A
Project Report On

FACIAL EXPRESSION RECOGNITION USING IMAGE PROCESSING

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Submitted as a partial fulfillment of

Bachelor of Engineering

B.E. (Semester VIII),Computer Engineering

[2013 - 2014]

from

Rizvi College of Engineering

New Rizvi Educational Complex, Off-Carter Road,

Bandra(w), Mumbai - 400050

Affiliated to

University of Mumbai

RIZVI EDUCATION SOCIETY'S
Rizvi College Of Engineering
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CERTIFICATE

This is certify that the project report entitled
"FACIAL EXPRESSION RECOGNITION USING IMAGE PROCESSING"
Submitted By

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Acknowledgement

I am profoundly grateful to **Prof. Nargis Shaikh** for her expert guidance and continuous encouragement throughout to see that this project rights its target since its commencement to its completion.

I would like to express deepest appreciation towards **Dr. Varsha Shah**, Principal RCOE, Mumbai and **Prof. Dinesh B. Deore**, HoD Computer Department whose invaluable guidance supported me in completing this project.

At last I must express my sincere heartfelt gratitude to all the staff members of Computer Engineering Department who helped me directly or indirectly during this course of work.

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ABSTRACT

This paper presents a facial expression recognition system employing Bezier curves approximation technique. The system is based on facial features extraction using the knowledge of the face geometry and approximated by 3rd order Bezier curves representing the relationship between the motion of features and changes of expressions. For face detection, color segmentation based on the novel idea of fuzzy classification has been employed that manipulates ambiguity in colors. Experimental results demonstrate that this method can recognize the facial expressions with an accuracy of more than 90cases. Finally the system has been implemented using a manipulator robot and issuing facial expression commands.From human face structure, We divide in 3 regions such as right eye, left eye and mouth areas from the face image. Firstly comes the face detection and then detection of the skin region.We crop the facial skin region and connect the largest skin region to detect the skin surface of the human face.

Keywords : Bezier curves, Facial expression, Facial Action Coding System (FACS), Face detection, Fuzzy classification, Skin color, YCbC.

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Chapter 1

Introduction

Facial expression analysis has been attracting considerable attention in the advancement of humanmachine interface since it provides a natural and efficient way to communicate between humans. Some application areas related to face and its expressions include personal identification and access control, video phone and teleconferencing, forensic applications, human-computer interaction, automated surveillance, cosmetology, and so on. But the performance of the face detection certainly affects the performance of all the applications. Many methods have been proposed to detect human face in images, they can be classified into four categories: knowledge-based methods, feature-based methods, templatebased methods and appearance-based methods.When used separately, these methods cannot solve all the problems of face detection like pose, expression, orientation, occlusion. Hence it is better to operate with several successive or parallel methods. Most of the facial expression recognition methods reported to date are focused on recognition of six primary expression categories such as: happiness, sadness, fear,anger, disgust and grief.For a description of detailed facial expressions, the Facial Action Coding System (FACS) was designed by Ekman and Friensen in the mid 70s. In FACS, motions of the muscles of the face are divided into 44 action units and any facial expression are described by their combinations.

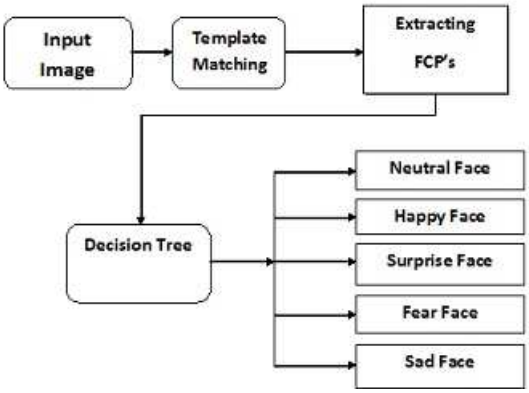


Figure 1.1: Genetic Flow Diagram

1.1 Motivation and Problem Statement

In the beginning, facial expression analysis was essentially a research topic for psychologists. However, recent progresses in image processing and pattern recognition have motivated significantly research works on automatic facial expression recognition. In the past, a lot of effort was dedicated to recognize facial expression in still images. For this purpose, many techniques have been applied: neural networks ,Gabor wavelets and active appearance models. A very important limitation to this strategy is the fact

that still images usually capture the apex of the expression, i.e., the instant at which the indicators of emotion are most marked. In their daily life, people seldom show apex of their facial expression during normal communication with their counterparts, unless for very specific cases and for very brief periods of time.

The automatic facial expression recognition system includes:

- Face Detector.
- Facial feature extractor for mouth, left and right eye.
- Facial Characteristic Point - FCP extractor.
- Facial expression recognizer.

1.2 Objectives

The project mainly aims to come up with a solution to the facial expression recognition problem by Sub Problems dividing it into sub-problems of classifications of some specific Action Units. The projects scope includes not only the two class problems which tell about whether an Action Unit is on or off, but also the multi-class problems that will inform the user about multi occurrences of more than one Action Unit at the same time. For this, different methodologies and techniques for feature extraction , normalization, selection and classification.solutions to these problems as well as taking the computational complexity and timing issues into consideration. The project objective is to implement face recognition in an optimum way in terms of run time onto the embedded system. Various algorithms and methodologies are studied and hardware resources planning will be done to achieve the goal.This kind of face recognition embedded system can be widely used in our daily life in different sectors. We hope that human life can be greatly helped with this technology. Some typical applications are listed as follows:-

- Business Meeting, Gathering.
- Education Teaching assistant.
- Audio-visual speech recognition(visual lip reading to enhance acoustic speech recognition).

Chapter 2

Literature Survey

2.1 Detection and Recognition of Facial Emotion using Bezier Curves

2.1.1 Summary

This presents an approach to recognize human facial expressions for human-robot interaction. For this, the facial features, especially eyes and lip are extracted and approximated using Bzier curves representing the relationship between themotion of features and changes of expressions. For face detection, color segmentation based on the novel idea of fuzzy classification has been employed that manipulates ambiguity in colors. Experimental results demonstrate that this technique can robustly classify skin region and non-skin region. In order to decide whether the skin region is face or not, largest connectivity analysis has been employed. This method can recognize the facial expression category, as well as the degree of facial expression change. Finally, the system has been implemented by issuing facial expression commands to a manipulator robot.

2.1.2 Approach Based:

Advantages:

- Lower complexity.
- Less computer demanding.

Disadvantages:

- Difficult to extend with more emotions.
- Less precise.
- Difficult to generalize to new data.

2.1.3 Coding Based:

Advantages:

- Precise.
- Versatile.
- Extensible.

Disadvantages:

- More computer processing required.
- More complexity.

Chapter 3

Proposed Work

3.1 Problem Statement

There is an inaccurate location and tracking of facial points. Also Pose, movement and rotation of the test person are limited. Glasses may hinder classification, especially thick and dark frames in detecting emotions. Face Reader can analyze one face at a time. Face Reader cannot classify facial expressions in test persons with a partial facial paralysis.

3.1.1 CONTRAST STRETCHING

Contrast stretching (often called normalization) is a simple image enhancement technique that attempts to improve the contrast in an image by 'stretching' the range of intensity values it contains to span a desired range of values, e.g. the full range of pixel values that the image type concerned allows. It differs from the more sophisticated histogram equalization in that it can only apply a linear scaling function to the image pixel values. As a result the 'enhancement' is less harsh. (Most implementations accept a gray level image as input and produce another gray level image as output.)

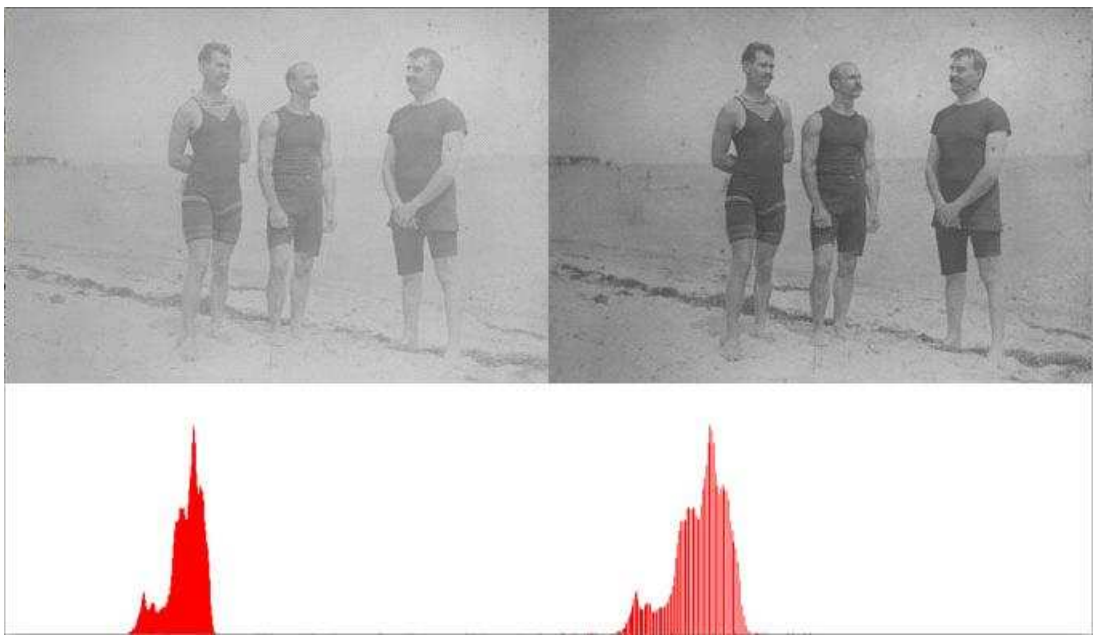


Figure 3.1: Contrast Stretching

Contrast stretching: do min max contrast stretching of the image. Find the minimum and maximum values of the pixels in an image, and then convert pixels from the source to destination like ((pixel-min) / (max-min))*255

