Single Image Based Face Recognition By Two-fold Neural Network Model for Smart Attendance

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DEPARTMENT OF COMPUTER SCIENCES

COMSATS UNIVERSITY ISLAMABAD, VEHARI CAMPUS

VEHARI – PAKISTAN

SESSION 2019-2023

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Sir Jawad Rafeeq

A DISSERTATION SUBMITTED AS A PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF BACHELORS IN COMPUTER SCIENCE

DEPARTMENT OF COMPUTER SCIENCES

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CERTIFICATE OF APPROVAL

It is to certify that the final year project of BS (CS) "Single Image Based Face Recognition By Two-fold Neural Network Model for Smart Attendance" was developed by **Saad Alam (Sp19-BCS-096)** and **Yusra Qayyum (Sp19-BCS-054)** under the supervision of "**Sir Jawad Rafeeq**" and that in his opinion; it is fully adequate, in scope and quality for the degree of Bachelors of Science in Computer Sciences.

Supervisor

External Examiner

Head of Department (**Department of Computer Science)**

DEDICATION

This Project is dedicated to my father, mother, teachers, my family members and my sincere friends who taught me that the best kind of knowledge to have is that which is learned for its own sake, And also taught me that even the largest task can be accomplished if it is also done one step at a time.

ACKNOWLEDGEMENT

All praise for Almighty **Allah**, who enable us to know about certain unknown things in the universe and helps us to overcome a lot of difficulties. All respect for **Holy Prophet Muhammad (PBUH)** who mentioned the difference of right and wrong path without doubt, to ensure the success in our lives.

I would like to sincerely thank all the individuals, people who helped me to complete this project, I am deeply indebted and wish my utmost appreciation and gratitude to my project supervisor **MR JAWAD RAFEEQ** for her encouragement, technical discussion, inspiring guidance, remarkable suggestions, keen interest and constructive criticism which enabled me to complete this project study.

I am expressing my thanks to honorable head of department **DR AQEEL U REHMAN and SIR JAWAD RAFEEQ** for providing me possible facilities for the completion of this project work.

I can't find perfect words to precise my heartiest gratitude to my loving parents and friends whose chain prayers, cooperation have created incredible impression in my life. In the end, I am again much thankful to Almighty **ALLAH** who helped in my project.

Project Team Members

Saad Alam

Yusra Qayyum

PROJECT BRIEF

PROJECT NAME	Single image based face recognition by two-fold Neural Network models for smart attendance
ORGANIZATION NAME	COMSATS University Islamabad Vehari Campus.
OBJECTIVE	Can be used in Universities, Colleges, Any Organization where record of presence and absence is required and also Security Purpose.
UNDERTAKEN BY	Saad Alam Yusra Qayyum
SUPERVISED BY	Sir Jawad Rafeeq Lecturer :Computer Science COMSATS University Islamabad Vehari Campus
STARTED ON	20/01/2022
COMPLETED ON	Complete
COMPUTER USED	Core i7 7th Generation
SOURCE LANGUAGE	Python Version 3.8
OPERATING SYSTEM	Ubuntu, Windows
TOOLS USED	MS Office Version 2016 Spyder Version 5.0.5, Pycharm , IP Webcam

ABSTRACT

Face recognition system plays a vital role in almost every sector. Face recognition is one of the most used biometrics. It can be used for security, authentication, and identification, and has got many more advantages. Despite having low accuracy when compared to iris recognition and fingerprint recognition, it is being widely used due to its contactless and non-invasive process. Furthermore, a face recognition system can also be used for attendance marking in schools, colleges, offices, etc. This system aims to build a class attendance system that uses the concept of face recognition as the existing manual attendance system is time-consuming and cumbersome to maintain. And there may be chances of proxy attendance. Therefore to overcome these issues, we purposed a system that consists of four phases- database creation, face detection, face recognition, and attendance updation. The database is created by the images of the students in class. Face detection and recognition are performed using Retina-Face and Xception deep neural network algorithms respectively. Faces are detected and recognized from a Single image of the classroom. Attendance will be saved in the Excel sheet. This project was implemented using 'TKINTER' and 'PYTHON'. It achieves a top1 accuracy of 79% and a top5 accuracy of 94.5% on the ImageNet dataset and achieves an accuracy of 99% on a public student class photo dataset.

Table of Content

1 Introduction

1.1 System Introduction

Every organization requires a robust and stable system to record the attendance of their students, and every organization has its own method to do so, some are taking attendance manually with a sheet of paper by calling their names during lecture hours and some have adopted biometrics system such as fingerprint, RFID card reader, and Iris system to mark the attendance. The conventional method of calling the names of students manually is a time-consuming event. In the RFID card system, each student assigns a card with their corresponding identity but there is a chance of card loss or an unauthorized person may misuse the card for fake attendance. While in other biometrics such as fingerprint, iris, or voice recognition students must wait in a queue to receive their attendance. So the process of attendance is time-consuming they all have their own flaws and also they are not 100% accurate. The use of Face-recognition for the purpose of attendance marking is a smart way of attendance system. Face recognition is a more accurate and faster technique among other techniques and reduces the chance of proxy attendance. Face recognition provides passive identification that a person who is to be identified does not need to take any action for their identity. Existing face recognition techniques for attendance are recognizing faces individually student but this purposed system has innovation in face recognition that recognize faces over on single image of a whole class consisting of a group of student. Considering all the above-mentioned points, it has been attempted to develop a face-based attendance system that could overcome some of the drawbacks of the previous systems. Using the designed software, the teacher only needs to take a single image of the class. Several photographs can be used to cover the entire class. Deep learning algorithms are then used by the app to detect and match faces in the photographs with student database records.

This project incorporates an involuntary attendance marking scheme that does not interfere with usual teaching procedures in any way. This technique eliminates traditional student recognition methods such as calling students' names or verifying their identity cards, which can both disturb the teaching process and frustrate students during review sessions. The device can also be utilized during exam sessions or other classroom events where punctuality is important.

