COMSATS University Islamabad

Islamabad, Pakistan

AUTONOMOUS AGE AND GENDER PROVISION

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Bachelor of Science in Computer Science (2017-2021)

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AUTONOMOUS AGE AND GENDER PROVISION

A project presented to

COMSATS Institute of Information

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In partial fulfillment of the

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By

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Declaration

We certify that this is my/our own work. The work has not, in whole or in part, been presented elsewhere for assessment. Where material has been used from other sources it has been properly acknowledged. If this statement is untrue, we acknowledge that we will have committed an assessment offence and shall be liable to punishable action under the plagiarism rules of HEC.

_____ _____

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Dated: _____

Dated: _____

FINAL APPROVAL

Certified that we have read this project report submitted by Miss. (Muazma Noor, Iram Shehzadi) and it is, in our judgment, of sufficient standard to warrant its acceptance by Department of Computer Science, University of Wah, Wah Cantt, for the (BS degree) in Computer Science.

Committee:

1. External Examiner _____

(Examiner Name)

Designation

University Name

2. Supervisor _____

(Supervisor Name)

3. Chairperson _____

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4. Dean/Director _____

(Dean/Director Name)

DEDICATION

To my Loving Parents and Teachers (An example)

Executive Summary

Facial recognition is always been a hot topic in AI since the apple introduces the facial security locks in iPhone. When it comes to recognition of a human face, two main keywords that grasp all attention are

1) Identification
2) Authentication

Automatic Gender prediction and Age Estimation from images as well as real time detection has become a real phenomenon that increases the computer vision-based applications now a day, especially in the expanding of social media and social media platforms. It also supportive in numerous real world problems and applications as well as security controls, Customer relationships managements, Biometrics, Entertainment, Cosmetology, Forensics, and Helping reboots etc.

There are numerous types of deep neural networks has been addressed to met the solution of human being biometric identification such that face detection and recognition. A Convolutional Neural Network (CNN) is a Deep Learning Algorithm which can acquire in sequence picture, appoint importance to different viewpoints in the picture and have the option to separate one from the other. The pre-preparing needed in CNNs is a lot of lower when contrasted with other grouping algorithms. While in basic strategies channels are hand-designed, with enough preparing, CNNs can gain proficiency with these channels and qualities.

ACKNOWLEDGEMENT

A journey is easier when you travel together. Interdependence is certainly more valuable than independence. This project is the result of work where we have been accompanied and supported by many people. It is a pleasant aspect that we have now the opportunity to express our gratitude for all of them. We express our sincere gratitude, regards and thanks to our respected supervisor Najam Dar for their excellent guidance, invaluable suggestions and continuous encouragement at all the stages of our project. Their interest and confidence on us were the reasons for all the success we have made. We have been fortunate to have them as our guide as they have been a great influence on us both as a person and professional. Above all, we are blessed with such caring parents. We extend our deepest gratitude to our parents for their invaluable love, affection, encouragement and support.

PROJECT BRIEF

PROJECT NAME	AUTONOMOUS GENDER AGE PROVISION
ORGANIZATION NAME	COMSATS UNIVERSITY ATTOCK CAMPUS
OBJECTIVE	TO PREDICT AGE AND GENDER BY FACIAL RECOGNITION
UNDERTAKEN BY	MUAZMA NOOR IRAM SHEHZADI
SUPERVISED BY	Mr. NAJAM DAR LECTURER DEPARTMENT COMPUTER SCIENCE COMSATS UNIVERSITY ATTOCK CAMPUS
STARTED ON	15/02/2020
COMPLETED ON	06/06/2021

COMPUTER USED	DELL Core i3 7th gen.
SOURCE LANGUAGE	Python version 3.8
OPERATING SYSTEM	Microsoft Windows 10
TOOLS USED	PyCharm 2020.2.3, Qt Designer, Microsoft Word, Microsoft PowerPoint

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CHAPTER 1

INTRODUCTION

1 Introduction:

The project demonstrates the real time age and gender prediction by face recognition. Now age and gender estimation by voice is comparatively easier than by face. The proposed desktop app determines age and gender by utilize all the essential characteristics of face in conditions of geometrical features. This project might be helpful for measuring the heat of this pandemic situation. The health organizations will be able to put extra effort on SOP, s for most infected age group. Haar-cascading is used for face detection and for feature extraction landmarks are used.

Automatic age and gender segregation have been linked to a growing number of applications, especially when it comes to social media and social media. On the other hand, the effectiveness of the methods presented in the real-world images is still very limited, especially when compared to the dramatic jump in recently reported performance on related facial recognition. We show that by reading presentations on the use of in-depth learning of convolutional neural network (CNN), a significant increase in performance can be achieved in these activities. Finally, we recommend a simple convolutional net design that can be used even if the amount of learning data is limited. We measure our approach to the latest Adience benchmark for age and gender and show it to be far superior to the current state of the art form. System tries to detect user face at any angle after capturing face image from webcam. For example when webcam is closed to user system detects face accurate but when user is far away from exact position in front of webcam, it tries to detect face as angle of face changes that is given below:

Figure 1- 1 face angles

The facial feature extracted from the image and compares the data will provide the output from the beginning to the end in the form of gender and age of the person. We then compile our project in the form of a desktop app that will control with an attractive interface such as a comparison with a simple tool to predict gender and age using the human face feature. Real-time facial recognition in video clips took place in 2001 using the frame of voila john. Paul voila and Michael john combined their face detection system with haar similar to the use of object recognition technology in digital photography to introduce adaboost, the first real-time face recognition.The real time gender prediction and age estimation is given below:

Figure 1- 2 Gender Age Label

1.1 Brief

Facial recognition is the procedure to recognize an individual face. The idea of recognizing face was coming into existence after the object recognition systems. Facial recognition is the group of biometric software that matches human being facial features and stores the data as a face feature. For this purpose, we uses deep learning algorithms to compare recognized objects (live image capture) through webcam or digital image to store face pixels in regulate to authenticate individual's face

Our project emulsifies about face recognition in aspect of prediction like age and gender, the process starts with user's face detection and basis on the geometrical features of face, it predicts gender and age and in the end the system compares the results of the software and user's real age. By this we will be able to examine system accuracy.

To increase the performance and accuracy of system, we have to use two techniques over sampling and single crop to dataset and to focus in building a system that has better computational speed, time complexity and accuracy. We proposed an efficient classification technique able to perform an automated categorization of different age grouping and two different gender of capturing image. Our purposed system is based on image preprocessing and classification. The proposed system takes user face images and will automatically predict the gender and age of that user accurately. Our system predict gender and age estimate of human not only one person at a time but also predict gender and estimate age of many persons who came in front of system. The prediction of gender and age of more than one person at a time is given below:

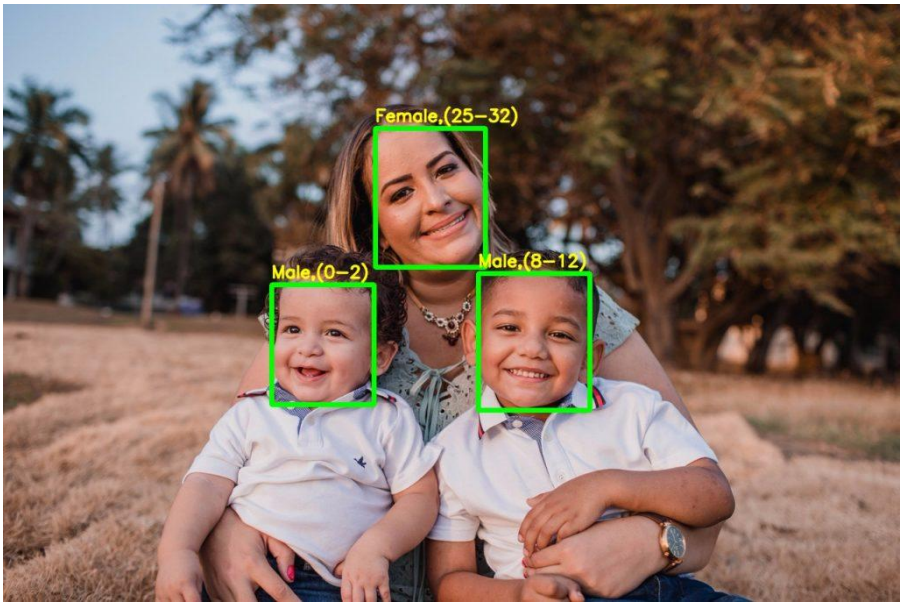

Figure 1- 3 Gender and Age label of multiple human

1.2 Relevance of Course Module

In this portion, we discuss some of relevance course module that helps us making our project.

1.2.1 Report Writing Skills

This course enables a person to identify the intended solution, deal with problems and write a report. Writing report guides on how to revitalize understanding of future developers and programs. The drafting of the report helps the business manager, or other organization to resolve it quickly in the selection and planning of anything. The significance of the design of the report is that it further assists in transferring within the labor organization, assessing business issues, and reversing financial fraud of normal operations.

1.2.2 Machine Learning

Machine learning is the discipline to make computers take action without over-measurement. In the past, mechanical learning has given us self-driving cars, active speech recognition, active web search, and highly advanced human genetic considerations. Machine learning has made incredible progress over the past few years, but we are still far from reaching human performance. Most of the time, a machine needs human support to complete its work. In collaboration, we have used Virtual Assistant solutions that fully integrate with the installation of a person's precise intelligence to convey a high degree of accuracy and understanding.

1.2.3 Human Computer Interaction

Human Computer Interaction (HCI) is a field of knowledge that reviews the plan and utilization of PC technology.HCI centers around interface among individuals, PCs and how to configure, assess, and execute intelligent PC frameworks that fulfill the client. People associate with PCs from multiple points of view which imply that having a decent interface that works with that cooperation is critical for our everyday exercises. Inadequately planned human-machine interfaces can prompt numerous sudden issues.

1.3 Project Background

In this project we are creating desktop application that can identifies human Gender and age on the basis of facial features and by using a comparative approach it calculates system accuracy. The user will be able to click picture through webcam then system will produce result on that basis on an interface of desktop application. The idea behind this project occurred in our mind to

measure the technology require for security concern that contains significance in modern ages. Automatic Gender prediction and age estimation from face pictures has drawn a lot of consideration recently; due it is a wide application in different facial investigation issues. Nonetheless, because of the huge intra-class variety of face pictures, the current models are as yet behind the ideal exactness level, which is essential for the utilization of these models in true applications. In this project, we propose a reflective learning system, in view of the gathering of attention and leftover convolutional networks, to predict the gender and age of any person in real time prediction with a high accuracy rate. Utilizing a consideration system empowers our model to zero in on the significant and informative portion of the face, which can assist it with making a more precise estimate. We train our model in a perform multiple tasks learning design, and expand the component inserting of the age classifier, with the predictable gender, and show that doing so can additionally build the precision old enough expectation. Our model is prepared on a popular face age and gender dataset name as Audience Bench Mark and accomplished promising outcomes. Through the representation of the consideration guides of the prepared model, we show that our model has figured out how to get touchy to the correct areas of the face.

1.3 Literature Review

The human face provides many details such as age, gender, and identity of these factors. Faces play a role in the critical situation between age estimates and gender predictions, by looking at their faces. Face detection and modeling is a unique feature of the human face that contributes greatly to the process of coping with the recognition of several challenges facing computer researchers and psychophysics. There are many methods suggested within the literature to allow for age and gender segregation. We briefly review the age and gender segregation literature and outline both the basic and human approaches that are most closely associated with our proposed approach, focusing on age and gender segregation of face images from unrestricted areas of the world. More recently, a growing number of investigators are beginning to use CNN in terms of age and gender. It categorizes the age and sex of the unclean images by calculating its best way to remove the feature. The CNN model can learn discriminatory affiliation, especially if the quantity of training images is large enough, to obtain the relevant details required in two categories.

1.4.1 Machine Learning Approach

Machine Learning plays an essential part in Computer Vision and provides hopeful results with improved accuracy .The machine learning also ensure the analysis of the different classification and regression problems and machine learning also provide the ability to make elegant and good algorithms that help to solve real world problems. The machine can estimate all possible moves from a given situation and select those that lead to some advantage. For examining the real world problems such as gender prediction and age estimation, machine learning provides a worthy approach for making efficient algorithms. There are following approaches that have been proposed by researchers.

1.4.2 Deep Learning Neural Network

Heba Mohsen proposed Deep Neural Network classifier (DNN) for classifying the gender and age classes. In model use the transformation and feature extraction tool and over all achieved 95% accuracy for the whole data set. In this technique, computation time is high and accuracy is low than other approaches.

