"Human Emotion Detection System"

A Major Project Report Submitted to Rajiv Gandhi Proudyogiki Vishwavidyalaya

Towards Partial Fulfillment for the Award of

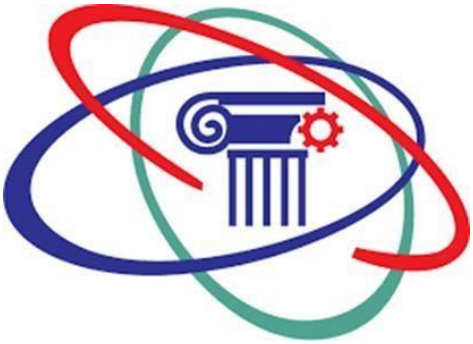
Bachelor of Technology in Computer Science & Engineering

Submitted by:

Abhinav Nagar (0827CS201010)
Ajay Sonere (0827CS201019)
Ankit Buade (0827CS201033)
Deepak Patidar (0827CS201063)

Guided by:

Prof. Ritika Bhatt
Computer Science and Engineering



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EXAMINER APPROVAL

The major project Entitled “Human emotion detection system” submitted by Abhinav Nagar(0827CS201010) Ajay Sonere (0827CS201019), Ankit Buade (0827CS201033), Deepak Patidar (0827CS201065) has been examined and is hereby approved towards partial fulfillment for the award of Bachelor of Technology degree in Computer Science Engineering discipline, for which it has been submitted. It is understood that by this approval the undersigned do not necessarily endorse or approve any statement made, opinion expressed, or conclusion drawn therein, but approve the project only for the purpose for which it has been submitted.

(Internal Examiner) (External Examiner)

Date: Date:

RECOMMENDATION

This is to certify that the work embodied in this major project entitled “Human emotion detection system ” submitted by **Abhinav Nagar (0827CS201010), Ajay Sonere (0827CS201019),Ankit Buade (0827CS201064), Deepak Patidar (0827CS201063)** is a satisfactory account of the bonafide work done under the supervision of Mrs. Ritika Bhatt, is recommended towards partial fulfillment for the award of the Bachelor of Technology (Computer Science Engineering) degree by Rajiv Gandhi Proudyogiki Vishwavidhyalaya, Bhopal.

(Project Guide)

(Project Coordinator)

(Dean Academics)

STUDENTS UNDERTAKING

This is to certify that the major project entitled “Human Emotion Detection system” has developed by us under the supervision of Mrs. Ritika Bhatt. The whole responsibility of the work done in this project is ours. The sole intension of this work is only for practical learning and research.

We further declare that to the best of our knowledge; this report does not contain any part of any work which has been submitted for the award of any degree either in this University or in any other University / Deemed University without proper citation and if the same work found then we are liable for explanation to this.

Abhinav nagar (0827CS201010)

Ajay Sonere (0827CS201019)

Ankit Buade (0827CS201033)

Deepak Patidar (0827CS201063)

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We thank the almighty Lord for giving us the strength and courage to sail out through the tough and reach on shore safely.

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We express profound gratitude and heartfelt thanks to **Dr Kamal Kumar Sethi**, Professor & Head CSE, AITR Indore for his support, suggestion, and inspiration for carrying out this project. I am very much thankful to other faculty and staff members of the department for providing me all support, help and advice during the project. We would be failing in our duty if do not acknowledge the support and guidance received from **Dr S.C. Sharma**, Director, AITR, Indore whenever needed. We take opportunity to convey my regards to the management of Acropolis Institute, Indore for extending academic and administrative support and providing me all necessary facilities for project to achieve our objectives.

We are grateful to our parents and family members who have always loved and supported us unconditionally. To all of them, we want to say “Thank you”, for being the best family that one could ever have and without whom none of this would have been possible.

Abhinav Nagar

Ajay Sonere

Ankit Buade

Deepak Patidar

Executive Summary

Human Emotion Detection System This project is submitted to Rajiv Gandhi Proudyogiki Vishwavidhyalaya, Bhopal (MP), India for partial fulfillment of Bachelor of Technology in Computer Science and Engineering branch under the sagacious guidance and vigilant supervision of Mrs. Ritika Bhatt.

This project harnesses the power of machine learning to gather, analyze, and assess review expression Using various dataset and ML algorithms, an Emotion analysis model is trained to determine the sentiments expressed in facial expression, categorizing them as Angry, sad, Happy, or neutral.

Emotion recognition has wide scope in many areas such as human computer interaction, biometric security etc. So it provides insight into artificial intelligence or machine intelligence that uses various supervised and unsupervised machine-learning algorithms to simulate the human brain

Key words: Machine Learning, Natural Language Processing, Sentiment analysis, Emotion Detection, feedback

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CHAPTER 1

1.1 INTRODUCTION

A Facial expression is the visible manifestation of the affective state, cognitive activity, intention, personality and psychopathology of a person and plays a communicative role in interpersonal relations. It have been studied for a long period of time and obtaining the progress recent decades. Though much progress has been made, recognizing facial expression with a high accuracy remains to be difficult due to the complexity and varieties of facial expressions

Generally human beings can convey intentions and emotions through nonverbal ways such as gestures, facial expressions and involuntary languages. This system can be significantly useful, nonverbal way for people to communicate with each other. The important thing is how fluently the system detects or extracts the facial expression from image. The system is growing attention because this could be widely used in many fields like lie detection, medical assessment and human computer interface. The Facial Action Coding System (FACS), which was proposed in 1978 by Ekman and refined in 2002, is a very popular facial expression analysis tool

The primary goal of these systems is to enhance human-computer interaction, personalize user experiences, and contribute to fields ranging from healthcare and education to marketing and security.

On a day to day basics humans commonly recognize emotions by characteristic features, displayed as a part of a facial expression. For instance happiness is undeniably associated with a smile or an upward movement of the corners of the lips. Similarly other emotions are characterized by other deformations typical to a particular expression. Research into automatic recognition of facial expressions addresses the problems surrounding the representation and categorization of static or dynamic characteristics of these deformations of face pigmentation.

The system classifies facial expression of the same person into the basic emotions namely anger, disgust, fear, happiness, sadness and surprise. The main purpose of this system is efficient interaction between human beings and machines using eye gaze, facial expressions, cognitive modeling etc. Here, detection and classification of facial expressions can be used as a natural way for the interaction between man and machine. And the system intensity vary from person to person and also varies along with age, gender, size and shape of face, and further, even the expressions of the same person do not remain constant with time.

However, the inherent variability of facial images caused by different factors like variations in illumination, pose, alignment, occlusions makes expression recognition a challenging task. Some surveys on facial feature representations for face recognition and expression analysis addressed these challenges and possible solutions in detail .

1.2 Motivation

In today's networked world the need to maintain security of information or physical property is becoming both increasingly important and increasingly difficult. In countries like Nepal the rate of crimes are increasing day by day. No automatic systems are there that can track person's activity. If we will be able to track Facial expressions of persons automatically then we can find the criminal easily since facial expressions changes doing different activities. So we decided to make a Facial Expression Recognition System. We are interested in this project after we went through few papers in this area. The papers were published as per their system creation and way of creating the system for accurate and reliable facial expression recognition system.

1.3 Problem Statement

Human emotions and intentions are expressed through facial expressions and deriving an efficient and effective feature is the fundamental component of facial expression system. Face recognition is important for the interpretation of facial expressions in applications such as intelligent, man-machine interface and communication, intelligent visual surveillance, teleconference and real-time animation from live motion images. The facial expressions are useful for efficient interaction Most research and system in facial expression recognition are limited to six basic expressions (joy, sad, anger, disgust, fear, surprise). It is found that it is insufficient to describe all facial expressions and these expressions are categorized based on facial actions .

Detecting face and recognizing the facial expression is a very complicated task when it is a vital to pay attention to primary components like: face configuration, orientation, location where the face is set.

1.4 Objectives

- To develop a facial expression recognition system.
- To experiment machine learning algorithm in computer vision fields.
- To detect emotion thus facilitating Intelligent Human-Computer Interaction.

1.5 Scope and Applications

The scope of this system is to tackle with the problems that can arise in day to day life. Someof the scopes are:

- The system can be used to detect and track a user's state of mind.
- The system can be used in mini-marts, shopping center to view the feedback of the customers to enhance the business,
- The system can be installed at busy places like airport, railway station or bus station for detecting human faces and facial expressions of each person. If there are any faces that appeared suspicious like angry or fearful, the system might set an internal alarm.
- The system can also be used for educational purpose such as one can get feedback on how the student is reacting during the class.

- This system can be used for lie detection amongst criminal suspects during interrogation
- This system can help people in emotion related -research to improve the processing of emotion data.
- Clever marketing is feasible using emotional knowledge of a person which can be identified by this system.
- Mental Health Monitoring: Emotion detection can be used to monitor and assess mental health conditions by analyzing facial expressions, voice tone, and other physiological signals.
- Patient Feedback: In healthcare settings, emotion detection can be used to analyze patient feedback, helping healthcare providers to understand and improve patient experiences.
- Student Engagement: Emotion detection systems can be employed to gauge student engagement and interest during online or in-person learning sessions, providing valuable feedback to educators. Adaptive Learning: Systems can adapt learning content based on the emotional state of the learner, offering a more personalized and effective educational experience.