Face recognition involves two steps, the first step involves the detection of faces and the second step consists of the identification of those detected face images with the existing database. There are a number of face detection and recognition methods introduced. Face recognition works either in form of appearance-based which covers the features of the whole face or feature-based which covers the geometric feature like eyes, nose, eyebrows, and cheeks to recognize the face. Our system uses a face recognition approach to reduce the flaws of an existing system with the help of deep learning, it requires a good quality camera to capture the images of students, and the detection process is done by Retina-Face Library which is based on CNN Model. And recognizing performance through deep learning.

The images captured by the camera is the see-to system for further analysis, the input image is then compared with a set of reference images of each of the student and mark their attendance.

1.2 Background of the System

In recent years, a number of face recognition-based attendance management systems have been introduced in order to improve the performance of students in different organizations.

- Face recognition Attendance system using HOG and CNN algorithm Aditya Kapse, Tejas Kamble, Ash tosh Lohar, Shubham Cha, udhari and Digambar Puri ITM Web Conf., 44 (2022) 03028 [1].

- Shah, K., Bhandare, D. et al. Face Recognition-Based Automated Attendance System. In: Gupta, D., Khanna, A., Bhattacharyya, S., Hassanien, A.E., Anand, S., Jaiswal, A. (Eds) International Conference on Innovative Computing and Communications, 2021[2]. Haar Cascade classifier has been used to detect faces by capturing features on the images like eye, nose, etc. The proposed method is evaluated against principal component analysis (PCA) and other techniques like the local binary patterns histogram (LBPH). It is observed that the accuracy of the proposed system is better than those of the later ones.
- Khawla Alhanaee, et al. have explained Face Recognition Smart Attendance System using Deep Transfer Learning, Procardia Computer Science, Volume 192, 2021[3]. This paper presents a facial recognition attendance system based on deep learning convolutional neural networks. We utilize transfer learning by using three pre-trained convolutional neural networks and training them on our data. The three networks showed very high performance in terms of high prediction accuracy and reasonable training time.
- Clyde Gomes, et al. have explained: the “Class Attendance Management System using Facial Recognition “which is published in the ITM Web of Conferences in January 2020 [4]. This paper introduces a new approach to automatic attendance management systems and extended computer vision algorithms.
- S. Sawhney, K. Kacker, S. J, and in, S. N. Singh, and R. Ghave have purposed "Real-Time Smart Attendance System using Face Recognition Techniques," by using Eigen face values, Principle Component Analysis (PCA), and Convolutional Neural Network (CNN).which is published in International Conference on Cloud Computing, Data Science & Engineering (Confluence),2019 [5].

- Japan and, Smit, et al. "Automated Attendance System Using Image Processing." 2018 Fourth International Conference on Computing Communication Control and Automation (ICCUBEA) IEEE, 2018 [6].
- Varadharajan, E., et al. "Automatic attendance management system using face detection."2016 Online International Conference on Green Engineering and Technologies(IC-GET).IEEE, 2016 [7].
- An Eigen face approach along with PCA algorithm for marking face recognition attendance system has been introduced by the author in, they mention the comparison of different face recognition algorithms in a more efficient [8].
- An efficient Attendance Management system is designed with the help of the PCtheylgorithm they have achieved accuracy up to 83% but their system performance decreases due to slight changes in light conditions [9].
- Ajinkya Patil with their fellows in proposed a face recognition approach for attendance marking the sing Viola jones algorithm, Haar cascades are used to detect faces in images and recognition performs through the Eigen face method [10].
- A has proposed that d, they marked attendance with the monthly progress of each student. There is a need for an alternative algorithm that can enhance the recognition of oriented faces [11].
- In Jomon Joseph, K. P. Zacharia proposed a system using image processing Eigen faces controller, based on Matlab. Their system works only with front face images and there is a need for a suitable method that works with the orientation of the system [12].
- Another approach of taking at the entrance system easily and securely, the author proposed a system with the help of artificial neural networks, they used PCA to extract face images and testing and training were achieved by neural networks, their system performs in various orientation. A 3D face

recognition approach for an attendance management system was proposed by Muthu Kalyani. K, Veera Muthu [13].

1.3 Objectives of the System

Face Recognition Attendance System from images has gained a lot of attention because of its increasing demand in many real-life applications, for example, Examination centers, classrooms, and any other place that need attendance. Instead of using conventional methods, this proposed system aims to develop an automated system that records the student's attendance by using facial recognition technology. The main objective of this work is to make the attendance marking and management system efficient, time-saving, simple, and easy. This project focuses on different types of faces recognize from the single image of class. It is used in various applications such as Attendance for Colleges, Universities, Schools, and any Organization in which work is done collaboratively.

The main objectives of the proposed system are as follows:

- To design and develop a face recognition based class attendance system that uses the concept of face recognition as the existing manual attendance system is time-consuming and cumbersome to maintain.
- To overcome the issues of proxy attendance that may occur in the manual attendance system.
- To implement a system that consists of four phases- dataset creation, face detection, face recognition, and attendance updation.
- To create a dataset of the students in class using their images.
- To perform face detection and recognition using Retina-Face and Xception deep neural network algorithms respectively.
- To detect and recognize faces from a single image of the classroom.
- To update attendance of day by day sheet in an excel file to maintain record.
- To implement the system using 'TKINTER' and 'PYTHON'.
- To achieve better accuracy than existing automated smart attendance

1.4 Significance of the System

With the advancement of technologies each and every day, humanity is slowly going towards contactless everything. It is quite evident that the future ahead of us will become so advanced that maybe 90%+ of the things that we are doing right now will be either automated or become contactless. One such advancement will be the face recognition technology or the FR tech, which is the prime focus of this project. Face recognition technology is a system or software which is capable enough to verify the identity of a person by analyzing an image. Some of the technologies or software are so advanced that even blurred pictures are sometimes rendered enough and analyzed to know the identity of the person. But today, our prime focus will be on one of the many applications of face recognition technology, and that is smart attendance based on face recognition using a single image.

- Ease in maintaining attendance.
- Reduced paperwork.
- Automatically operated and accurate
- Reliable and user-friendly.
- Increased productivity.

This technique represents our small contribution to modernizing the education system. Examples of facial recognition in real life:

- In Schools, Colleges, and Universities used for attendance
- Also used in industry for employee attendance.
- For security purposes on ATM machines.
- Control access to sensitive areas such as g laboratories, military bases, bank vaults, etc.