3.1.2 SKIN COLOUR CONVERSION

Skin-color Conversion technique is considered as an effective tool for face detection because it is invariant to changes in size, orientation and occlusion . In this paper, we propose to use the YCbCr color space for two reasons:

- By using YCbCr color space, we can eliminate as much as possible the variation of luminance component caused by the lighting condition.
- The YCbCr domain is extensively used in digital video coding applications. YCbCr is a color space that separates the luminance from the color information. Luminance is encoded in the Y and the blueness in Cb and the redness in Cr. It is very easy too convert from RGB to YCbCr :

Analysis of YCrCb color space on human skin color

Any RGB digital image can be converted into YCrCB color space using following equation:

Y=0.299R + 0.587G + 0.114B
Cb = -0.169R - 0.331G + 0.500B
Cr = 0.500R - 0.419G - 0.081B

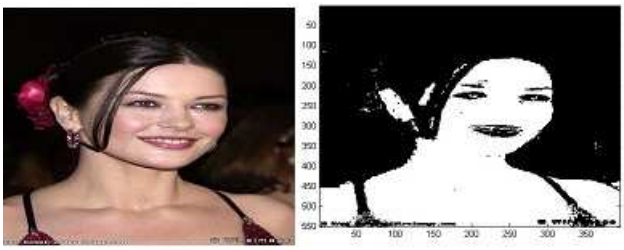


Figure 3.2: Original to YCrCB

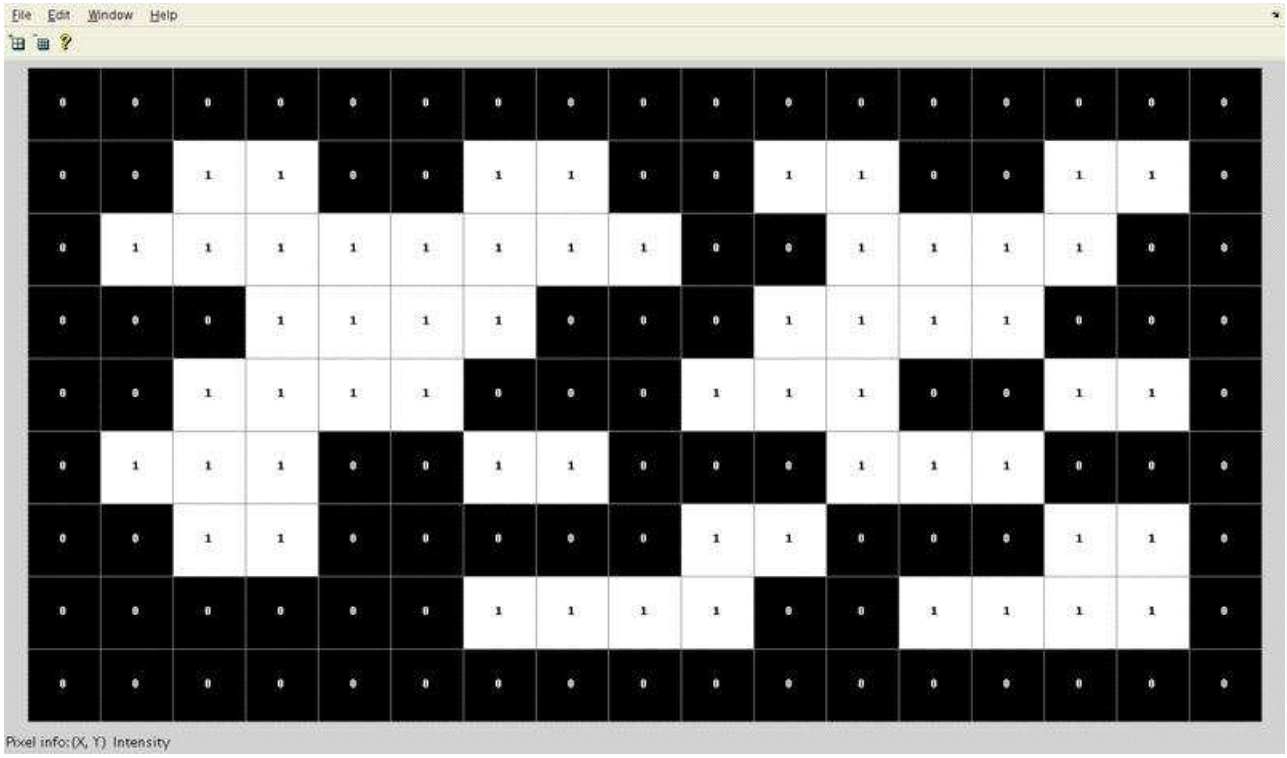
3.1.3 CONNECTED COMPONENT LABELLING

Connected-component labeling (alternatively connected-component analysis, blob extraction, region labeling, blob discovery, or region extraction) is an algorithmic application of graph theory, where subsets of connected components are uniquely labeled based on a given heuristic. Connected-component labeling is not to be confused with segmentation.

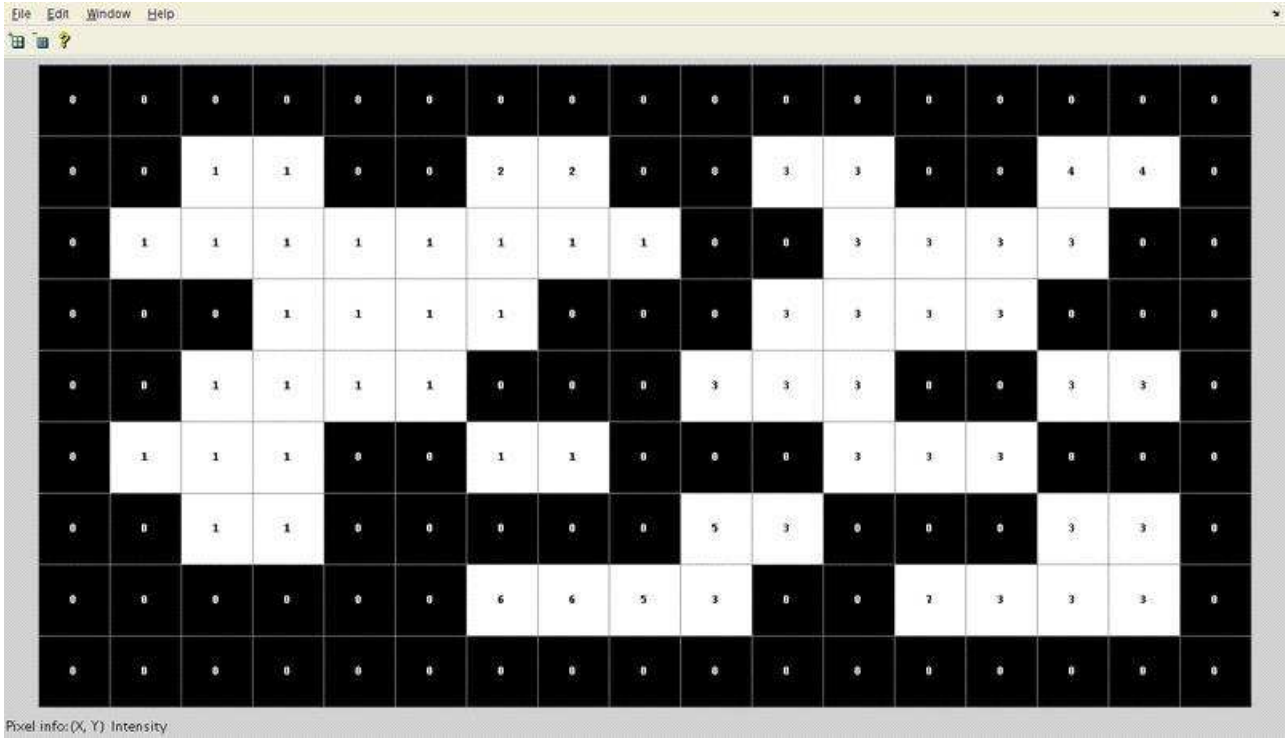
Connected-component labeling is used in computer vision to detect connected regions in binary digital images, although color images and data with higher dimensionality can also be processed. When integrated into an image recognition system or human-computer interaction interface, connected component labeling can operate on a variety of information.