1.6 Team Organization

AJAY SONERE : I am the project Manager and frontend developer of this project from Creating to executing all work is executed by me and my team.

DEEPAK PATIDAR: I am the backend developer in this project Data integration is Done all by me

ABHINAV NAGAR: I am backend developer in this project. Training Machine learning model on datasets taken from kaggel is done by me

ANKIT BUADE : I am the researcher in this project carrying out all the necessary research and analyzed it properly, according to analyzing the project and I am tester for this project all the necessary steps of Testing is carried out by me .

1.7 Report Structure

The project HUMAN EMOTION DETECTION SYSTEM is primarily concerned with MACHINE LEARNING AND ARTIFICIAL INTELLIGENCE and whole project report is categorized into five chapters.

Chapter 1: Introduction- introduces the background of the problem followed by rationale for the project undertaken. The chapter describes the objectives, scope and applications of the project. Further, the chapter gives the details of team members and their contribution in development of project which is then subsequently ended with report outline.

Chapter 2: Review of Literature- explores the work done in the area of Project undertaken and discusses the limitations of existing system and highlights the issues and challenges of project area. The chapter finally ends up with the requirement identification for present project work based on findings drawn from reviewed literature and end user interactions.

Chapter 3: Project methodology - starts with the project proposal based on requirement identified, followed by benefits of the project. The chapter also illustrate software engineering paradigm used along with different design representation. The chapter also includes block diagram and details of major modules of the project. Chapter also gives insights of different type of feasibility study carried out for the project undertaken. Later it gives details of the different deployment requirements for the developed project.

Chapter 4: Development and testing - includes the details of different Technology/ Techniques/ Tools/ Programming Languages used in developing the Project. The chapter also includes the different user interface designed in project along with their functionality. Further it discuss the experiment results along with testing of the project. The chapter ends with evaluation of project on different parameters like accuracy and efficiency.

Chapter 5: Experimentation and results - First of all, system was trained using different random samples in each dataset by supervised learning. In each datasets the data were partitioned into two parts for training and testing. Every dataset have completely different samples which are selected randomly in uniform manner from the pool of given dataset

Chapter 6: Conclusion - Concludes with objective wise analysis of results and limitation of present work which is then followed by suggestions and recommendations for further improvement.

CHAPTER 2

2. LITERATURE REVIEW

2.1 Planning

In planning phase study of reliable and effective algorithms is done. On the other hand data were collected and were preprocessed for more fine and accurate results. Since huge amount of data were needed for better accuracy we have collected the data surfing the internet. Since, we are new to this project we have decided to use local binary pattern algorithm for feature extraction and support vector machine for training the dataset. We have decided to implement these algorithms by using OpenCv framework.

2.1.2 Literature Reviews

Research in the fields of face detection and tracking has been very active and there is exhaustive literature available on the same. The major challenge that the researchers face is the non-availability of spontaneous expression data [1]. Capturing spontaneous expressions on images and video is one of the biggest challenges ahead [2]. Many attempts have been made to recognize facial expressions. Zhang et al investigated two types of features, the geometry-based features and Gabor wavelets based features, for facial expression recognition.

Appearance based methods, feature invariant methods, knowledge based methods, Template based methods are the face detection strategies whereas Local Binary Pattern phase correlation, Haar classifier, AdaBoost, Gabor Wavelet are the expression detection strategies in related field [3]. Face reader is the premier for automatic analysis of facial expression recognition and Emotient, Affectiva, Karios etc are some of the API's for expression recognition. Automatic facial expression recognition includes two vital aspects: facial feature representation and classifier problem [2].

Facial feature representation is to extract a set of appropriate features from original face images for describing faces. Histogram of Oriented Gradient (HOG), SIFT, Gabbor Fitters and Local Binary Pattern (LBP) are the algorithms used for facial feature representation [3,4]. LBP is a simple yet very efficient texture operator which labels the pixels of an image by thresholding the neighborhood of each pixel and considers the result as a binary number. The operator labels the pixels of an image by thresholding the 3X3 neighborhood of each pixel with the center value and considering the result as a binary number [3]. HOG was first proposed by Dalal and Triggs in 2005. HOG numerates the appearance of gradient orientation in a local path of an image.

For classifier problem we use algorithms like Machine learning, Neural Network, Support Vector Machine, Deep learning, Naive Bayes. The formation of histogram by using any of facial feature representation will use Support Vector Machine (SVM) for expression recognition. SVM builds a hyperplane to separate the high dimensional space. An ideal separation is

achieved when the distance between the hyper plane and the training data of any class is the largest .

The size of the block for the LBP feature extraction is chosen for higher recognition accuracy. The testing results indicate that by using LBP features facial expressions recognition accuracy is more than 97%. The block LBP histogram features extract local as well as global features of face image resulting higher accuracy. LBP is compatible with various classifiers, filters etc. .

2.1.3 Data collection

Some of the public databases to evaluate the facial expression recognition algorithms are:

2.1.4 COHN-KANADE AU Coded Facial Expression Database

Subjects in the released portion of the COHN-KANADE AU-Coded Facial Expression Database are 100 university students. They ranged in age from 18 to 30 years. Sixty-five percent were female, 15 percent were African-American, and three percent were Asian or Latino. Subjects were instructed by an experimenter to perform a series of 23 facial displays that included single action units and combinations of action units. Image sequences from neutral to target display were digitized into 640 by 480 or 490 pixel arrays with 8-bit precision for grayscale values. Included with the image files are "sequence" files; these are short text files that describe the order in which images should be read. The seven expressions are angry, surprise, contempt, fear, and disgust [4]. Fig.1 shows the 8 expressions with each from a different subject.

Figure 1: The eight expression from one subject

2.1.5 Japanese Female Facial Expression (JAFFE) Database

This database contains 213 images in total. There are 10 subjects and 7 facial expressions for each subject. Each subject has about twenty images and each expression includes two to three images. The seven expressions are angry, happy, disgust, sadness, surprise, fear and neutral respectively [4]. Fig.2 shows the seven expressions from one subject.

Figure 2: The seven expression from one subject

Table 1: Data Collections

Database	Sample Details	Available Descriptions
COHN-KANADE Database (also known as CMU-Pittsburg data- base) [1].	• 585 image sequences from 97 subjects • Age: 18 to 30 years • Gender: 65% female • Ethnicity: 15% African - Americans and 3% of Asians and Latinos	"Annotation of FACS Action Units and emotion-specified expressions"
The Japanese Female Facial Expression (JAFFEE) Data-base [1].	• 213 images of 7 facial expressions (6 basic facial expressions + 1 neutral) • 10 Japanese female models.	"Each image has been rated on 6 emotion adjectives by 92 Japanese subjects"

2.2 Dataset Preparation

The proposed system was trained and tested using two datasets namely COHN-KANADE and JAFFE. The COHN-KANADE dataset consists of 500 images sequences from 100 subjects whereas the JAFFE dataset consists of 213 images. For our experiment we have used 6481 images for training and 1619 images for testing fromm different subjects of Cohn-Kanade dataset. Similarly, 107 images were used for training and 106 images were used for testing from JAFFE dataset.

We normalized the faces to 72 pixels. Based on the structure of face facial images of 256*256 pixels were cropped from original images. To identify the facial image automatic face detection was performed by using the face detector of our own system based on Haar classifier. From the results of face detection including face location, face width and face height were automatically created.

Finally images were cropped in accordance to the result given by the face detector and further cropped images were used for training and testing.

Figures below show the original image and cropped image:

Figure 3: Original Image from data set

Figure 4: Cropped Image from Data set

2.3 Requirement Specification:

Requirement analysis is mainly categorized into two types:

Functional requirements:

The functional requirements for a system describe what the system should do. Those requirements depend on the type of software being developed, the expected users of the software. These are statement of services the system should provide, how the system should react to particular inputs and how the system should behave in particular situation.

Non-Functional requirements:

Nonfunctional requirements are requirements that are not directly concerned with the specified function delivered by the system. They may relate to emergent system properties such as reliability, response time and store occupancy. Some of the nonfunctional requirements related with this system are hereby below:

a) Reliability: Reliability based on this system defines the evaluation result of the system, correct identification of the facial expressions and maximum evaluation rate of the facial expression recognition of any input images.

b) Ease of Use: The system is simple, user friendly, graphics user interface implemented so any can use this system without any difficulties.

2.4 Feasibility Study

Before starting the project, feasibility study is carried out to measure the viable of the system. Feasibility study is necessary to determine if creating a new or improved system is friendly with the cost, benefits, operation, technology and time. Following feasibility study is given as below:

2.4.1 Technical Feasibility

Technical feasibility is one of the first studies that must be conducted after the project has been identified. Technical feasibility study includes the hardware and software devices.

The required technologies (Python language and Anaconda IDE) existed.

2.4.2 Operational Feasibility

Operational Feasibility is a measure of how well a proposed system solves the problem and takes advantage of the opportunities identified during scope definition. The following points were considered for the project's technical feasibility: The system will detect and capture the image of face. The captured image is then (identified which category)

2.4.3 Economic Feasibility

The purpose of economic feasibility is to determine the positive economic benefits that include quantification and identification. The system is economically feasible due to availability of all requirements such as collection of data from

- JAFFE
- COHN-KANADE

2.6.4 Schedule Feasibility

Schedule feasibility is a measure of how reasonable the project timetable is. The system is found schedule feasible because the system is designed in such a way that it will finish prescribed time.