2 Overall Description

2.1 Product Perspective

The system consists of a camera that captures the images of the classroom and sends it to the image enhancement module. After enhancement the image comes in the Face Detection and Recognition modules and then the attendance is marked on Excel sheet. At the time of enrolment templates of face images of individual students are stored in the Face database. Here all the faces are detected from the input image and the algorithm compares them one by one with the face database. If any face is recognized the attendance is marked on the Excel sheet from where anyone can access and use it for different purposes. This system uses a protocol for attendance. Teachers come in the class and just press a button to start the attendance process and the system automatically gets the attendance without even the intensions of students and teacher. In this way a lot of time is saved and this is highly secure process no one can mark the attendance of other. Attendance is maintained on the Excel file so anyone can access it for it purposes like administration, parents and students themselves. Face Database is the collection of face images and extracted features at the time of enrolment process.

Attendance Updation After face recognition process, the recognized faces will be marked as present in the excel sheet and the rest will be marked as absent and the list of absentees. Faculties will be updated with monthly attendance sheet at the end of every month.

The architecture of used CNN Model is shown in the above mentioned diagram. CNN is a mathematical construct that is typically composed of three types of layers (or building blocks): convolution, pooling, and fully connected layers. The first two, convolution and pooling layers, perform feature extraction, whereas the third, a fully connected layer, maps the extracted features into final output, such as classification. A convolution

layer plays a key role in CNN, which is composed of a stack of mathematical operations, such as convolution, a specialized type of linear operation. Xception is a deep convolutional neural network architecture that involves Depthwise Separable Convolutions. Xception stands for "extreme inception", it takes the principles of Inception to an extreme. it first applies the filters on each of the depth map and then finally compresses the input space using 1x1 convolution by applying it across the depth.

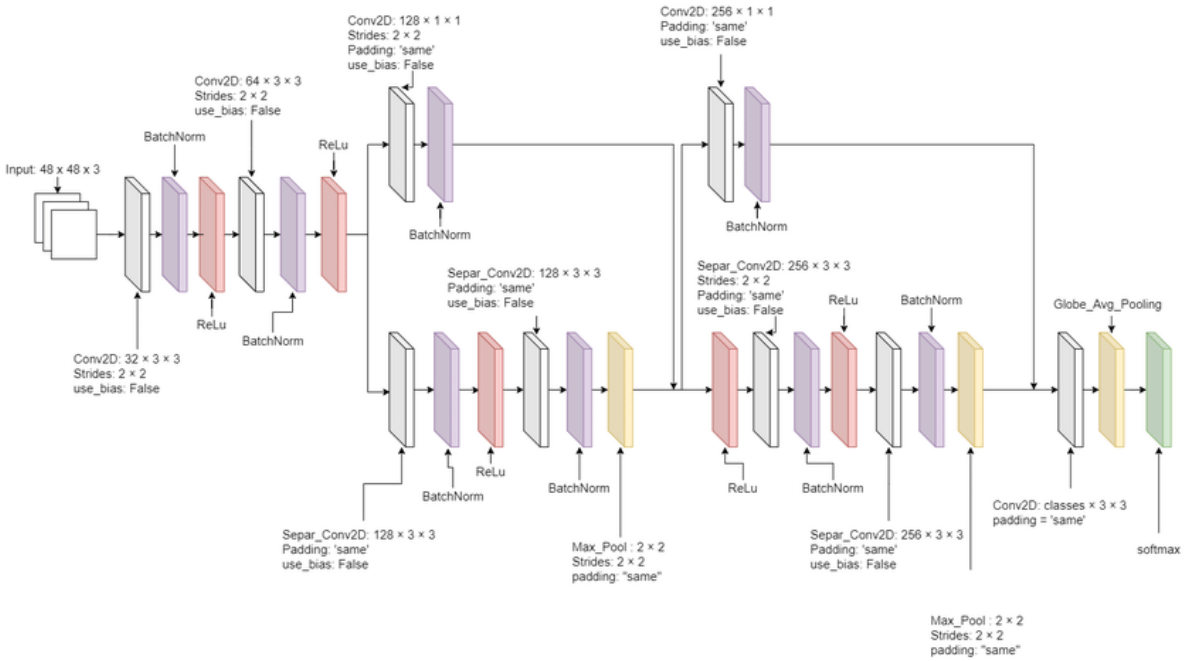

Figure 2.1: Xception Model Architecture

2.2 Product Scope

The main intention of this project is to solve the issues encountered in the old attendance system while reproducing a brand new innovative smart attendance system that can provide convenience to the institution. In this project, an application will be developed which is capable of recognizing the identity of each individuals and eventually record down the data into a database system. Apart from that, an excel sheet is created which shows the students attendance.

The followings are the project scopes:

- The targeted groups of the attendance monitoring system are the students and staff often educational institution.
- The database of the attendance management system can hold up to 2000 individual's information.
- The facial recognition process can only be done for whole class at a time.
- It required no any internet connection.
- Using this system we will able to accomplish the task of marking the attendance in the classroom automatically and output is obtained in an excel sheet as desired in real-time.
- However, in order to develop a dedicated system which can be implemented in an educational institution, a very efficient algorithm which is insensitive to the lighting conditions of the classroom has to be developed.
- Higher definition cameras required.
- Also a camera of the optimum resolution has to be utilized in the system.
- Poor Image Quality limits face recognition
- Small image size also effects on face recognition prediction result.
- Different face angle also effects on face recognition.
- Distance also effect on image quality.
- Data processing and storage also affect to model in prediction result.

2.3 Product Functionality

Following are the functions that the user can perform:

- Capture image
- Verify Attendance
- View Attendance Record
- Train New Dataset

Following are the functions that the system can perform:

- Performs pre-processing to reduce noisy data.

- Apply segmentation.
- Classify data using CNN.
- Display results.

First of all, it captures the input image. After capturing the image, it will preprocess the image and resize image into size that required for Xception CNN Model for training. By using Retina-Face Library face detection will be done and extracts features from the image by Xception Model and then stored in trained set database. Similarly face recognition is done by using Xception Model. And then extracted features will be compared with the trained data set.

If it matches attendance will be updated in the attendance excel sheet.