Graphical example of two-pass algorithm:

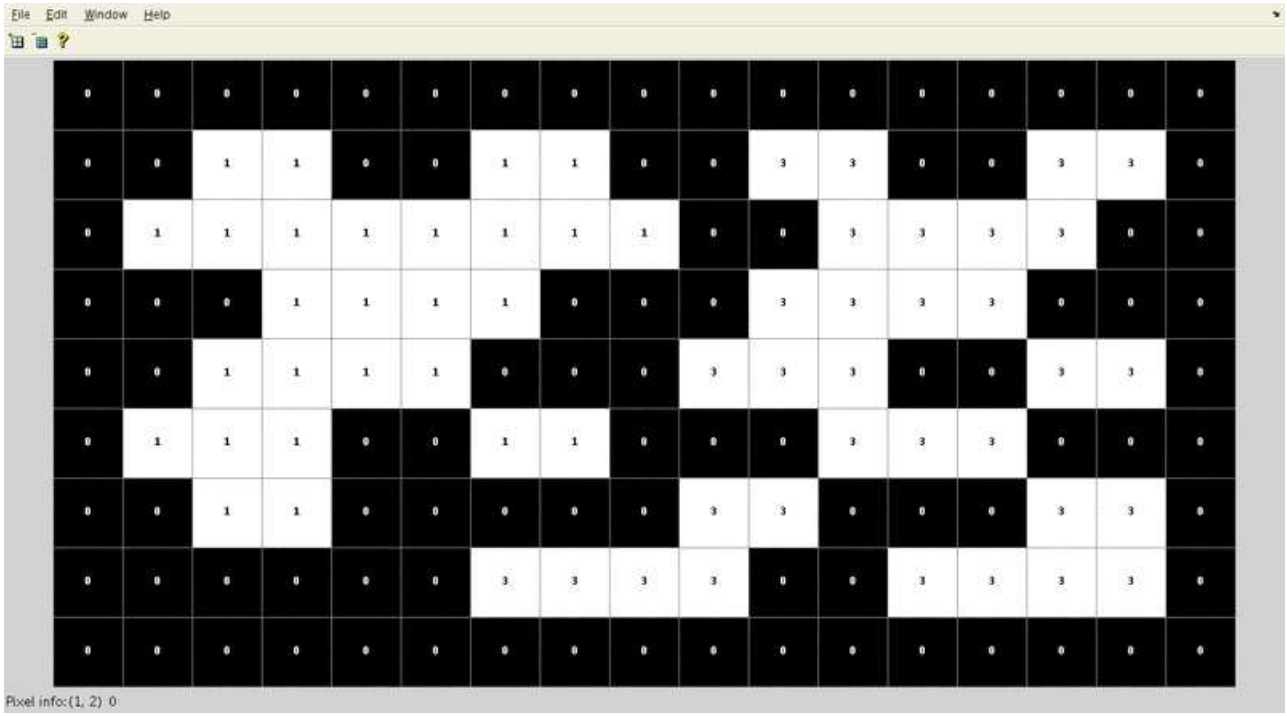
1. The array from which connected regions are to be extracted is given below (8-connectivity based).



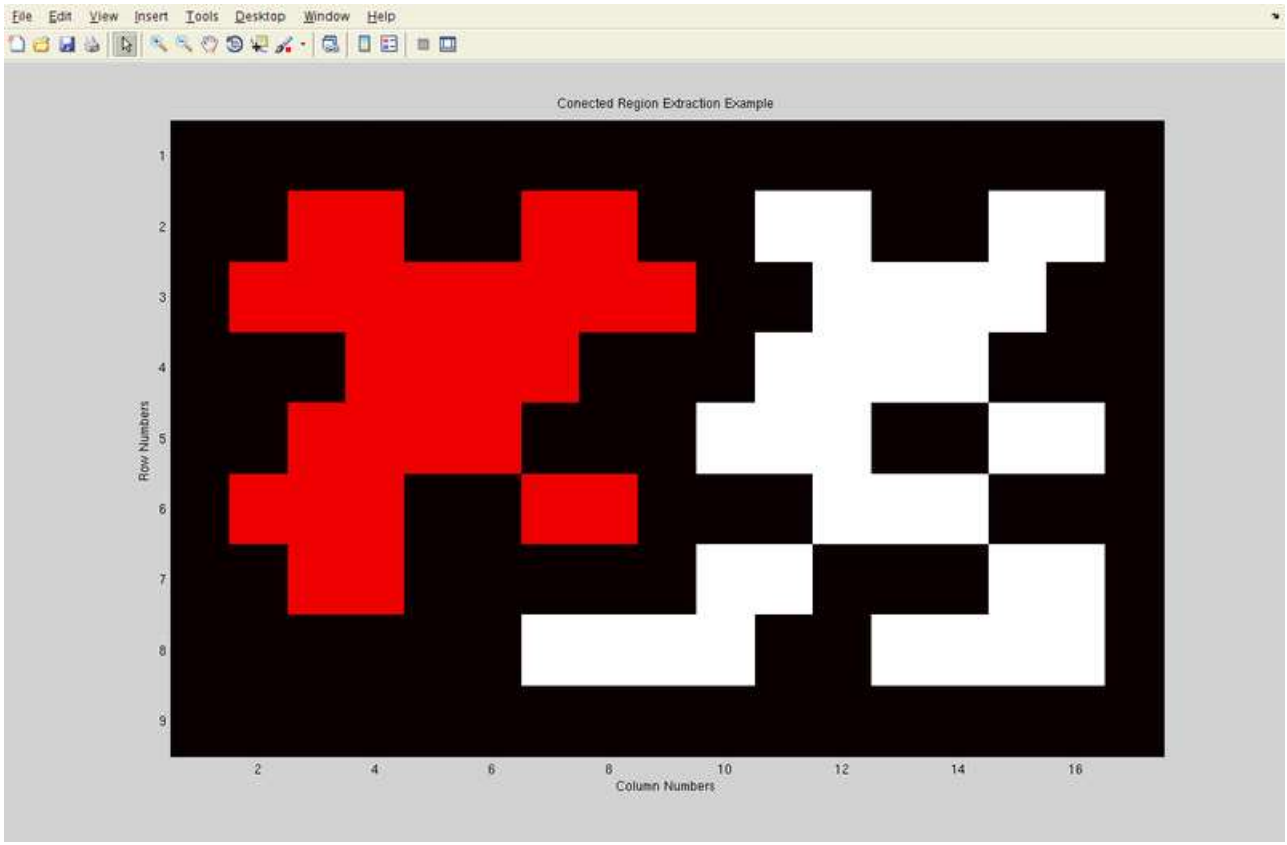
2. After the first pass, the following labels are generated. A total of 7 labels are generated in accordance with the conditions highlighted above.



3. .Array generated after the merging of labels is carried out. Here, the label value that was the smallest for a given region ”floods” throughout the connected region and gives two distinct labels, and hence two distinct labels.



4. Final result in color to clearly see two different regions that have been found in the array.



3.1.4 BINARY CONVERSION OF THE IMAGE

A binary image is a digital image that has only two possible values for each pixel. Typically the two colors used for a binary image are black and white though any two colors can be used. The color used for the object(s) in the image is the foreground color while the rest of the image is the background color.

Figure 3.3: Conversion to binary

3.1.5 EYE AND MOUTH EXTRACTION PROCEDURE

EYE EXTRACTION:

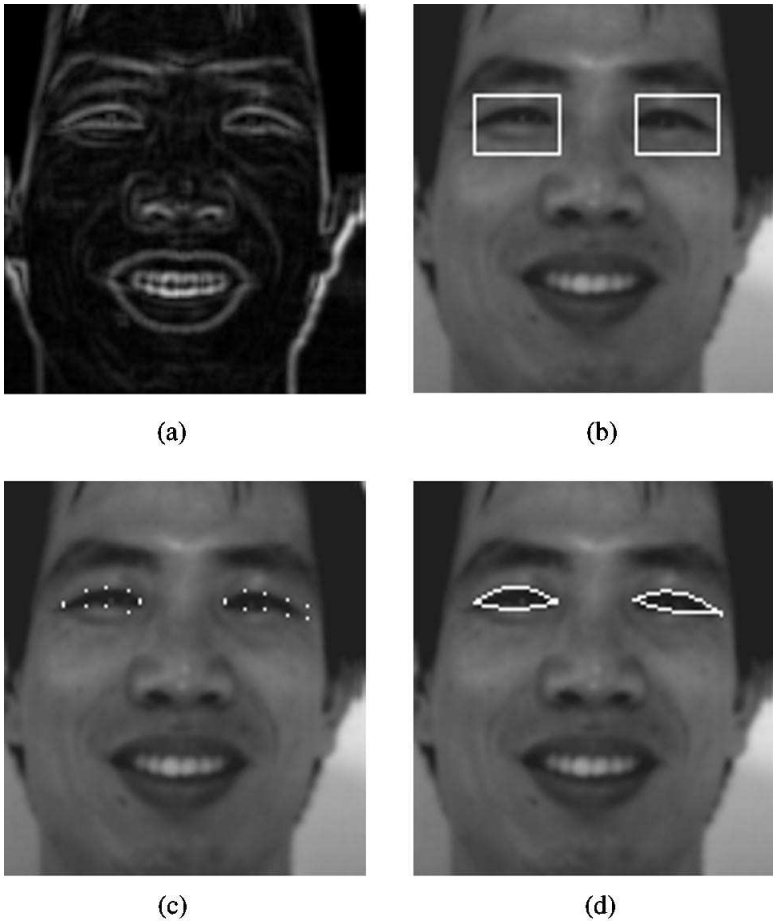


Figure 3.4: Eye Extraction

An eye extraction procedure:
(a) A morphology-based edge image.
(b) Initial rectangular blocks to confine the eyes.
(c) Final landmark points for eye contours.
(d) Extracted eye contours.

