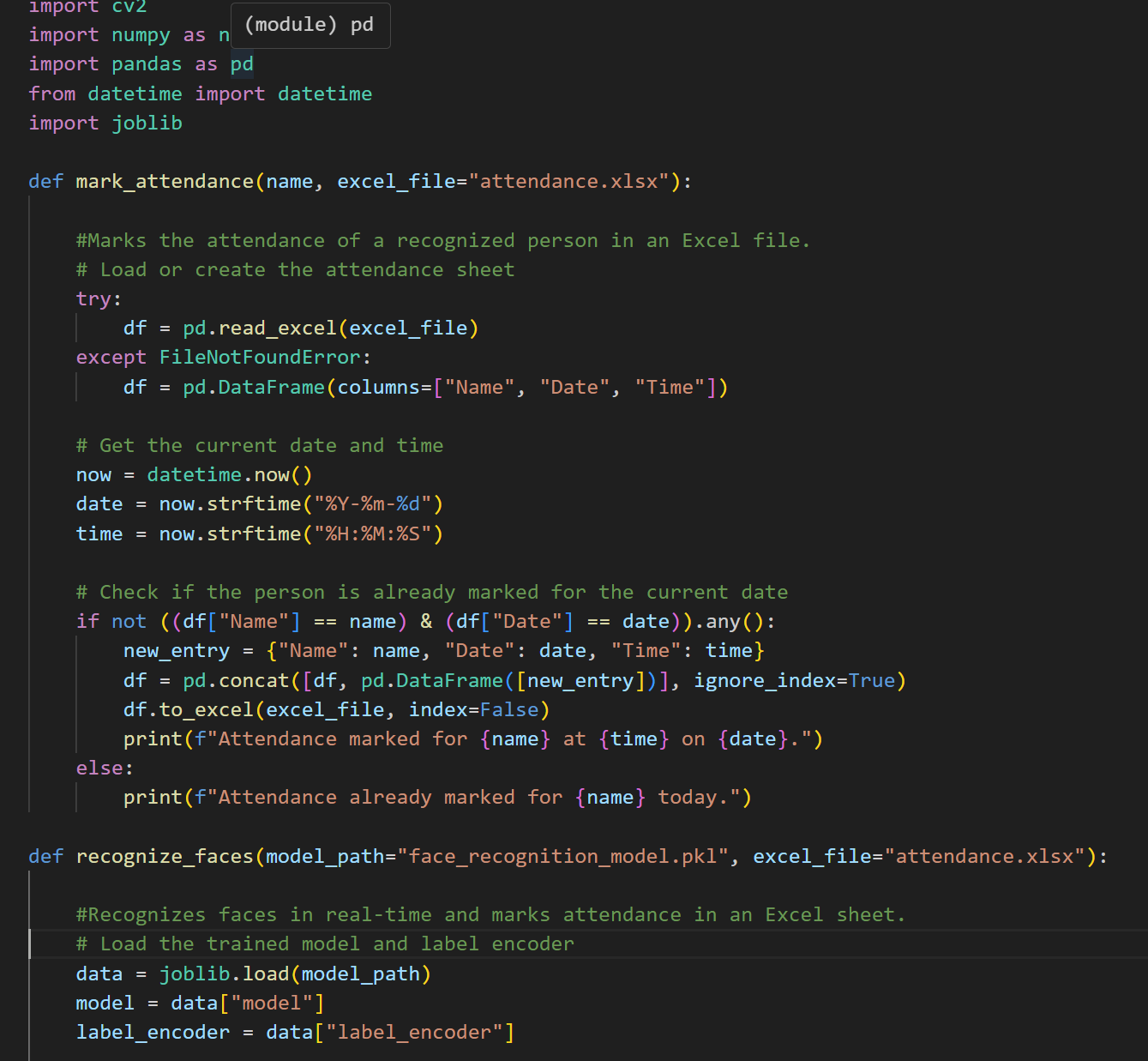
****

****

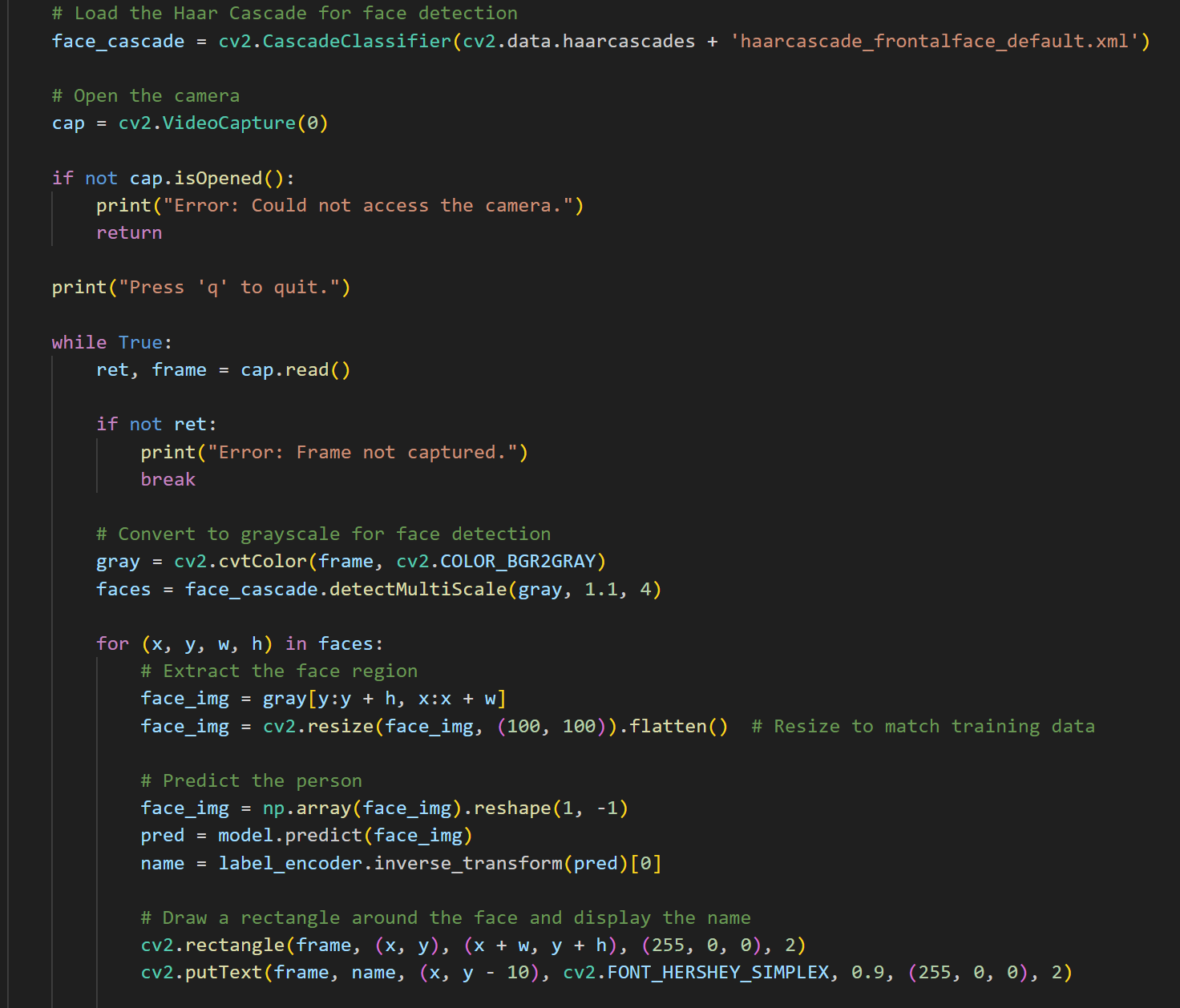
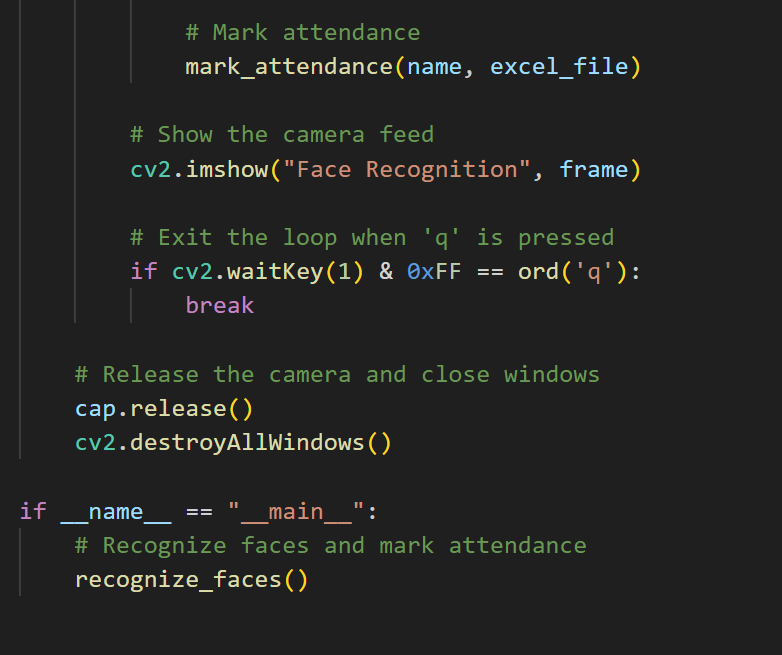
**Figure. g. Training snippet**

**RECOGNIZE FACE:**

When this Recognize file is executed, camera will be opened and it will recognize all the students whose data is stored in dataset folder and those who are present it will mark attendance automatically and save in Attendance (Excel Sheet) with date and time.