2.4 Users and Characteristics

2.4.1 Commercial User

This kind of user will use to this system for their commercial purpose. Like banks, software houses, industries and other companies where record of employee is required use FRA application to make attendance process automated. It is efficient, time saving, simple and easy.

2.4.2 Academic User

This kind of user will use FRA in academic purpose to maintain record of presence and absence of staff and students. Like Schools, Colleges, and Universities. It is efficient, time saving, simple and easy.

2.5 Operating Environment:

Hardware	**Software**
PC/Laptop	Python 3.8
Camera(External)	Anaconda Navigator
RAM 8GB	Spyder IDE, Pycharm IDE
Processor Core i7 (5^{th} Gen)	Windows, Linux

3 Specific Requirements

3.1 Functional Requirements

3.1.1 Capture Image

First capturing the facial image by high quality camera.

3.1.2 Dataset

Collect dataset to perform model training. In this system ,used ImageNet dataset for Transfer learning.

3.1.3 Image Pre-processing

Another functionality of the system is to perform pre-processing on the images that are provided by the user. Image pre-processing are the steps taken to format images before they are used by model training. In this system these steps include removal of noise from the images, Contrast enhancement to make the work area differentiable from the background, remove unwanted objects from the images and resizing of the image.

3.1.4 Segmentation

The segmented region is vital for feature extraction and it needs to be well focused and precise. Therefore, the segmentation is important to extract a region of interest that provides a precise Area faces. Segmentation involves the fundamental step of separating the face from the background and aims to separate the face from the other objects.

3.1.5 Classification

Classification is the last step to determine the segmented face belongs to which class. Classification will be done using a machine learning Algorithm known as CNN.

Deep learning is a machine learning technique in which a computer model performs classification tasks directly learning from text, images or sound.

Models are trained on a large number of datasets and CNN architectures containing many layers. In computer vision deep learning is used to detect and extract features automatically.

3.2 Use Case Diagram

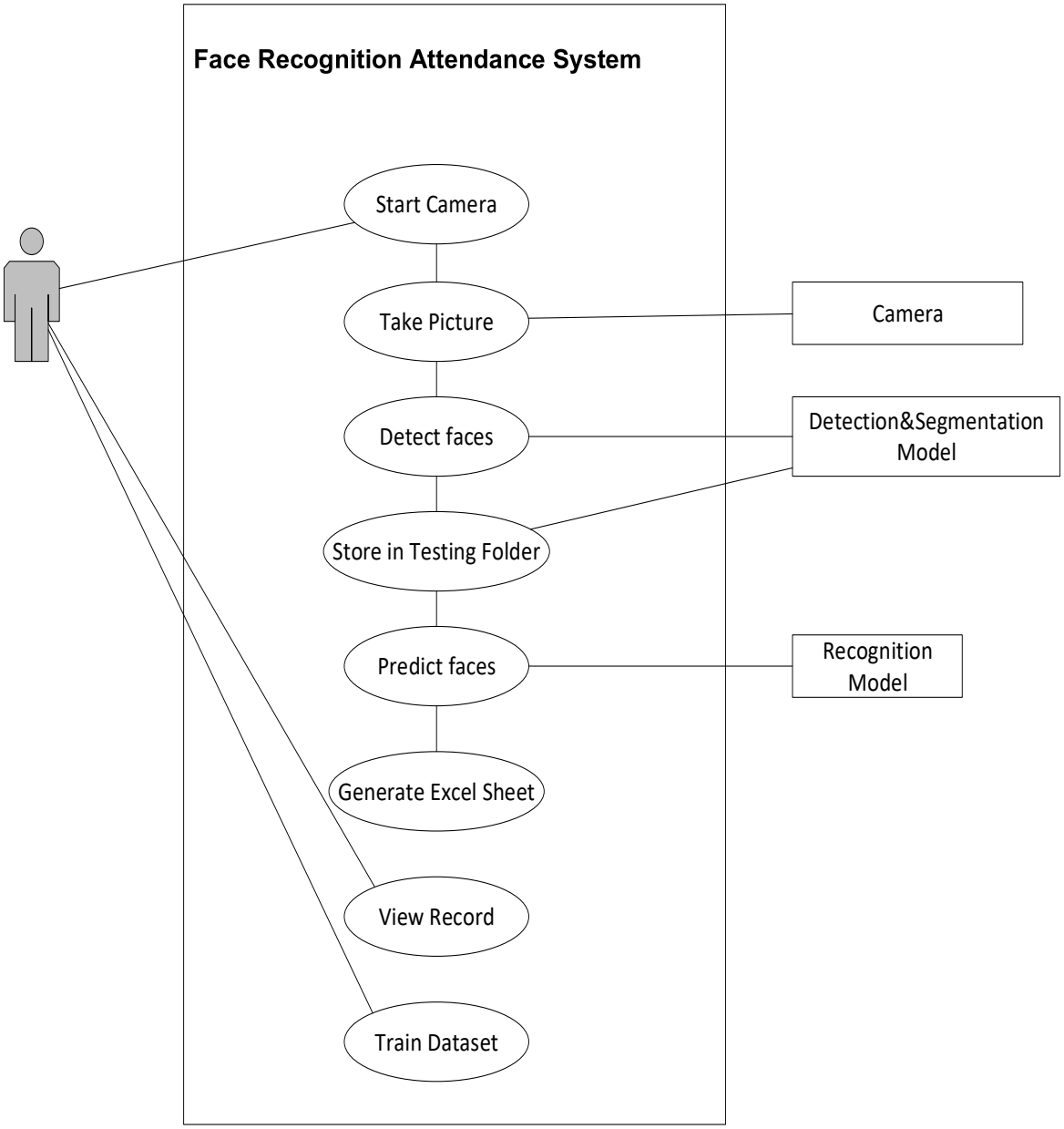

Figure 3.1: Use Case

3.3 Data Flow Diagram

Below given is a Data Flow Diagram which shows how the information flow through the system.