MOUTH EXTRACTION

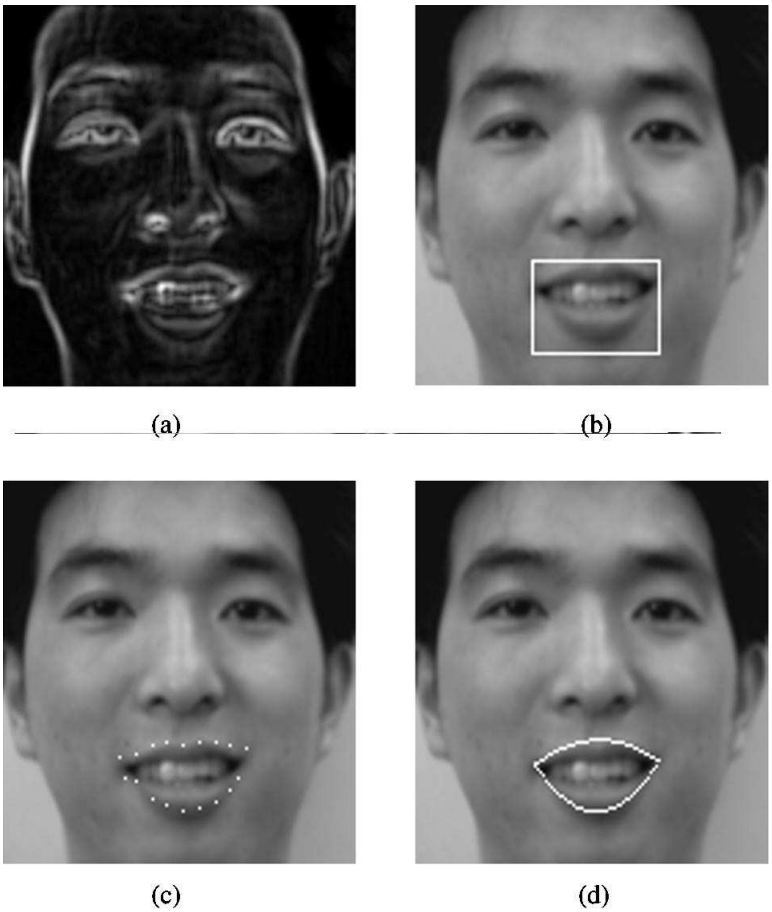


Figure 3.5: Mouth Extraction

A mouth extraction procedure.
(a) A morphology-based edge image.
(b) Initial rectangular block to confine the mouth.
(c) Final landmark points for mouth contours.
(d)Extracted mouth contours.

3.1.6 DETECTING BEZIER CURVES

A Bezier curve is a parametric curve frequently used in computer graphics and related fields. Bezier curves are also used in the time domain, particularly in animation and interface design.

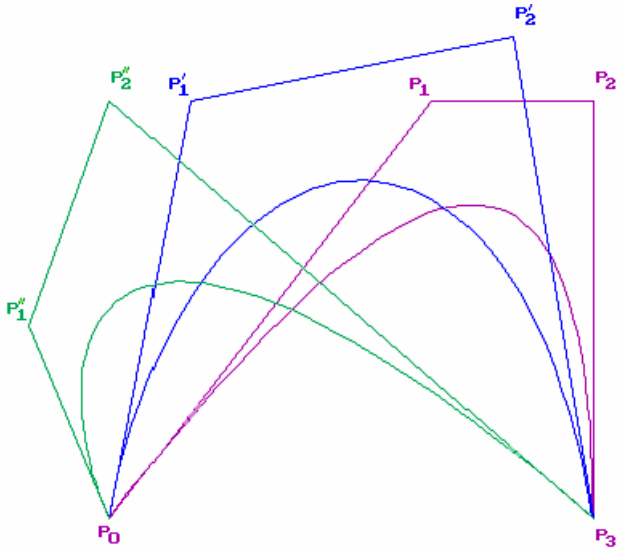
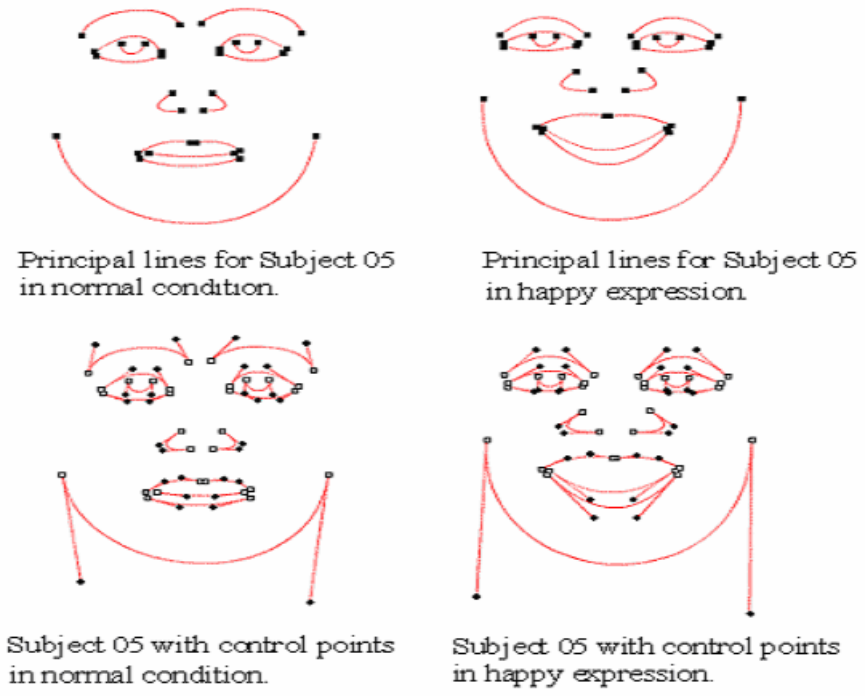


Figure 3.6: Bezier curves with their control points.

Figure 3.7: Face Data(Normal and Happy)



Chapter 4

Project Design

4.1 Flowchart

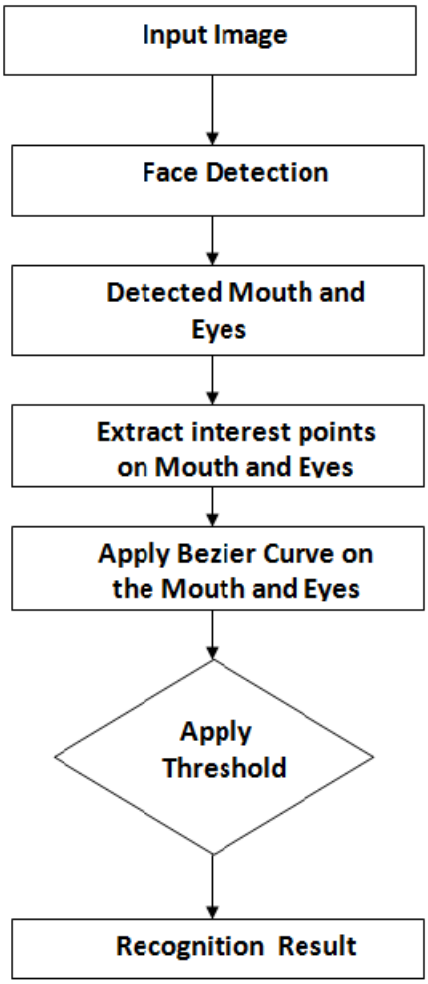


Figure 4.1: Flow Chart

4.2 Use Case Diagram

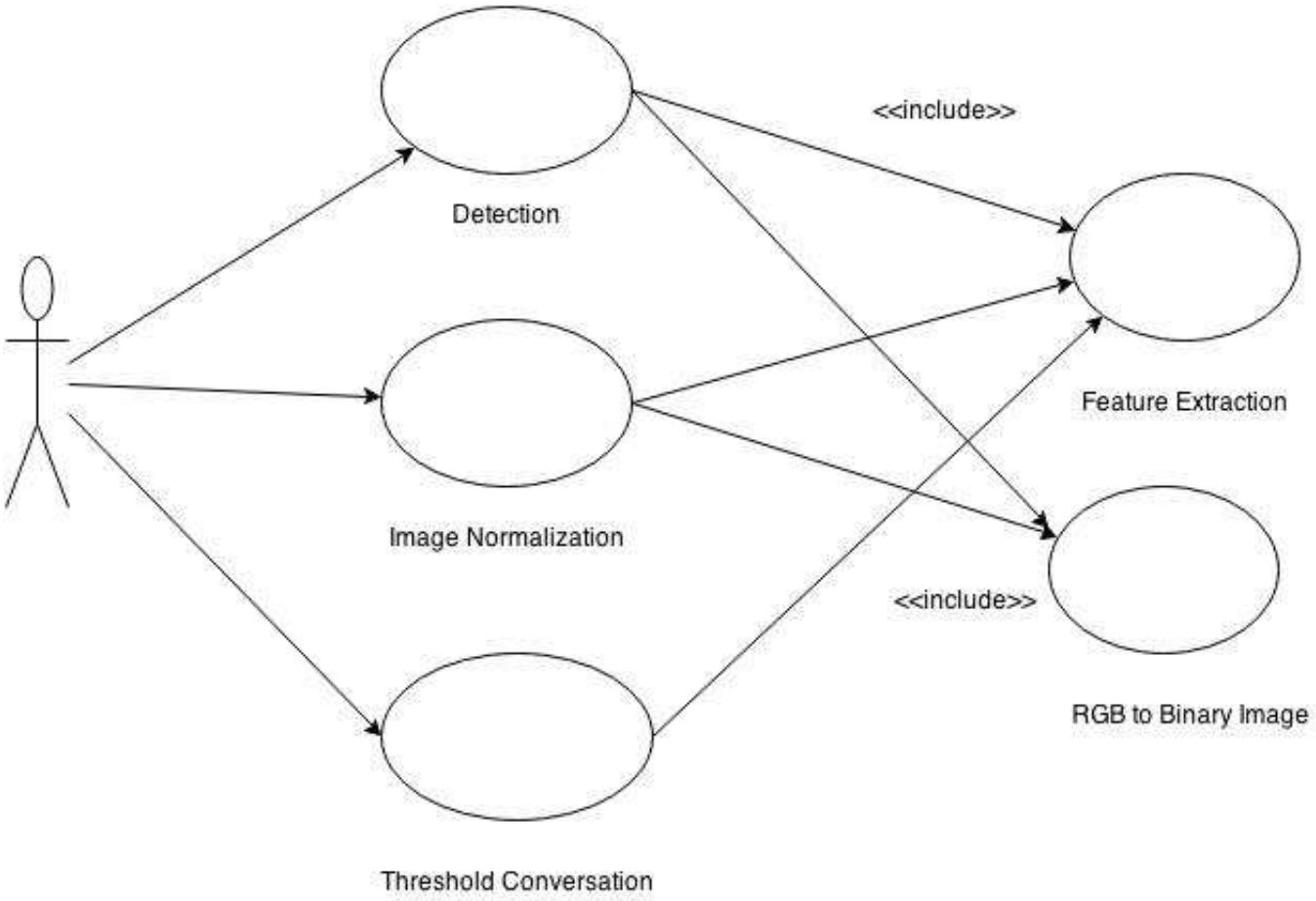


Figure 4.2: Use Case Diagram

4.3 Requirements

HARDWARE RESOURCES:

- System Processor: Pentium IV or later.
- Bus: 32- Bit.
- RAM: 512MB DDR RAM.
- Hard drive: 20GB.
- Display: SVGA Color.
- Key board: Windows compatible.
- Web Camera (OPTIONAL).

