Identification of Gender and Face Expression using Machine Learning

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A Report is submitted to the **Department of Computer Science, Bahria University, Islamabad**
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Certificate

It is to certify that the Final Year Project report titled as "Identification of Gender and Face Expression using Machine Learning", which is a system that recognizes the gender and sensory expression of a person, authored by Fahad Rashid and Tahir Mehmood under the supervision of Mr. Ghulam Ali Mirza and it confirms that the effort documented in accordance to the mandatory standards for incomplete fulfillment of the degree of Bachelors in Information Technology.

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November 11th, 2018

Abstract

The face is one of the easiest methods to differentiate the separate identity of one another. Face recognition is a particular identification system that uses particular qualities of an individual to classify the one's identity. Human face recognition technique mainly contains two levels, namely face recognition, where this method resides too fast in humans, excluding under circumstances, where the object is placed at the short distance away, and then the introduction, which classifies into individual faces. Level is then simulated and established as a model for face identification is the most considered biometrics technology and established by professionals. Face recognition has been an attractive issue for image processing scholars throughout the last couple of years because of many significant applications like video face identification at hospitals and security check-posts, digital image processing, etc. In this system we are going to sense faces and then we identify two things based on the face features; one is gender and the second is expression. Gender and Facial expressions show a dynamic role in human interface and communication. As people carry on to spot enhanced use of human machine communications, it is important for devices to be able to recognize gender and mood in order to boost the validity. If the machineries can be expert to resolve gender and mood to better-quality grade then human can merely utilize these machineries for counseling or other areas of human life such as for psychological assessments. Our mind's intellect has dedicated nerve cells reacting to native structures of the sight such as, edges, gestures, lines, or positions. Our symbolic cortex collects these spread pieces of information into useful forms. Facial recognition aims to get preferred information and align them into a useful demonstration in order to achieve for identification or classification goals. Face recognition is knowledge talented of recognizing or confirming a person from digital image or video frame from the source of video.

Acknowledgments

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Acronyms and Abbreviations

ML	Machine Learning
GUI	Graphical User Interface
CNN	Convolutional Neural Network
FER	Face Emotion Recognition
UTK	University of Tennessee, Knoxville

“The Science of today is the technology for tomorrow”.

Edward Teller

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Chapter 1

Introduction

1.1 Background

Face recognition is the job of classifying the previously identified entity as a recognized or unrecognized face. Face recognition basically is to adopt if the "face" is somebody identified, or unidentified, by means of this goal, a database of facial features in reply to authenticate this input face. Face detection contains to separate picture windows into two modules; one covers face but it is a problematic case as unities occur between expressions, they can differ significantly in terms of different skin color, facial look, and age factor. The issue is additional complex by opposing light environments, image resolutions, and structure, also the probability of incomplete obstruction and mask. The perfect face sensor would be intelligent to identify the occurrence of any face beneath any set of light settings, in any background. The second module is the face localization job that targets to take the picture as an input and output the place of any face inside that image as nearly bounded container through (x, y, breadth, height).[1]

This project is an attempt to provide the face recognition and identification system which brings advantages of guessing the gender and facial expression of an individual. Face recognition and identification systems are much popular and rapidly growing across the multi-national technology giants like Apple or Samsung but we are intended and focused to use this technology in such a way that we are developing an application of this system for ease of use.

1.2 Problem Description

In modern days, face recognition apps face many issues like age factor, lightening environments, skin tone, and twin face problems. This project aims to resolve gender classification and face expression classification that would be used in security surveillance systems and in different institutions of the modern era. While developing this project we came to notice a problem of an age factor. The stored look to an individual is slightly changed as compared to the individual in reality after some time. It is known as age factor problem.[2] For example, if we store an image of an individual in database and after three years some facial features might be changed. Similarly in twin faces two persons having the same face structure will also make clash, but in our case we are not working on this twin problem because we are working on “Gender” this means that male and female faces are different so we are on safe side. On the other hand, skin tone problem will occur in between our aim. For example, in Africans too dark faces will require high quality of cameras to capture the facial features of an individual. So we will be considering these issues while developing the project to make it error-free.

1.3 Project Objectives

The objective of our project is to develop a facial recognition and identification system that will detect a face by camera of the computer and then elaborate either the person is male or female based on an individual's facial properties. Furthermore, the system will also be able to identify the facial expressions of a human like happy, angry, disgusted, neutral, sad, surprised, and fearful. Face expressions will be determined on the basis of land marks placed on different location of the face that is very helpful to figure out the expressions and gender of an individual. [3]

1.4 Project Scope

The scope of our project is mainly comprised of three parts: face detection, face extraction, and gender, emotion recognition. To propose such kind of technique that provides the validity against the facial look, slight similar, lightening condition, and presence or absence of accessories. The testing for the system will be performed on UTK faces dataset and Kaggle dataset for Face Emotion Recognition (FER) challenge. A wide range of experiments are yet to be applying to reveal the success, effectiveness, and efficiency of the method.

1.5 Summary

In an innovative era of technology, people tend to divert their interests towards automated lifestyles. Everyone wants to ace in their life standards. Technology is just the name of utilizing concepts into everyday applications. In the modern age, everyone wants machines to ease their daily life's tasks because machines reduce human efforts and costs and make life better, smart, innovative, and reliable. Our motivation and dedication are to contribute this system to humanity that is moving towards innovation for a better future.

Chapter 2

Literature Review

In this section, we will cover the overall major techniques of human face recognition and identification systems. This segment will give a clear picture of pros and cons for each method that is being used in past. The techniques under consideration are Eigen-faces, dynamic-link architecture, neural-networks, geometrical facial feature matching, hidden-Markov model, 3D-morphable model, and template-matching. The above techniques or methods will be observed on the basis of facial representation and classification criteria they used.

In the recent era of innovation in the face recognition research area, the new algorithms and techniques are introduced. This segment will also take the reader to get to know the pros and cons of recent methods introduced. The techniques under construction will be line-edge-map (LEM), support-vector-machine (SVM), and multiple-classifier-system (MCS).[5]

2.1 Face Recognition System

The face is one of the easiest methods to differentiate the separate identity of one another. Face recognition is a particular identification system that uses the particular qualities of an individual to classify one's identity. Human face recognition technique mainly contains two levels, namely face recognition, where this method resides too fast in humans, excluding under circumstances, where the object is placed at the short distance away, and then the introduction, which classifies into individual faces. The level is then simulated and established as a model for face identification is the most considered biometrics technology and established by professionals. Face recognition has been an attractive issue for image processing scholars throughout the last couple of years because of many significant applications like video face identification at hospitals and security check-posts, digital image processing, etc. In this system we are going to sense faces and then we identify two things based on the face features; one is gender and the second is expression.[6] Gender and Facial expressions show a dynamic role in human interface and communication. As people carry on to spot enhanced use of human machine communications, it is important for devices to be able to recognize gender and mood in order to boost the validity. If the machinery can be expert to resolve gender and mood to better-quality grade then human can merely utilize these types of machinery for counseling or other areas of human life such as for psychological assessments. Our mind's intellect has dedicated nerve cells reacting to native structures of the sight such as edges, gestures, lines, or positions. Our symbolic cortex collects these spread pieces of information into useful forms. Facial recognition aims to get preferred information and align them into a useful demonstration in order to achieve for identification or classification goals. Face recognition is a knowledge talented of recognizing or confirming a person from digital image or video frame from the source of video.