1.4.3 Convolutional Neural Network

CNN is the most admired deep learning algorithm used It's great at computer vision; its computational Spots features that are effective and natural No monitoring. There is only one layer of CNN compared to Contains a conventional neural network, but a hidden layer Different types of inner layers, in particular Culprit layer, polling layer, fully enclosed layer, and Normal layer. In 2015, Levi et al. produced a CNN-based model, consisting of five layers, three resolutions, and two fully integrated layers. This model is used to predict the gender and age of unrestricted real face images. The model incorporates the center-crop and sample method, capturing minor inaccuracies in unrestricted images. Yi et al., In their research paper, used CNN's end-to-end program to study the deeper structure and the required parameters, solving age, gender, and nationality of classification tasks. Residual Networks Residual Networks (RoR), the model incorporates a RoR structure, which was

determined by gender and weight loss layer in the ImageNet dataset, and was ultimately optimized in the IMDb-WIKI-101 database.

1.4.4 Comparison of CNN research work

Table 1- 1 Comparison of CNN

Author	**Purposed Work**	**Target**	**Accuracy**
Kwon and Lobo (1999)	Developed the extremely first method for age estimation focusing on geometric features of the face that determine the ratios among different dimensions of facial features.	Age Estimation	80%
Lanitis et al(2004)	Proposed an Active Appearance Model (AAM) based method that incorporated both the geometric and texture features.	Extract Feature for Gender and Age prediction	85%

Shubham Mittal , Shiva Mittal (2019)	Gender identification from Facial Images using Convolution Neural Network Fifth International Conference on Image Information Processing (ICIIP)	Gender Recognition	90%

1.5 Analysis for Literature Review

We dealt with the age group classification and the gender of the images of the faces of the undivided and unorganized imaginary world. We presented this work as a multi-class classification problem and trained the model as a classification-based loss training target. CNN Design is an end-to-end learning architecture, including feature extraction and classification steps. There are four confusing layers in the extraction phase, with the resulting parameters, including the number of filters, the kernel size of each filter.

The predicted procedure is a combination of two steps: neck-based cascade classification and facial recognition manipulation in the principal module analysis. A classification of facial detection and recognition methods is evaluated and a visual recognition and identification solution is proposed as a preliminary step for video verification. Implementing facial recognition using principal component analysis using four distance classifications is proposed.

1.6 Methodology and Software Lifecycle of Project

The essential and construction brick of a project is to describe methodology i.e. steps to describe development of project. For developing of “Gender Age Provision”, we have selected strategically model type that can be molded simply after designing. We have to use agile development strategy for development of our model for project.

1.6.1 Agile Development

Agile development is interactive software development strategy that involves collaboration and selforganizational cross-functional teams. This involves deliverance of project incrementally rather than builds and deliver whole project. Gender Age Provision application is basically desktop based solution of research paper. We must deliver progress report to supervisor on incremental basis and on that we progressively develop this application. Basically, agile is amalgamation of methodology and techniques.

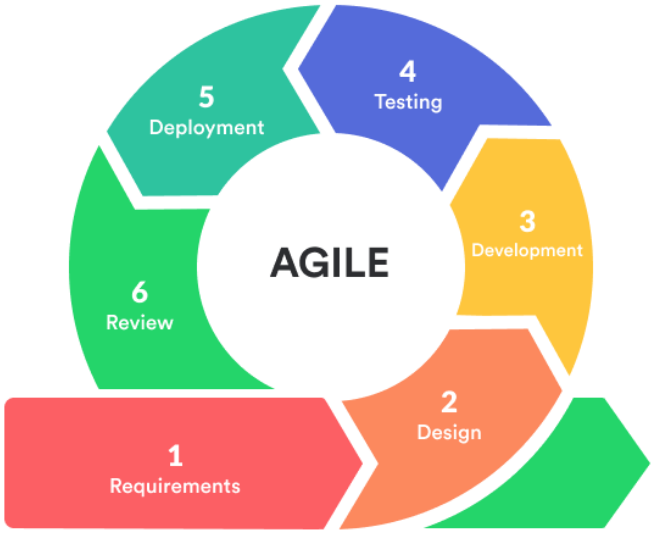

Figure 1- 4 Agile Development Cycle

1.6.2 Rationale behind selected methodology

We have used Agile Methodology in building our desktop application. We have built our application in different layers according to our initial planning. While building each layer we have discussed each and everything with our customer and users. A customer and user shared his ideas with us, and we did with him, and after discussing each idea we had work on the best idea to find best output. We have followed each step of agile development methodology while building each layer of the project.

CHAPTER 2

PROBLEM STATEMENT

2.1 Problem Statement

Gender predictions and age estimation of faces categorize real world facial images into age and gender prediction. Age and gender predictions of unfiltered faces categorize unconstrained real world facial images into predefined age and gender. Generally gender predicts and age estimation does not work in real time environment. The gender and age of a person predict through photo, from that person's facial features from live video camera. Early work on age estimation, enthused by studies of aging in biology, proposed representing faces by obtaining facial measurements that modify with a person's age.

2.2 Deliverables and Development Requirements

2.2.1 Deliverables

With the development of smart devices, such as smartphones and smart televisions, the natural user interface (NUI) is becoming increasingly attractive and necessary in modern times. Additionally, 3DTV NUIs can be measured in a similar modern era with current research on triangular (3D) video processing techniques. NUIs take advantage of natural interactions with a system using default functions, algorithms and physical human characteristics. For example, people have been using hand gestures, speech and mobile device gestures to interact with machines such as computers and smart devices.

In a previous study, fingerprint instruments were raised according to the design of a finger glove system. In conjunction with touch and speech, the human face, which contains detailed information about the individual, has been used for human machine interaction in many applications including human face recognition, gender classification, age measurement, facial identification and age measurement using face images.

Our projected desktop application "Gender and Age Provision" determines age and gender in close to to real-time by utilizing all the essential characteristics of human face in conditions of geometrical features and the system will be deliverable in marketing level with some additional feature and modification of that application. Estimation of both the module is categorized into

textual and external feature. The algorithmic structure with the aim of going to be followed in this project is Voila Johns algorithm. The classifiers used in project will be Square Euclidian distance method and the dataset we will used to train software will be Audience Benchmark gender and age classification. By algorithmic structure voila jones algorithm will be used. OpenCV will be used as face detection. For output PC Camera will be used to take input from user and estimated age and gender will be displayed to the user with image displayed.

2.2.2 Development Requirements:

Developmental requirements are the key step in any project to finish the implementation successfully we need two elements that are:

- A full set of designing interface and specification
- The proper procedures, standards, and toolkits

The IDE used for this purpose is “JetBrains PyCharm Community Edition 2019.2.0” in which we did back end coding for gender prediction and age estimation. The language that is used for coding is Python. This is dataset-based work and using dataset is Audience Bench Mark containing more than 10,000 images. The python built-in libraries and functions are also used that are supported by “Anaconda Distribution”. The graphical user interface is created by using “PyQT Designer”. The documentation is written in “MS WORD” and presentation slides are completed using “MS PowerPoint”. A system with high-quality GPU and 8 GB RAM is required for our project. The operating System containing window 10 is used for developing that system.

2.2.2.1 Software Requirement

- Operating System with installing Window 10
- Python in Anaconda 3.6 version for code implementation
- PyQt Designer for front end user interface

2.2.2.2 Hardware Requirement

- 8 GB Internal Memory

2.2.2.3 Languages

- Python

2.2.2.4 Libraries

- Numpy
- Open CV
- Time
- Torch
- Math

2.3 Tools and Techniques:

Table 2- 1 Tools and Technologies

Tools and Technologies	Version	Rationale
Pycharm	2019	IDE
MS Word	2013	Documentation
MS Power Point	2013	Presentation
pyQt Designer	2019	User Interface
Visual Paradigm Online	Online	Working Flow diagrams

CHAPTER 3

REQUIREMENT ANALYSIS

3 Requirement analysis

The requirement gathering and analysis is most important phase of project development because the outcome of this stage is the software requirements specifications (SRS) document to facilitate and serves as the starting point for the next phase of software development and software design. It is necessary to note that the software requirements specification (SRS) and analysis stage focuses only on what the software system should do and no, how it should be done to facilitate the implementation facts. Before starting the project developmental task we have to gather the entire requirement and wrote all the requirements and then we have to discuss these requirement contains quires. After collecting the data requirement, we have to go next step that is project planning including required cost, time, resources, advantages and disadvantages.

After collecting the requirements, we compose a software requirement specification (SRS) document in which there is comprehensive explanation of project which is helpful for user as well as developer. The experiment phase is constructed that exhibits the flow chart of system. The Gender prediction is a classification problem and Age estimation is a regression problem. And we have to require human faces in front of our system as an input to recognized the gender and estimate the age of user or any person. We analyze these requirements that need to develop our project that is Gender and Age provision.

3.1 Use Case Diagram

Use case diagram is graphically demonstration of consumer interaction with system that shows functionality and actions allowable to application. Fundamentally, here we have to show the interaction between different entities of the system application. The functionalities are interconnected to each other. Our front end shows interactive interface, functions and feature that application can execute. We have to detect human face through web cam in our system then perform preprocessing that includes further operations contains face detection and feature extraction. Then we pass that preprocessed image to convolution neural network (CNN) that train model for gender prediction and age estimation. After this a square box is created around human face that contains label is displayed in result and application closes. The use cases are

image capture, preprocessing, classification, identify gender perdition and Age estimation and then close application.

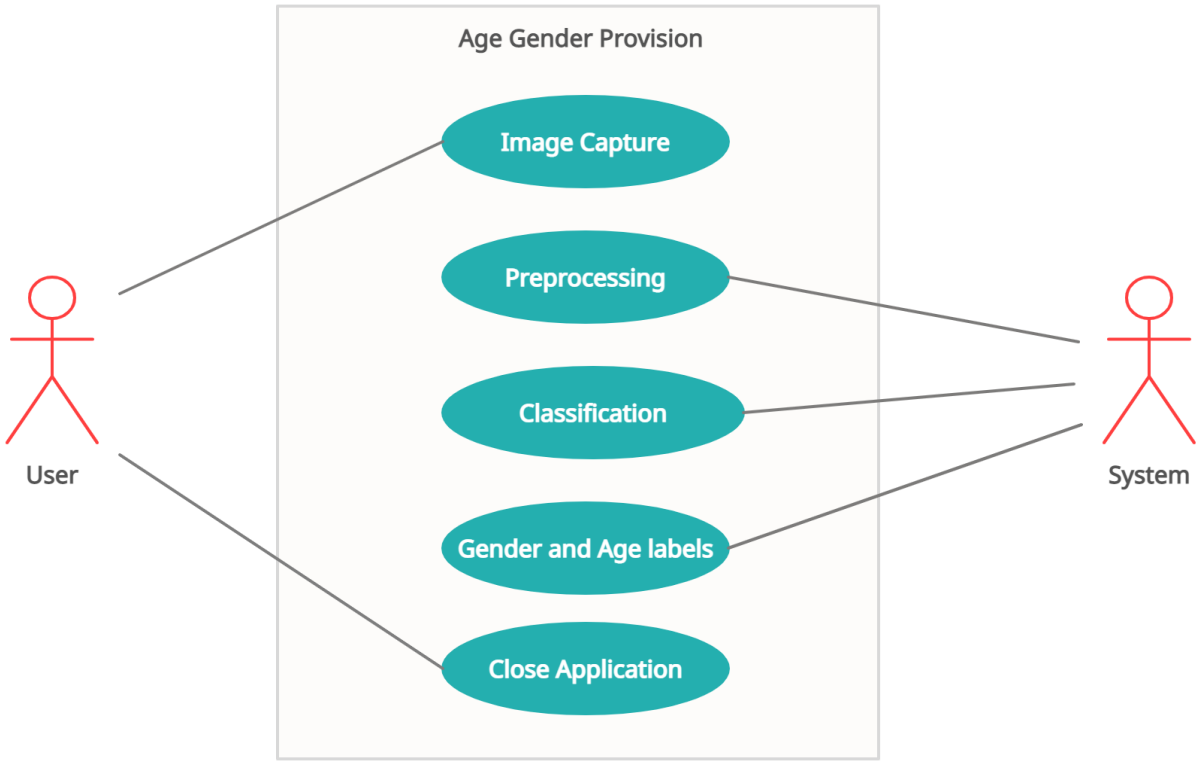

Figure 3- 1 Use Case Diagram

3.2 Detailed Use Case Diagram

There are following a test case that represents the interaction of an actor with system “Gender and Age provision”.