2.5 Study of Existing System's

Affectiva: Affectiva provides emotion recognition software that uses computer vision and deep learning to analyze facial expressions. It is applied in areas such as market research, advertising, and human-computer interaction.

Microsoft Azure Face API: Microsoft Azure Face API includes emotion recognition capabilities. It can analyze facial expressions in images to determine emotions such as happiness, sadness, anger, and surprise.

IBM Watson Tone Analyzer: IBM Watson Tone Analyzer is part of the IBM Watson API suite. It can analyze text to determine emotional tones, helping businesses understand and respond to customer sentiments in written communication.

OpenFace: OpenFace is an open-source facial behavior analysis toolkit. It provides tools for face recognition, facial landmark detection, and emotion analysis. It is widely used in research and development.

Kairos: Kairos offers an emotion analysis API that can detect and analyze facial expressions in images or videos. It is used in applications such as customer feedback analysis and user engagement measurement.

2.6 Software and Hardware Requirement

2.6.1 Software Requirement

Following are the software requirement necessary of the project:

a) Python programming language

b) Anaconda Navigator (selective)

c) OpenCV framework

d) Windows 10 OS

e) Streamlit framework

2.6.2 Hardware Requirement

Following are the hardware requirement that is most important for the project:

a) Fluently working Laptops

b) RAM minimum 4Gb

c) Web Camera

CHAPTER 3

3. PROJECT METHODOLOGY

3.1 System Design

System design shows the overall design of system. In this section we discuss in detail the design aspects of the system:

3.2 System Diagram of Emotion Detection system

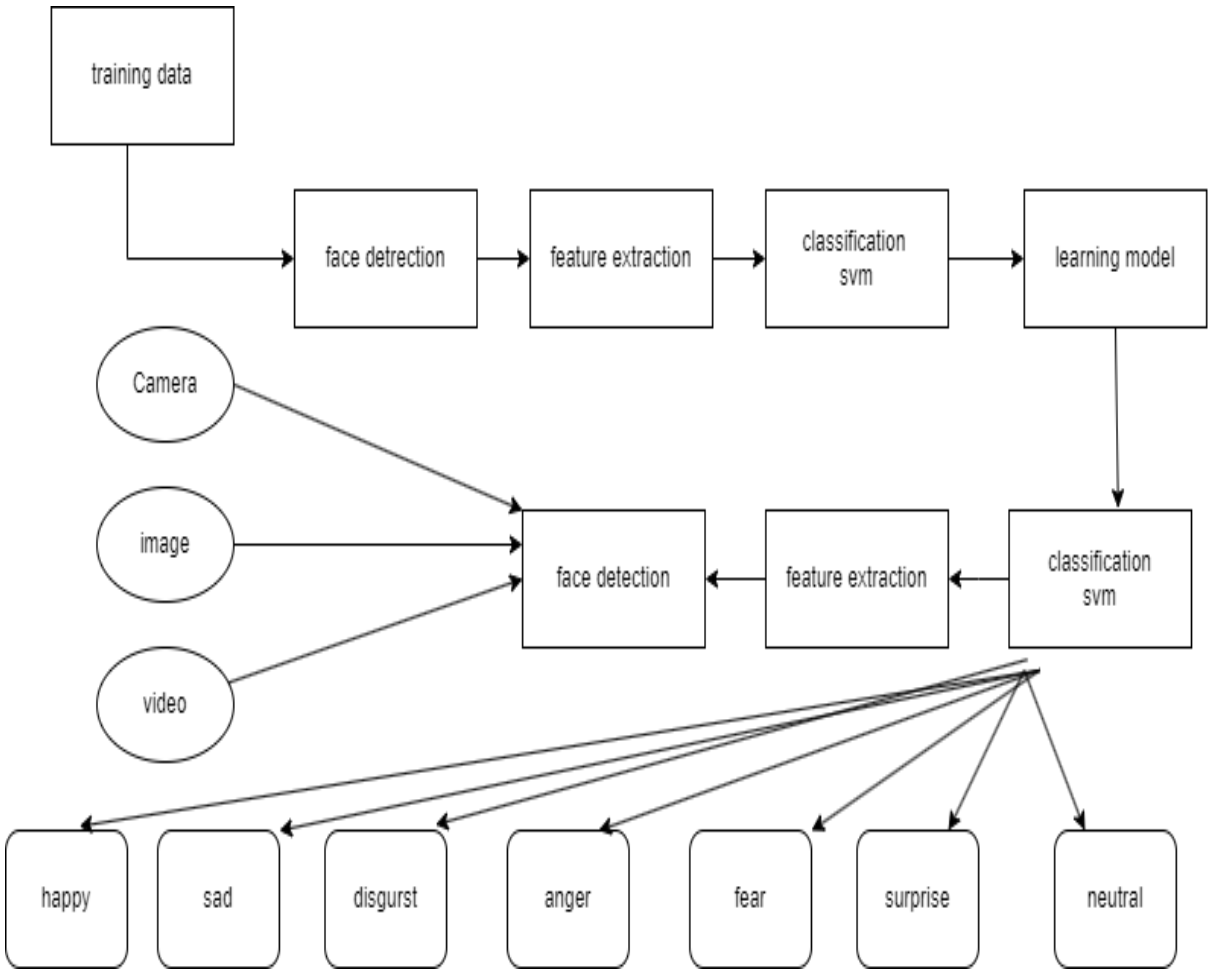


Figure 5 System Diagram of human emotion detection system

3.3 System Flowchart of Emotion Detection system

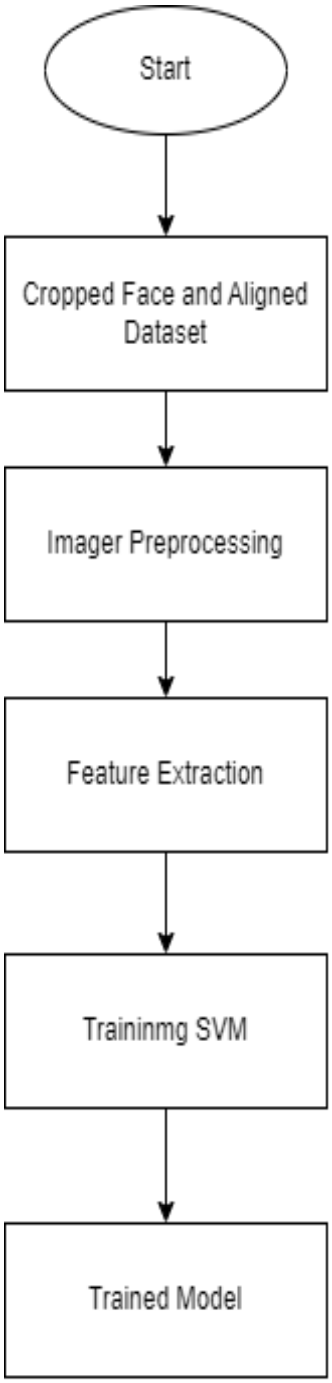


Figure 6 : Flowchart of Training Emotion Detection Software

3.4 Activity Diagram of Training Human emotion Detection System

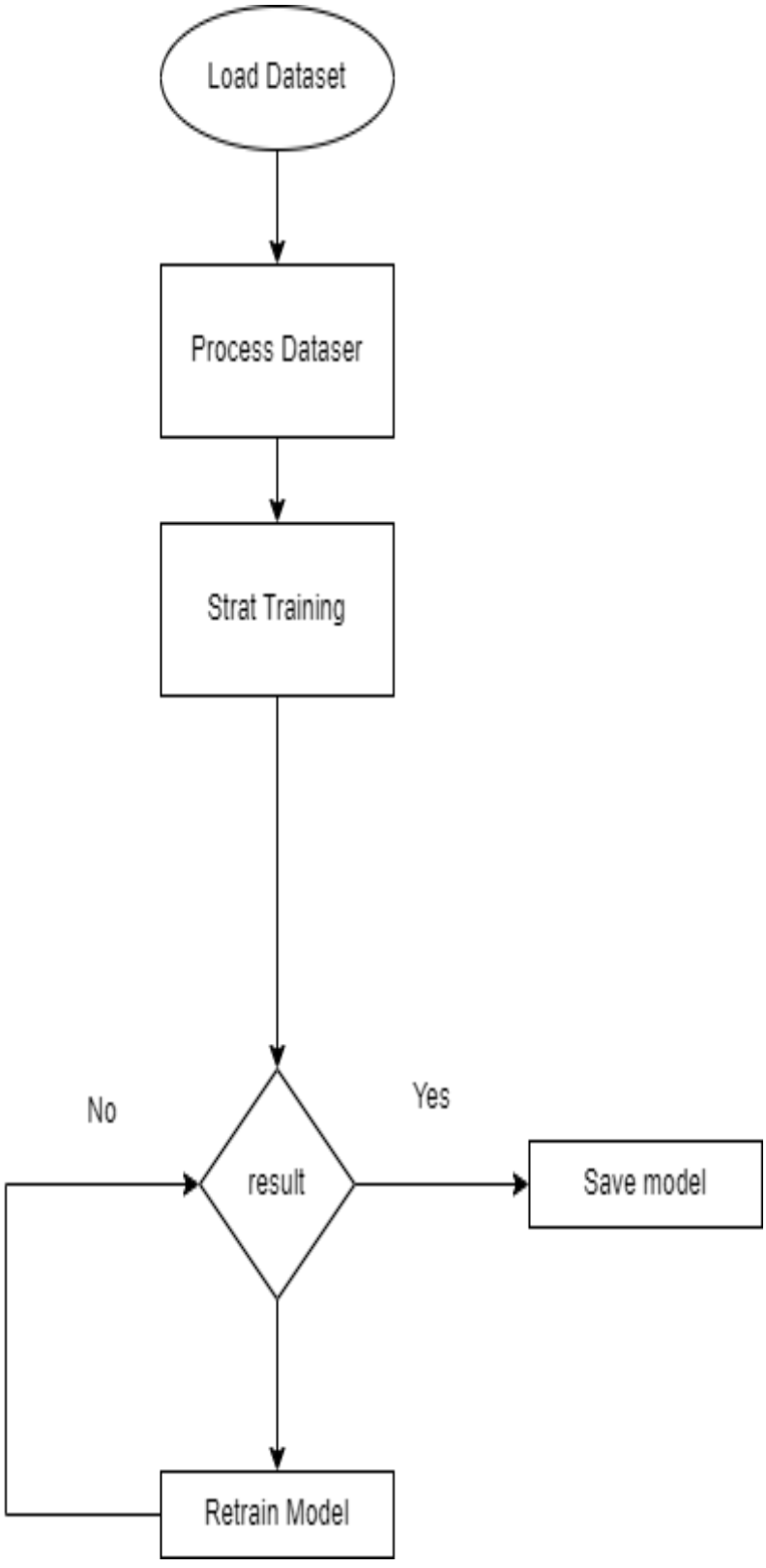


Figure 7 : Activity Diagram of Training Human emotion Detection System

3.5 Flowchart of Testing Human Emotion Detection System

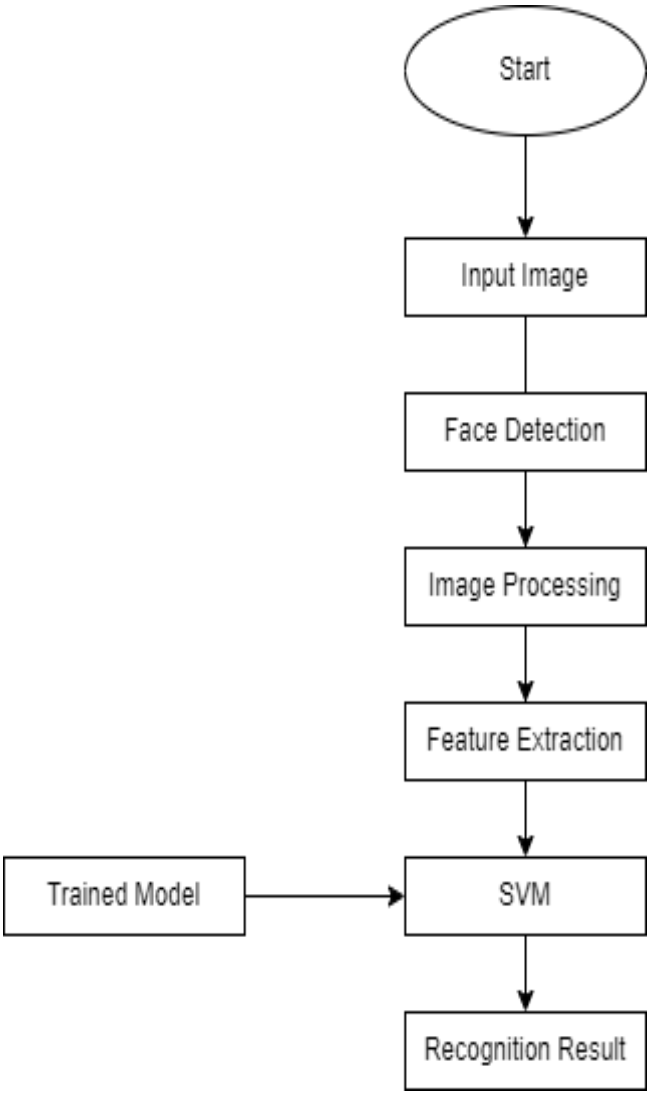


Figure 8 : Flowchart of Testing Human Emotion Detection System

3.6 Use Case Diagram Of Human Emotion Detection System

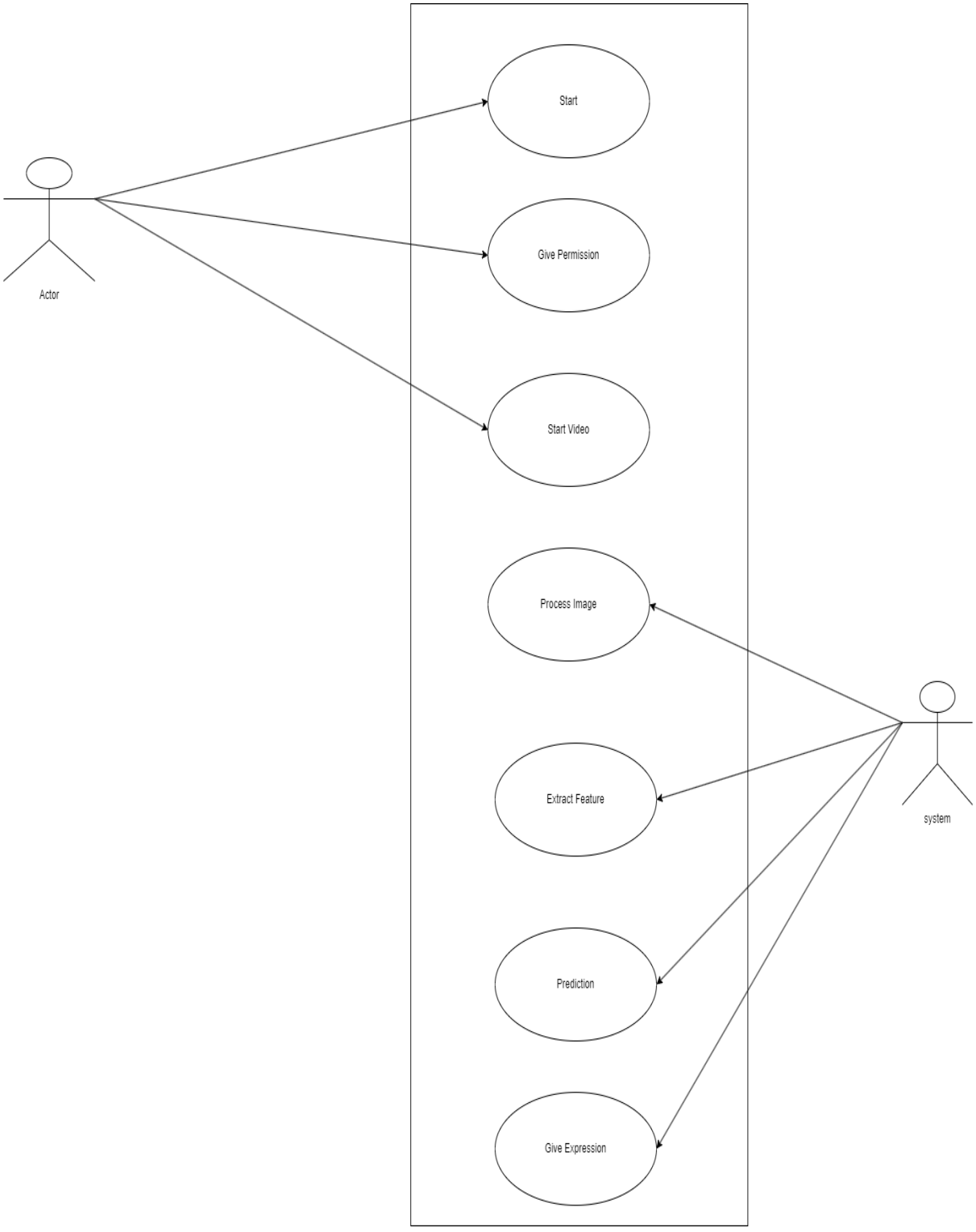


Figure 9: Use Case Diagram Of Human Emotion Detection System

3.7 Class Diagram of Human Emotion Detection System

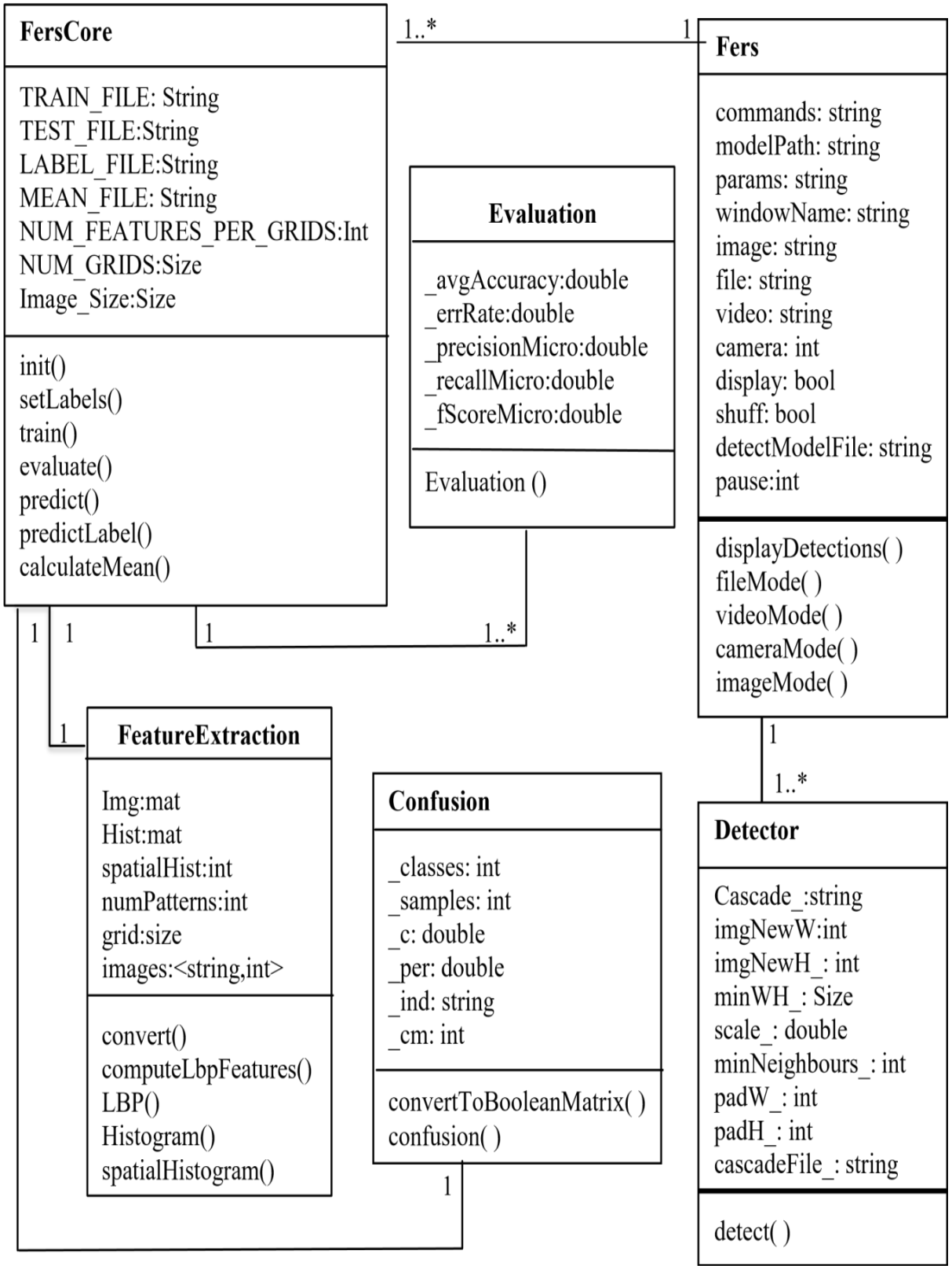


Figure 10 : Class Diagram of Human Emotion Detection System

3.8 Sequence Diagram of Human Emotion Detection System

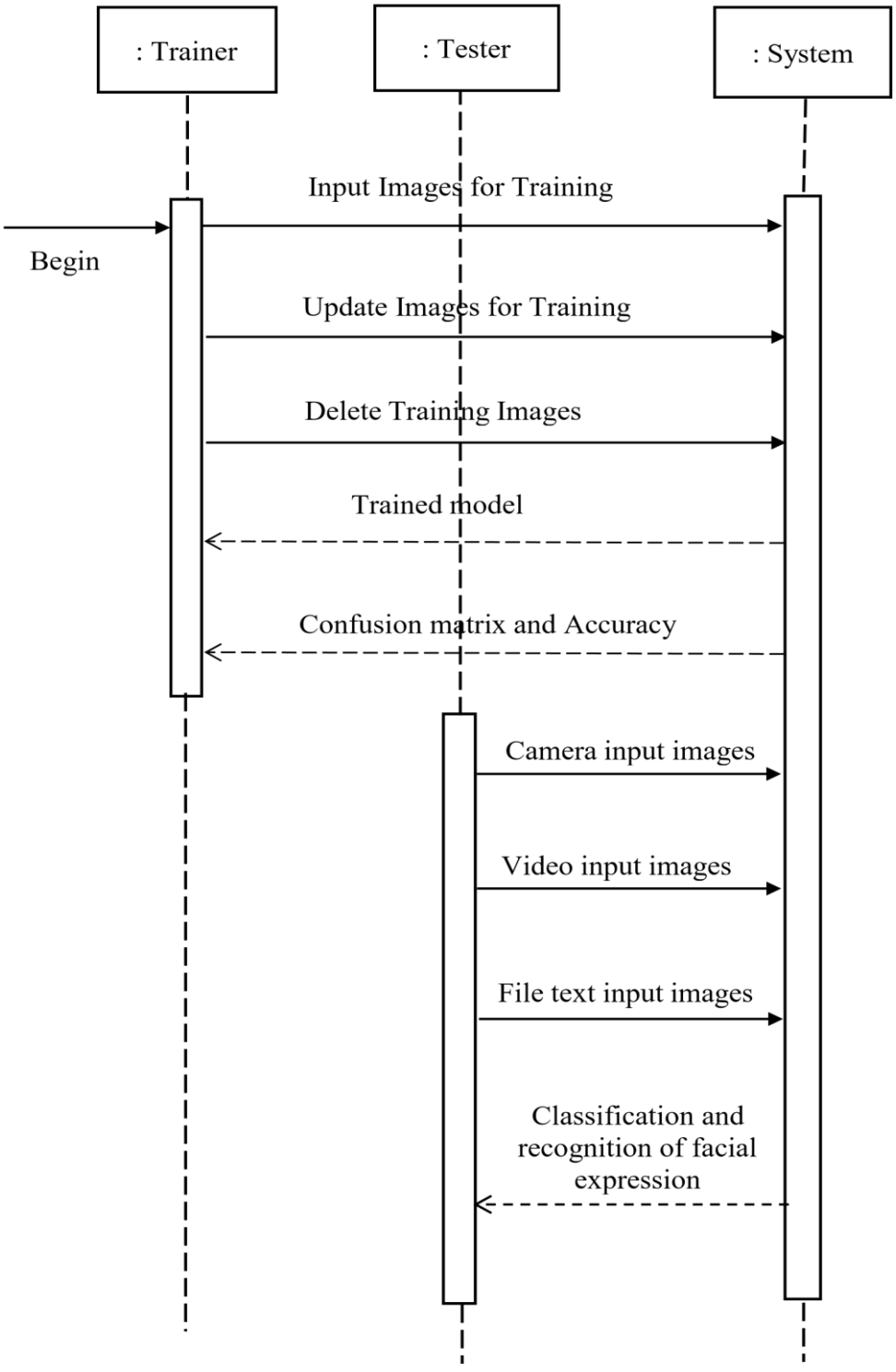


Figure 11 : Sequence Diagram of Human Emotion Detection System

3.2 Steps Involved in Facial Expression Recognition

The facial expression recognition system is trained using supervised learning approach in which it takes images of different facial expressions. The system includes the training and testing phase followed by image acquisition, face detection, image preprocessing, feature extraction and classification. Face detection and feature extraction are carried out from face images and then classified into six classes belonging to six basic expressions which are outlined below:

3.2.1 Image Acquisition

Images used for facial expression recognition are static images or image sequences.

Images of face can be captured using camera.

3.2.2 Face detection