2.2 Past Techniques

2.2.1 Eigen-faces

Eigen-faces is one of the best methodically explored methods to face identification, Eigen-picture, Eigen-vector, and the last one is Principal-Component Analysis (PCA). The principal component analysis used to well signify images of looks. The weights labeling every face are achieved by bulging the face picture on the Eigen-picture. In mathematical perspective, Eigen-faces are the principal components in providing of faces. The Eigen-vectors are well-organized to signify diverse measures of the difference separately among the faces. An individual face can be signified exactly through a linear mixture of the Eigen-faces. It can also be approached by using only the "finest" Eigen-vectors where the Eigen-values are large. [7]

2.2.2 Neural Networks

The attraction of using neural networks is because of its non-sequential in the network. The very first an artificial neural networks (ANN) procedures that used for face identification is just a single layer adaptive network which basically covers a distinct network for every recorded person. The method of building a neural network architecture is vital for popular identification. It is much reliant on the envisioned application.

2.2.3 Graph Matching

Graph matching is a technique for face recognition and identification. Basically, it provides us a dynamic-link-structure for misrepresentation invariant entity or object recognition which engaged elastic-graph-matching for identifying the nearest kept graph. It is sub-branch to traditional artificial neural networks.

2.2.4 Hidden Markov Models (HMM)

Hidden Markov Models is a very popular modeling technique for speech systems. When this technique is applied to human face recognition the faces were instinctively separated into areas like the eyes, nose, mouth, etc., which can be related to the conditions of a hidden-Markov-model. HMM needs only one-dimensional consideration order and pictures are two-dimensional, the images should only be transformed into both 1D chronological orders and 1D spatial orders.

2.2.5 Geometrical Feature Matching (GFM)

Geometrical feature matching methods are based on the calculation on geometrical features set from an image of a face. This is one of the useful techniques. The face identification is feasible even at rough resolution, we can say at least 8x6 pixels when the only facial structures are barely shown in depth, suggests and explains that the whole

geometrical structure of the face attributes is enough for identification. The whole formation can be explained through a vector demonstrating the location and size of the major facial properties, like eyes and eyebrows, nose, mouth, and the structure of face framework.

2.2.6 Template Matching

A modest kind of template matching is that a test picture characterized as a 2-D array of strength values is matched by using an appropriate metric like the Euclidean distance, with a single template demonstrating the entire face structure. There are a couple of other further classy varieties of template matching on face identification and recognition. An individual can be able to use not just one, but more than one template from diverse lookouts to signify a person's face.

2.2.7 3D Morphable Mode

The Morphable face model is based on a vector space demonstration of different faces that are made as any convex grouping of outline and texture vectors of a set of samples define an accurate an individual’s face.

2.3 Recent Techniques

2.3.1 Line Edge Map (LEM)

Edge information is a beneficial object demonstration feature which is unresponsive to radiance alterations to a certain degree. However, the edge map is extensively used in numerous pattern identification arenas. Edge pictures of elements can be used for object identification and to get related correctness.

2.3.2 Support Vector Machine (SVM)

SVM is a method that is deliberated the best method for universal purpose pattern recognition due to its great simplification speed deprived of the need to enhance other information. Instinctively, assumed a set of facts fitting to two classes, the support vector machine discovers the hyperplane that splits the prime potential portion of points of the similar class on a similar side.

2.3.3 Multiple Classifier Systems (MCS)

Multiple Classifier Systems are based on the mixture of outputs set of diverse classifiers are planned in the area of facial identification as a technique of emerging good performance organization methods. Usually, the method that is used in design outline identification systems has been examined by comparing the performance of numerous classifiers in result to choose one of the best.

2.4 Proposed Work

In this project, we will develop a facial recognition and identification system that will detect a face then elaborate either the person is male or female based on an individual's facial features on real time. Furthermore, the system will also be able to identify the face expression. Face expressions will be determined on the basis of land marks placed on different location of the face that will be much helpful to figure out the expressions and gender of an individual.

This project is an attempt to provide the face recognition and identification system which brings advantages of guessing the gender and facial expression of an individual. Face recognition and identification systems are much popular and rapidly growing across the multi-national technology giants like Apple or Samsung but we are intended and focused to use this technology in such a way that we are developing an application of this system for ease of use.

The system that is under development will assist and support in simplifying everyday observational tasks of security surveillance systems. In airport check points it will also help to stop drug trafficking by examining the passengers' strange expressions while on the board or at immigration check points. This system will assist by shortening the time taken by a human being to identify expressions of more than one to two simultaneously.

Chapter 3

Requirement Specifications

3.1 Existing Systems

In modern days, face recognition apps face many issues like age factor, lightening environments, skin tone, and twin face problems. This project aims to resolve gender classification and face expression classification that would be used in security surveillance systems and in different institutions of the modern era. While developing this project we came to notice a problem of an age factor. The stored look to an individual is slightly changed as compared to the individual in reality after some time. It is known as age factor problem. For example, if we store an image of an individual in database and after three years some facial features might be changed. Similarly in twin faces two persons having the same face structure will also make clash, but in our case we are not working on this twin problem because we are working on "Gender" this means that male and female faces are different so we are on safe side. On the other hand, skin tone problem will occur in between our aim. For example, in Africans too dark faces will require high quality of cameras to capture the facial features of an individual. Face identification and recognition have just acknowledged a flourishing consideration and attention from the developer community as well as from public community. The concern from the overall public community is typical because of the modern occasions of terror across the globe, which has enlarged the need for valuable safety systems. Facial identification and recognition systems are distant from partial to security systems as defined above. To build these dissimilar systems, exact and forceful automatic facial identification approaches and practices are desired. Though, these practices and approaches are not existing yet or only available in extremely difficult, costly setups.[8]

3.2 Proposed System

In this project, we will develop a facial recognition and identification system that will detect a face then elaborate either the person is male or female based on an individual's facial features. Furthermore, the system will also be able to identify the face expression. Face expressions will be determined on the basis of land marks placed on different location of the face that will be much helpful to figure out the expressions and gender of an individual. This project is an attempt to provide the face recognition and identification system which brings advantages of guessing the gender and facial expression of an individual. Face recognition and identification systems are much popular and rapidly growing across the multi-national technology giants like Apple or Samsung but we are intended and focused to use this technology in such a way that we are developing an application of this system for ease of use.