3.2.1 Use Case # 01 (Image Capture)

Table 3- 1 Use Case 01

Use Case ID	Use case 01
Use Case Name	Image Capture
Actor	User
Description	Image of human face will be capture from web cam
Triggers	Human face will be recognized through web cam in system for further preprocessing
Pre-condition	User must have a system
Post-Condition	Image of human face will go for preprocessing contains feature extraction
Normal Flow	No error
Alternative Flow	No alternative path
Expectation	If no user or human face come in front of system then system not proceed further and displays message “No Face Detected”
Business Rule	It may be many faces come in front of system at a time

3.2.2 Use Case # 02 (Preprocessing)

Table 3- 2 Use Case 02

Use Case ID	Use case 02
Use Case Name	Preprocessing
Actor	System
Description	Unconstrained and unfiltered image of human face will be further proceeding for feature extraction processes.
Triggers	Human face will be recognized through web cam in system and ready for preprocessing
Pre-condition	User must come in front of system
Post-Condition	Image of human face will go for classification
Normal Flow	System cannot processed further until human face detects
Alternative Flow	No alternative path
Expectation	Preprocessing of unconstrained image contains feature extraction
Business Rule	It may be many faces come in front of system at a time and then proceed all faces

3.2.3 Use Case # 03 (Classification)

Table 3- 3 Use Case 03

Use Case ID	Use case 03
Use Case Name	Classification
Actor	System
Description	Image of human face will be classified
Triggers	Image of human face is done preprocessing and is ready for classification according to given classes
Pre-condition	Image of human face has been preprocessed
Post-Condition	Gender and Age of user is predicted
Normal Flow	No error
Alternative Flow	No alternative path
Expectation	Preprocessed image of human face should be classified
Business Rule	It may be many faces come in front of system at a time and then classified all faces

3.2.4 Use Case # 04 (Gender and Age label)

Table 3- 4 Use Case 04

Use Case ID	Use case 04
Use Case Name	Gender and Age label
Actor	System
Description	Image of human face will be labeled as predicted gender and age
Triggers	Classification of image of human face is done
Pre-condition	Image of human face has been classified
Post-Condition	Respond back to user with predicted gender and age
Normal Flow	No error
Alternative Flow	No alternative path
Expectation	Gender and age of user is predicted and displayed on screen
Business Rule	Gender and Age of one or more images is predicted at a time and then labeled all the faces

3.2.5 Use Case # 05 (Close Application)

Table 3- 5 Use Case 05

Use Case ID	Use case 05
Use Case Name	Close Application
Actor	System
Description	Gender and Age of user is displayed
Triggers	Gender of user ids predicted and Age is also estimated
Pre-condition	Output is displayed to user
Post-Condition	No more action is performed
Normal Flow	No error
Alternative Flow	No alternative path
Expectation	Displayed final output and results
Business Rule	Click on close icon or cross button

3.3 Functional Requirement

Functional requirements are the features that developers be required to implement to enable users to achieve their tasks and involves process, functionality, method that suppose to be perform. It's essential to build obvious both for the developmental group and the stakeholders. Normally, functional requirements illustrate system activities under specification and conditions.

Table 3- 6 Functional Requirements

Serial Number	**Functional Requirement Description**
FR-1	Reliable Model
FR-2	Interface to interact
FR-3	Image of human face
FR-4	Image preprocessed
FR-5	predict gender and age on basis of facial feature
FR-6	Classification labels
FR-7	Compare both the results and give the matched ratio percentage.

- **FR-1:**
  A reliable model for classification of Gender (having male and female category) and Age (classified into eight classes) taking minimum response time.
- **FR-2:**
  Desktop application will give the interface where user will be able to interact with system and access all the functionality offered by project.
- **FR-3:**

After start of application user will open webcam and system will find the area of interest from the captured image.

- **FR-4:**
  In preprocessing step the system extract the feature of human face just after the face detection.
  User will be asked for to write age, the sole purpose to take age input is to use it as a comparative approach to find system accuracy.
- **FR-5:**
  After all the inputs taking capturing images system will predict user gender and age by using facial features.
- **FR-6:**
  When system predict the gender and age of user then it displays labels of gender and age as a output just top of the box around that user face.
- **FR-7:**
  System will compare the user input age and predicted age by system and by using this approach we will be able to calculate system accuracy.

The application will be developed in python framework and can be run on compatible with any system having python setup installed. “Gender and Age Provision” is a desktop application for classifying gender and age. The main features involve training of model, and testing of model. The application is capable of preprocessing, classification and can predict the gender and age estimation. Let user can easily understand interactive interface.

3.3.1 Training of CNN model

CNN is classifier, which gets trained on gender and age prediction dataset of images. The trained model generates a file that will help in predicting gender and age label. The model is trained in epochs.

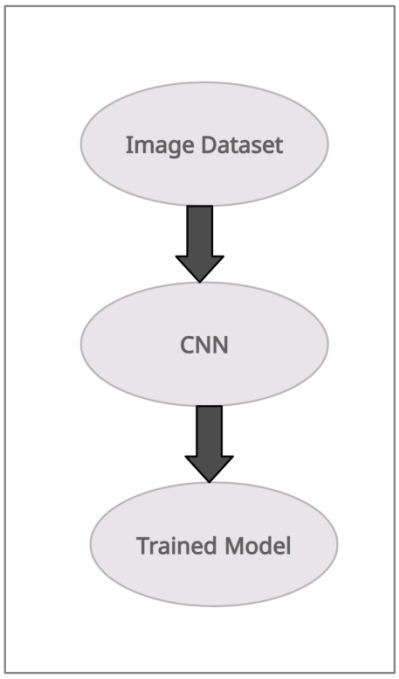

Figure 3- 2 Training CNN

3.3.2 Testing Model (Application)

After training the model application is ready to be tested means can predict gender and age of user by displaying on user interface.

3.3.3 Image capture

On application start-up, we input a capturing face image by clicking on “Open camera”. By clicking this button and user should came in front of system, then system detect face image for classifying Gender and Age.

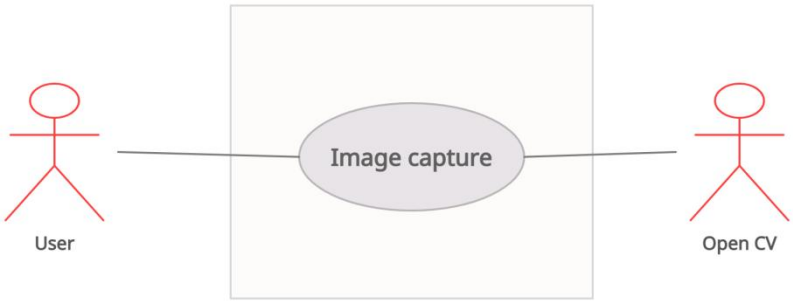

Figure 3- 3 Image capture

3.3.4 Preprocessing

After face detection image goes for further preprocessing. In preprocessing we apply two techniques that are over sampling and single crop on dataset to increase the accuracy of system.

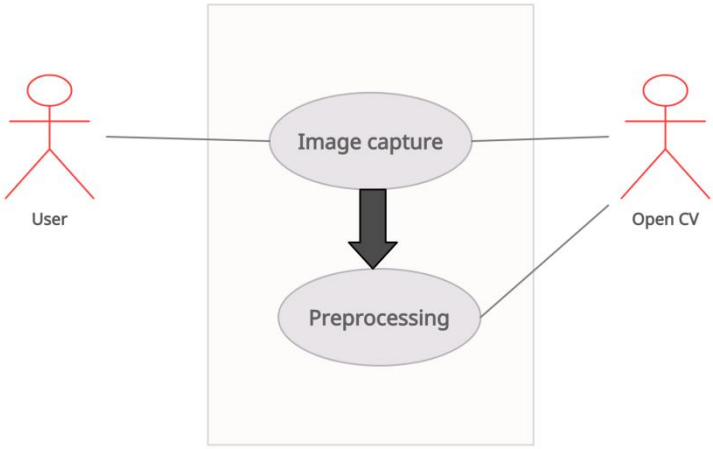

Figure 3- 4 Preprocessing

3.3.5 Classification

Image after preprocessing goes for classification for predicting Gender and Age label.

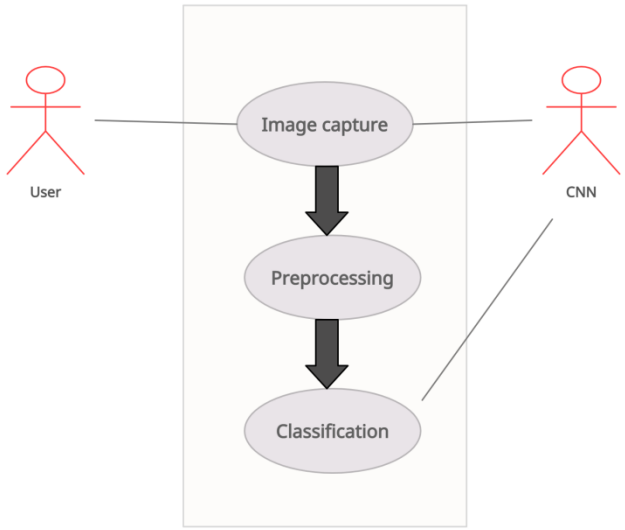

Figure 3- 5 classification

3.3.5 Gender and Age label

Finally the Gender and Age label is displayed on screen after preprocessing.

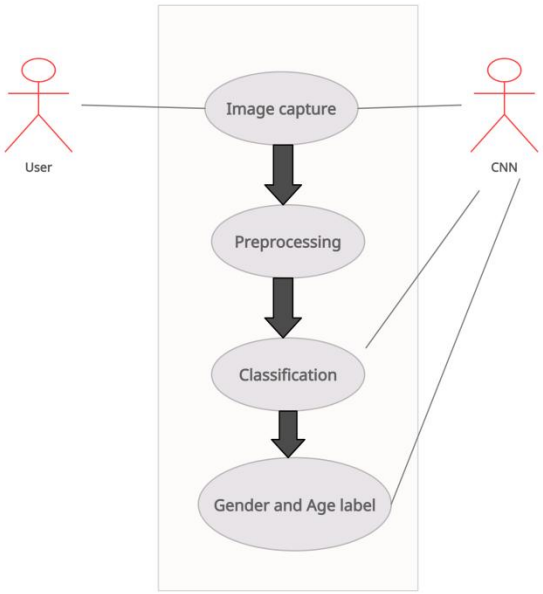

Figure 3- 6 **Gender and Age label**

3.3.6 Close application

To exit the application user can click on closing icon. Clicking on this icon will result in closing of application.

Figure 3- 7 close application

3.4 Nonfunctional requirements

Table 3- 7 Non Functional Requirements

Serial Number	Nonfunctional Requirement Description
NFR-1	Usability
NFR-2	Robustness
NFR-3	Efficiency
NFR-4	Secure
NFR-5	Flexible
NFR-6	Response Time

3.4.3 Usability:

The interface will be simple enough that it will be easily understandable by any kind of user

3.4.4 Robustness:

For any unexpected input it will display a suitable message system will have ability to deal with any startling input.

3.4.5 Efficiency:

Communication will be highly responsive and easy to use.

3.4.6 Flexible:

The user will be able to use application at anywhere.

3.4.7 Security:

Any kind of input provided by the user will keep confidential and all the standards of security will be maintained.

3.4.8 Response Time:

"Gender and Age Provision" is desktop application that will be a reliable computer-based solution takes less time to identity the gender and age of user with their face angles.

CHAPTER 4

DESIGN AND ARCHITECTURE

4. Design and Architecture

The graphical demonstration is a set of concepts that are an element of architecture, counting principles, elements, and components. Our described architecture consists of two main modules: One is Front end module and other is backend module. Front end module contains an interactive interface that allows user to input face of user has come in front of system. The user face then sent to trained model where the respective result displayed on screen after some preprocessing and classification. The overall architecture will explain the complete view of developing model Figure 4-1. Front end of the application is designed in python. For designing, we use PYQT5 library.

4.1 System Architecture

“Gender and Age provision” is desktop application for predicting gender and age estimation label by classifying an image of human face. The developed application will allow the user to input image of his face, preprocess it, classify it and predict label of gender prediction and age estimation. The predicted label of age and gender will be displayed on screen.