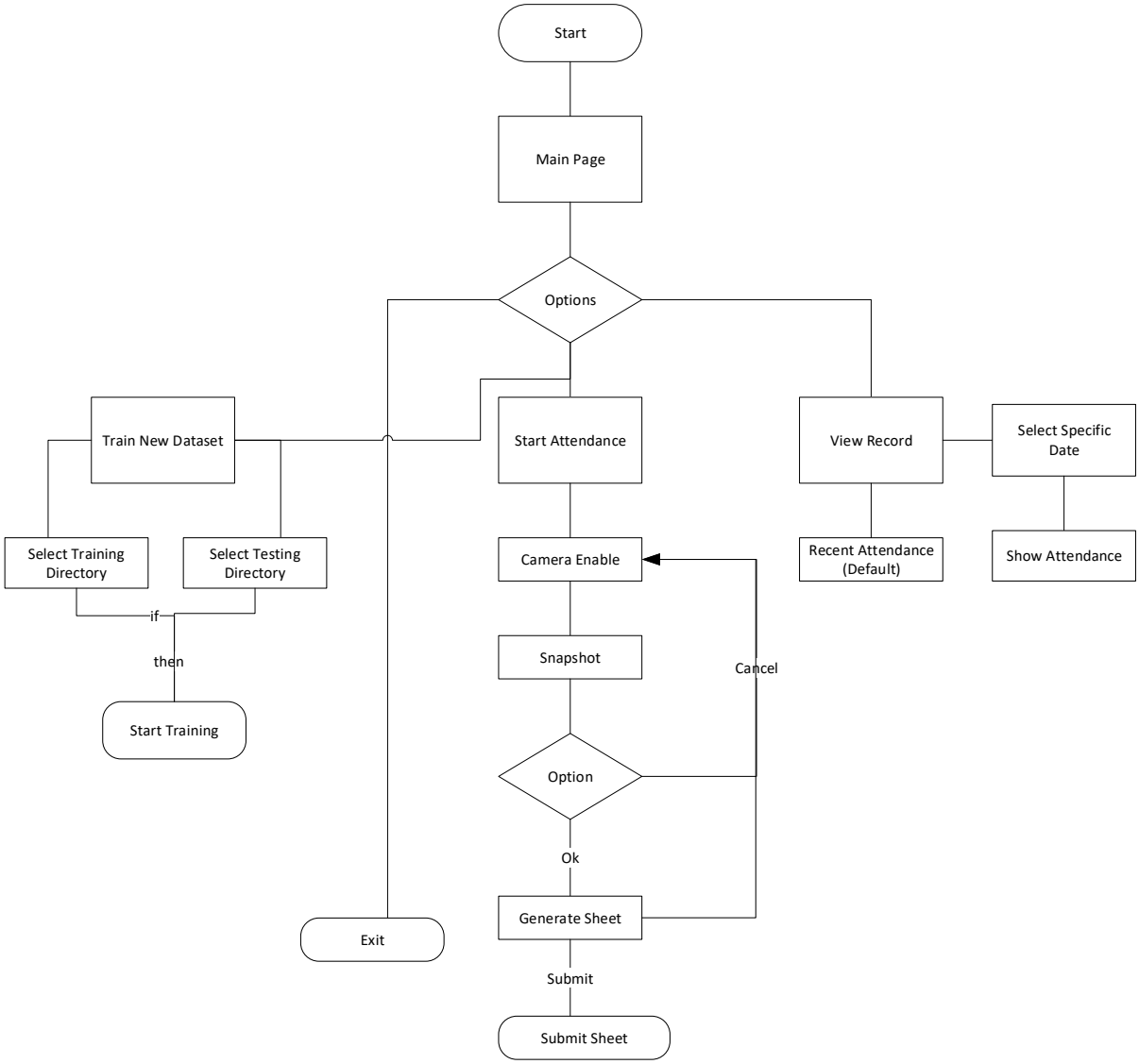

Figure 3.4: Data Flow

4 NON Functional Requirements

4.1 Performance Requirements:

In terms of performance this system should predict the output accurately i.e.

the output should be close to the reality.

4.2 Accuracy and Precision

The system should perform its process in accuracy and Precision to avoid problems. Maintainability: The maintenance group should be able to fix any problem that occurs suddenly. Speed and Responsiveness: Execution of operations should be fast.

4.3 Software Quality Attributes:

4.3.1 Reliability:

Predictions made by the system should be reliable i.e. user can trust that the output is correct and can proceed to his work depending on the output.

4.3.2 Usability:

System should be easy to use and should react accordingly and transverse quickly between its states.

4.3.3 Speed and Responsiveness:

Execution of operations should be fast.

5 Design Specification

In Design Specification phase which is based on design specification specify the Design factors like system design or logical design or architecture design. The system design specifies the overall system design includes logical or physical operations etc. Architecture design specifies the model architecture that model works. You would also be able to describe the algorithm that used to develop the system. This chapter also describes the system interaction and use case of the system.

5.1 System Design

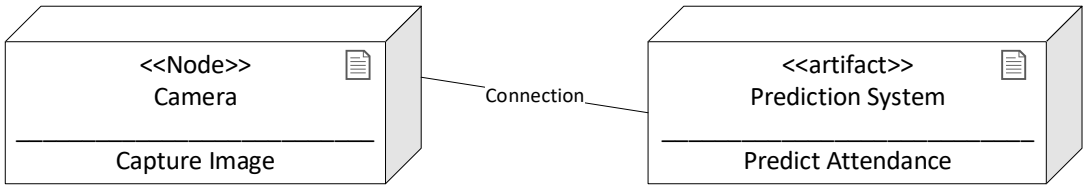

Figure 5.1: Deployment Diagram

5.2 Logical Design

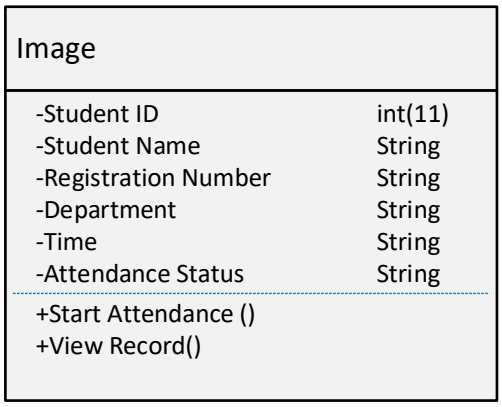

Figure 5.2: Class Diagram for Logical view

5.3 System Architecture

The architecture of this face recognition based attendance system is shown in the above mentioned diagram. The working of this smart attendance system is very simple and easy to understand. To bring this system into work, we will need some hardware devices for our project. Firstly, we will need a high definition camera which has to be fixed in the classroom at a suitable location from where the whole class can be covered in the camera. When the camera takes the picture of all students, that picture is enhanced for further processing. In the enhancement, the picture is first transformed in grayscale image, and then it will be equalized using histogram technique. After enhancement, the picture will be given for detecting the faces of students which will be done by face detection algorithm. Then after detection of faces, each student's face will be cropped from that image, and all those cropped faces will be compared with the database of faces. In that database, all students' information will be already maintained with their image. By comparing the faces one by one, the attendance of students will be marked on Excel sheet.