3.3 Requirements Specification

Before the development of any system, the major consideration that should be completed properly is the requirements specification. The requirements specification is prepared to

deliver a way or direction to the development team that requires to be completed and how it must be done. Below are the given the functional and non-functional requirements of our proposed system.

3.4 Functional Requirements

- The system should detect human faces.
- The system should be able to identify gender from the face of a human.
- The system should be able to identify the face expressions of an individual.

3.5 Non-functional Requirements

3.5.1 Reliability Requirements

The reliability of this system defines by the evaluation outcome, precisely identification, and recognition of facial expressions, and maximum evaluation percentage of results of any input picture.

3.5.2 Ease of Use

The system must be simple, attractive, and with the responsive Graphical User Interface (GUI) so that one can use it without any difficulty.

3.5.3 External Interface Requirements

The system must be reinforced with the best lightening environments. Faces must be fully brightened so that it helps to recognize the facial features precisely.

3.5.4 Usability Requirements

The system must be easy to use and simple to understand.

3.6 Use Cases

A use-case is a number of functions and operations which describe the interface between the system and actors to attain the desired goal.

3.6.1 Main System Use Case Diagram

The Core use-case diagram contains the complete system operations and functionalities of the overall system which comprises of one main actor (User) as shown in below figure 3.1.

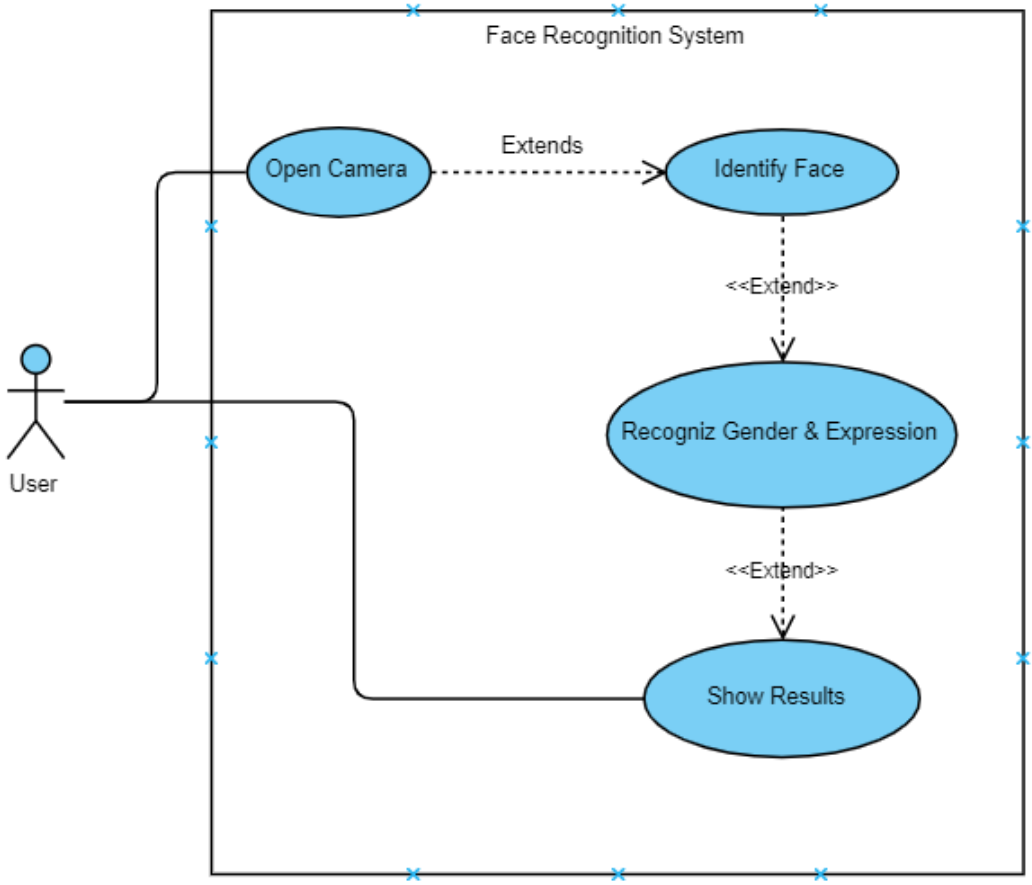

Fig. 3.1:*Main Use Case Diagram*

Table 3.1: Face Detect use case Description

Use case name	Main Use case, Identify Face
Use Case ID	U001
Data	Face of the human / Realtime
Actor	User
Pre-condition	Camera of the system must be enabled
Post condition	System should identity the face of the human
Description	The system should be working, and the camera of the system must be enabled so that it can function properly to identify the face of human.
Alternative Flow	Lightening condition not suitable

Table 3.2: Results use case Description

Use case name	Main Use case, Results
Use Case ID	U002
Data	Facial Features
Actor	User
Pre-condition	Facial features must be recognized
Post condition	Results/outcomes displayed to the User
Description	After the successful identification and recognition from the facial expressions of a person, the result is displayed to the user.
Alternative Flow	Same face features of two persons

3.7 Scenarios

3.7.1 Scenario 1: Open Camera

Table 3.3: Scenario 1: Open Camera

User Task Profile Targeted	Student User
Subject Persona	Tahir
Scenario Description	Opening the camera of the Laptop

Background:
Tahir is a student at Bahria University Islamabad. He is a brilliant student and always looks for new opportunities In Computer related fields. He wants to enter in the domain of face recognition system.
Objective:
He wants to open the camera of the laptop screen and for detection and recognition purpose.
Narrative:
Tahir opens the camera of the Laptop. After opening the camera successfully, he looks an interactive interface where he can look his face.

3.7.2 Scenario 2: Detect Face

Table 3.4: Scenario 2: Detect Face

User Task Profile Targeted	Student User
Subject Persona	Tahir
Scenario Description	Detection of face

Background:
Tahir is a student at Bahria University Islamabad. He is a brilliant student and always looks for new opportunities in Computer related fields. He wants to enter in the domain of face recognition system.
Objective:
He wants to detect his face after opening the camera of the Laptop. So that he can easily detect the structure of face can see how the face recognition system works.
Narrative:
The face is detected successfully after the opening of the camera of Laptop.