SOFTWARE RESOURCES:

- IDE: Microsoft Visual Studio
- Operating System: Windows 7/8
- .NET Framework 4.0
- AForge Framework

Chapter 5

Implementation & Technologies Used

5.1 Implementation

Lets look at the major steps associated with implementation. Note that many of these activities need to be completed ahead of time. You cannot start planning for implementation while you are actually implementing.

STEP 1: INPUT IMAGE
The image is taken captured by the web-cam or provided as input through browse.

STEP 2: CONTRAST STRETCHING OF THE IMAGE:
It performs min max contrast stretching of the image. Find the minimum and maximum values of the pixels in an image, and then convert pixels from the source to destination like ((pixel-min) / (max-min))*255.

STEP 3:SKIN COLOUR CONVERSION OF THE IMAGE:
In skin colour conversion, the skin of the person is converted to white pixel and the rest of the parts are converted to black pixel.

Any RGB digital image can be converted into YCrCB color space using following equation:

Y=0.299R + 0.587G + 0.114B
Cb = -0.169R - 0.331G + 0.500B
Cr = 0.500R - 0.419G - 0.081B

STEP 4: DETECTING CONNECTED REGION:
Connected-component labeling is used in computer vision to detect connected regions in binary digital images, although color images and data with higher dimensionality can also be processed. When integrated into an image recognition system or human-computer.

STEP 5: BINARY CONVERSION OF THE IMAGE:
A binary image is a digital image that has only two possible values for each pixel. [1] Typically the two colors used for a binary image are black and white though any two colors can be used. [1] The color

used for the object(s) in the image is the foreground color while the rest of the image is the background color.

STEP 6: EXTRACTING EYES AND LIPS FROM THE BINARY IMAGE TO DETECT BEZIER CURVES:
Left eye, right eye and the lips are extracted from the binary image and extracted from the image and Bezier curves are drawn accordingly. From the Bezier curves, emotions are detected by comparing its values from the database.

STEP 7: TO DETECT EMOTIONS OF THE PERSON:
Bezier curves are drawn and respected values from the Bezier curves are extracted and compared with values from the database and an appropriate emotion is detected. The algorithm that we have used is as follows -

```
if (Math.Abs(pt - lip_1) + Math.Abs(pt1 - lip_2) + Math.Abs(pt2 - lip_3) +
Math.Abs(pt3 - lip_4) + Math.Abs(pt4 - l_e_1 ) + Math.Abs(pt5 - l_e_2) +
Math.Abs(pt6 - l_e_3) + Math.Abs(pt7 - l_e_4) + Math.Abs(pt8 - r_e_1) +
Math.Abs(pt9 - r_e_2) + Math.Abs(pt10 - r_e_3) + Math.Abs(pt11 - r_e_4)
< min)
{
 emo = 0;
 min = (Math.Abs(pt - lip_1) + Math.Abs(pt1 - lip_2) + Math.Abs(pt2 - lip_
3) + Math.Abs(pt3 - lip_4) + Math.Abs(pt4 - l_e_1 ) + Math.Abs(pt5 - l_e_
2) + Math.Abs(pt6 - l_e_3) + Math.Abs(pt7 - l_e_4) + Math.Abs(pt8 - r_e_
1) + Math.Abs(pt9 - r_e_2) + Math.Abs(pt10 - r_e_3) + Math.Abs(pt11 -
r_e_4) );
}
```

5.2 Technology Used

5.2.1 VISUAL STUDIO

Visual Studio 2005 was released in October 2005. Microsoft released service Pack 1 for Visual Studio 2005 on 14 December 2006. Visual Studio 2005 was upgraded to support all the new features introduced in .NET Framework 2.0, including generics and ASP.NET 2.0. The IntelliSense feature in Visual Studio was upgraded for generics and new project types were added to support ASP.NET web services. Visual Studio 2005 also includes a local web server, separate from IIS, which can be used to host ASP.NET applications during development and testing. It also supports all SQL Server 2005 databases. Database designers were upgraded to support the ADO.NET 2.0, which is included with .NET Framework 2.0. C++ also got a similar upgrade with the addition of C++/CLI which is slated to replace the use of Managed C++. Other new features of Visual Studio 2005 include the ”Deployment Designer” which allows application designs to be validated before deployments, an improved environment for web publishing when combined with ASP.NET 2.0 and load testing to see application performance under various sorts of user loads.

5.2.2 C#

In June 2000, Microsoft announced both the .NET platform and a new programming language called C#. C# is a simple, modern, object oriented, and type-safe programming language derived from C and C++. C# (pronounced ”C sharp”) is firmly planted in the C and C++ family tree of languages, and

will immediately be familiar to C and C++ programmers. C# aims to combine the high productivity of Visual Basic and the raw power of C++.C# is a strongly-typed object-oriented language designed to give the optimum blend of simplicity, expressiveness, and performance. The .NET platform is centered on a Common Language Runtime (similar to a JVM) and a set of libraries which can be exploited by a wide variety of languages which are able to work together by all compiling to an intermediate language (IL). C# and .NET are a little symbiotic: some features of C# are there to work well with .NET, and some features of .NET are there to work well with C# (though .NET aims to work well with many languages).

C# AND IT'S FEATURES

1. C# is a simple, modern, object oriented language derived from C++ and Java.
2. It aims to combine the high productivity of Visual Basic and the raw power of C++.
3. It is a part of Microsoft Visual Studio7.0.
4. Visual studio supports Vb, VC++, C++, Vbscript, and Jscript. All of these languages provide access to the Microsoft .NET platform.
5. .NET includes a Common Execution engine and a rich class library.
6. Microsoft's JVM equiv. is Common language run time (CLR).
7. CLR accommodates more than one language such as C#, VB.NET, Jscript, ASP.NET, C++.
8. The classes and data types are common to all of the .NET languages.
9. We may develop Console application, Windows application, and Web application using C#.
10. In C# Microsoft has taken care of C++ problems such as Memory management, pointers etc.
11. It supports garbage collection, automatic memory management and a lot

5.3 Working

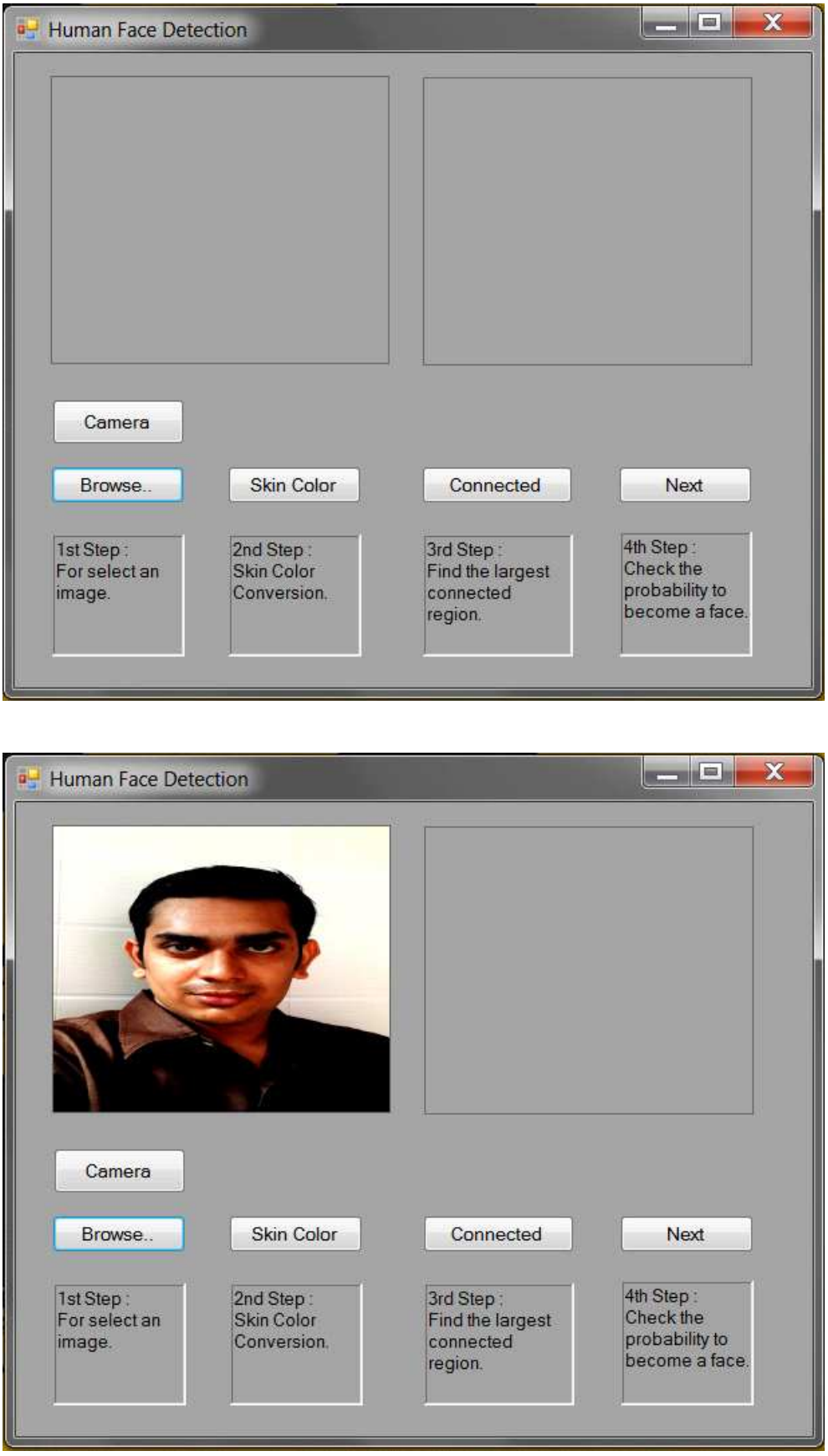


Figure 5.1: STEP 1:Select an image by clicking Browse button.