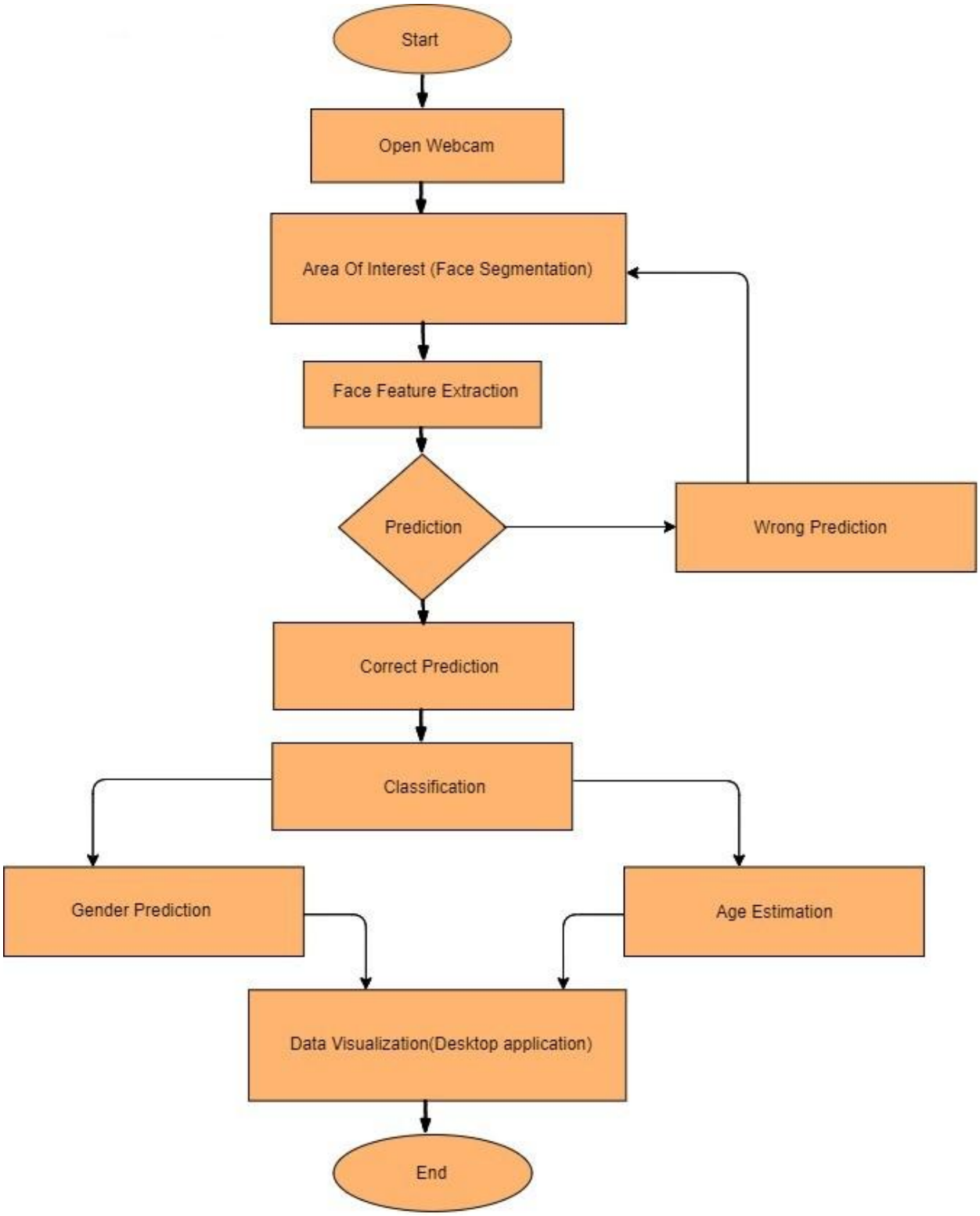

Figure 4- 1 system architecture

4.2 Data Representation (Diagram and Description)

4.2.1 Data Flow Diagram

Dataflow diagram shows entire flow of data and information between modules of the system. There are two main modules of our project that is “Gender Prediction” and “Age Estimation”. These two modules further divides in sub modules that are “Image capture”, “Preprocessing”, “Classification” and “Predict gender and age label”. When user comes in front of system, system detect user’s face and application will preprocess and classify it and respond back by predicting the label of gender and age and then display result to user.

4.2.1.1 Data Flow Diagram Level 0

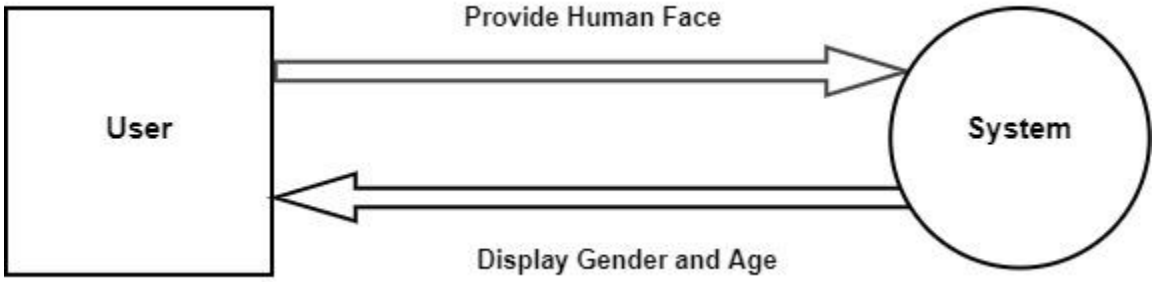

Figure 4- 2 dataflow level 0

In level 0 we have two entities that are “user” and “system”. User provides his face as input and application can predict gender and age of that user as output. In Figure 4-1, the data flow diagram of the “Gender Age provision” application is shown, represents that we are inputting user’s face image and as a result application is responding back in the form of predicting gender and age label.

4.2.1.2 Data Flow Diagram Level 1

The complete flow of each module of our project has been shown in figure below.

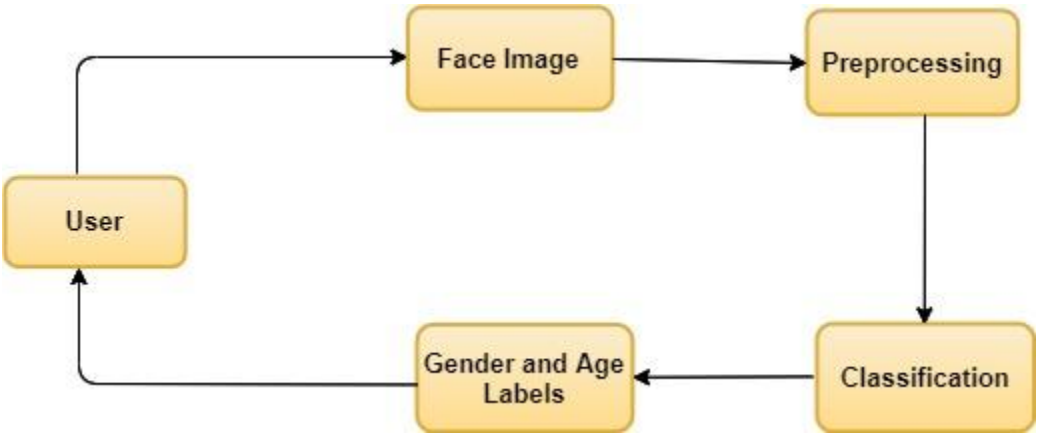

Figure 4- 3 dataflow level 1

4.3 Process Flow / Representation

The activity diagram is fundamentally described as “behavioral diagram” that depicts main working of application from start to end.

4.3.1 Activity Diagram

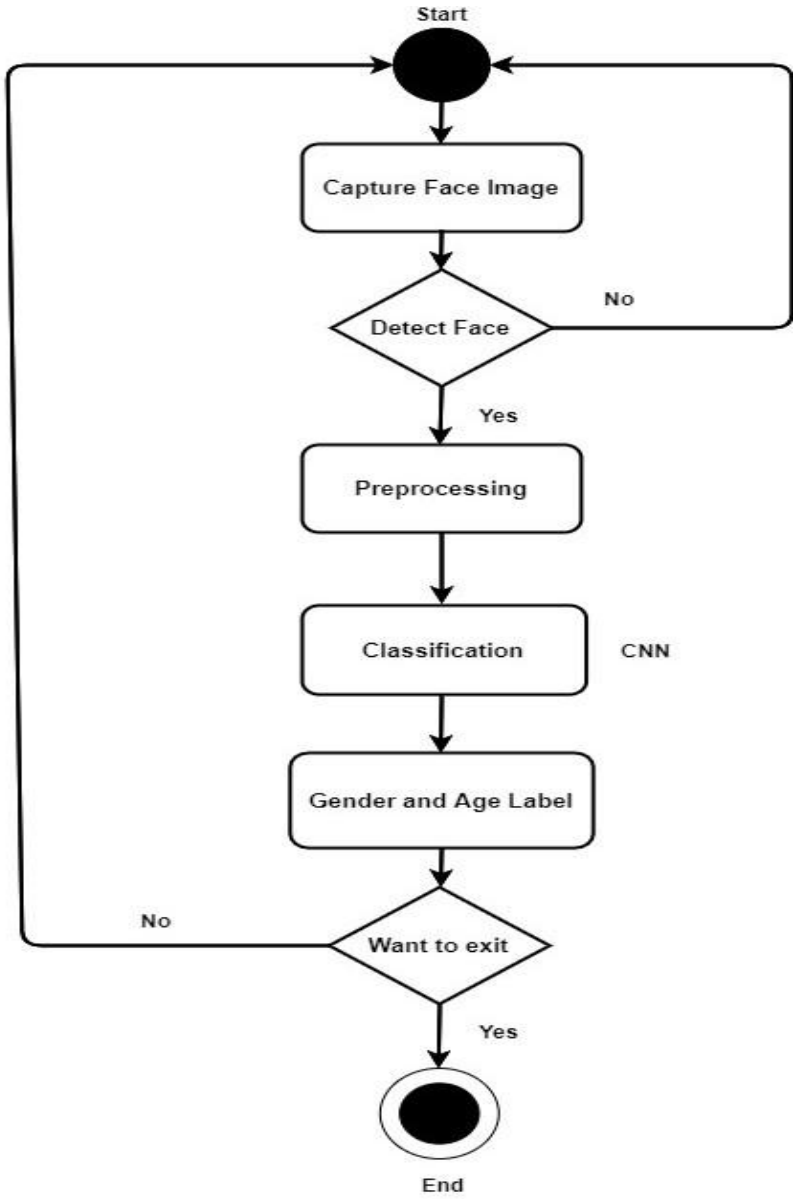

Figure 4- 4 Activity Diagram

4.3.2 Use Case Diagram

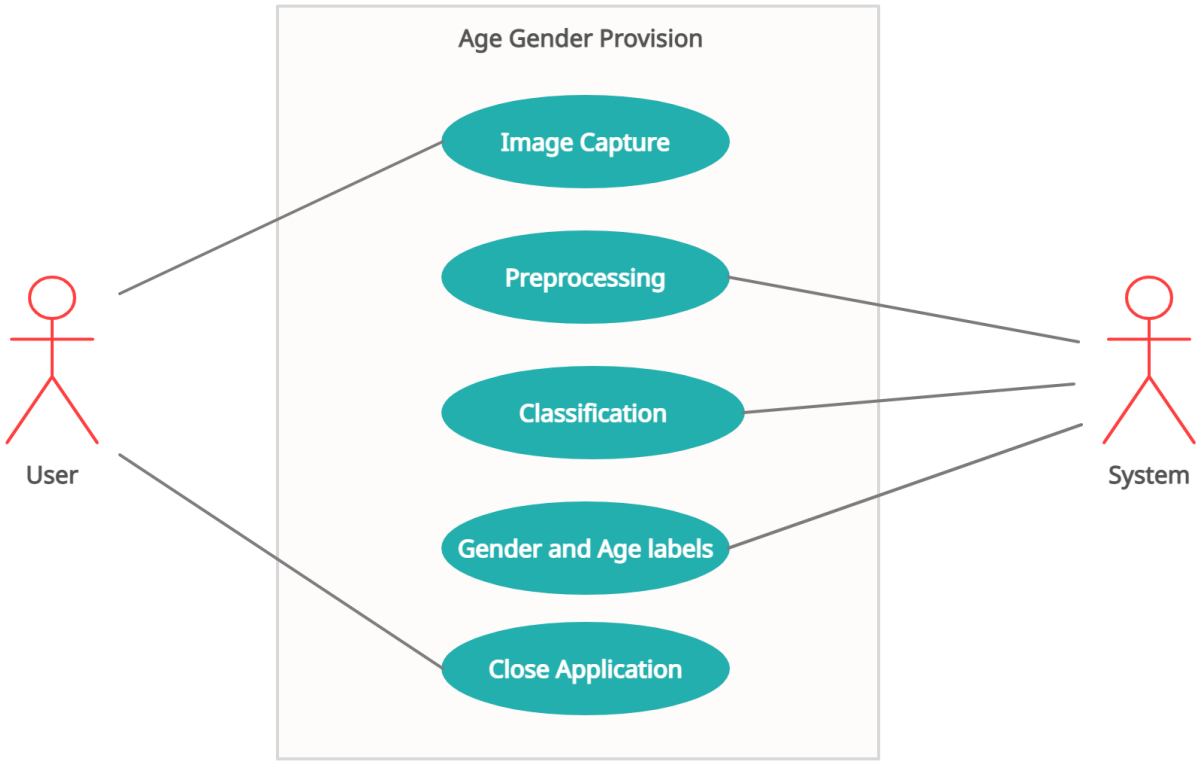

Figure 4- 5 Use Case Diagrams

4.4 Design Models

4.4.1 Sequence Diagram

Sequence diagram describes the exact sequence, life line and timing of each activity, which has to be performed in project. In this figure, sequence diagram of the "Age Gender Provision" desktop application has shown given below:

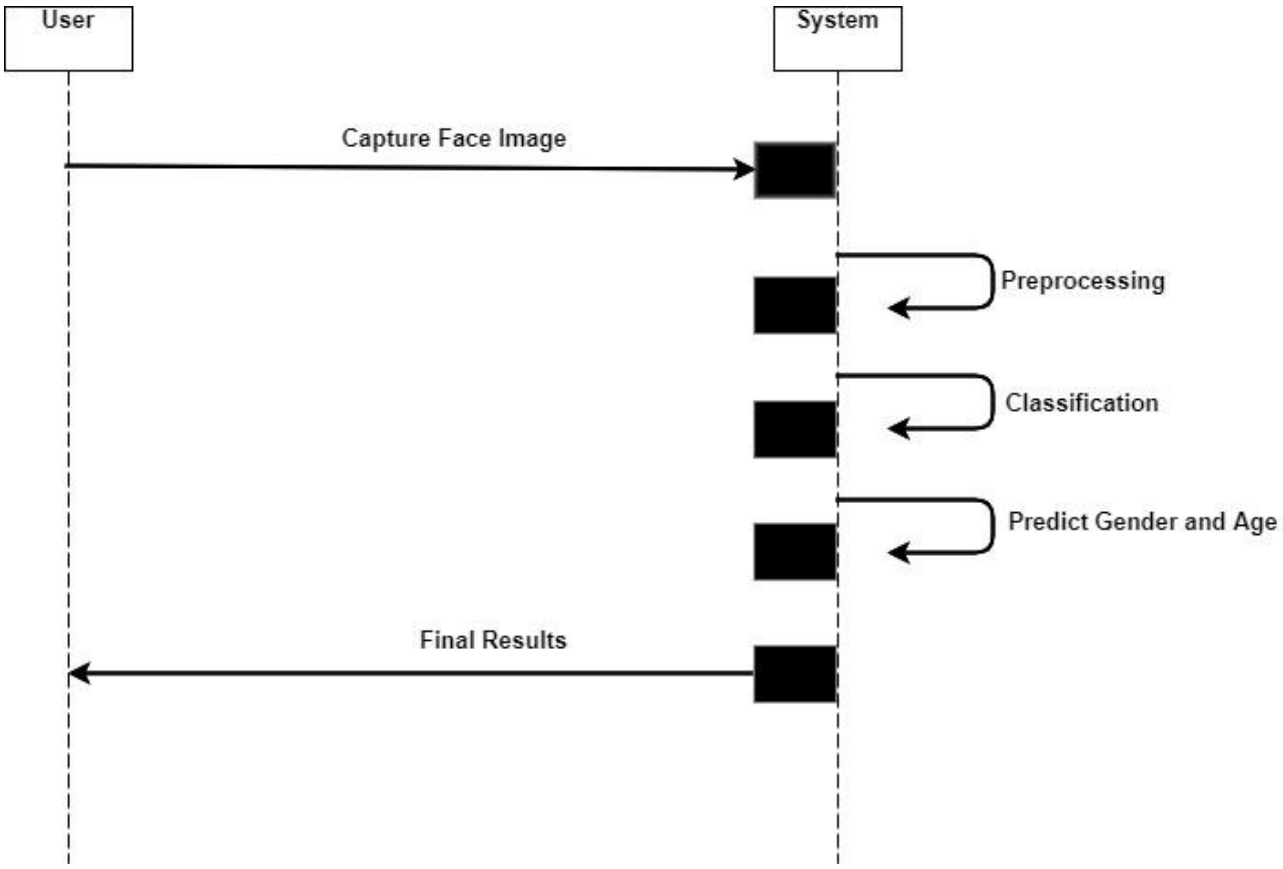

Figure 4- 6 Sequence Diagram

4.4.2 Class Diagram

In Unified Modeling Language (UML), class diagram is a static diagrammatic structure representation in which we give explanation of classes, functions, attributes, and relationship between them. Class diagram of our project is given below:

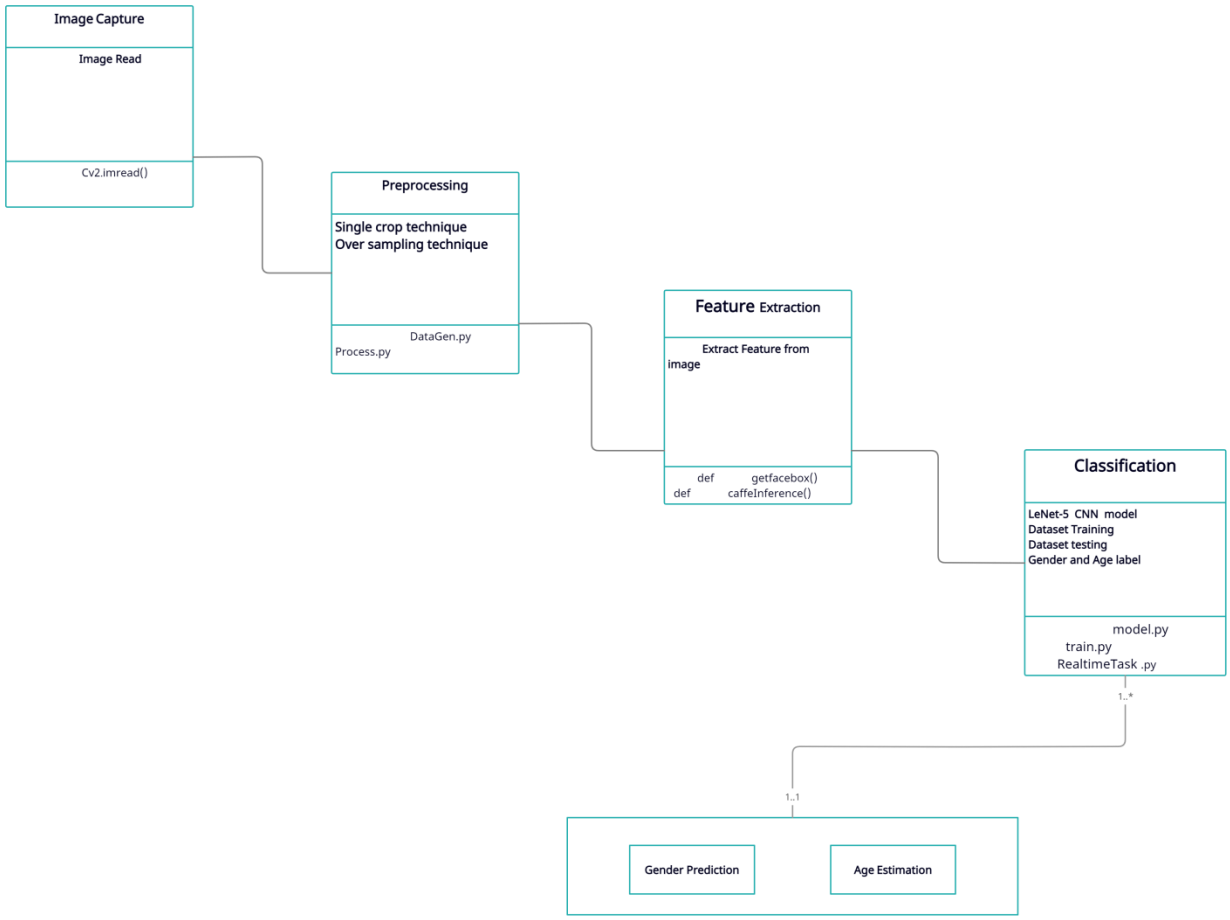

Figure 4- 7 Class Diagram

CHAPTER 5

Implementation

5. Implementation

In this chapter, we will discuss the whole implementation through algorithms and user interface we have to develop the project. This phase is the most well-known phase of development as from this step; we renovate our idea into consequential picture. This is the most considerable and challenging step towards learning and developing skills. A desktop application is result of successful implementation of project the various algorithms, testing approaches and the results.

5.1 Algorithms and libraries

There are following libraries that we used in implementation of project.

5.1.1 Open CV

OpenCV is a elevated performance library in digital image processing and computer vision. It is operational with a huge set of functions and algorithms for real time computer vision and analytical projects. It was developed thus that real time analytics of images and identification can be completed for various desktop applications and android applications.

5.1.2 Numpy

Numpy library stands for “Numerical Python”, which is an open source Python library and work for perform a variety of mathematical and scientific tasks. Numpy library contains multidimensional arrays and matrices, by the side of high level mathematical functions that work on these arrays and matrices. This library used to solve statistical, classification and regression problems.

5.1.3 Time

Python's time component code provides many ways to represent time, such as objects, numbers, and strings. In addition to representing time, it also provides functionality, such as waiting during code execution and measuring code performance.

5.1.4 Torch

The PyTorch is an open source machine learning library of python that is worked for implementing and training neural network based on deep learning model. The pyTorch library is developed by Facebook AI research group. It can be worked within Python and also C++ compiler. Pytorch is enormously popular in research labs (like Facebook, Microsoft, and Sales Force etc).

5.1.5 Math

The Python math element is an important feature that is designed to deal with mathematical operations. The packages of math come with the standard Python release and have been there from the beginning. This library is used for mathematical operation such as combination, permutation, trigonometric function, exponential functions, solving quadratic equations.

5.2 Dataset

The database we have chosen for our project is the Asian database Audience Benchmark acts as a benchmark for facial images and has a variety of real-world features such as sound, lighting, position, and appearance. The photos were made with Flicker's albums and distributed under a Creative Commons (CC) license. It has nearly 10,000 images of 2000 subjects in eight years and is almost 1GB in size. We are using data enhancement by capturing a random output of 227 × 227 pixels from a 256 × 256 input image and a random mirror in the front and in the background. There are the following attributes in data that which are following:

- Face detection
- Gender prediction
- Age classification
- Gender and age Labels

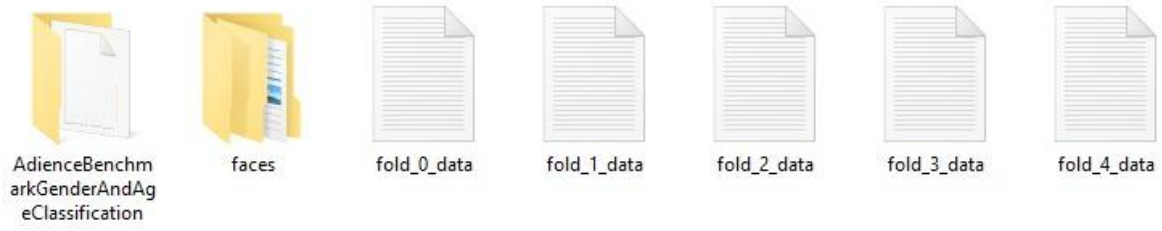

Figure 5- 1 Dataset directories

Table 5- 1 dataset information

Categories	**0-2**	**4-6**	**8-13**	**15-20**	**25-32**	**38-43**	**48-53**	**60-100**	**Total images**
Male	745	928	934	734	2308	1294	392	442	8192
Female	682	1234	1360	919	2589	1056	433	427	9411
Both	1427	2162	2294	1653	4897	2350	825	869	19487

5.3 Preprocessing

Image Processing is an important task in project. Before bringing data into classification, data should be clean, well specified, and consistent. First system detects the user face and then preprocessed the image of face for further processes. In processing we use two techniques (single crop and over sampling) to increase the accuracy of system to prediction of gender and estimation of age.

- **Centre Crop:**
  In centre crop techniques, to feed the entire network with a photo of the face, cut to 227 × 227 about the surface area.

- **Over-sampling**

We extract five 227 × 227 pixel crop circles for faces, four corners of the 256 × 256 photo frame, and an additional crop circle from the center of the face image. The network is available for all five face images, as well as their horizontal displays.

5.4 CNN Architecture

We implemented the simple CNN architecture proposed by Newman Abionand. The architecture consists of three decision layers, followed by the corrective linear operation and the polling layer. The first two layers are also behind the normalization of the local reaction. The first convective layer has 96 filters of 7.7 pixels, the second convective layer has 256 filters of 5.5 pixels, and the third and final convective layer has 384 filters of 3.3 pixels. Finally, two completely connected layers are added, each containing 512 neurons.

See Figure 5-2 for a detailed diagram view:

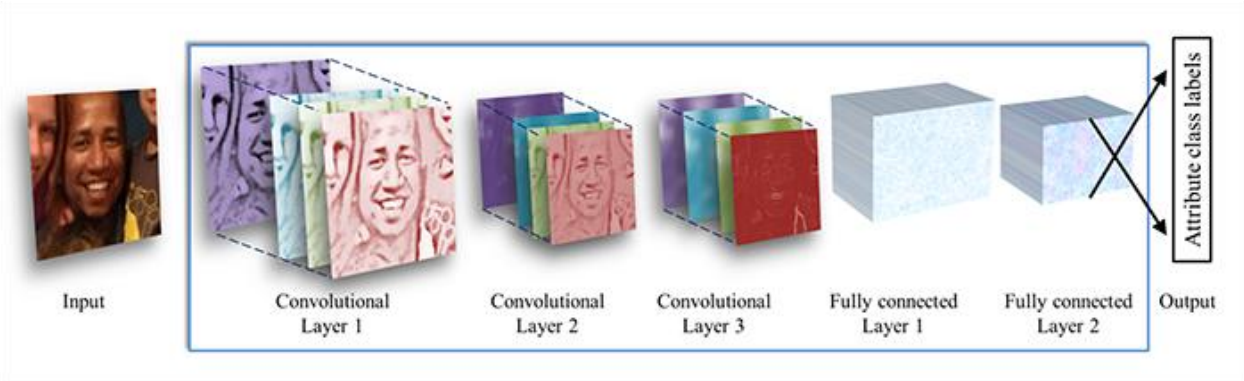

Figure 5- 2 CNN architecture

5.4.1 Convolution

All three color channels are processed directly by the CNN network. Images from the database were initially reversed to 256 × 256 and 227 × 227 yields were fed on the CNN network. We have applied three layers of specificity to CNN. The next three layers of solution are then different.