3.7.3 Scenario 3: Recognize Face

Table 3.5: Scenario 3: Recognize Face

User Task Profile Targeted	Student User
Subject Persona	Tahir
Scenario Description	Recognition of face

Background:
Tahir is a student at Bahria University Islamabad. He is a brilliant student and always looks for new opportunities in Computer related fields. He wants to enter in the domain of face recognition system.
Objective:
He wants to guess the gender of his face. The system tells him that whether Tahir is male or female. The system also displays his face expressions like happy, sad, disgusted, neutral, crying, fearful etc.
Narrative:
The system tells correctly after the analyzing of face structure of Tahir.

Chapter 4

System Design

4.1 System Architecture

The following diagrams show the whole architecture of our “Identification of Gender and Face Expression using Machine Learning System”. The architecture diagram is established based on the order of the complete project. The whole system Architecture of the applications describes the working of the components and the flow of the work among different functionalities.

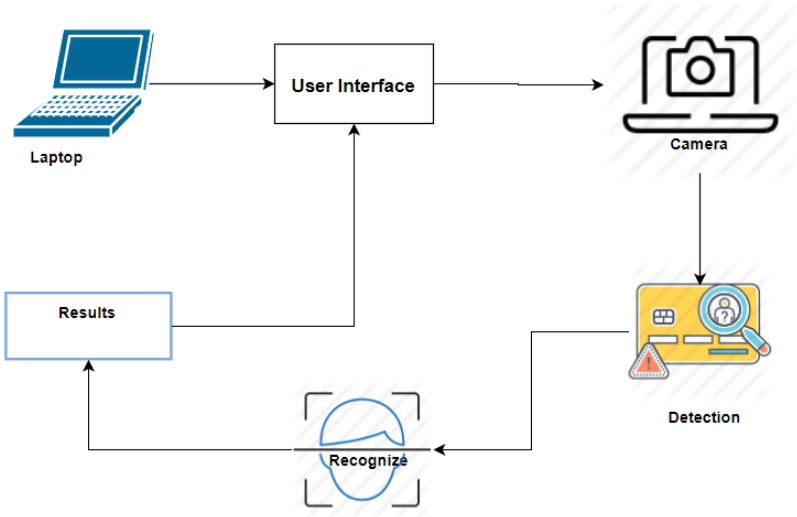

Fig. 4.1*: System Architecture Diagram*

Fig. 4.1: Describes a system’s behavior where a user shows an interface of laptop and opens the camera of it. The camera of the laptop then detects a face of the human and then recognizes whether the person is male or female. Also it shows the expressions of an individual and shows the results real time in the user interface.

4.2 Design Constraints

The interface of the system is easy to use and user friendly. It does not include some these external facilities which can effect as an aspect of design constraints. The procedure and algorithm that is intended to recognize the face of an individual and determine gender and expression. The system is capable enough to attract the user and easy to manage.

4.3 Design Methodology

The system includes the incremental and iterative process models for development. These process models are pretty much useful as these make sure the separation of worries. Each component is developed and tested independently that guarantees fast testing and progress. The main objective is to avoid complications, difficulties, and dependency among the components of the system. Figure (4.2) expresses the design methodology of the system.

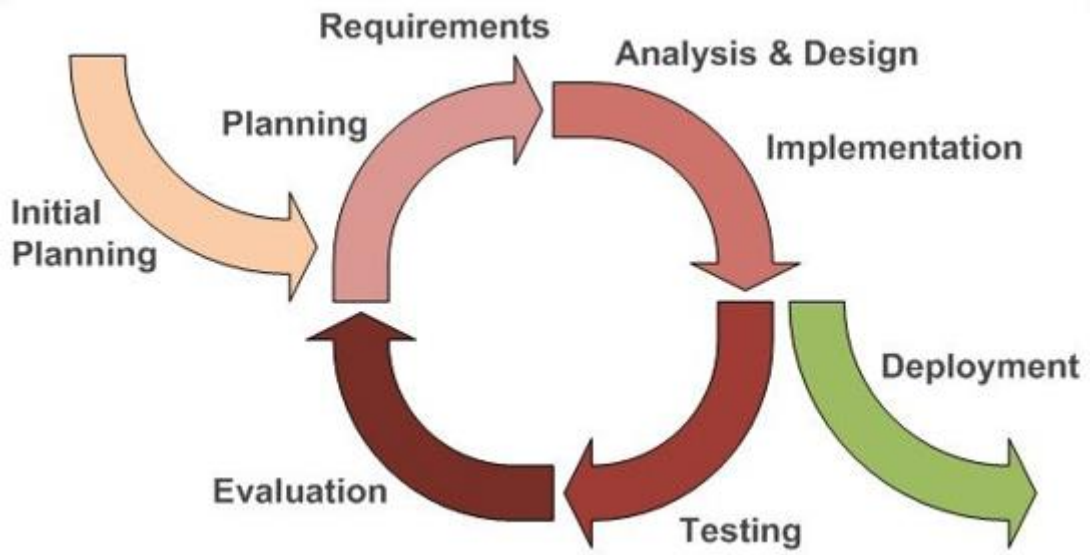

Fig. 4.2: *Incremental & Iterative Model of Development*

4.4 High Level Design

The high level design of the system states the main components of the system. It signifies the whole design of the system and the relation of the data flow among the major components and modules of the system. (Fig 4.3) shows the logical design of the system.

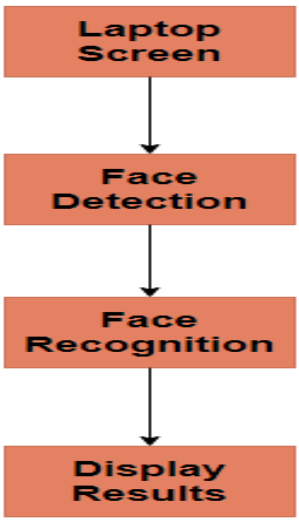

Fig. 4.3*: Logical & Conceptual Diagram of Application*

Fig 4.3: Describes the logical behavior of the system which states that how a user interacts with the system. A user opens user interface (Laptop Screen), opens camera and the camera detects the face first and then recognizes whether the user is male or female with the expressions and displays the results real-time.

4.4.1 Sequence Diagram

The Sequence diagram characterizes the sequence of stages involved from the start of the system. It displays the user's interaction with the system and also defines the series of actions that can be done by the user as an input. Figure (4.4) labels the complete order diagram of the system.

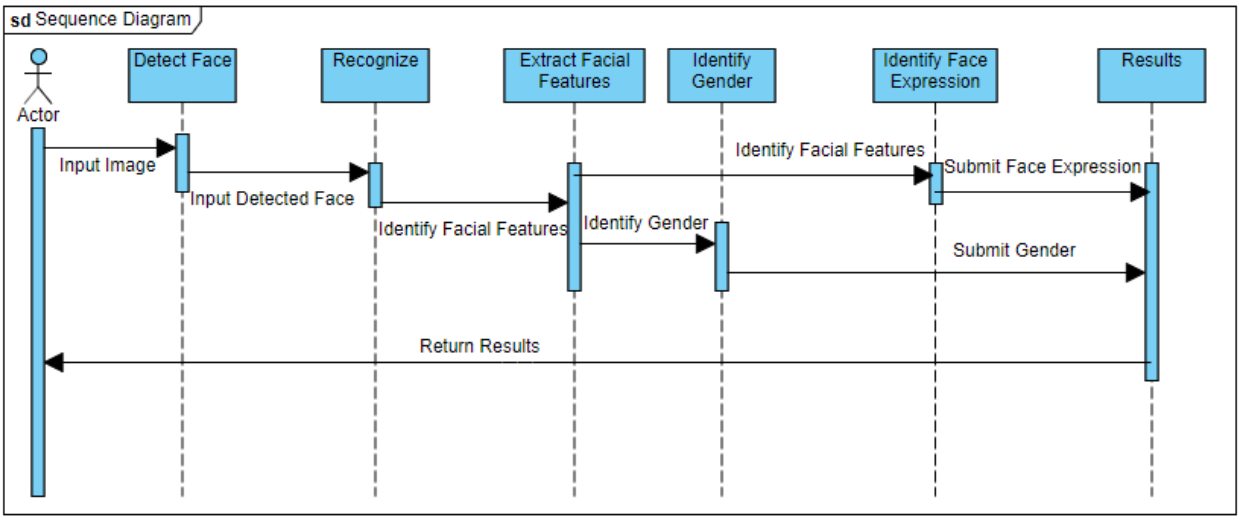

Fig. 4.4*: Main Sequence Diagram of the System*

Fig 4.4: Shows the sequence of actions about a user. First a face of human is detected, if the decision is ok, detected, then it gives feedback and then moves further for recognition. After the detection of face it moves towards guessing the gender of the person and also expressions of the person. After successful completion of all the sequences it returns the results to user.

4.5. Low Level Design

Low Level Design of the systemdescribes the complete systematic mechanism of the high level diagram. The low level design is much helpful because it is valuable for the process development where everymodule is explained in full detailto well understand of the system's interaction and functionalitywith the other system's components.

4.5.1 State Machine Diagram:

The State machine diagram describes dissimilar states and positions of the system. (Fig.4.5) shows the state diagram of the system.

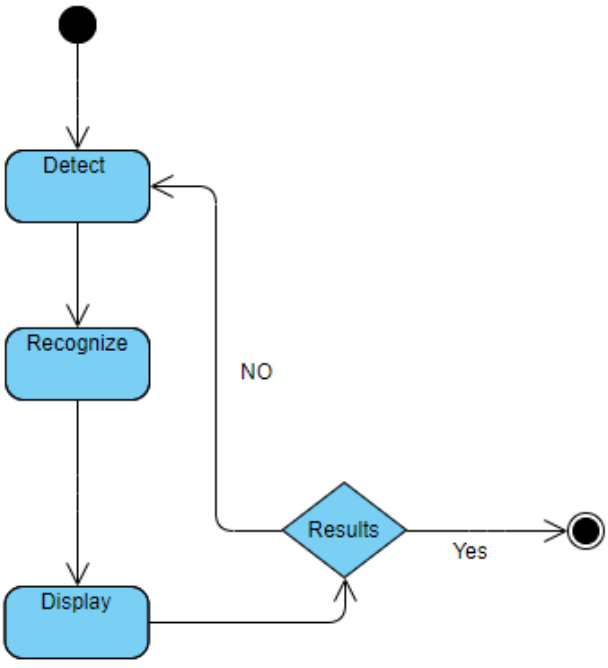

Fig. 4.5: State Machine Diagram

Chapter 5

System Implementation

This chapter will concentrate on the application's implementation and how it has been established using the CNN model that is MobileNetV2. MobileNetV2 is a major enhancement over MobileNetV1 that was the previous version, and it focuses the art state for mobile image recognition as well as categorization, recognition of objects, and semantic segmentation. MobileNetV2 is commercialized as part of Tensor Flow Classification Library.

5.1 System Architecture

There are two-tier architectures in which the application is based on; first layer is the system through which a user interacts with, that is GUI and in the second tier is the logical layer which controls and managing the processing and measuring of faults takes place. So while developing this application, dissimilar image exploration and pattern recognition procedures are used.

5.1.1 Face Detection

OpenCV is the library of machine learning. OpenCV was developed to deliver a general infrastructure for computer vision applications and to go faster the use of machine awareness in the marketable products. The faces that are detected in real time is the simple just like to call a function that is CV.detect_face. It will return the cropped faces from CV video capture function.

5.1.2 Get Detected Face

The face detected from OpenCV library is then passed after resizing to the dimension that was specified while training the model to predict.

5.1.3 Recognize Face

After getting the predictions from both models (Gender and Emotion) the results are stored in a variable to display. The results that are stored will be displayed on the upper side of the detected face.

5.1.4 Display Results

The results are updated in real time camera feed. The combination of both predictions is displayed together on each face of an individual seen on camera feed.

5.2 Tools and Technology Used

Tools and technologies which are used to develop our application are stated below

5.2.1 Spyder IDE

Spyder is the most powerful and open source cross-platform integrated development environment (IDE) for the purpose of programming in the Python language.

5.2.2 Anaconda Navigator

Anaconda Navigator is a desktop GUI that contained in Anaconda distribution that lets people to introduce applications and handle so called Conda packages, conditions and networks without the use of command-line instructions. This navigator can explore for multiple packages on Anaconda Cloud, install them in an environment, run the packages and revise them. It is available for Windows, macOS and Linux.

5.2.3 CNN

Convolutional Neural Network (CNN) is deep neural networks' class, often useful to examining visual imagery. The use of CNNs quite little pre-processing is like other image classification algorithms.

5.2.4 MobileNetV2

It is the future Generation of On-Device Computer Vision Networks.The capability to operate deep networks on private mobile devices enhances the user understanding, which offers anytime and anywhere access.

5.2.5 Keras with TensorFlow backend

Keras is a high-level API of neural networks which is in Python language and much capable of running on top of TensorFlow. TensorFlow is an open source AI library that uses data flow graphs to construct models. It letsdesigners to generate high scale neural networks with multiple layers.

5.2.6 Dataset

For Gender recognition we have used UTK_Face dataset. It is a across-the-board face dataset with vast age (range from 10 to 85 years old). The dataset contains more than 28,000 faces with filename as age, gender, and region. The dataset contains people from almost all the continents. We have used this dataset just because we are developing and testing on the people with Asian faces and this option was feature in the hat for us because we have found a large dataset covering mostly Asian Faces [9]. Initially this data was mixed and we have separated it into 2 classes, one Male and second Female.