Figure 5.2: STEP 2:Then click Skin Color button.

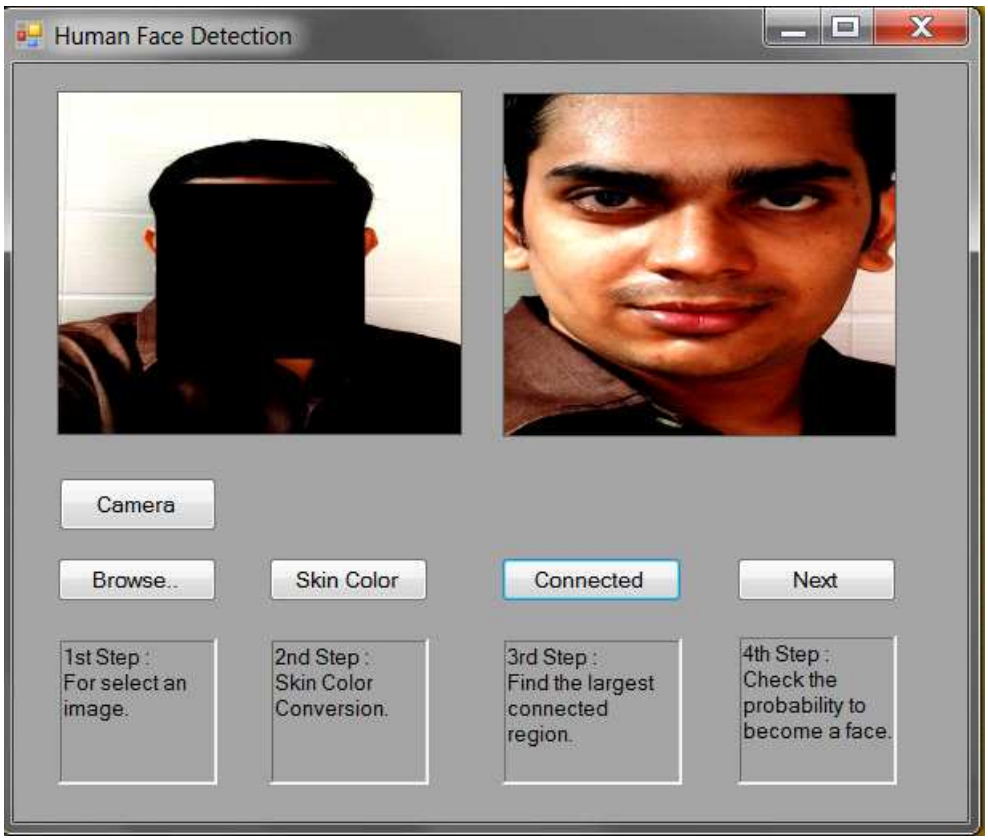


Figure 5.3: STEP 3:Then click Connected button.

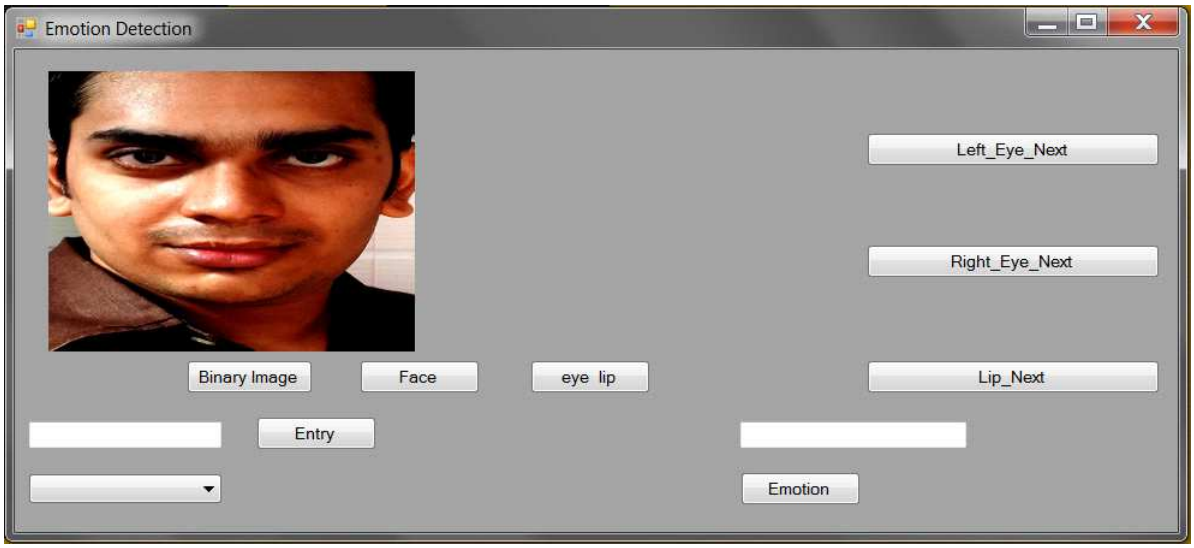


Figure 5.4: STEP 4:Then click Next button then it will open a new window.

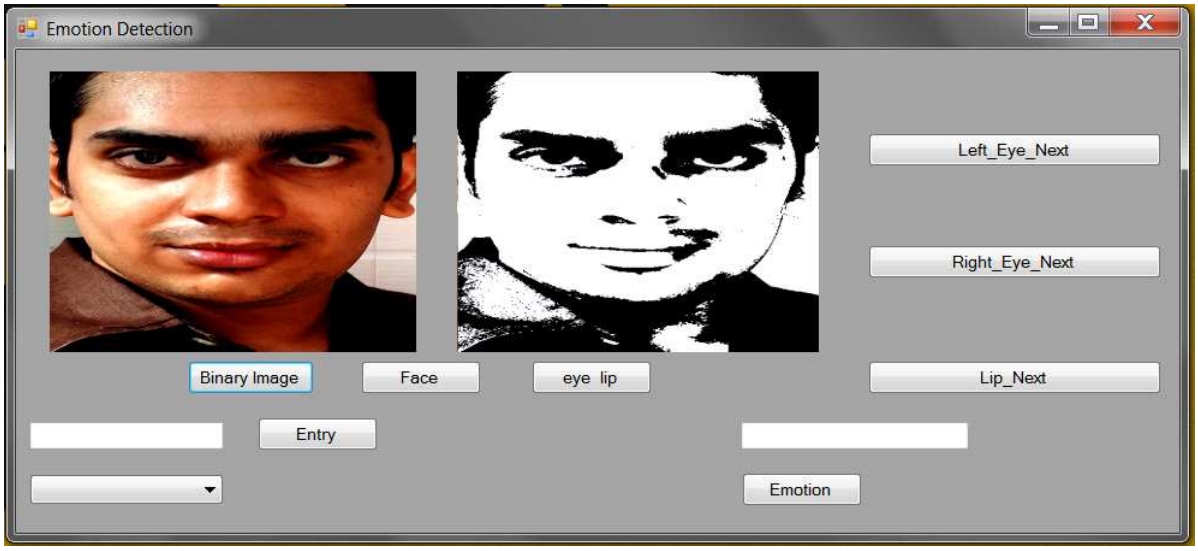


Figure 5.5: STEP 5:Then click Binary Image button.

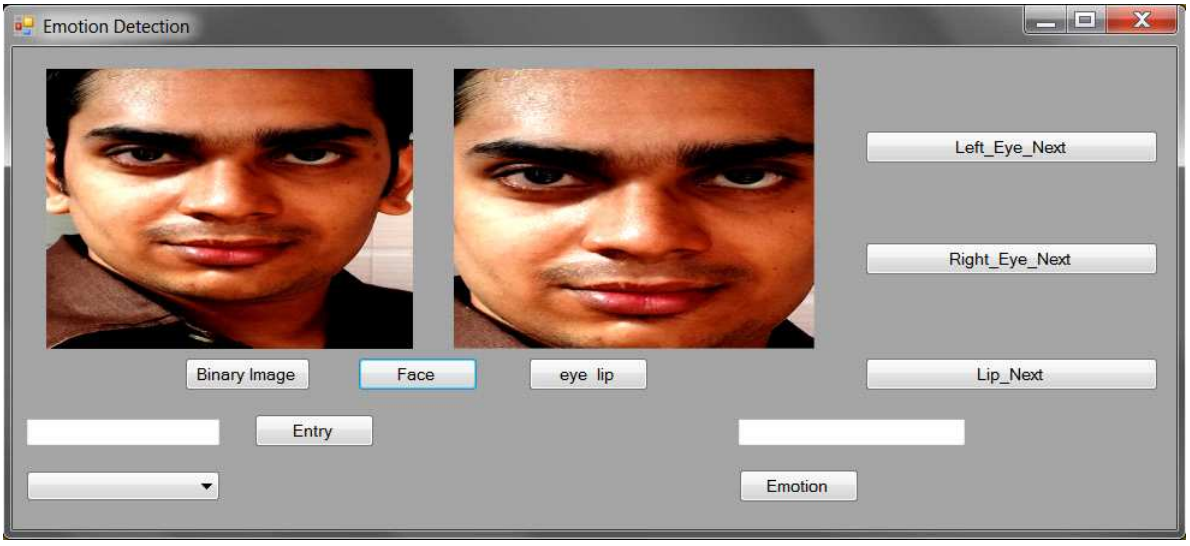


Figure 5.6: STEP 6:Then click Face button.