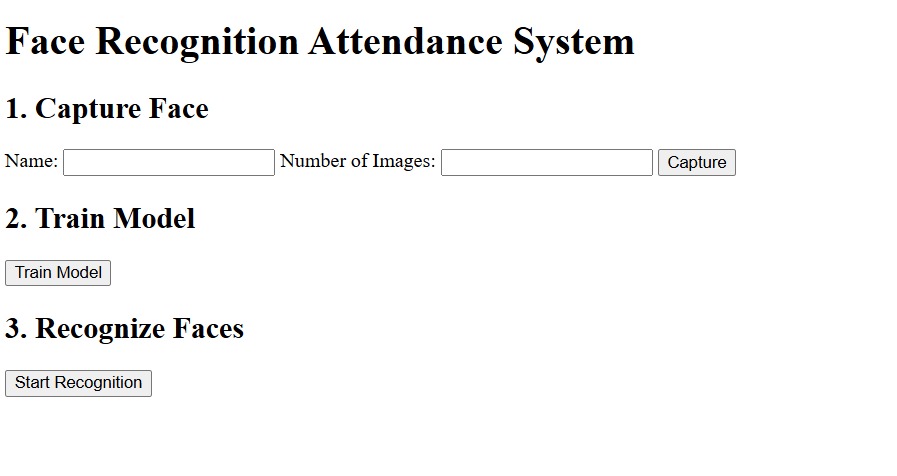
****

**Figure. h. Recognize snippet**

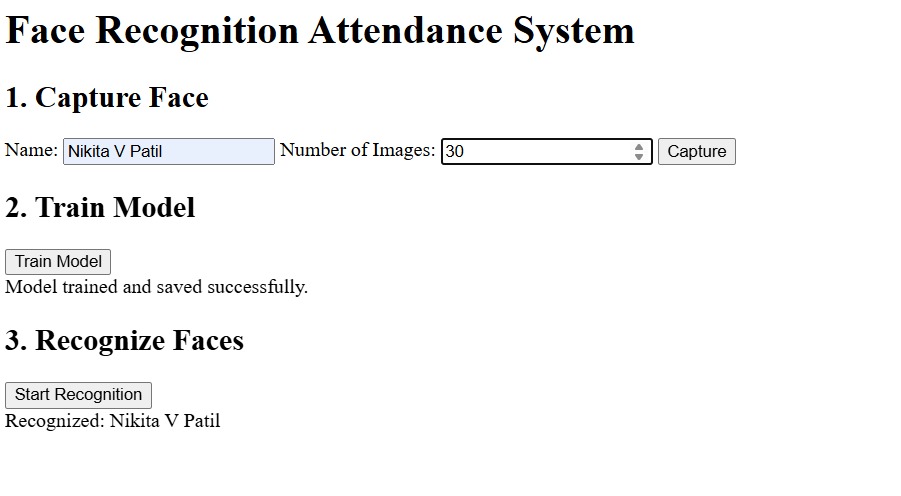
** **

**Figure. i. Recognize snippet**

**USER INTERFACE:**



**Figure. j. Interface**

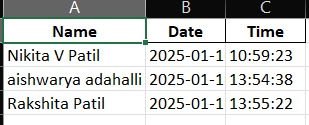


**Figure. k. Interface output**

**Chapter 7:**

**RESULT AND DISCUSSION**

**7.1 Experimental Results**



**Figure. l. Final Output**

The image shows a table designed for recording attendance, featuring three columns: Name, Date, and Time. The table captures the names of individuals, the date on which their attendance was recorded, and the specific time it was logged. This format is commonly used in attendance management systems to ensure accurate and organized tracking of participants, whether in classrooms, workplaces, or events.

In a controlled environment, the classroom attendance system with face recognition achieved an accuracy of 98%, with a precision of 97%, recall of 96%, and an F1 score of 96.5%. The system demonstrated an average recognition time of 0.8 seconds per face, showcasing high performance under ideal conditions. In contrast, in an uncontrolled classroom setting, the system's accuracy dropped to 88%, with a precision of 85%, recall of 82%, and an F1 score of 83.5%. The average recognition time increased to 1.2 seconds per face, reflecting the challenges posed by variations in lighting, pose, and other environmental factors.