• 96 filters of size 3 × 7 × 7 pixels applied to the input in the first convolutional layer, followed by a modified operator (ReLU), a max-pooling layer that obtains a maximum number of 3 × 3 regions with steps of two pixels and a standard inner layer.

• A 96 × 28 × 28 front cover is then processed by a second convolutional layer, consisting of 256 filters of 96 × 5 × 5 pixels. Again, this is followed by ReLU, a max-pooling layer, and the normal response area with the same hyperparameters.

• Finally, the third and final convolutional layer works in 256 × 14 × 14 environments using a set of 384 filters the size of 256 × 3 × 3 pixels, followed by ReLU and max-pooling layer.

5.4.2 Fully Connected Layers

The following layers are fully connected to CNN:

• The first layer is fully integrated with the aim of securing the release of the third convolutional layer and contains 512 neurons, followed by ReLU and the dropout layer.

• A second fully connected layer for the purpose of detecting 512 magnitude of the first layer is fully connected and also contains 512 neurons, followed by ReLU and a stop layer.

• A third, fully integrated layer that points to final age and gender classes.

Finally, the release of a fully integrated end layer is fed into the softmax layer for the purpose of providing access to each age and gender category. The countdown is completed by delighting the class with the great possibilities of the test image provided.

5.5 LeNet-5 CNN Architecture

In 1998, the development of LeNet-5-type CNN was introduced in a research paper entitled “Gradient-Based Learning Applied to Document Recognition” by Yann LeCun, Leon Bottou, Yoshua Bengio, and Patrick Haffner. It is one of the first and almost all basic structures of CNN and we use this CNN technique in our work of predicting gender and age estimates. There are seven layers of the LetNet-5 model.

• The first layer of the LeNet-5 contains an image of the input surface with a size of 32 × 32. It is composed of six filters of 5 × 5 resulting in a size of 28x28x6.

• The second layer of LeNet-5 is a pooling process that filters 2 × 2 and 2 strides. As a result, the image size will be 14x14x6.

• The third layer involves the operation of a convolution with 16 filter sizes of 5 × 5 followed by the fourth layer of integration with the same 2 × 2 filter size and two categories. Therefore, the resulting image size will be reduced to 5x5x16.

• When the scale of the face is reduced, the fifth layer is a convolutional layer fully connected with twenty-one filters in size 5 × 5. In this LeNet-5 layer, each of the twenty units in this layer will be connected to four hundred units (5x5x16) from the previous layers. The sixth layer is also a fully integrated layer consisting of eight and four units.

• The final seventh layer of LeNet-5 will be a soft-max output layer with classes that may be 'n' depending on the number of classes available in the database.

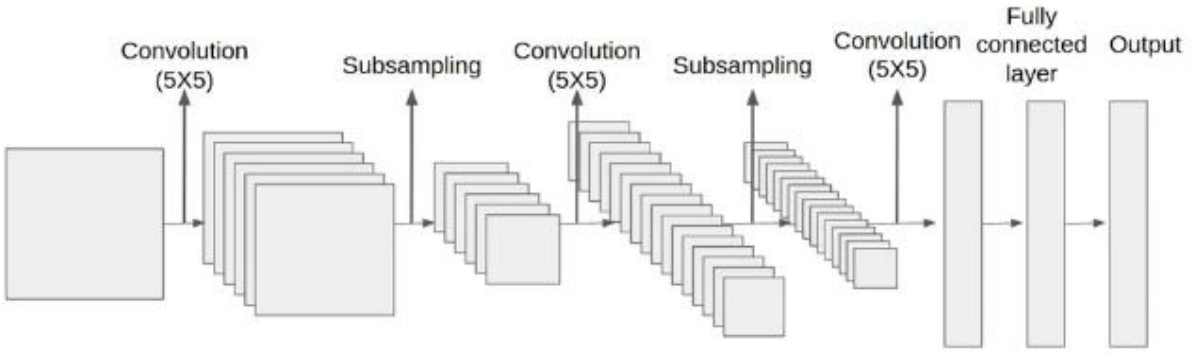

Figure 5- 3 LeNet-5 CNN Architecture

5.6 Training and Testing Phase

5.6.1 Training phase

We do not use pre-trained models in this project to start a network; the network model is first trained and then uses the LetNet-5 model, from scratch, without using any data other than images and labels available by Audience Benchmark. This should be compared to the use of the CNN LetNet-5 model used for face recognition, where we use approximately 10,000 images for training and we use 8000 images to access training data. In the faces of each training face, the directed image, the vector of the label is the length of the number of classes (two per gender, eight classes of age-division function). First, we use stop reading (randomly set the output number of network neurons to zero). The network includes two stop layers with an output value of 0.5 (50% chance of setting the output value of the neuron to zero). Second, we use data

expansion by taking a random output of 227 × 227 pixels from a 256 × 256 input image and showing it randomly forward and backward training.

5.6.2 Testing phase

We used 2000 images for testing from gender and age classes. Testing data give a glance of CNN was trained and able to classify the gender type and age class.

5.6.3 Output

Accuracy of the whole trained model is returned as an output in same window. Accuracy of each module (Gender and Age) is also predicted separately. When all steps stated above run successfully, our model return that output as accuracy of whole network, testing accuracy, training accuracy, accuracy of gender prediction and age estimation.

5.7 Classification Accuracies

There are following accuracies that we achieved after training and testing data and whole implementation of project module (Gender Prediction and Age estimation).

Table 5- 2 Classification accuracies

Labels	Gender and Age classes	Accuracy	Overall Accuracies
1	Gender class	90%	90%
2	Age Classes	85%	

5.7.1 Accuracy Graph

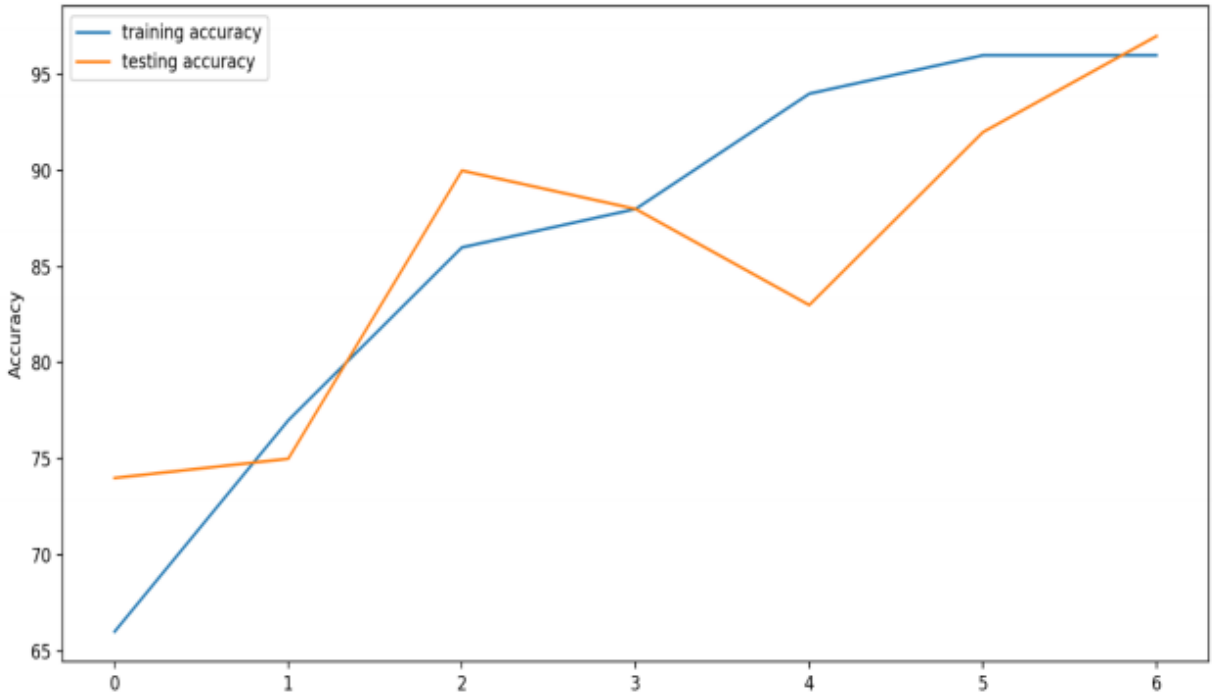

Figure 5- 4 Accuracy Graph

5.7.2 Loss Graph

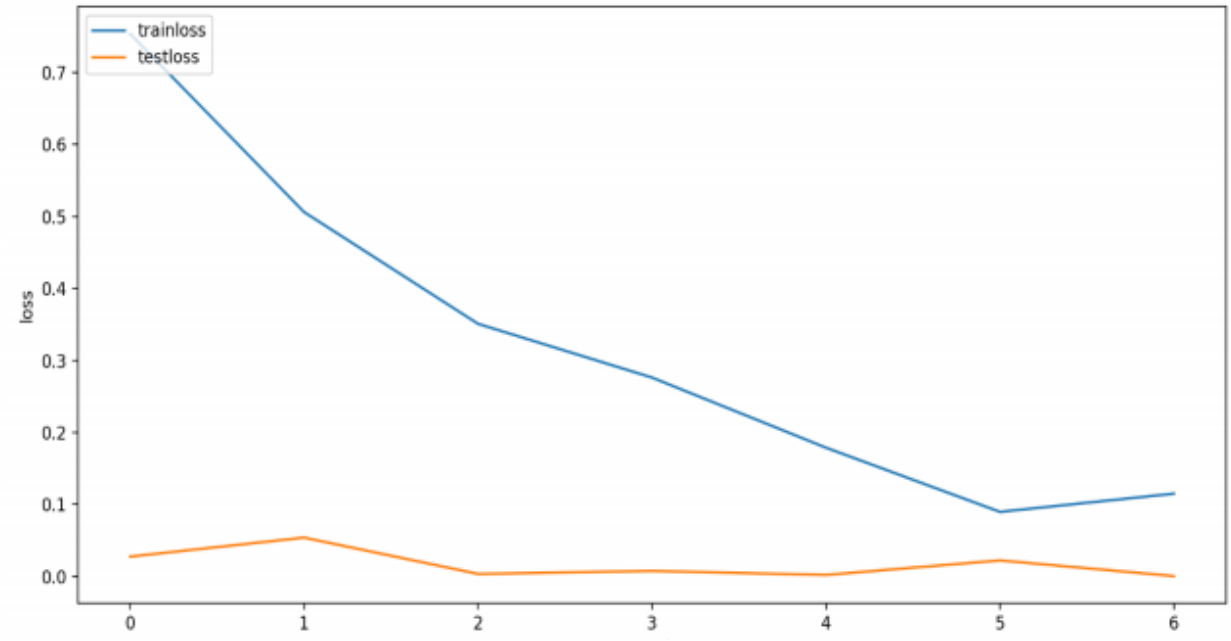

Figure 5- 5 Loss graph

5.7.3 Gender Prediction Accuracy on Adience Benchmark

There are listed signify accuracy ± standard errors over all Gender (Male and Female) categories.

Table 5- 3 gender accuracy

Method	**Accuracy**
LeNet-5 CNN Model	85%
Using Single Crop	89%
Using Over-sampling	90%

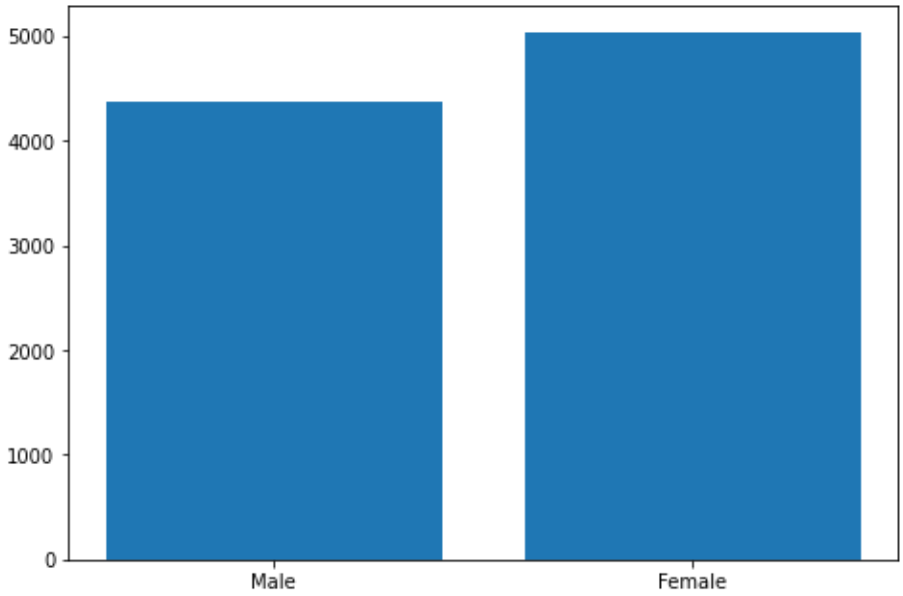

Figure 5- 6 Gender accuracy graph

5.7.4 Age estimation Accuracy on Adience Benchmark

There are listed signify accuracy ± standard errors over all Age (0-2 4-6 8-13 15-20 25-32 38-43 48-53 60-100) categories.

Table 5- 4 Age accuracy

Method	**Accuracy**
LeNet-5 CNN Model	75%
Using Single Crop	76%
Using Over-sampling	77%

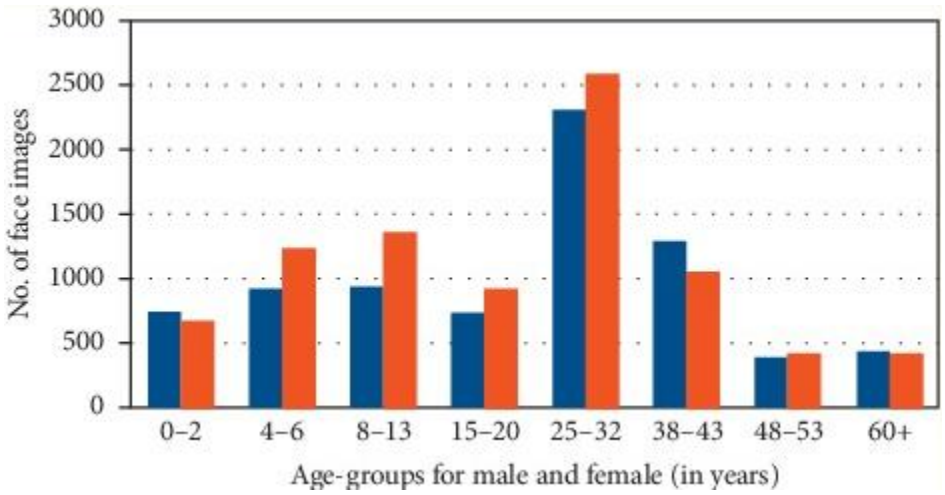

Figure 5- 7 Age accuracy graph

5.8 User Interface

The Simple and interactive interface will permit the user to understand easily. After installation of PyQt Designer, interface of desktop application is designed. Buttons allow user for clicking and capturing the face image, each button is named as per functionality so that it makes sense. As application will start splash screen will open and after splash screen main screen will open and allow functionalities of modules.

The Working of each module and page of interface has been shown below step by step.

5.8.1 Welcome Screen

When application start user interact with first screen of interface having welcome screen of "Gender and Age provision" that is given below:

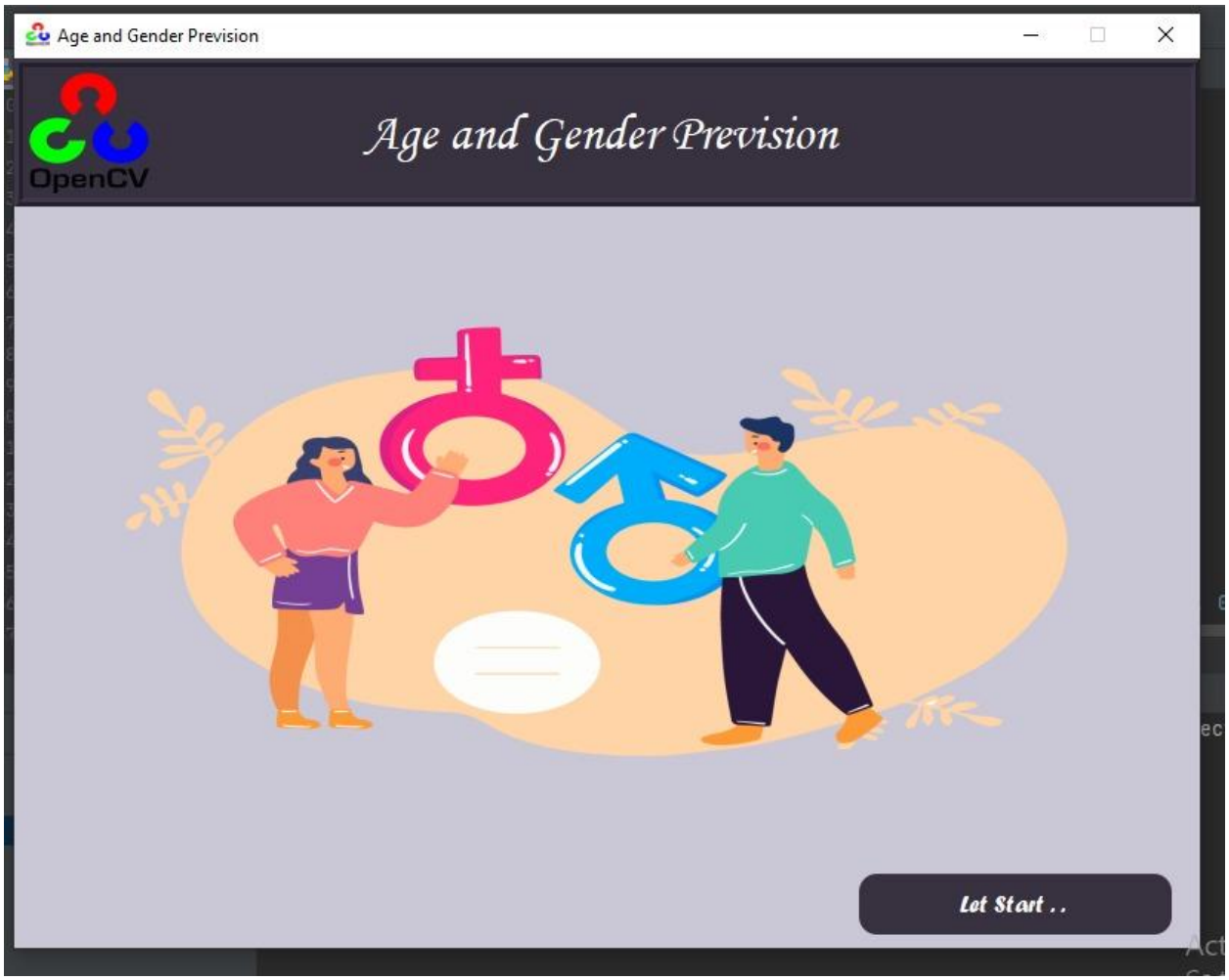

Figure 5- 8 Welcome screens

5.8.2 Main window screen

After splash screen application contains main window where system allow user to open camera and then system will predict his or her gender and age. The main window screen is given below:

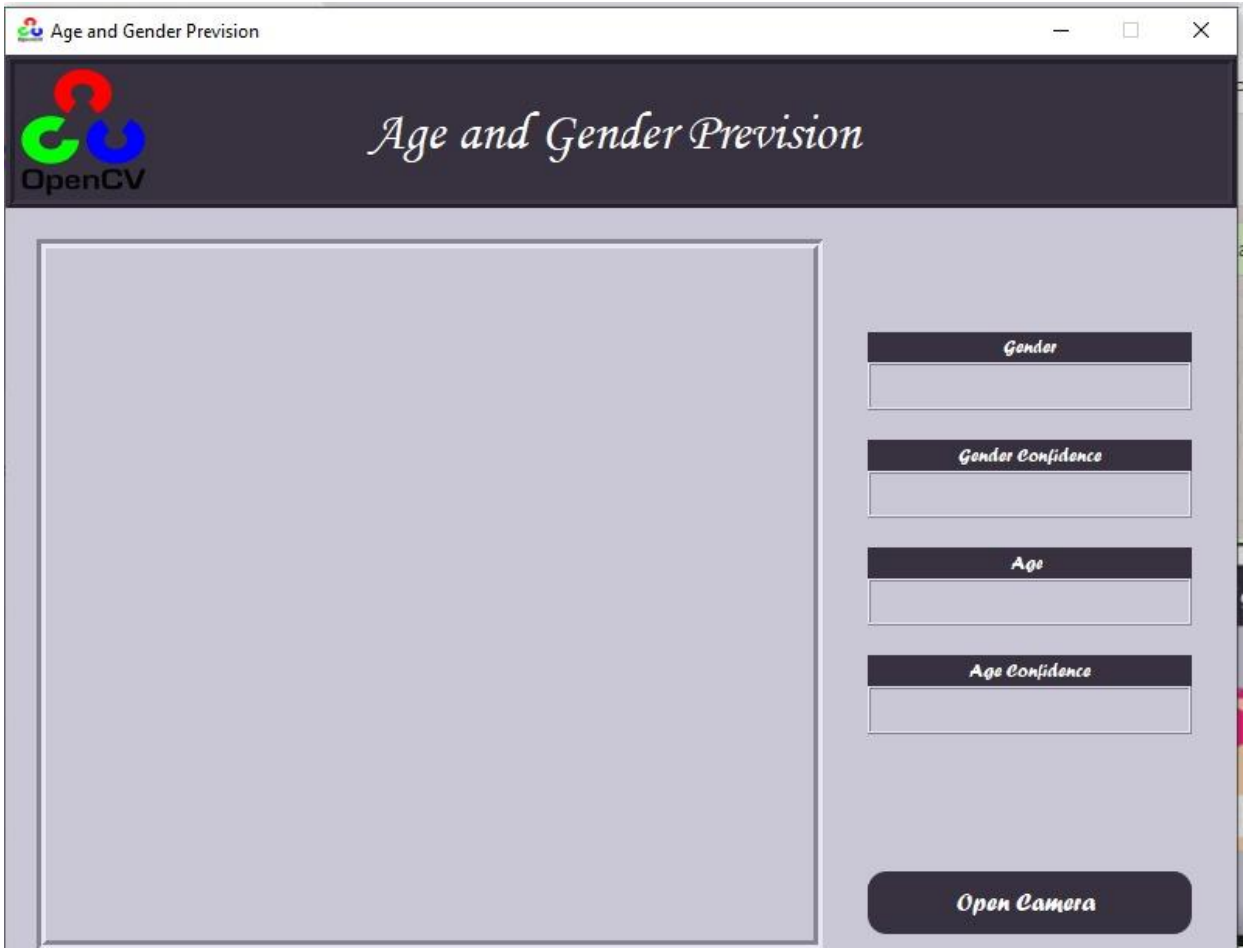

Figure 5- 9 Main window screens

5.8.3 Gender and Age Prediction

When user click on “open camera” button the webcam will be open and system first detect user’s face and then it predict his or her gender and age label as shown in figure. The other side labels also contain the gender, its confidence and age, its confidence.

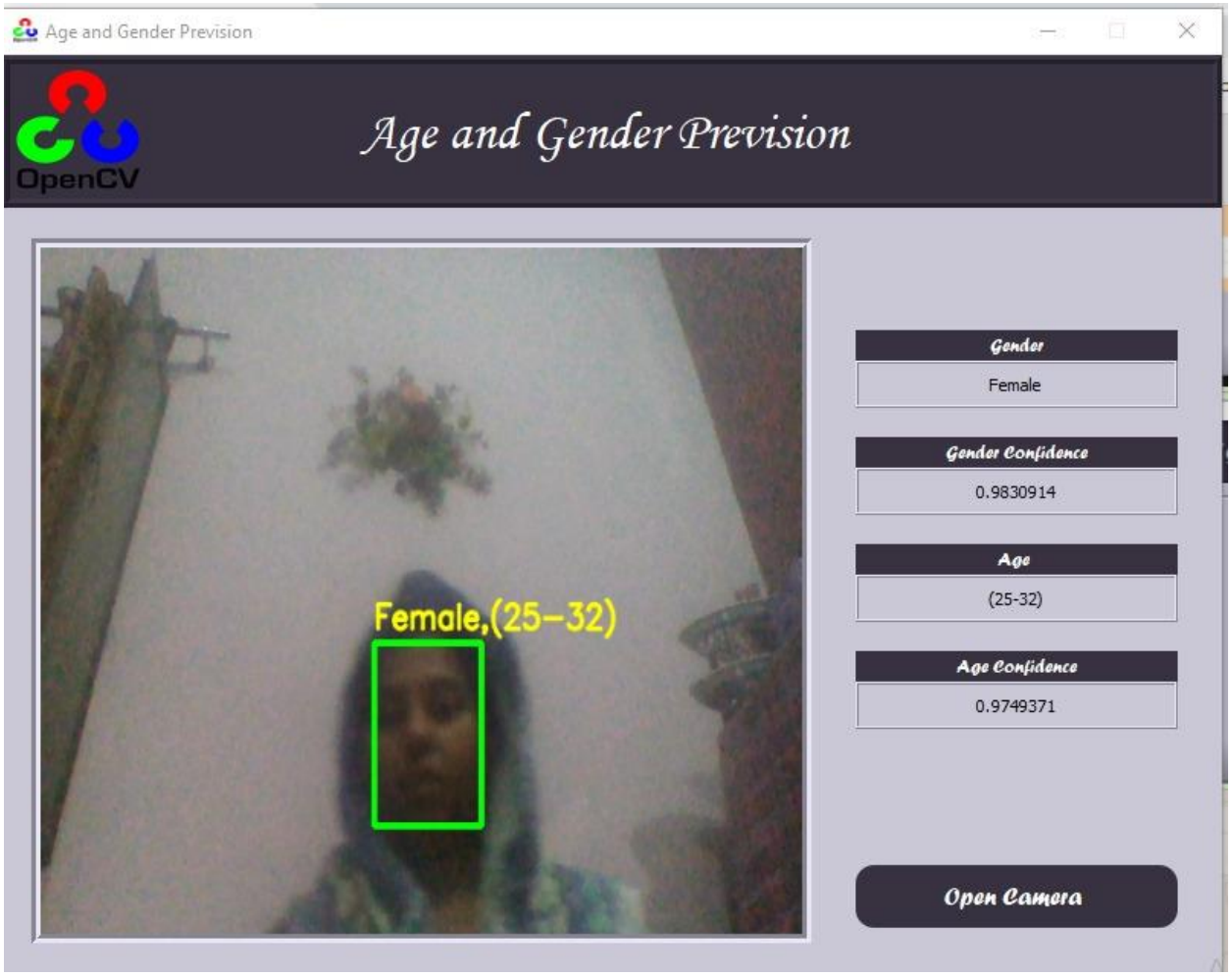

Figure 5- 10 Label screen

5.8.4 No face detection

When user click on button “open camera” and not come in front of web cam then system does not detect any human face and shows the error message “NO FACE DETECTION”.