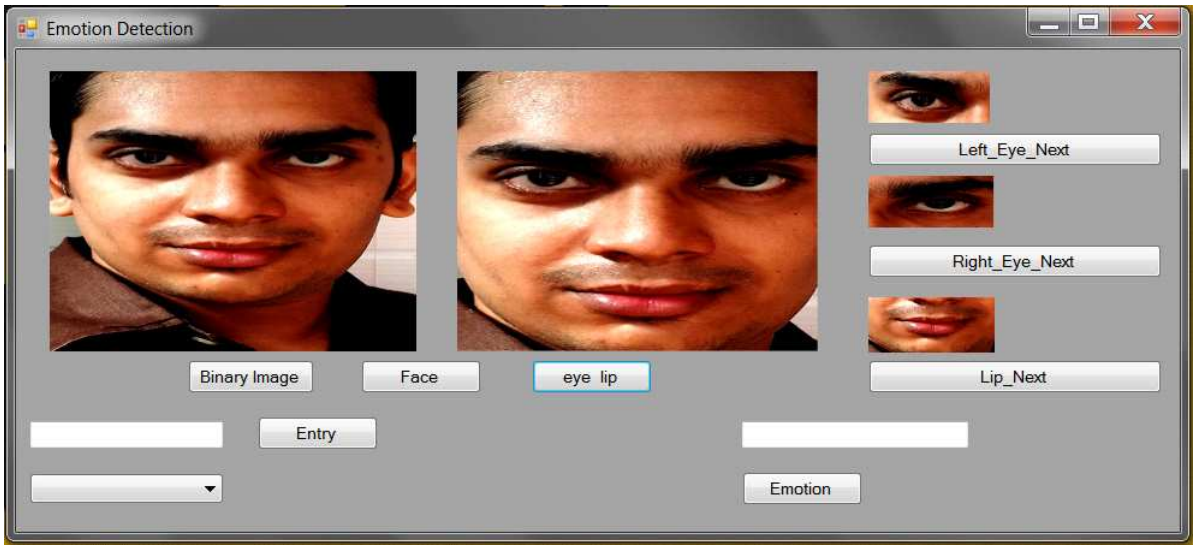


Figure 5.7: STEP 7:Then click eye lip button.

Figure 5.8: STEP 8:Then click Left Eye Next button.

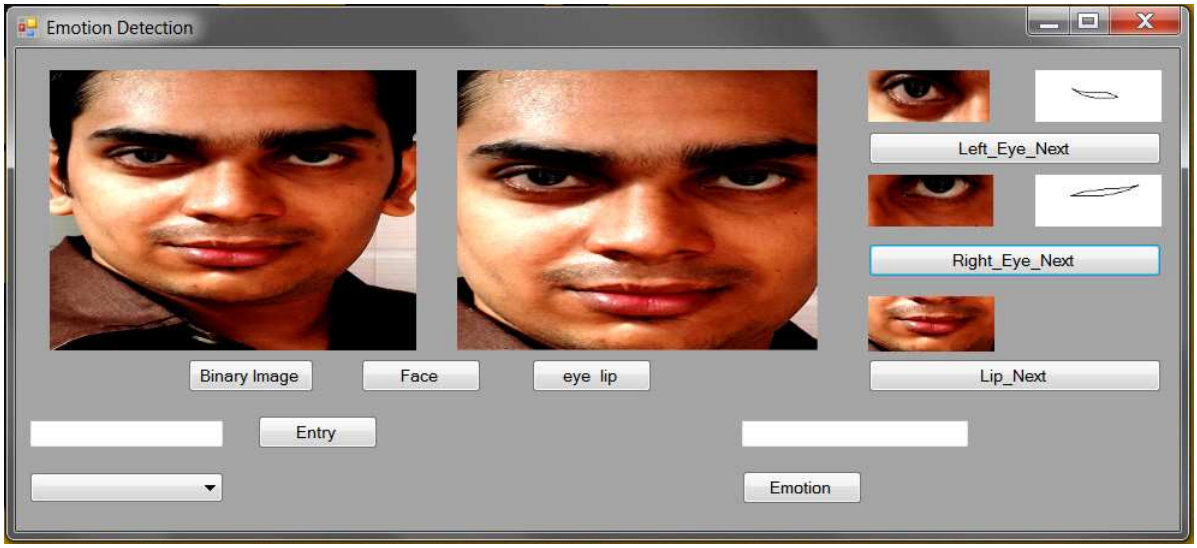


Figure 5.9: STEP 9:Then click Right Eye Next button.

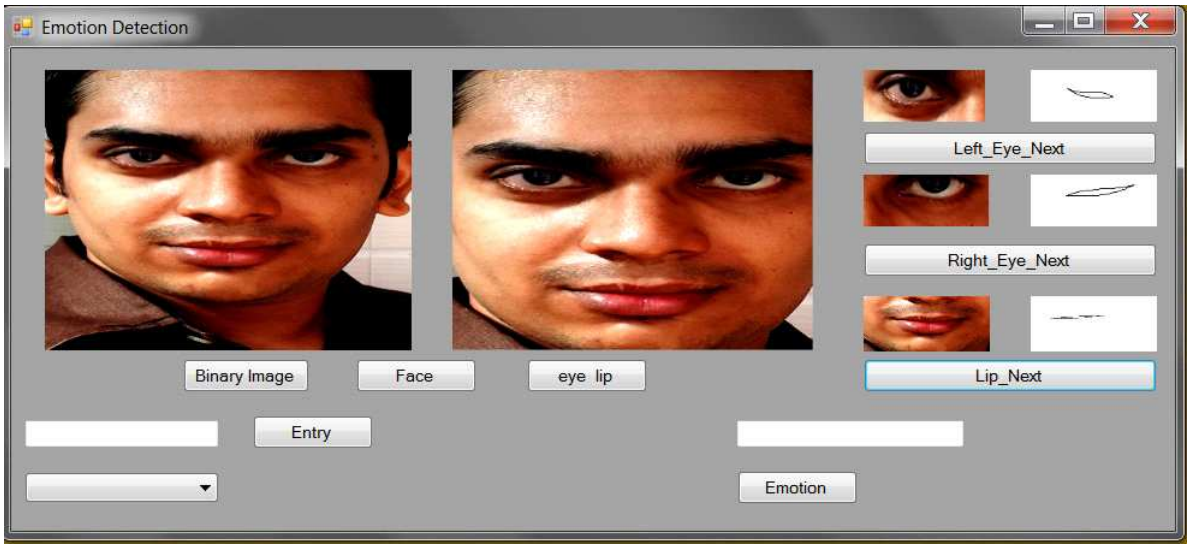


Figure 5.10: STEP 10:Then click Lip Next button.

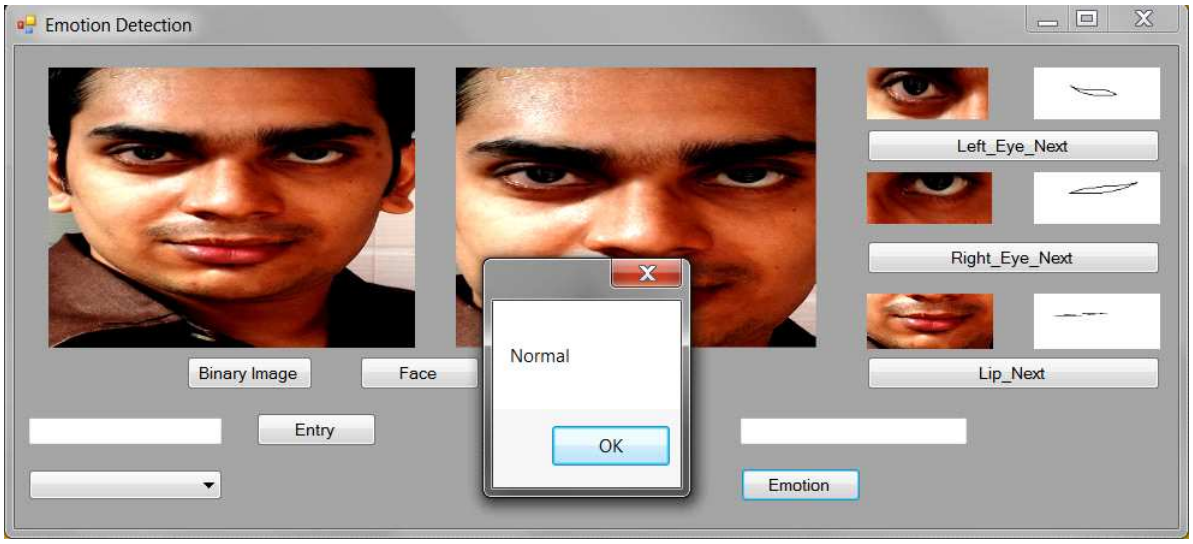


Figure 5.11: STEP 11:Then click Emotion button for show the emotion.

Chapter 6

Test Cases, Project Time Line & Task Distribution

6.1 Test Cases

6.1.1 Test plan

The test plan approach that has been used in our project includes the following:

Design verification or Compliance test: These Stages of testing have been performed during the development or approval stage of the product, typically on a small sample of units.