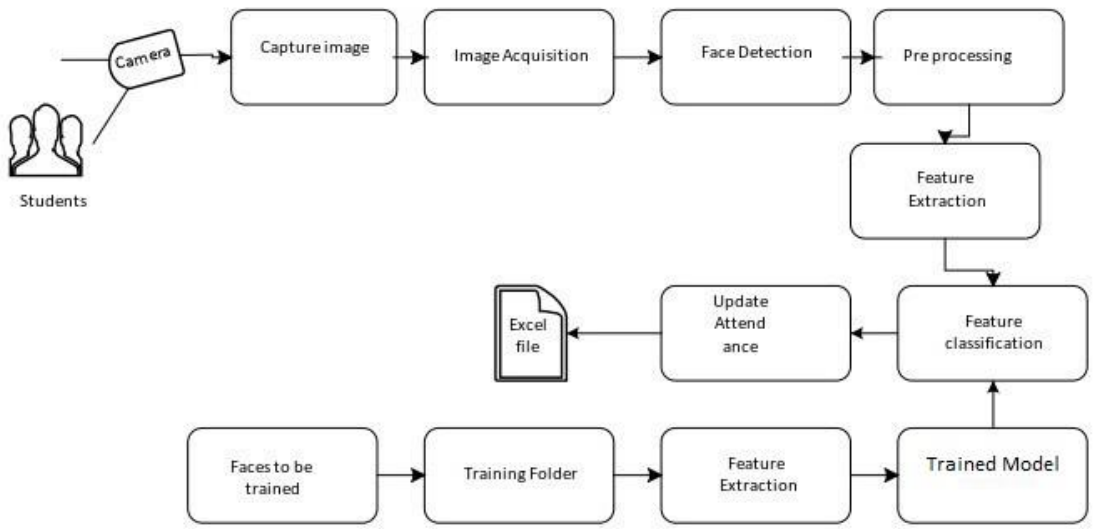

Figure 5.3: System Architecture

5.4 Algorithmic Viewpoint

General Algorithm:

Run python file of project.

Splash Screen of the system appear.

After that, User Interface of main page appear.

Step 1: Click on Start Attendance.

1. Camera will be enable.
2. Take snapshot of class group.
3. If snap is visible than click “OK”, otherwise click “cancel” button to retry Camera.
4. If click Ok, generate Attendance sheet for verification of the students strength. Otherwise click cancel to retry camera.

Step 2: Click on View Record.

1. Recent Attendance will show in the screen by default.
2. If you want to check specific date record, select date from Combo Box from upper left corner of the screen.

Step: 3 Click on Train New Dataset to train the dataset of new faces.

1. Firstly select the Training directory.
2. Second step is to select the Testing directory, and click on Start Training.

Step: 4 Click on Exit to terminate the system.

6 Development And Tools

6.1 Introduction

To Implement the Single Image Based Face Recognition By Two-fold NN Model for Smart Attendance we use state-of-the-art technologies that include python as programming language, Spyder IDE easy integrated development environment to create python application, Anaconda navigator, OpenCv tool to handle the camera, Transfer Learning Xception Model used to Recognition of faces and Retina Face Library to detection and extract faces from group photo.

6.2 Development

6.2.1 Tools and Technologies Used

The technologies and tools that we are using in this project are as follows in given table:

	Tools	**Version**	**Rational**
Tools And Technologies	MS Word	2016	Documentation
	MS PowerPoint	2016	Presentation
	MS Excel	2016	Record Attendance
	Anaconda	2022	AI platform
	Spyder	5.1.5	IDE
	Technology	**Version**	**Rationale**
	Python	3.8	Programming Language
	Tkinter	TCL\TK 8.6	Library

	Technology	**Version**	**Rationale**
	Tensorflow	2.11.0	Library
	OpenCv	4.6.0	Library
	Numpy	1.23.5	Library
	PIL	1.2a0	Image Library
	RetinaFace	0.0.10	Library
	openpyxl	3.0.5	Library
	Keras	2.3.0	Library
	pandas		
	Matplotlib		Library
	Subprocess		Library
	Globe		Library

6.2.2 External APIs/ Eternal Hardware:

Our System did not use any APIs

External hardware:

Our system is using IP Web Cam for Capturing Image.

6.3 System Implementation

6.4 Data and Information flow in the system

Start Attendance:

User capture image of the class by clicking on Start Attendance Button and camera will take a snapshot of the class and the record will submit after prediction from the image.

View record:

User can view the previous records of the attendance.

Train New Dataset:

User can train new dataset by giving directory path of the training data and the testing data. Then click the button for start training.

Exit:

User can terminate the process with Exit button.

Data flow Diagram of The system is given below:

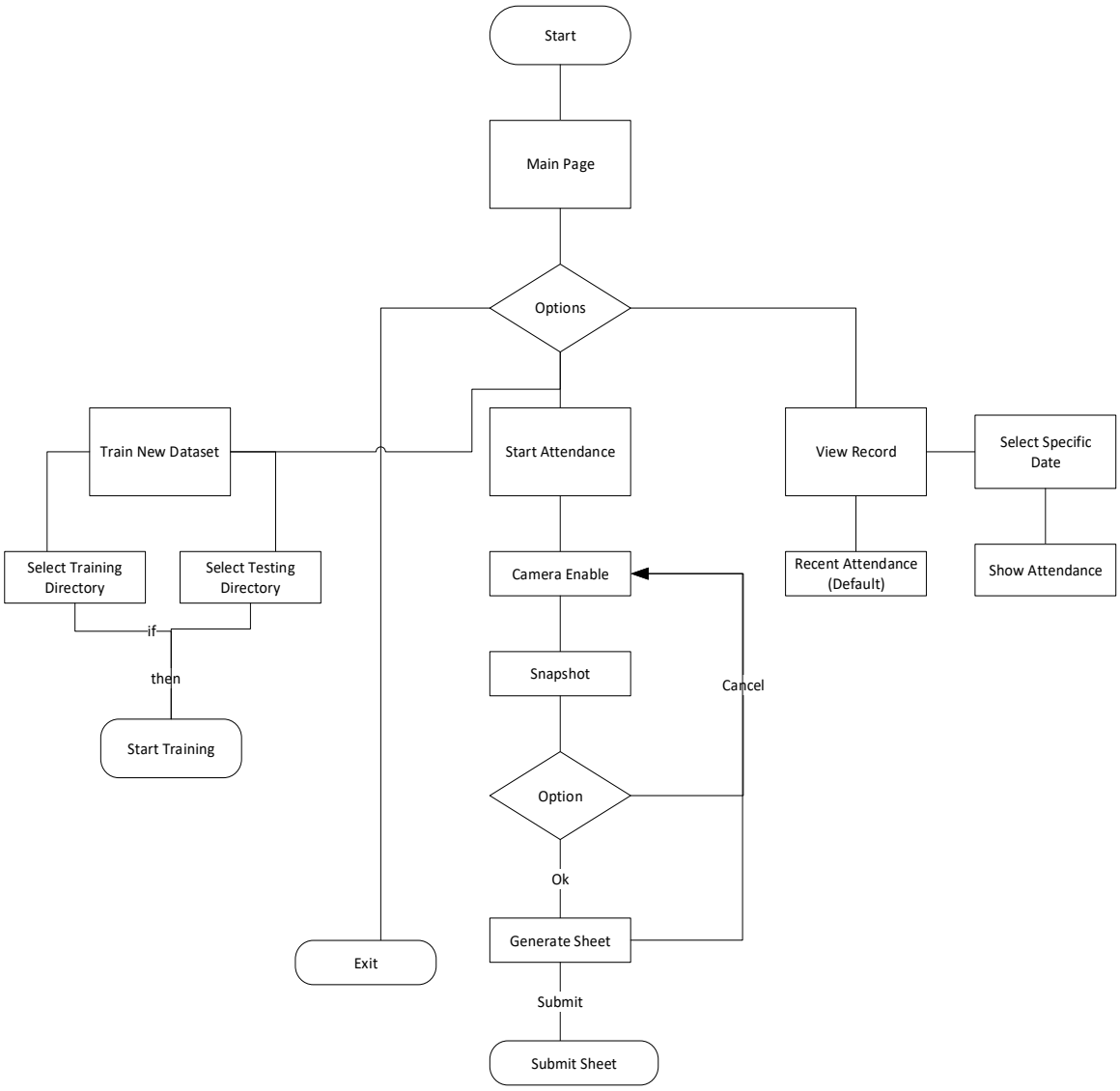

Figure 6.4: Level 1 DFD

6.5 User Interface

We developed simple and easy desktop graphical user interface (GUI) that have four buttons so user can interact with system easily.

- Start Attendance
- View Record
- Train New Dataset
- Exit

We use Canva frame for output screen and text area for prediction label. We use user friendly colour and graphics in our interfaces. User can understand interface by reading text and by seeing icons.

We design Interface in python by using Tkinter library.

Figure6.5.1: Start Attendance (Camera Enable)