Face Detection is useful in detection of facial image. Face Detection is carried out in training dataset using Haar classifier called Voila-Jones face detector and implemented through Opencv. Haar like features encodes the difference in average intensity in different parts of the image and consists of black and white connected rectangles in which the value of the feature is the difference of sum of pixel values in black and white regions .

3.2.3 Image Pre-processing

Image pre-processing includes the removal of noise and normalization against the variation of pixel position or brightness.

a) Color Normalization

b) Histogram Normalization

3.2.4 Feature Extraction

Selection of the feature vector is the most important part in a pattern classification problem. The image of face after pre-processing is then used for extracting the important features. The inherent problems related to image classification include the scale, pose, translation and variations in illumination level. The important features are extracted using LBP algorithm which is described below:

3.2.5 Local Binary Pattern

LBP is the feature extraction technique. The original LBP operator points the pixels of an image with decimal numbers, which are called LBPs or LBP codes that encode the local structure around each pixel. Each pixel is compared with its eight neighbors in a 3 X 3 neighborhood by subtracting the center pixel value. In the result, negative values are encoded with 0 and the others with 1. For each given pixel, a binary number is obtained by merging all these binary values in a clockwise direction, which starts from the one of its top-left neighbor. The corresponding decimal value of the generated binary number is then used for labeling the given pixel. The derived binary numbers are referred to be the LBPs or LBP codes.