Second Dataset set was obtained from dataset challenge organized by kaggle. The dataset was used in deep CNN for emotion recognition. It consist of around 38000 images classified into 7 classes [10].

5.3 Development/Environment Language Used

Our project has been established in Python programming language which is a very popular and extensively used object oriented programming language. It supports integration with a massive number of libraries. It also offers numerous predefined actions for the suitability of the developers.

5.3.1 Python

Python is a high level and object oriented programming language. It has many features and supports many programming standards like procedural, object-oriented, and functional programming.

5.4 Methodology of the System

5.4.1 Gender Recognition

Initially, in this project we have used UTK_Face dataset. The total images in the dataset are 7,111. It is across-the-board face dataset with vast age (range from 10 to 85 years old). We further separated them into 2 classes, Male face images of 3130 and Female face images of 3981. Detected face is rescaled and inserted into the model for prediction. We have used MobileNetV2 that is a pre-trained model previously trained on ImageNet. We are using it as a feature extractor. The total parameters are 2,260,546 and the trainable are 2,226,434. The reason behind using pre-trained model was that it was trained on large dataset and results were efficient. After that we have used Pooling layer because it reduce special dimensions in order to prepare for final output layer, then we have used a Dense layer which gives output of two classified classes, one for male and another for female.

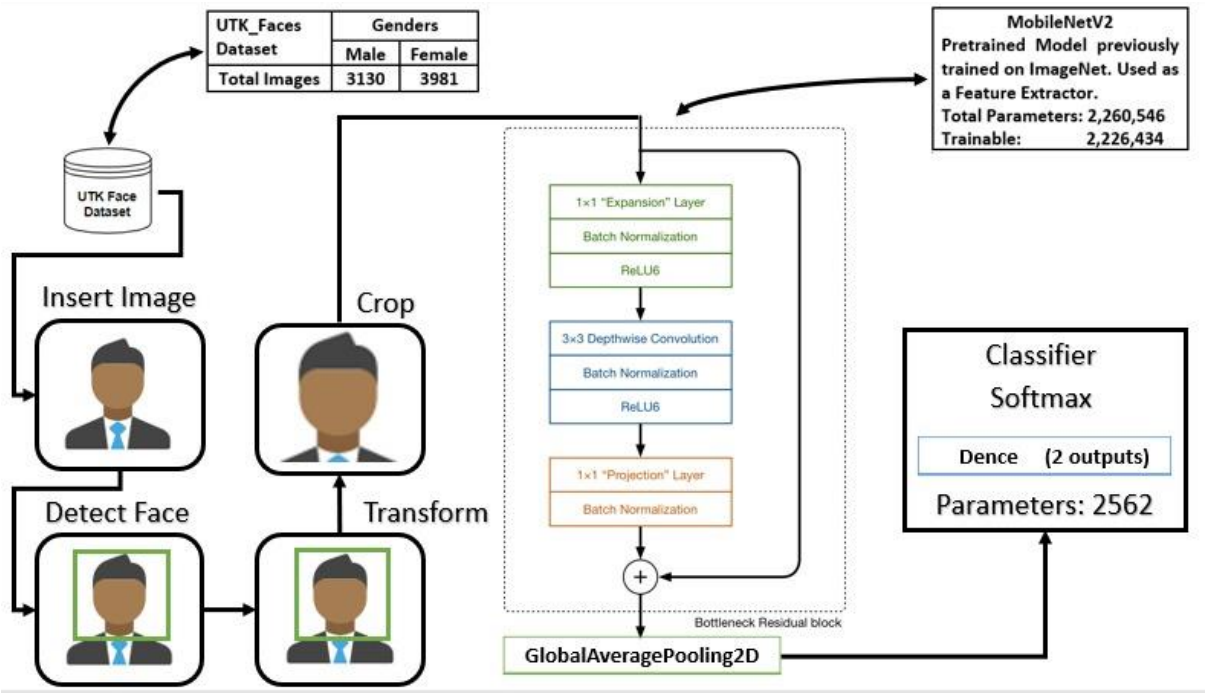

Fig. 5.1: Gender Methodology Diagram

5.4.2 Expression Recognition

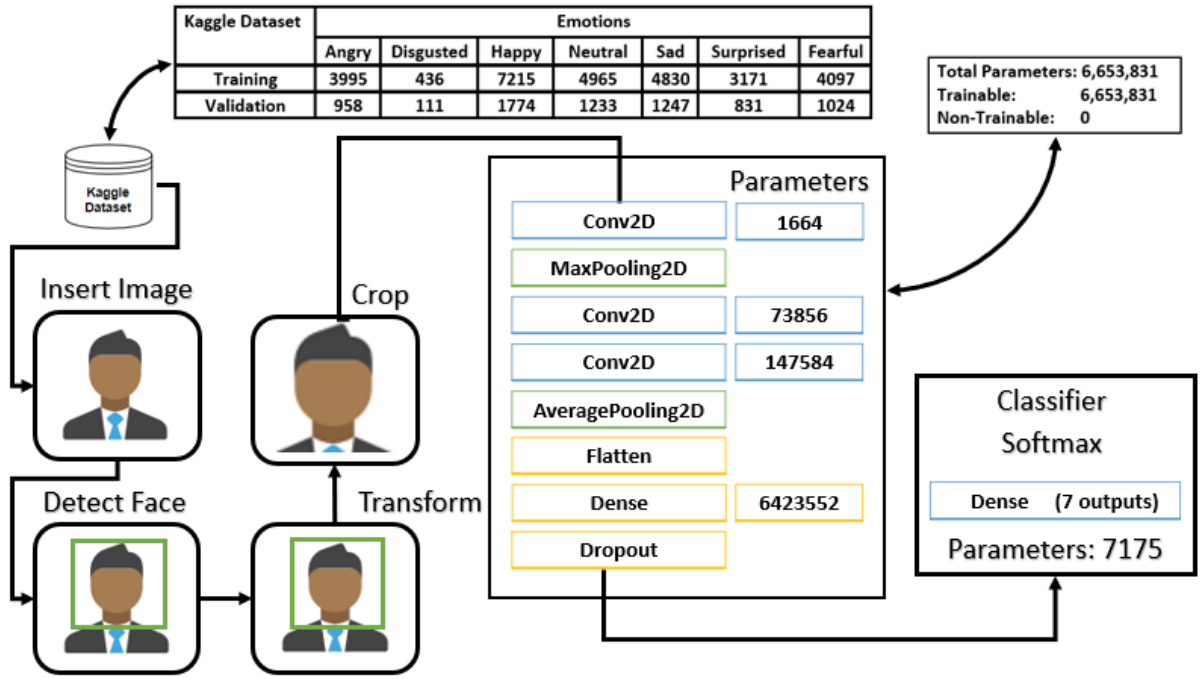

Fig. 5.2: Emotion Methodology Diagram

For Emotion recognition purpose, we have used dataset provided for a challenge organized by Kaggle. The dataset consists of 38000 images of individuals in different kind of expressions. We classified them into 7 classes (Angry, Disgusted, Happy, Fearful, Neutral, Sad and Surprised). Detected face is rescaled and inserted into the model for prediction. We have used Conv2D layer which have 64 filters. After that Pooling layer is created to reduce