Figure 6.5.2 Class Image

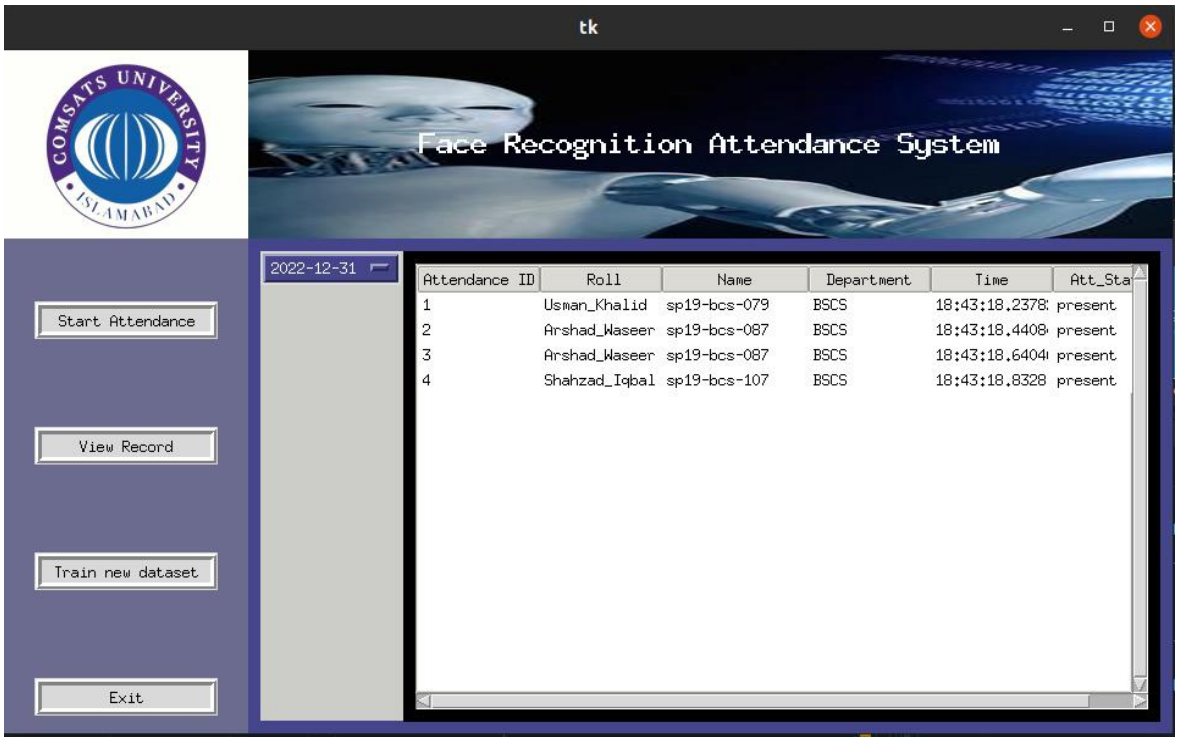

Figure 6.5.3 View Record Record

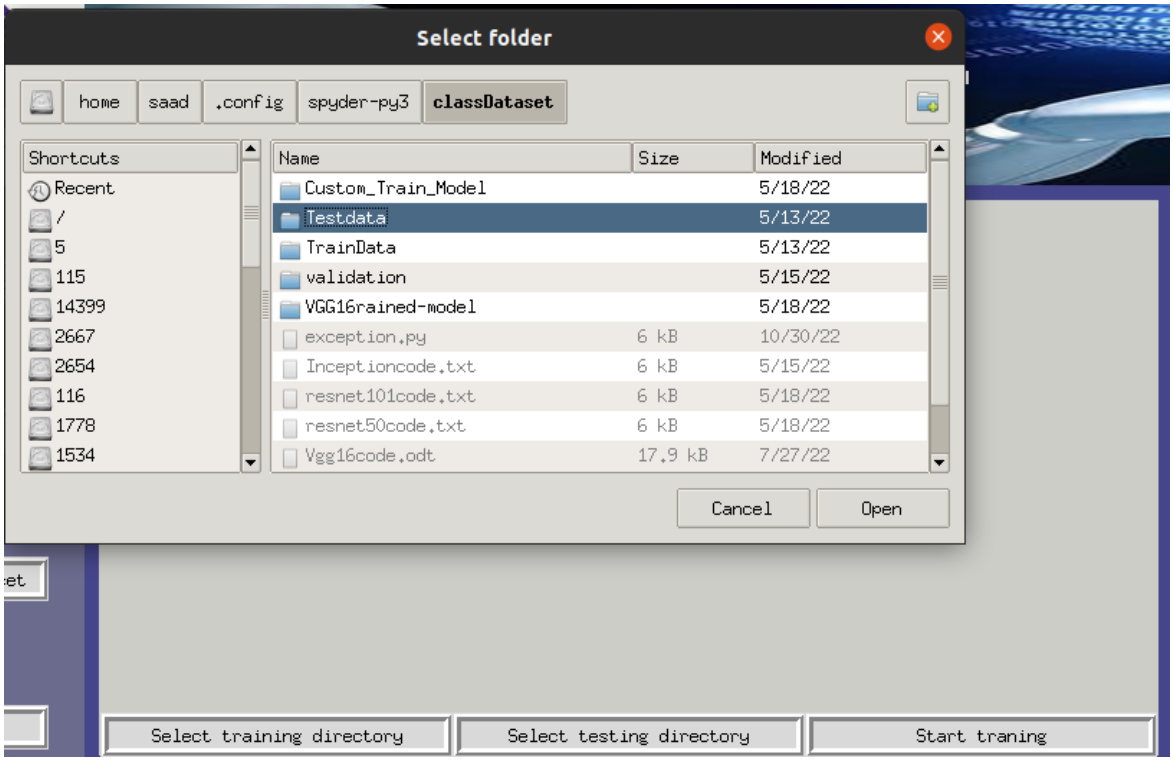

Figure 5.6.4 Select Testing and Training directory

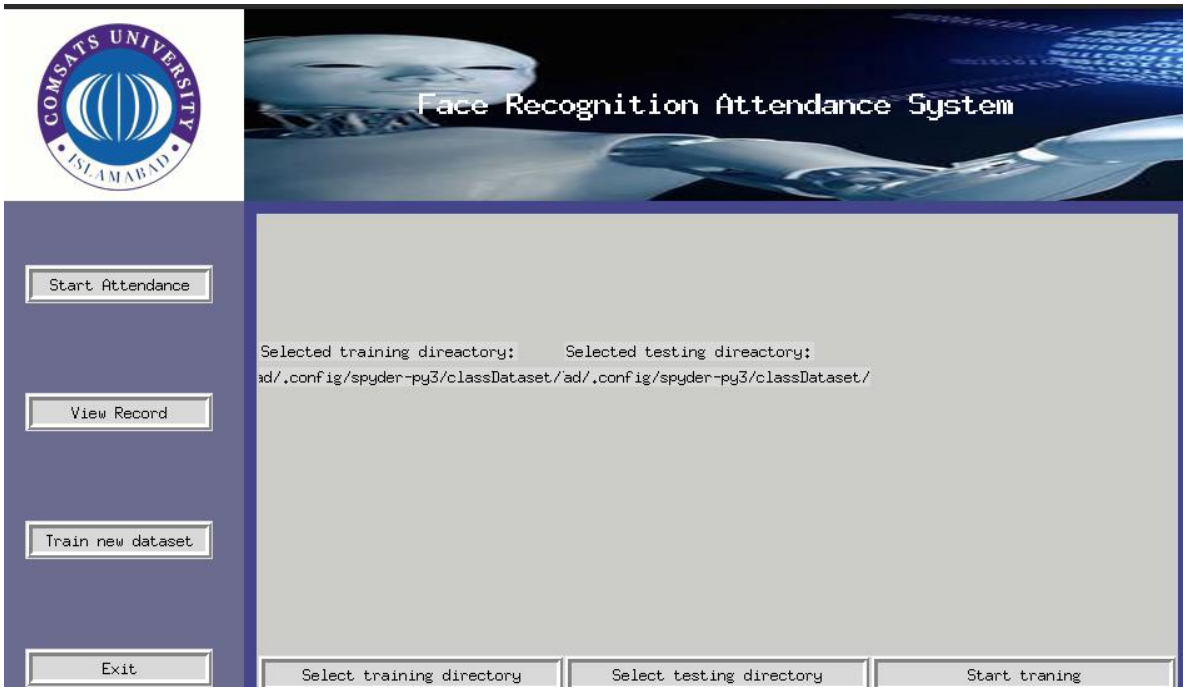

Figure 5.6.5 Train new dataset

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[5] https://ieeexplore.ieee.org/abstract/document/8776934/

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