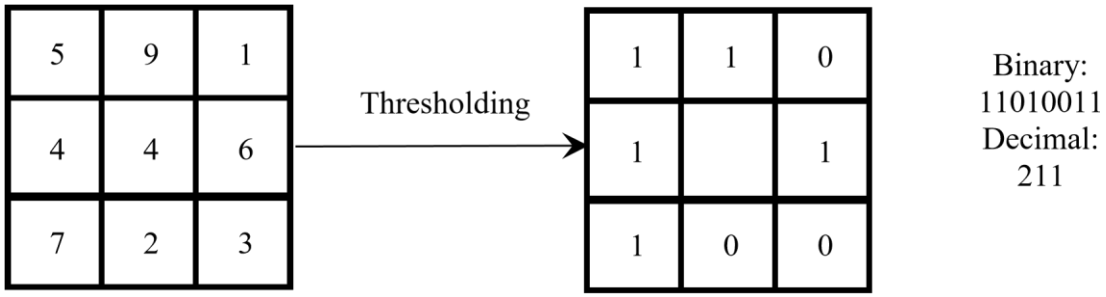
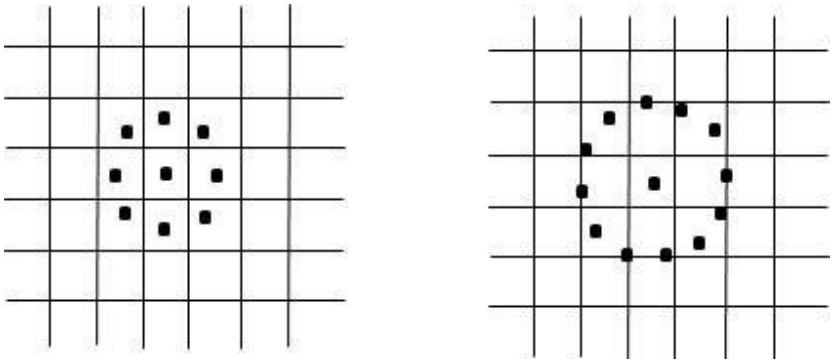


Figure 10: The Basic LBP Operator



(P=8,R=1.0) (P=12,R=1.5)

Figure 12: Two examples of extended LBP

The limitation of the basic LBP operator is that its small 3×3 neighborhood cannot capture the dominant features with large scale structures. As a result, to deal with the texture at different scales, the operator was later extended to use neighborhoods of different sizes [7]. Using circular neighborhoods and bilinearly interpolating the pixel values allow any radius and number of pixel in the neighborhood. Examples of the extended LBP are shown above (Figure 5.3.2), where (P, R) denotes sampling points on a circle of radius of R.

Further extension of LBP is to user uniform patterns. A LBP is called uniform if it contains at most two bitwise transitions from 0 to 1 or vice versa when the binary string is considered circular. E.g.00000000, 001110000 and 11100001 are uniform patterns. A histogram of a labelled image f1(x, y) can be defined as

$$x,y\ I\ (fl(x, y) = i),\ \ i = 0, \dots , n - 1 \quad (1)$$

Where n is the number of different labels produced by the LBP operator and This histogram contains information about the distribution of the local micro-patterns, such as edges, spots and flat areas, over the whole image. For efficient face representation, feature extracted should retain also spatial information. Hence, face image is divided into m small regions R0, R1,…,Rm and a spatially enhanced histogram is defined as [2]

$$x,y\ I\ (fl(x, y) = i)I((x, y)\epsilon Rj \quad (2)$$

3.2.6 Classification

The dimensionality of data obtained from the feature extraction method is very high so it is reduced using classification. Features should take different values for object belonging to different class so classification will be done using Support Vector Machine algorithm.

3.2.7 Support Vector Machines

SVM is widely used in various pattern recognition tasks. SVM is a state-of-the-art machine learning approach based on the modern statistical learning theory. SVM can achieve a near optimum separation among classes. SVMs is trained to perform facial expression classification using the features proposed. In general, SVM are the maximal hyperplane classification method that relies on results from statistical learning theory to guarantee high generalization performance.

Kernel functions are employed to efficiently map input data which may not be linearly separable to a high dimensional feature space where linear methods can then be applied. SVMs exhibit good classification accuracy even when only a modest amount of training data is available, making them particularly suitable to a dynamic, interactive approach to expression recognition [10].

An ideal separation is achieved when the hyper plane and the training data of any class is the largest. This separating hyper plane works as the decision surface. SVM has been successfully employed for a number of classification tasks such as text categorization, genetic analysis and face detection [11].

Given a training set of labeled samples:

$$D = \{(x, y \mid x \in Rn, y \in \{-1,1\}\ \ p = 1 \quad (1)$$

A SVM tries to find a hyperplane to distinguish the samples with the smallest errors.

$$\text{w. } x - b = 0 \quad (2)$$

For an input vector xi, the classification is achieved by computing the distance from the input vector to the hyperplane. The original SVM is a binary classifier .

3.2.8 System Evaluation

Evaluation of the system can be done using following methods:

a) Precision

Precision estimates the predictive value of a label, either positive or negative, depending on the class for which it is calculated; in other words, it assesses the predictive power of the algorithm. Precision is the percentage of correctly assigned expressions in relation to the total number of aspects.

$$precson = \frac{tp}{tp + \int p}$$

(1)

b) Recall

Recall is a function of its correctly classified examples (true positives) and its misclassified examples (false negatives). Recall is the percentage of correctly assigned expressions in relation to the total number of expressions.

$$recall = \frac{tp}{tp + fn} \quad (2)$$

c) F-score

F-score is a composite measure which benefits algorithms with higher sensitivity and challenges algorithms with higher specificity. The F-score is evenly balanced when β = 1.

It favours precision when β > 1, and recall otherwise.

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$$F - measure = \frac{(\beta^2 + 1) * precson * recall}{\beta^2 * precson * recall} \quad (3)$$

All three measures distinguish the correct classification of labels within different classes. They concentrate on one class (positive examples). Hence, precision and recall do measure different properties and we therefore need a combined quality measure in order to determine the best matching aspect to expression category mappings. The so called F- measure fm computes the harmonic mean of precision and recall and allows taking into account both properties at the same time Note that the overall recall recallov is also known as accuracy.

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CHAPTER 4

4 DEVELOPMENT AND TESTING

4.1 Programming Language and Coding Tools

a) Python: Python is a high-level, interpreted, and general-purpose programming language known for its simplicity and readability. It was created by Guido van Rossum and first released in 1991. Python's design philosophy emphasizes code readability and ease of use, making it a popular choice for beginners as well as experienced developers. Python has a rich ecosystem of frameworks and libraries that simplify the development of applications. Examples include Django and Flask for web development, NumPy and Pandas for data manipulation, TensorFlow and PyTorch for machine learning, and many more. Python's popularity continues to grow, and it remains one of the top programming languages for both beginners and experienced developers alike. Its ease of learning, readability, and broad applications make it a versatile language in the ever-evolving world of technology.

b) Anaconda Navigator : Anaconda Navigator is a graphical user interface that comes with the Anaconda distribution. It provides an easy-to-use interface for managing environments, installing packages, and launching applications related to data science, machine learning, and scientific computing.

Through Anaconda Navigator, users can create, export, list, remove, and update environments directly using a visual interface. It also allows for the installation of popular data science packages and IDEs with a single click.

While Anaconda Navigator itself is not an IDE, it facilitates the integration of popular development environments like Jupyter Notebooks, Spyder, and Visual Studio Code, making it a convenient tool for data scientists and developers working on Python-based projects.

4.1.2 Framework

a) OpenCV : OpenCV (Open Source Computer Vision Library) is an open source computer vision and machine learning software library. OpenCV was built to provide a common infrastructure for computer vision applications and to accelerate the use of machine perception in the commercial products. Being a BSD-licensed product, OpenCV makes it easy for businesses to utilize and modify the code.

The library has more than 2500 optimized algorithms, which includes a comprehensive set of both classic and state-of-the-art computer vision and machine learning algorithms. These algorithms can be used to detect and recognize faces, identify objects, classify human actions in videos, track camera movements, track moving objects, extract 3D models of objects, produce 3D point clouds from stereo cameras, stitch images together to produce a high resolution image of an entire scene, find similar images from an image database, remove red eyes from images taken using flash, follow eye movements, recognize scenery and establish

markers to overlay it with augmented reality, etc. It has C++, C, Python, Java and MATLAB interfaces and supports Windows, Linux, Android and Mac OS.

b) Streamlit : Streamlit is an open-source Python framework designed for rapid development of datadriven web applications. It enables developers and data scientists to create interactive and visually appealing applications with minimal effort, using simple Python scripts.

Streamlit is particularly popular in the data science and machine learning communities due to its focus on simplicity and quick prototyping. Streamlit seamlessly integrates with popular data science libraries like Pandas, NumPy, and Matplotlib. Users can visualize and manipulate data directly within the app, creating a smooth workflow for data analysis and exploration.

4.2 System Testing

System testing was done by giving different training and testing datasets. This test was done to evaluate whether the system was predicting accurate result or not. During the phase of the development of the system our system was tested time and again.

The series of testing conducted are as follows:

4.2.1 Unit Testing

In unit testing, we designed the whole system in modularized pattern and each module was tested. Till we get the accurate output from the individual module we worked on the same module.

4.2.2 Integration Testing

After constructing individual modules all the modules were merged and a complete system was made. Then the system was tested whether the prediction given by training dataset to testing set was correct or not. We tried to meet the accuracy as higher as much as we can get. After spending a couple of days in integration testing the average accuracy of our system was 91%.

1.Alpha testing

Alpha testing is the first stage of software engineering which is considered as a simulated or actual operational testing done by the individual member of the project. Alpha testing is conducted by the project developers, in context of our project.

2.Beta Testing

Beta testing comes continuously after alpha testing which is considered as a form of external user acceptance testing. The beta version of the program is developed to and provided to limited audience. This is the final test process in the case of this project. In this system the beta-testing is done by our colleagues and the project supervisor.

4.2.3 Test Case and Analysis

Test Case 1

Test Case ID	TC001
Test Case Summary	It will check whether the model detect the emotion type HAPPY or not
Test Procedure	Provide image to model
Expected Result	Model should Properly detect HAPPY Face
Actual Result	Actual results were 100%
Status	Pass

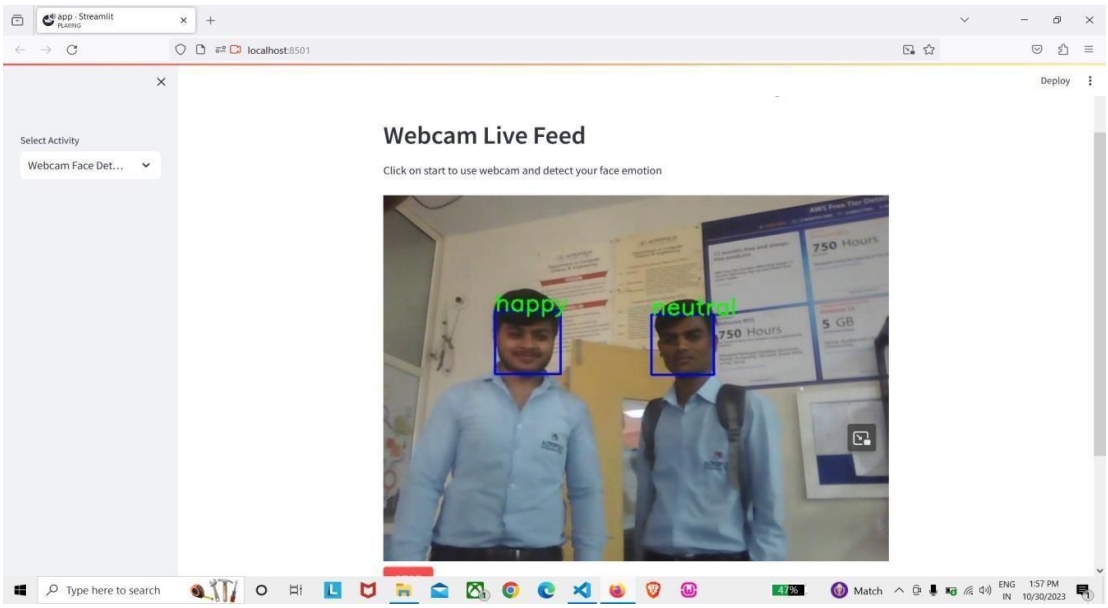


Figure 12: Test case 1

Test Case 2

Test Case ID	TC002
Test Case	It will check whether the Model Detect Neutral mood or not
Test Procedure	Provide image to model
Expected Result	Results were 100%
Actual Result	Pass

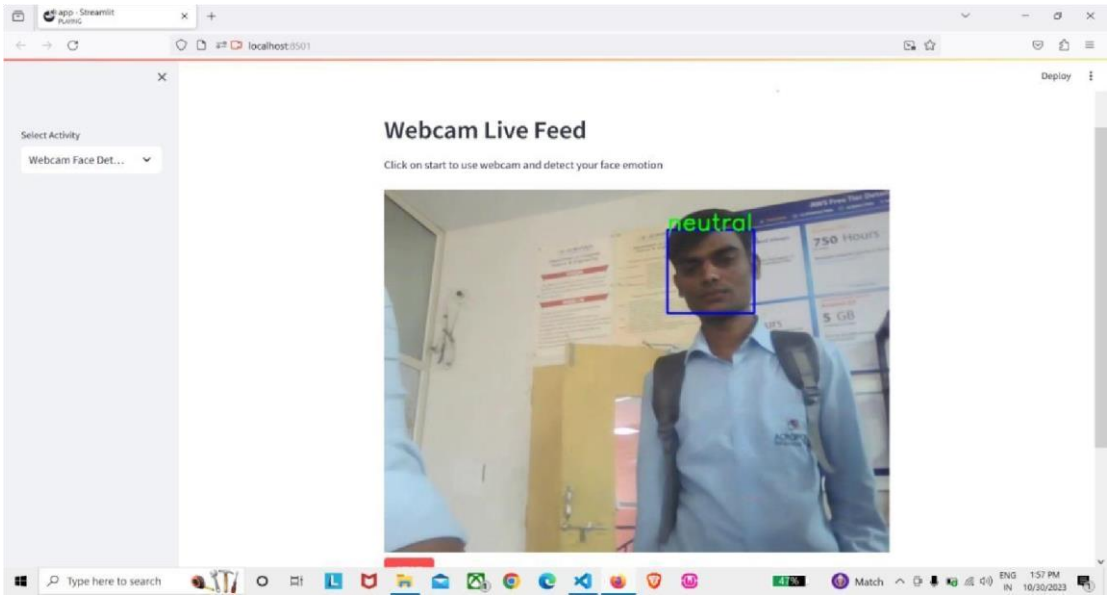


Figure 13: Test case 2

TEST CASE: 3

Test Case ID	TC002
Test Case Summary	It will check whether the Model Detect multiple faces or not
Test Procedure	Provide multiple image
Expected Result	Results were 100%
Actual Result	Pass

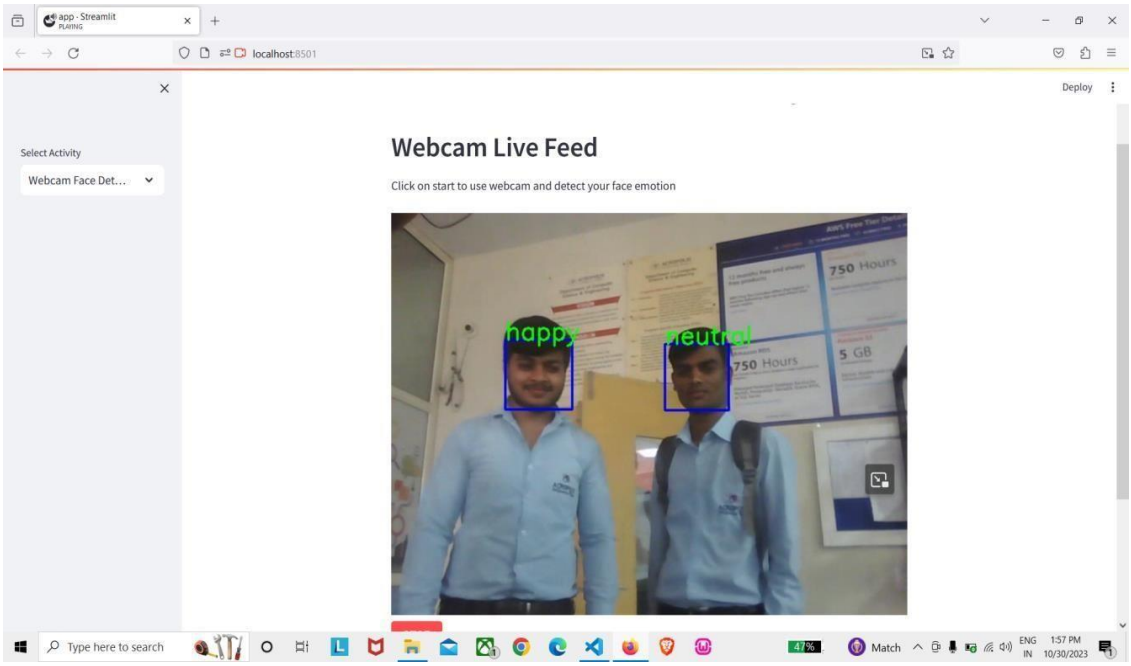
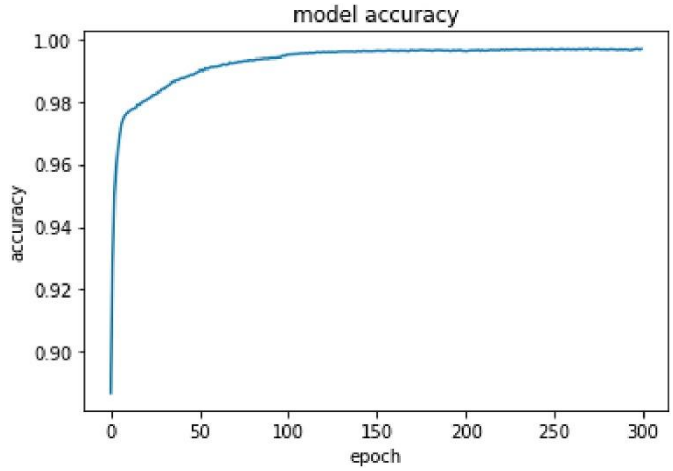
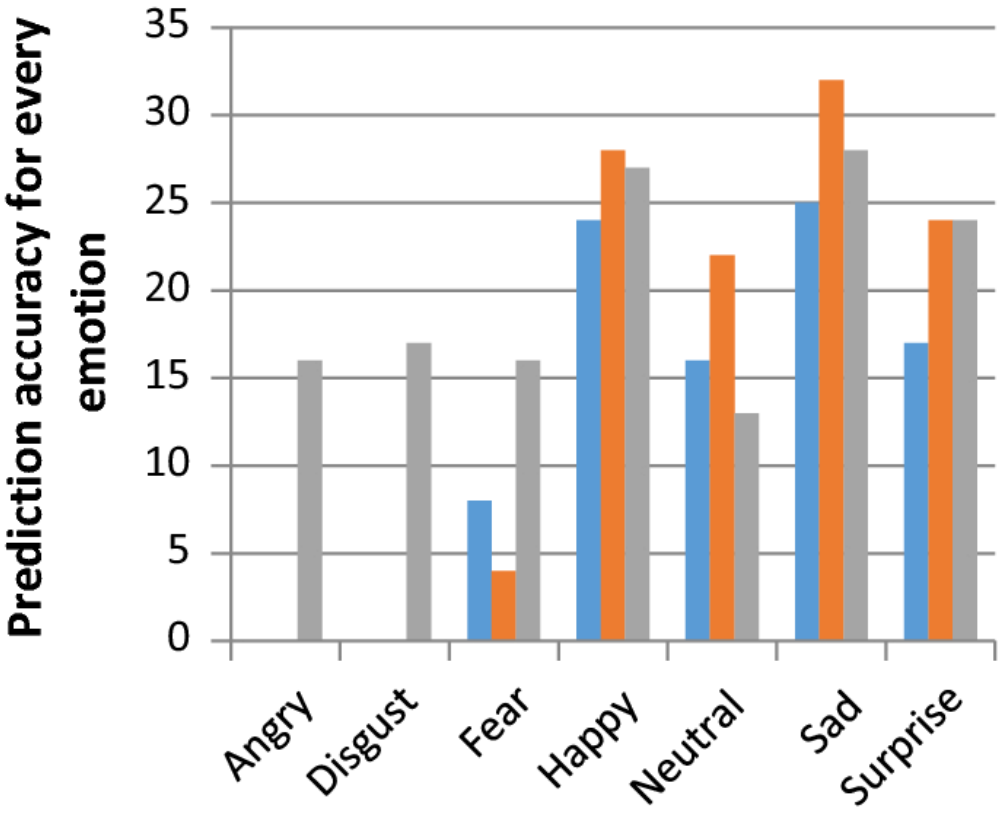