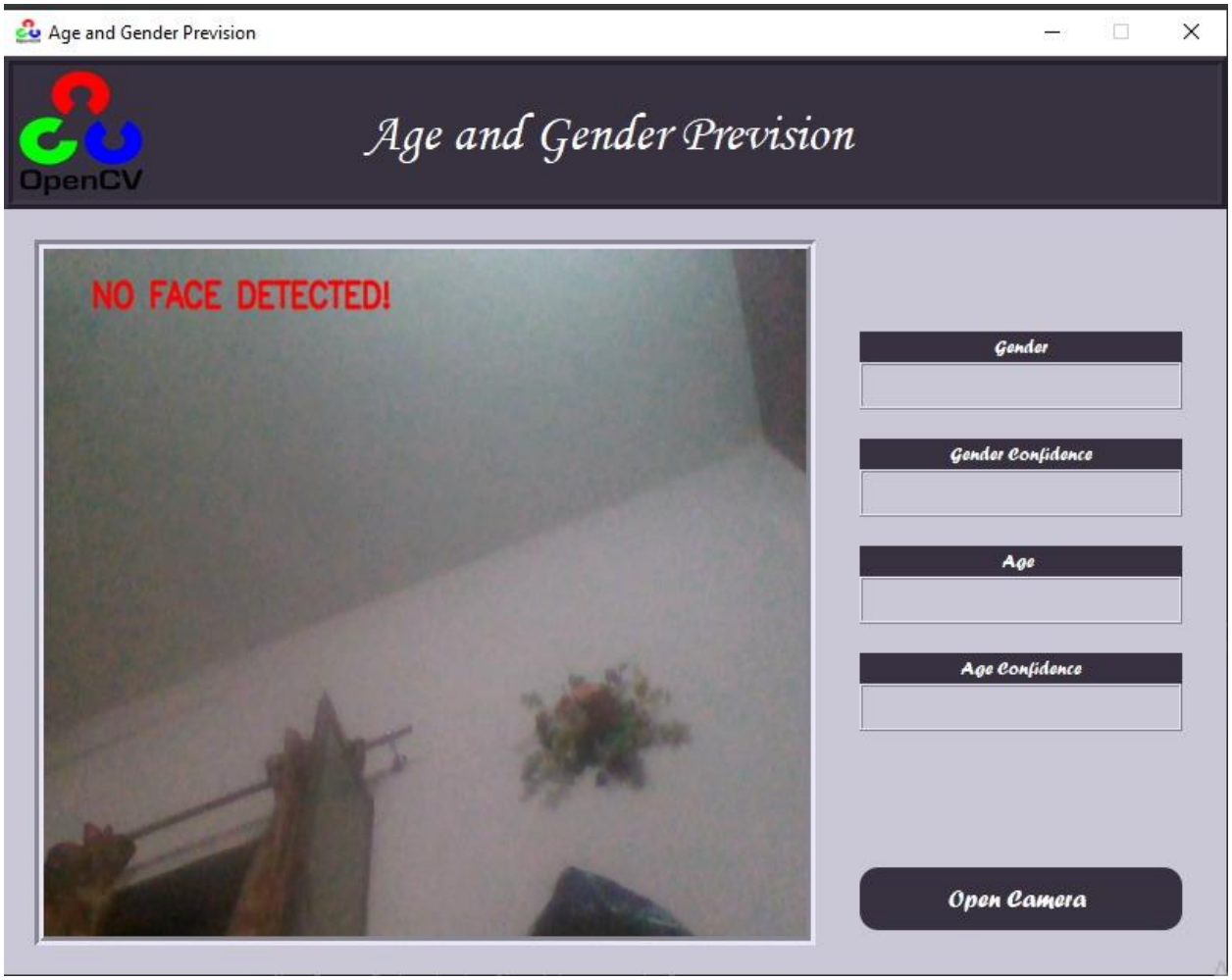

Figure 5- 11 No face detection error

CHAPTER 6

Testing and Evaluation

6. Testing and Evaluation

Evaluation is the important stage of project in which we have to analyze the performance of application by performing different tests to check the effectiveness and efficiency of application. Testing is also an important stage for any developmental software system or any application. In this stage, we test the functionality of each module of the system in an organized way and test the entire performance of system that our system and application fulfill user's requirement or not.

6.1 Manual Testing

In manual testing, no automated tools are used and test cases are executed manually. It helps to be familiar with the visible and hidden flaws in the system. Initially, the documents are observed by the tester to discover about the testing areas of the developmental system. We have to analyze the required documentation to meet all of the requirements. Each code is checked and then the functionality of each module is checked.

6.1.1 System Testing

In system testing, entire system is evaluated on basis of its functionality. The Graphical User Interface (GUI) will be tested in system testing phase. The input will be given to the system through the GUI and the outputs will be checked. System testing includes both of functional and non-functional testing. The user's face image is provided to system and system is able to predict the gender and age of user and then classification results are examined.

6.1.2 Unit Testing

In unit testing, we test each unit and module of our system and check whether the system is according to the user's requirements or not. This testing can be performed in each unit. Unit testing is mentioned for entire CNN model.

6.1.2.1 Image Capture

Image capture is done by clicking the button name “Open Camera” it opens the system webcam and then system create a rectangular box around area of interest(user face).

6.1.2.2 Preprocessing

Image Processing is an important task in project. Before bringing data into classification, data should be clean, well specified, and consistent. First system detects the user face and then preprocessed the image of face for further processes. In processing we use two techniques (single crop and over sampling) to increase the accuracy of system to prediction of gender and estimation of age.

6.1.2.3 Dataset

- **Training dataset**

For training purpose, the selected dataset should be compared with CNN implementations used for face identification, wherever almost 10,000 of images are used for training from dataset and we use 8000 images for training data. For every training image, the target, label vector is in the length of the number of described classes two for gender (Male and Female), eight classes of the age classification task (0-2, 4-6, 8-13, 15-20, 25-32,

38-43, 48-53, 60-100).

- **Testing dataset**

We used 2000 images for testing from gender and age classes. Testing data give a glance of CNN was trained and able to classify the gender type and age class. All images have (227,227) dimension that extract from (256,256) by applying single crop and over sampling techniques to images.

6.1.2.4 Classification

For classification, initially we prepared a CNN model that has been trained on our dataset (Audience Benchmark). Our trained model is saved in extension which we gave to our system

and test the given image, the input image is compared with trained CNN LetNet-5 model. Then it detects the human face and predicts the gender and age of that human through facial feature then our system displays the result.

6.1.3 Functional Testing

In functional testing, we have to test the functionality of the system that the functions are working according to the given requirements or not. For functional testing, we have to generate the test cases. They are performed to check effectiveness of application from user point of view.

Test Case 01:

Table 6- 1 Test Case 01

Serial No.	**Test Case**	**Attribute and Values**	**Expected Results**	**Final Results**
01	Image capture	The user should be in front of system that system can identify the user face.	The system detects the area of interest (user's face).	The system successfully detects the user face.

Test Case 02:

Table 6- 2 Test Case 02

Serial No.	**Test Case**	**Attribute and Values**	**Expected Results**	**Final Results**
02	Without capturing image	If user is present in front of system then system must be finds area of interest.	System tries to identify user's face until it finds area of interest.	System successfully tries to identify user's face until it finds area of interest.

Test Case 03:

Table 6- 3 Test Case 03

Serial No.	**Test Case**	**Attribute and Values**	**Expected Results**	**Final Results**
03	Without capturing image	If user is present in front of system then system must be finds area of interest.	System tries to identify user's face until it finds area of interest.	System successfully tries to identify user's face until it finds area of interest.

Test Case 04:

Table 6- 4 Test Case 04

Serial No.	**Test Case**	**Attribute and Values**	**Expected Results**	**Final Results**
04	Classification	System classification of gender and age according to given classes to trained model.	System compare user's face image to trained model and categorized their gender and age .	System successfully compare user's face image to trained model and categorized their gender and age.

Test Case 05:

Table 6- 5 Test Case 05

Serial No.	**Test Case**	**Attribute and Values**	**Expected Results**	**Final Results**
05	Gender Prediction and Age Estimation Labels	Compare input image with trained load model.	System should Predict the labels of image.	System successfully predicts the labels of image.

6.1.4 Integration Testing

When all modules of project are integrated and when frontend linked to backend, then the outcome shown is accurate as shown below.

Table 6- 6 Integration Testing

No.	**Test case**	**Attribute and value**	**Expected result**	**Result**
1	Image Capture	The user is required to come in front of system that system can detect his face and predict gender and age.	Detected image is ready to be shown.	Detected image successfully shown on system screen.
2	Without image capturing	If user click button of any other operation.	Error message to be shown “No Face Detected”.	Error alert shown instead of capturing image.
3	Preprocessing	Output image available.	By applying Single Crop and over sampling techniques to datasets to increase the accuracy of system.	Image preprocessed successfully.

4	Classification	Compare input capturing images with trained model.	Predict the gender and age label of image.	Gender and age label of image predicted successfully.
5	No Face detected	No object appears.	System found no image and should not be classified.	Classification unsuccessful due to not detecting face.

CHAPTER 7

Conclusion and Future Work

7.1 Conclusion

A comprehensive study of full participation on gender prediction and age estimation can be used to solve real time problems having unconstrained images. In addition to the distinction of a few functions, function extraction is actually performed using only one individual element extractor or possibly a one-time classifier in various additional functions. Then it is possible to do an attribute extraction.

The two essential conclusions can be strained from our findings. Firstly, CNN can be used to make available better age and gender categorization outcome, considering the very small size of modern random image sets labeled for age and gender. Secondly, the ease of our model means that using more training data, broader spectrum systems may be better able to improve results than those described here. Age, gender and other facial features characterize significant information for a wide variety of tasks. Our work leads us to conclude that unstable geography analysis has been the best way to estimate an individual's age range. In order to properly identify the eyes and the hair of the eyes, the face in the picture should be without the spectator. The image should be of a straight face. There should be only one human face in the image. Our implementation containing 85% accuracy for age groups and 90% accuracy for gender identification.

Before bringing data into classification, data should be clean, well specified, and consistent. First system detects the user face and then preprocessed the image of face for further processes. In processing we use two techniques (single crop and over sampling) to increase the accuracy of system to prediction of gender and estimation of age.

The experimental outcome show that the method of estimating the projected age proceeds from earlier methods by producing improved estimates. By mean of the projected age estimation method, we investigate the special effects of gender and facial expressions on prediction performance. We established that gender and facial expressions influence age estimation merely if the system can be accurately trained with a large number of images from huge dataset. To conclude, we explore the accuracy of classification on the Adience Benchmark dataset for age and gender prediction. Our projected approach achieves up to date performance in the current age model and gender categorization, which considerably outperforms the current model.

7.2 Future Work

These results will be encouraging, future work will include improvement in ranking results and overall accuracy. Towards the future, results that are good for gender recognition and age estimation system in medical field (pregnancy ultrasound, healthcare robots), and to good for age estimation containing other then male and female (Transgender) as well as years of opinion can be achieved using migration learning strategies with reliable extension. With more wide-ranging and diverse datasets, the overall gender classification and age estimation accuracy can be considerably increased with a face mask, glasses, different face angles and poses. Also, this automated system can be implemented in clinics for decision-making and medical treatment tools. In addition, sophisticated architecture, region-based CNN and a combination of multiple algorithms can enhance CNN performance. Furthermore, the classification of neural networks can be used to verify ethnic estimation, affective behavior analysis, and several additional demographic characteristics.

CHAPTER 8

References

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