the spatial dimensions. Again Conv2D layer is introduced but at this time 128 filters are used, another Conv2D layer is introduced but at this time 128 filters are used. After this Convolution 2D Layers, Pooling layer is embedded in order to reduce the spatial dimensions. Now this pooling map is reduced to single column. Now fully connected layer is connected neural network by using dense layer. After that it is connected to the last Dense Layer in which 7 outputs are generated in order to identify expression.

Chapter 6

System Testing and Evaluation

As it is already specified in earlier chapter, in face recognition, the algorithm gives us the location of any size of the picture area that covers a face well-defined of a human's two eyes, a mouth, and a nose. So, there is an obvious danger of detecting wrong positives in the system. Thus, if we want to get a satisfactory performance, any algorithm of face detection used should reduce the wrong positive rate as well as an incorrect negative rates.

This application practices the Local Binary Pattern Histogram (LBPH) algorithm framework for the detection of face. The Local Binary Pattern Histogram becomes extremely proficient, effective, and efficient which helps in the approaches of image scaling and methods to identify the faces of different sizes also from different angles to the viewer. The most important thing that is the "quality of the picture" is also taken into attention while investigating the application.

6.1 Graphical User Interface Testing

Graphical User Interface (GUI) testing is a procedure that assess how simply a user or customer interacts with the system using the interface. The Graphical User Interface is user friendly, easy to use, and simple considering the type of people and their cognition psychology so that the user having no expertise or knowledge computer system can effortlessly know the use of the system by just clicking the camera button.

6.2 Usability Testing

The usability testing is to confirm that the user having no technical expertise and the knowledge of particularly domain is able to use the system easily.

6.3 Software Performance Testing

The reason of software performance testing is to authenticate all of the non-functional requirements of the application. The non-functional requirements of our system involve reliability, efficiency, and response time.

6.4 Compatibility Testing

Compatibility testing is very important when developing any kind of system. It deals with the platform on which the application can be executed. As we have developed our system in Windows OS then it must be running on any Windows Operating Systems.

6.5 Load Testing

Load testing efficiently deals with the answer time or response time of the application. In this application it is achieved to measure the time interval in which the face is detected and identified.

6.6 Installation Testing

Installation testing is a practice of running the application on multiple operation systems. Our application is good enough and easily installed and executed on Windows Operation Systems only.

6.7 Test cases

Table 6.1*: TestCase1*

Test Case id	1
Function to be tested	Application launched successfully or not
Initial State	Application must be installed
Input	Press Start Button
Expected Output	Application should launch successfully
Output	Application is launched successfully
Status	Pass

Table 6.2:TestCase2

Test Case id	2
Function to be tested	Detection Successfully or unsuccessfully
Initial State	Camera must be enabled
Input	Face should be in front of camera
Expected Output	Detection of face should be done
Output	Successful detected
Status	Pass

Table 6.3:TestCase3

Test Case id	3
Function to be tested	Recognition Successful or not successful
Initial State	Camera must be detected the face first
Input	Face should be in front of camera
Expected Output	Gender should be recognized
Output	Successful recognized the face
Status	Pass

6.8 Test Cases and results

In order to test our application, we performed several tests and analyzed that gender is identified with 57% test accuracy but the expressions of an individual was identified 61%.

Table 6.1: Gender Confusion Matrix

		Predicted	
Actual	N=820	Female	Male
	Female	233	177
	Male	251	159

Table 6.2: Gender Accuracy Precision and Recall

N=820	Precision	Recall
Female	0.48	0.57
Male	0.47	0.39

Table 6.3: Emotion Confusion Matrix

		Predicted						
	N=700	Angry	Disgust	Fearful	Happy	Neutral	Sad	Surprise
Actual	Angry	43	0	16	14	14	12	1
	Disgust	17	60	6	2	5	10	0
	Fearful	7	4	43	7	14	19	6
	Happy	3	0	1	83	8	4	1
	Neutral	8	0	7	10	58	17	0
	Sad	11	1	12	11	16	48	1
	Surprise	3	0	10	5	1	3	78

Table 6.4: Emotion Accuracy Precision and Recall

N=700	Precision	Recall
Angry	0.47	0.43
Disgust	0.92	0.60
Fearful	0.45	0.43
Happy	0.63	0.83
Neutral	0.50	0.58
Sad	0.42	0.48
Surprise	0.90	0.78
Micro avg	0.59	0.59
Macro avg	0.61	0.59
Weighted avg	0.61	0.59

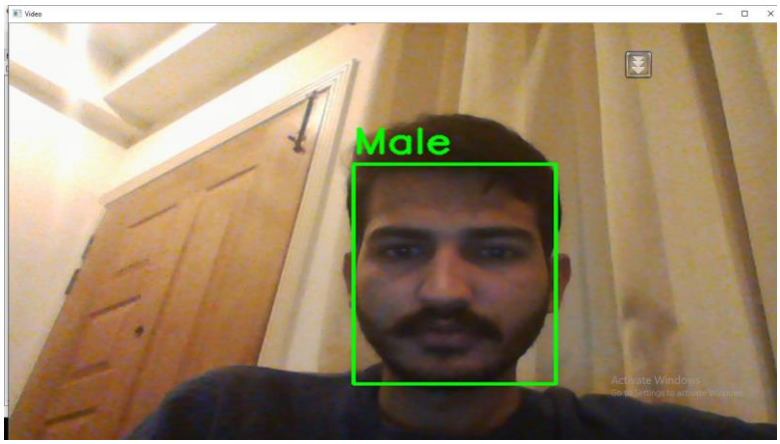

Fig. 6.1*: Male Face Detected*

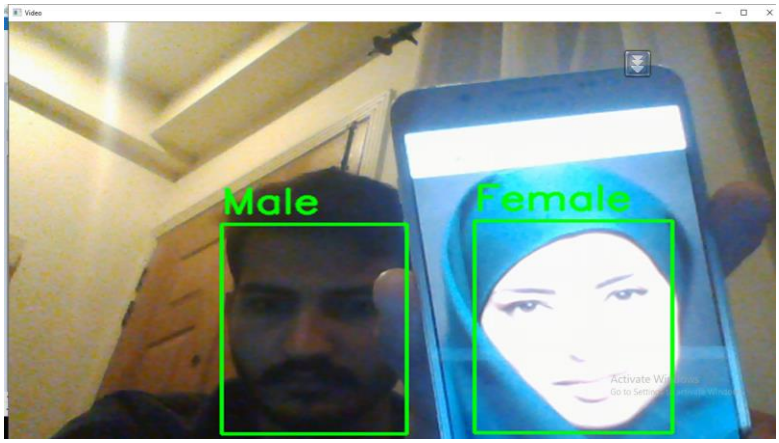

Fig. 6.2: *Female and male face detected*

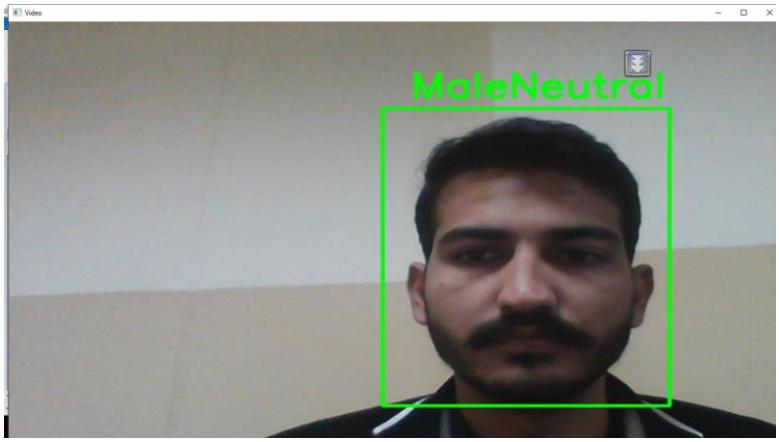

Fig. 6.3: *Gender with Neutral emotion*

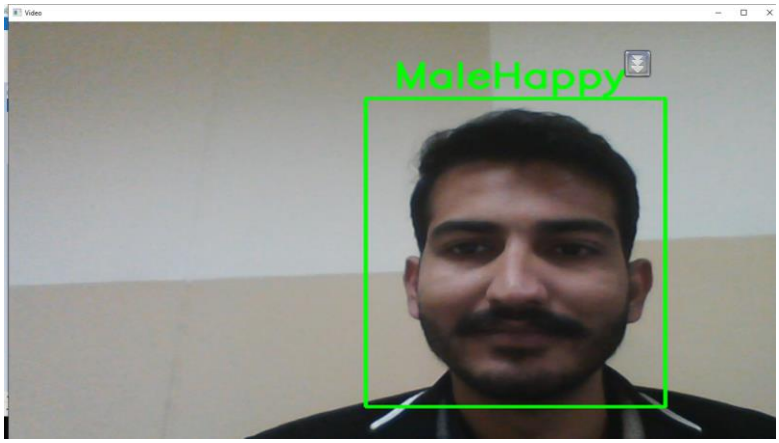

Fig. 6.4: *Gender with Happy emotion*

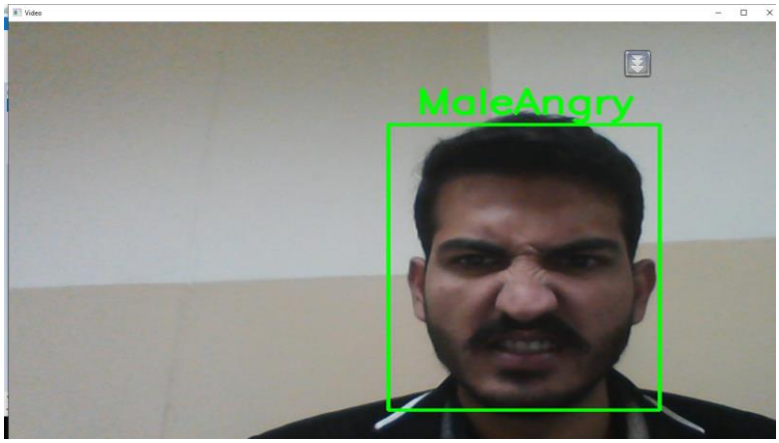

Fig. 6.5: *Gender with Angry emotion*

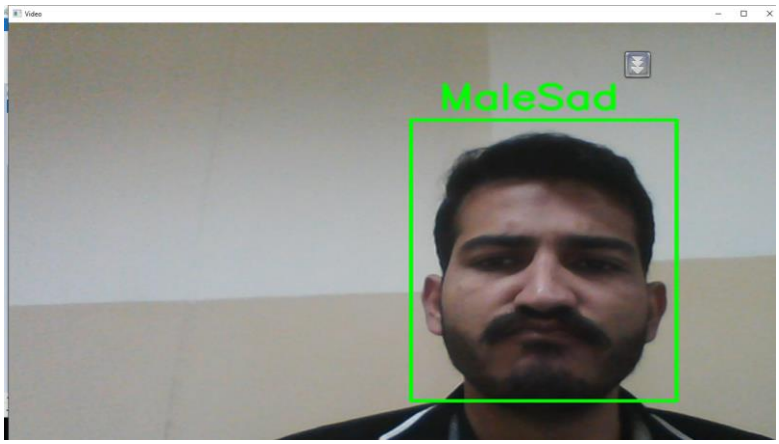

Fig. 6.6: *Gender with Sad emotion*

Chapter 7

Conclusions

7.1 Conclusion

This project is the part of those efforts that are growing over the ages. Basically this project has a huge impact in the society. As this project was based on programming that we practiced in our degree and for us it meant disciplining ourselves in learning about latest skills and excellent programming practices. Building this particular CNN model helped us to learn python and development for machine learning. We enhanced some significant teachings during this period and enhanced some ideas to the matter which we tried with our best efforts to share in this report. We tried with our best efforts and knowledge to analyze at the problem from different viewpoints which shaped few new ideas that could be exposed in the upcoming years. Furthermore, we also learnt short term project formation and implementation which contains:

- Requirements Gathering
- Researching about the field or domain
- Designing of System
- Simple functional and testing quality
- Communication with multiple tools and technologies
- Time management

Developing and designing model using CNN was absolutely an overland challenging task for us. We acknowledged the experiment to make this application which will help users detecting and identifying of different faces of a human. Implementing model was very exciting job.
We selected building a Machine Learning Application because of massive market demand and opportunity.

7.2 Improvements for Future

Due to the limited time and resources we had to fulfill the requirement in the limited time. In future we will extend it as a social media application same like snapchat. We can deploy this project as a domain in recruitment process, like we can attach it to a video calling application, So that the meantime expressions can be identified that might help recruiter to access the candidate psychologically.

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