Figure 13: Test case 3

4.2.4 Graphs Of the results of various expression



Graphs Of the different Expressions



4.2.5 Pie chart for the different expression

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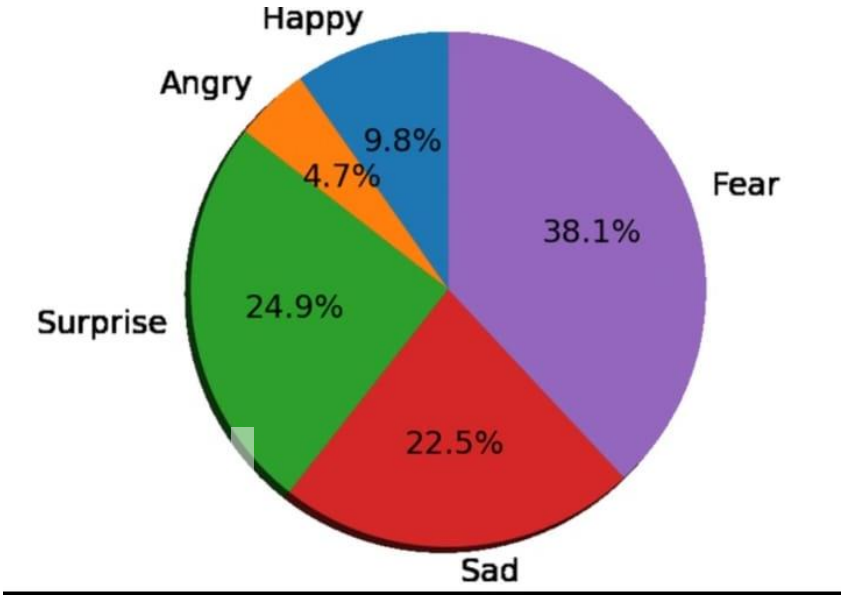

CHAPTER 5

5.1 EXPERIMENTATION AND RESULTS

The aim of this project work is to develop a complete facial expression recognition system. Two datasets, COHN_KANADE and JAFFE were used for the experimentations. First of all, system was trained using different random samples in each dataset by supervised learning. In each datasets the data were partitioned into two parts for training and testing. Every dataset have completely different samples which are selected randomly in uniform manner from the pool of given dataset. The COHN_KANADE datasets included 585 directories of both subject and session where there were 97 subject directories and 8795 image files in total and partitioned was made in the ratio of 8:2 i.e. 6481 (80%) for train and 1619 (20%) for test. Similarly, JAFFE dataset included 213 images which was partitioned in the ratio of 7.5:2.5 i.e. 160 (75%) for train and 53 (25%) for test.

The confusion and accuracy evaluation results of COHN-KANADE and JAFFE datasets are as below:

Table 2: Confusion matrix of COHN-KANADE

Labels	Angry	Disgust	Fear	Happy	Neutral	Sad	Surprise
Angry	259	0	0	0	0	1	0
Happy	25	40	173	98	1	19	0
Neutral	1	1	12	0	111	0	0
Sad	1	1	1	1	0	228	0
Surprise	12	15	141	1	0	11	60

In the above table, row shows the actual classes and column shows the predicted classes. The classifier made a total of 1619 predictions where the classifier predicted angry for 300 times , happy for 99 times, neutral for 112 times, sad for 259 times and surprise for 61 times.

Table 3: Accuracy of COHN-KANADE

Evaluation Types	Results Percentages
Precision	83.6412
Recall	95.0822
F-score	88.9955

The above table shows that 83.6412% of the expressions were predicted 95.0822% of the expressions were correctly assigned. The harmonic mean of precision and recall was 88.9955%.

Table 4: Confusion matrix of JAFFE

Labels	Angry	Happy	Neutral	Sad	Surprise
Angry	4	0	0	1	0
Happy	0	10	2	0	0
Neutral	0	0	6	0	0
Sad	0	0	0	10	0
Surprise	0	0	1	0	2

In the above table, row shows the actual classes and column shows the predicted classes. The classifier made a total of 53 predictions where the classifier predicted angry for 4 times, happy for 10 times, neutral for 9 times, sad for 11 times and surprise for 2 times. Whereas in reality 6 cases were angry, 12 was happy, 6 was neutral, 10 was sad and 3 was surprise.

Table 5: Accuracy of JAFFE

Evaluation Types	Percentages
Precision	91.8986
Recall	98.3649
F-score	95.0218

The above table shows that 91.8986% of the expressions were predicted, 98.3649% of the expressions were correctly assigned. The harmonic mean of precision and recall was 95.0218%.

CHAPTER 6

6.1 CONCLUSION AND RECOMMENDATION

This project proposes an approach for recognizing the category of facial expressions. Face Detection and Extraction of expressions from facial images is useful in many applications, such as robotics vision, video surveillance, digital cameras, security and human-computer interaction. This project's objective was to develop a facial expression recognition system implementing the computer visions and enhancing the advanced feature extraction and classification in face expression recognition.

In this project, seven different facial expressions of different persons' images from different datasets have been analyzed. This project involves facial expression preprocessing of captured facial images followed by feature extraction using feature extraction using Local Binary Patterns and classification of facial expressions based on training of datasets of facial images based on Support Vector Machines. This project recognizes more facial expressions based on JAFFE, COHN-KANADE face database. To measure the performance of proposed algorithm and methods and check the results accuracy, the system has been evaluated using Precision, Recall and Fscore. The same datasets were used for both training and testing by dividing the datasets into training samples and testing samples in the ratio of 8:2 of COHN-KANADE and 7.5:2.5 of JAFFE. The Precision, Recall and Fscore from the COHN-KANADE dataset were 83.6142%, 95.0822% and 88.9955% respectively and JAFFE dataset were 91.8986%, 98.3649% and 95.0218% respectively.

Experiment results on two databases, JAFFE and the COHN-KANADE dataset, show that our proposed method can achieve a good performance. Facial expression recognition is a very challenging problem. More efforts should be made to improve the classification performance for important applications. Our future work will focus on improving the performance of the system and deriving more appropriate classifications which may be useful in many real world applications.

6.2 Future Scope

Face expression recognition systems have improved a lot over the past decade. The focus has definitely shifted from posed expression recognition to spontaneous expression recognition. Promising results can be obtained under face registration errors, fast processing time, and high correct recognition rate (CRR) and significant performance improvements can be obtained in our system. System is fully automatic and has the capability to work with images feed. It is able to recognize spontaneous expressions. Our system can be used in Digital Cameras wherein the image can be captured only when the person smiles. In security systems which can identify a person, in any form of expression he presents himself. Rooms in homes can set the lights, television to a person's taste when they enter the room. Doctors can use the system to understand the intensity of pain or illness of a deaf patient. Our system can be used to detect and track a user's state of mind, and in mini-marts, shopping center to view the feedback of the customers to enhance the business etc.

Certainly, here are some more use cases for facial emotion detection systems in online shopping :

- Customized Product Recommendations
- Real-time Customer Feedback Analysis
- Enhanced User Experience
- Dynamic Pricing Strategies
- Improved Customer Service
- Adaptive Advertising Campaigns
- Fraud Prevention
- Market Research and Consumer Behavior Analysis
- Virtual Try-on and Fitting Rooms
- Enhanced Product Development

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