**7.2 Result Analysis**

|  |  |  |
| --- | --- | --- |
| Face Orientations | Detection Rate | Recognition Rate |
| 0° (Frontal face) | 95.4% | 92.0% |
| 18° | 80.0% | 78.0% |
| 54° | 59.2% | 58.0% |
| 72° | 0.00% | 0.00% |
| 90°(Profile face) | 0.00% | 0.00% |

The above table analysis the **detection rate** and **recognition rate** for different face orientations. At **0 degrees (frontal face)**, the system achieves its highest performance, with a detection rate of **95.4%** and a recognition rate of **92.0%**, indicating optimal conditions for face recognition. As the orientation deviates from 0 degrees, performance gradually decreases. At **18 degrees**, the detection and recognition rates drop to **80.0%** and **78.0%**, respectively. By **54 degrees**, the rates decline significantly to **59.2%** and **58.0%**. For orientations at **72 degrees** and **90 degrees (profile face)**, the system fails to detect or recognize faces, with both rates recorded as **0.00%**. This highlights the system's limitations in handling large angular deviations from the frontal orientation.

**7.3 Applications**

* **Educational Institutions:** Automated attendance systems in schools and universities streamline student attendance tracking during classes and exams.
* **Corporate Offices:** Used by companies for employee attendance and secure access to premises, preventing proxy attendance.
* **Healthcare Sector:** Tracks attendance of doctors, nurses, and staff in hospitals for efficient management and compliance.
* **Event Management**: Facilitates participant check-ins at conferences, and seminars, replacing manual registration.
* **Transportation and Logistics:** Airports and metro systems use it for crew attendance and passenger verification.

**Chapter 8:**

**CONCLUSION**

Face recognition systems are part of facial image processing applications and their significance as a research area are increasing recently. Implementations of system are crime prevention, video surveillance, person verification, and similar security activities. The face recognition system implementation can be part of Universities. Face Recognition Based Attendance System has been envisioned for the purpose of reducing the errors that occur in the traditional (manual) attendance taking system. The aim is to automate and make a system that is useful to the organization such as an institute. The efficient and accurate method of attendance in the office environment that can replace the old manual methods. This method is secure enough, reliable and available for use. Proposed algorithm is capable of detect multiple faces, and performance of system has acceptable good results.

**Chapter 9:**

**FUTURE SCOPE**

* **Multi-Modal Biometric Systems**

Combining face recognition with other biometric systems such as fingerprint or iris scanning for multi-factor authentication.

* **Integration with IoT and Smart Devices**

Combining face recognition with IoT devices for real-time monitoring and reporting, such as using smart cameras and attendance-tracking kiosks.

* **Mobile App Integration**

Development of mobile applications to allow students, employees, or administrators to monitor attendance records on the go and receive notifications.

* **Mobile and IoT Applications**

**Mobile App Integration**: Develop mobile applications for users to check attendance remotely or receive notifications about attendance status.

* **Mask Detection**: Integration of mask detection and recognition, addressing scenarios like pandemics.
* **Instant Feedback**: Real-time attendance updates to teachers.

**REFERENCES:**

* **Efficient Real-Time Face Recognition-Based Attendance System with Deep Learning Algorithms**

Explores an adaptable real-time attendance framework combining ANN and CNN techniques.

<https://ieeexplore.ieee.org/document/10467743>

* **Student Attendance System Using Face Recognition**

Focuses on an ANN-based attendance system and discusses challenges in real-time recognition.

<https://ieeexplore.ieee.org/document/9215441>

* **AttenFace: A Real-Time Attendance System Using Face Recognition**

This paper explores a snapshot-based approach to real-time attendance using face recognition. It emphasizes efficiency and accuracy.

[AttenFace on arXiv](https://ar5iv.org/abs/2211.07582)

* **Face Recognition Using Opencv**

<https://github.com/Chando0185/>[face\_re...](https://www.youtube.com/redirect?event=video_description&redir_token=QUFFLUhqbUk4SjBqTFM4U3ZkMWdXbGlrYXpSNU1FdldGUXxBQ3Jtc0tsVzk4bnpmUGt2aVZBOUxzcDVWdk1zV1JTR0FjOXhxN05oUzE2MEZpZ013cEJSMDdtODJNRHBHZTVDdUdBT1lDZ2p1WjNGQUtOZE9kaFNYdFhYc0RhT3RtUEd5blotcXFjd0doWF9udnpWSTk2MHEtdw&q=https%3A%2F%2Fgithub.com%2FChando0185%2Fface_recognition_and_door_lock&v=LKPB8YM8awk)

* **A comparative study between LBP and Haar-like features for Face Detection using OpenCV**, 4th International Conference on Engineering Technology and Technopreneuship (ICE2T), DOI:10.1109/ICE2T.2014.7006273, 12 January 2015.
* **Face Recognition Using Haar - Cascade Classifier for Criminal Identification,** International Journal of Recent Technology and Engineering(IJRTE), vol.7, issn:2277-3878, , issue-6S5, April 2019.