6.1.2 Test Coverage

The design verification tests have been performed at the point of reaching every milestone. Test areas included testing of various features such as Contrast Stretching, Skin Color Conversion, Largest connected region, Binary image Conversion, Eyes and Mouth Detection, Drawing Bezier Curves, Detecting Emotions ,etc.

6.1.3 Test Methods

Testing of diverse features has been performed in Facial Expression Recognition System. For each module, corresponding outputs were checked. For testing each module, the output produced from running the code was checked with the test data set.

6.1.4 Test Responsibility

The team members working on their respective features performed the testing of those features. Test responsibilities also included, the data collected, and how that data was used and reported.

6.1.5 Methods used For testing

We used the following methods for testing:

Unit Testing

Unit testing is a method by which individual units of source code, sets of one or more program modules together with associated control data, usage procedures, and operating procedures, are tested to deter-

Test case ID.	Step Description	Expected Result	Actual Result	Pass/Fail
1	User captures the image to be uploaded	Image not taken Properly or Wrong image	Recapture image	Pass
2	User selects a image	The selected image should be opened	The selected document is opened	Pass
3	User selects image of very high resolution or Noisy image.	Prompt the user to enter another image of smaller resolution	Message displaying this is not a Human Face or this image is not proper to find an emotion	Pass
4	User selects image of person with mixed emotions	Best Case Scenerio is taken	Selects single Emotions which is the closest	Pass
5	User selects image displaying correct emotion of the person	Correct Emotion is Displayed	Display the Emotion Box message with the correct gesture.	Pass

mine if they are fit for use. In our tool, we considered each module as one unit and tested these units with help of test cases and test plan developed. Unit testing was carried out on each module and on every function within the module. Output of each unit was assessed for accuracy and if found incorrect, appropriate corrections were made.

Integration Testing

Integration testing is the phase in software testing in which individual software modules are combined and tested as a group. The modules of our tool were integrated together in order to verify that they provide the required functionalities appropriately. The various modules were tested together to check for their accuracy and compatibility.

6.2 Task Distribution

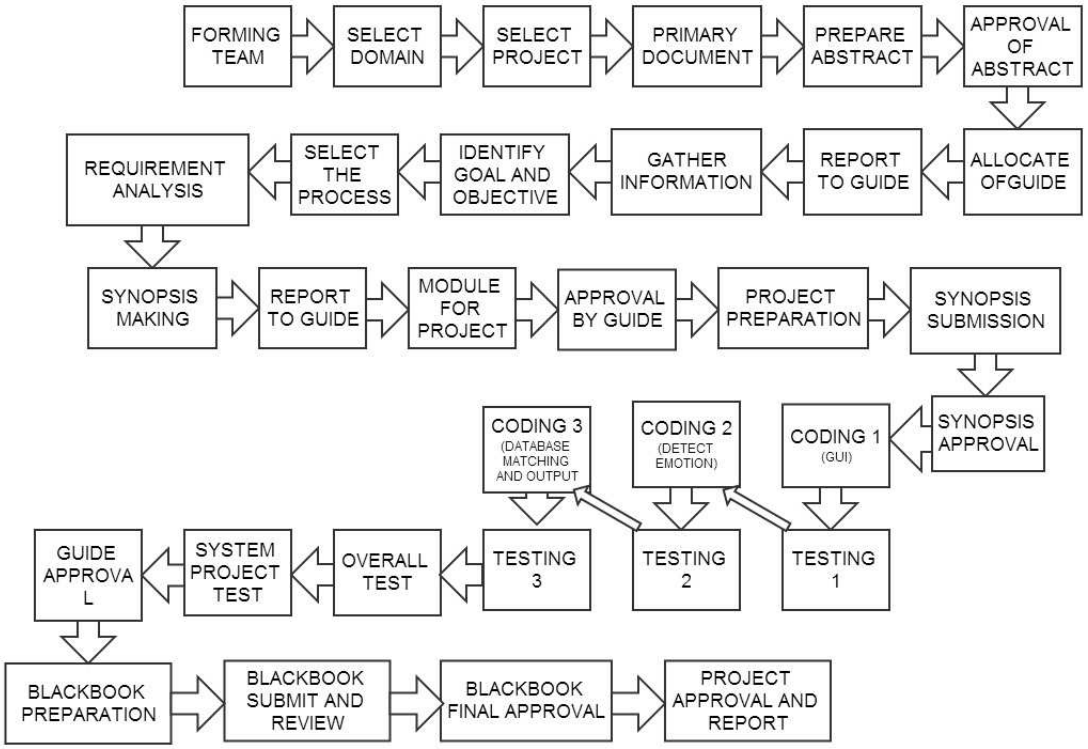


Figure 6.1: Task Distribution

6.3 Gantt Chart

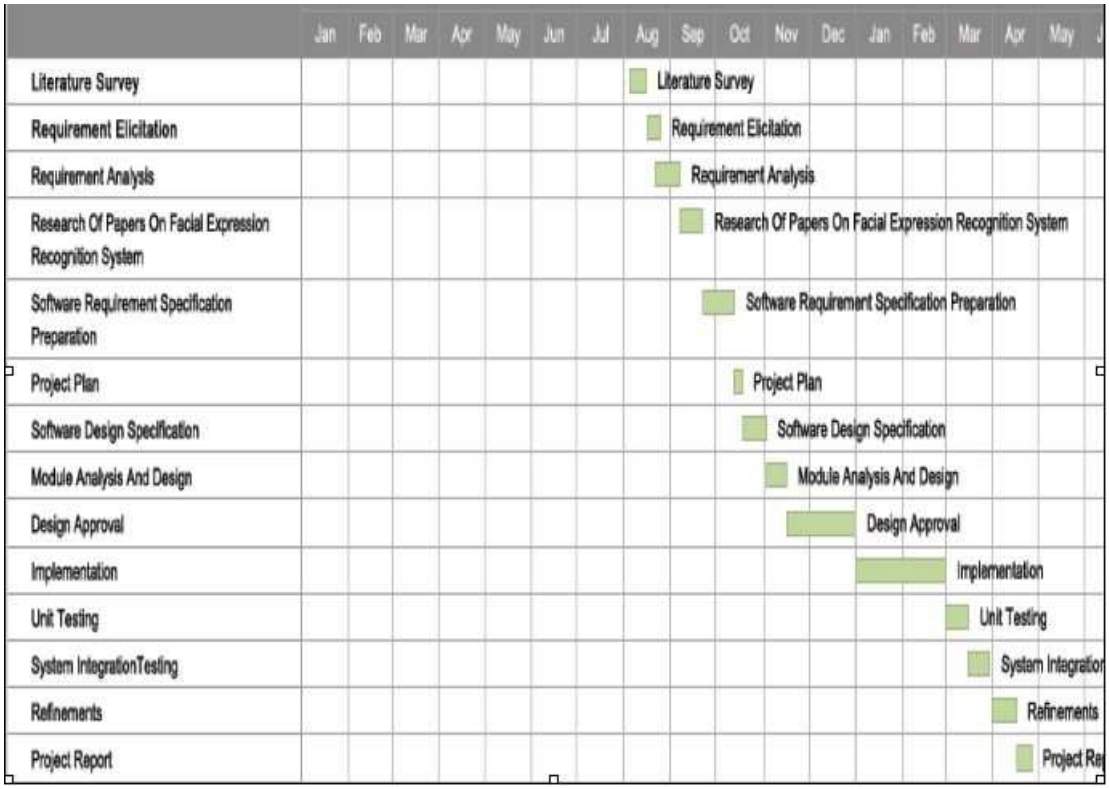


Figure 6.2: Gantt Chart

6.4 Project Time Line

The following table shows the expected flow of work for the accomplishment of the required result.

Table 6.1: Project Time Line

No.	Description	Duration	Complexity	Status
1	Literature Survey:Gathering information for facial expression detection	1 week	1	Done
2	Literature Survey:various methods to detect facial points	1 weeks	2	Done
3	Literature Survey:various methods available for Emotion detection	2 weeks	2	Done
4	Application of techniques to the image	2 weeks	3	Done
5	Use and implementation of Bezier curves	2 week	3	Done
6	Setup and implementation	3 weeks	5	Done
7	Coding:Environment setup for building UI and backhand	4 weeks	4	Done
8	Testing of Project	2 weeks	4	Done
9	Final Testing and application	2 weeks	4	Done

Chapter 7

Conclusion and Future Scope

7.1 Future Scope

High correct recognition rate (CRR), significant performance improvements in our system. Promising results are obtained under face registration errors, fast processing time. System is fully automatic and has the capability to work with video feeds as well as images. It is able to recognize spontaneous expressions. Our system can be used in Digital Cameras where in the image is captured only when the person smiles, or if the person doesnt blink his eyes. 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 persons taste when they enter the room. Doctors can use the system to understand the intensity of pain or illness of a deaf patient.

7.2 Conclusion

This project proposes a new approach for recognizing the category of facial expression . We have constructed the expression models by using average Bzier curves from several subjects. In this project, four different facial expressions of more than 20 persons pictures have been analyzed. In this project, 3rd order Bzier curve has been used to identify the face outlines and expressions. The adoption of the cubic Bzier curves means only four control points are sufficient to represent a curve. Although this method has been implemented for a few persons, but the experimental results nevertheless demonstrate that our system is reliable if the images represent a distinct view of the faces and are low resolution images. There is a lot of scope for the project to explore, for e.g. by improving the Eye-Lip detection procedure, and trying out the project for images taken at different angles and higher resolutions.

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[6] *http://google.com*

Appendix A

Project Hosting

The project is hosted at Google Code. The complete source code along with the manual to operate the project and supplementary files are uploaded.

Project Link : https://code.google.com/p/proquiz

QR CODE: