HUMAN FACE, FACIAL ORGANS AND EXPRESSION DETECTION SYSTEM.

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This Report Presented in Partial Fulfillment of the Requirements for the Degree of Bachelor of Science in Computer Science and Engineering.

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APPROVAL

This Project titled **"Human Face and Facial Expression Detection System**", submitted by Md Noor Uddin, Afifa Mustare Anonnya and Ausmaul Husna to the Department of Computer Science and Engineering, Daffodil International University, has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of BSc. in Computer Science and Engineering (BSc) and approved as to its style and contents. The presentation has been held on 9th December 2018.

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DECLARATION

We hereby declare that, this project has been done by us under the supervision of **Md. Tarek Habib, Assistant Professor and Department of CSE,** Daffodil International University. We also declare that neither this project nor any part of this project has been submitted elsewhere for award of any degree or diploma.

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Finally, we must acknowledge with due respect the constant support and patients of our parents.

ABSTRACT

A human-computer interaction system for an automatic face recognition or facial expression recognition has attracted increasing attention from researchers in psychology, computer science, linguistics, neuroscience and related disciplines. In this report, we present four things: (a) Face Detection (b) Eye Detection (c) Lip detection (e) Emotion Detection. The first period of face detection involves skin color detection using YCbCr color model, flaming reparation for getting uniformity on face and morphological operations for retaining the required face part. The output of the first period is used for extracting facial features like eyes, nose and mouth using AAM (Active Appearance Model) method. The third phase, automatic facial expression recognition involves simple Euclidean distance method. In this method, the Euclidean distance between the feature points of the training images and that of the query image is compared. Based on minimum Euclidean distance output image expression is selected.

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CHAPTER 1
INTRODUCTION

1.1 Objective

Communication involves each verbal or spoken and nonverbal or unspoken, approaches of making sure our message is heard. A simple smile can suggest our approval of a message, at the same time as a scowl might sign displeasure or confrontation. know-how facial expressions and their which means is a critical part of communication. Emotion popularity via facial features detection is one of the critical fields of observe for human-computer interaction. To discover a facial feature one machine, want to come upon numerous variabilities of human faces which include coloration, posture, expression, orientation and so forth. To discover the expression of a human face first its miles required to come across the exclusive facial capabilities including the movements of eye, nostril, lips etc. after which classify them evaluating with skilled information using a suitable classifier for expression reputation. On this research, a human facial expression popularity device is modelled the usage of eigenface method. The proposed method makes use of the HSV (Hue-Saturation-Value) color model to locate the face in a picture. PCA has been used for lowering the excessive dimensionality of the eigenspace and then with the aid of projecting the check picture upon the eigenspace and calculating the Euclidean distance between the check picture and suggest of the eigenfaces of the education dataset the expressions are classified. A common place dataset is used for schooling motive. the grey scale snap shots of the face are used by the gadget to categories four basic feelings consisting of surprise, sad, normal and happy [8].

1.2 Proposed System

We proposed an application in where we can select any photo and the system can identify the face if it is a human photo containing face. In the next part, the system can identify the eye and lip one by one. Finally, the system can identify, four basic facial expression (emotion) like surprise, sad, normal and happy.

1.3 Methodology to be used for this project

After login into our application, a user found a home page containing four functionalities such as human face detection, human eye detection, human lip detection and human facial expression detection and also there is another function name “All in one” where all the functions are working at a time by taking only one input image. In every function, a user needs to select a photo and system can automatically identify right result in front of us.

CHAPTER 2

SYSTEM REVIEW

2.1 Human Face, Facial Organs and Expression Detection System

Our system is an automated desktop-based application. There is no need to install the application, just run the face.exe file and use the system. To access, a user must login into the system with valid user id and password. After successful login, all the following four functionalities are open to use.

2.2 Accomplishment challenges

Accomplishment challenges are this type of task which is really difficult to overcome. But things can be solved. There are lots of challenges came ahead to develop the “Human Face, Facial Organs and Expression Detection System” such as security issues, personal information sharing, fake photo input etc.

2.3 Benefits of the project

Using “Human Face, Facial Organs and Expression Detection System”, anyone can get following facilities:

- Human Face Detection
- Human Eye Detection
- Human Lip Detection and
- Human Facial Expression Detection

2.4 Human Face Detection

In our system a user can select any photo and our system will identify is it a photo of human beings or not. If it is not containing human face, it says not human face and if it contains human face, it identifies the face part and display in the separate area.

2.5 Human Eye Detection

In our system, a user can select any photo and our system will identify is it a photo of human beings or not. If it contains human face, it identifies the eye and display in the separate area.

2.6 Human Lip Detection

In our system, a user can select any photo and our system will identify is it a photo of human beings or not. If it contains human face, it identifies the lip and display in the separate area.

2.7 Human Emotion Detection

In our system, a user can select any photo and our system will identify is it a photo of human beings or not. If it contains human face, it identifies the lip and eye and considering both of this, it identifies the human facial expression and convert it into smile, sad, surprise and normal expression.

2.8 User Access

For using this system in the admin level, a user must be created or registered. To complete this task a general blank form needs to be filled with user information, user ID and password. A user can modify the entered data or information about them with the help of administration later. Administration has all the rights to delete any user and create them.

CHAPTER 3
TECHNOLOGIES USED IN THE PROJECT

3.1 Introduction

Our offered platform is followed desktop-based rule. In this system, we used C# for server-side programming and Microsoft access for database. If anyone interested in gaining practical and comprehensive insight into the C# programming language and Microsoft access database and these prominent technologies can be used together to create dynamic, database driven web application, this project can be the great help for them [1], [2], [3].

3.2 C# Overview

C# is an elegant and type-safe object-oriented language that enables developers to build a variety of secure and robust applications that run on the .NET Framework. You can use C# to create windows client applications, XML web services, distributed components, client-server applications, database applications and much more. Visual C# provides an advanced code editor, convenient user interface designers, integrated debugger and many other tools to make it easier to develop applications based on the C# language and the .NET Framework [4], [5].

C# syntax is highly expressive, yet it is also simple and easy to learn. The curly-brace syntax of C# will be instantly recognizable to anyone familiar with C, C++ or Java. Developers who know any of these languages are typically able to begin to work productively in C# within a very short time. C# syntax simplifies many of the complexities of C++ and provides powerful features such as nullable value types, enumerations, delegates, lambda expressions and direct memory access which are not found in Java. C# supports generic methods and types which provide increased type safety and performance and iterators which enable implementers of collection classes to define custom iteration behaviors that are simple to use by client code. Language-Integrated Query (LINQ) expressions make the strongly-typed query a first-class language construct [6], [7].

3.3 Microsoft Access 2013 overview

Microsoft access 2013 has plenty of reasons to get excited. The best Microsoft access release to date, it sports more nice new features than you can count and the improvements extend to both performance and manageability. In a few cases, such as the resource governor, you will wish Microsoft had taken the functionality a little further. But whether you manage an OLTP environment or an OLAP environment or both, you will most likely find Katmai compelling. It easily passes my own five-point test for upgrades like change data capture, lookup cache, data compression, PowerShell integration and policy-based management.

3.4 Why Microsoft Access 2013

Streamlined Installation:

Microsoft access 2013 can be installed using "setup wizards"; the installer also detects, downloads and installs any required prerequisite updates. These features reduce the complexity of installing the software. Individual components such as database services, analysis services and integration services can be installed separately. Microsoft access 2013 automatically updates security patches to reduce maintenance costs.

Better Performance Features:

Microsoft access 2013 has transparent data compression and encryption built in. There is no need to modify or change programs to encrypt data. Microsoft access 2013 has more efficient access control and permission management tools and offers better performance in data collection. Microsoft access 2013 also integrates with Microsoft office.

Even though Microsoft access 2013 supports databases up to 524 terabytes (TB), its data compression features can reduce the database size. Backup databases can also be compressed.

Better Security Features:

Microsoft access 2013 has strong authentication and access protection and has better password management features to enforce stronger passwords and frequent changing of passwords.

Microsoft access 2013 uses policy-based management to detect non-compliance security policies which allows only authorized personnel access to the database. Security audits and events can be written automatically to log files.

Lower Ownership Costs:

Microsoft access 2013 includes advanced compression, data management tools, disk partitioning, data mining tools, enterprise reporting and advanced security at no additional cost. Microsoft access 2013 includes backwards compatibility with Microsoft access 2000 and 2005, so there is no need to update or upgrade every computer.

Facts:

Corporations such as Unilever, Citi, Barclay's Capital and Siemens use Microsoft access 2013. Microsoft access 2013 is recognized as the best seller and top-growth best seller by CRN Magazine.

CHAPTER 4
DATABASE SYSTEM

4.1 Overview of database system

Database server consisting with a computer program and it provides database services to other computers, mainly depend on the client-server model. The term used to refer to the back-end system of a database application using server architecture. These back-end sometimes called a database server. Database server performs tasks as data analysis, storage, data-manipulation, archiving, backup and recovery also. In this chapter, we will discuss about our system database server that is used for our project, we used Microsoft access 2013 for our project.

4.2 Face and Facial Expression Identify System

Our system is fully an offline line-based system. It uses Microsoft access 2013, the total system developed with C# and which is very flexible with Microsoft access database. First, we designed our total database structure that means, how many entity and attributes required for our system and then we select the referential integrity and choose cardines. Finally, we crate our total database system.

4.3 Total ERD for our system

The Final result of ER-modeling is called the ER-Diagrams (ERD). ER-modeling is a data modeling technique used in software engineering to produce a conceptual data model of an information system. Diagrams created using this ER-modeling technique are called Entity-Relationship diagram or ER diagram or ERD. So, you can say that ER diagrams illustrate the logical structure of databases.

Dr. Peter Chen is the originator of the ER model. His original paper about ER-modeling is one of the most cited papers in the computer software field. Currently the ER model serves as the foundation of many system analysis and design methodologies, computer-aided software engineering (CASE) tools and repository systems.

ERD for our total database system: -

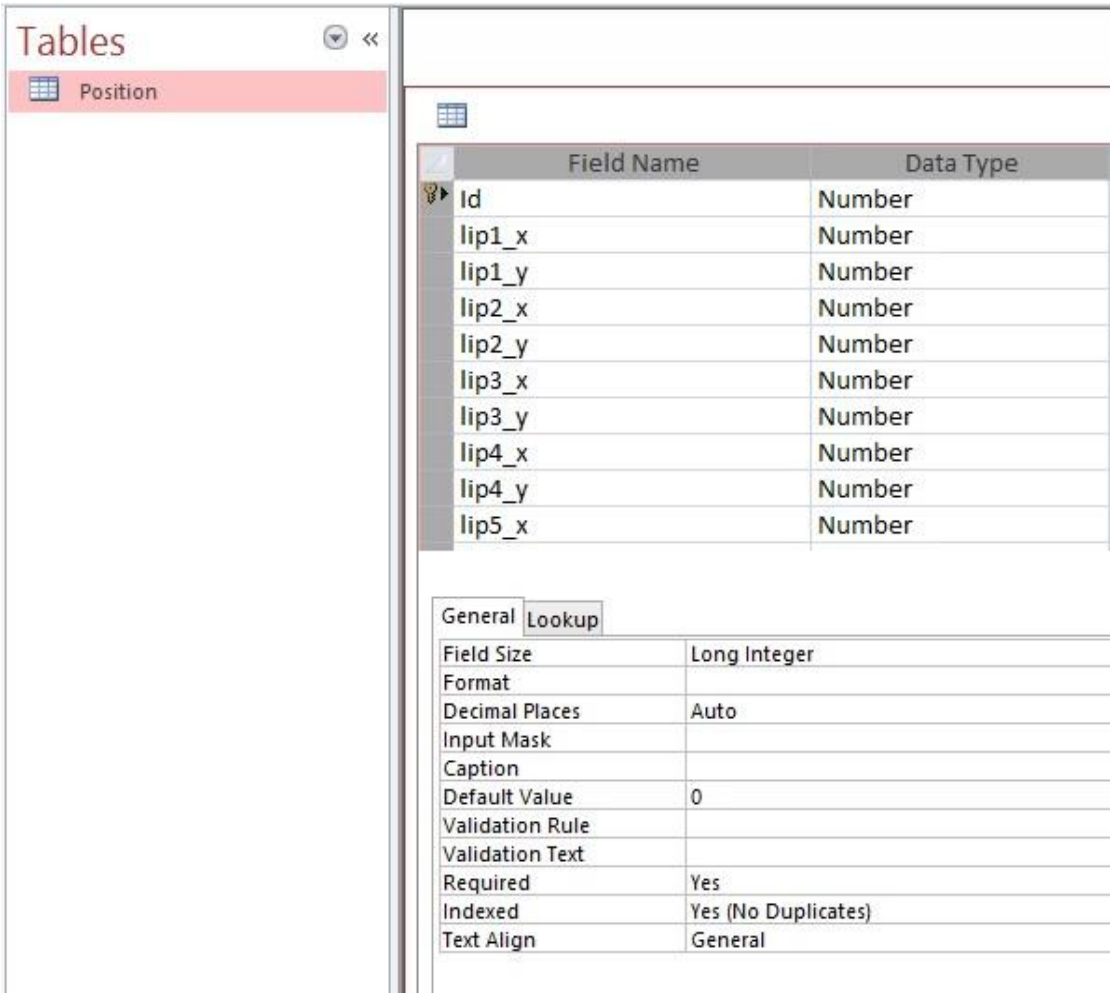


Figure 4.1: Total Database ERD

Table 4.1: Data/Value of “position” table (Position of lip, left and right eye)

Id	lip1_x	lip1_y	lip2_x	lip2_y	lip3_x	lip3_y	lip4_x	lip4_y	lip5_x	lip5_y
1	48	71	80	68	112	67	145	68	80	81
2	15	20	28	16	41	15	54	18	28	23
3	20	47	29	42	38	41	47	45	29	50
4	10	24	21	21	32	20	44	22	21	24
5	2	8	20	7	38	5	56	5	20	15
6	44	34	66	22	88	22	112	34	66	41
7	41	34	64	26	87	25	111	31	64	33
8	38	23	64	20	90	19	117	21	64	27
9	15	7	24	3	33	3	44	6	24	10
10	9	20	21	17	33	17	46	22	21	27
11	6	27	29	23	52	23	75	27	29	35
12	22	36	47	30	72	29	99	35	47	37
13	26	42	52	36	78	36	104	41	52	47
14	6	27	29	23	52	23	75	27	29	35
0	0	0	0	0	0	0	0	0	0	0

CHAPTER 5
DEVELOPMENT

5.1 Overview of development

We develop offline student communication board using Microsoft platform. We use C# .Net and Microsoft access. First of all, we try to collect main requirement by consulting among us and some other students. Then try to create the interfaces. Based on the requirements and templates of interfaces we create database. Finally, we design the UI and related methods and functions.

After completing the development part, we do test and finally close the development part and keep it ready for use.

The different phases of our development parts are:

- Requirement Analysis
- Template Design
- Database Design
- UI Design
- Coding (Method and Function)
- Testing

5.2 Total system

Here we try to describe the total system that we develop:

- Human Face Detection
- Human Eye Detection
- Human Lip Detection and
- Human Facial Expression Detection

5.2.1 Login Page

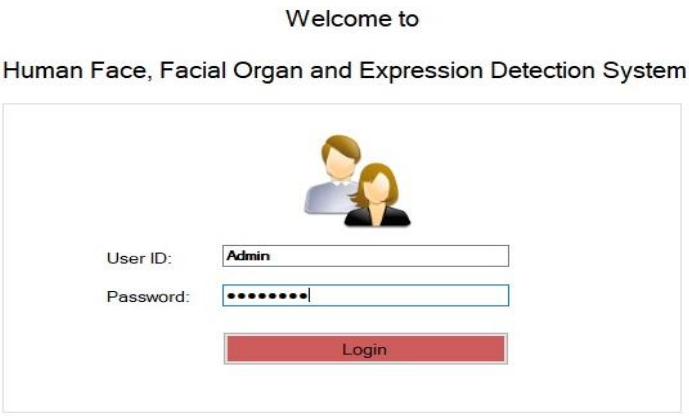


Figure 5.1: Login page

5.2.2 Home Page

First of all, if any one goes to our application, he/she can see the home page first. From home page anyone can go to all five areas as bellow:

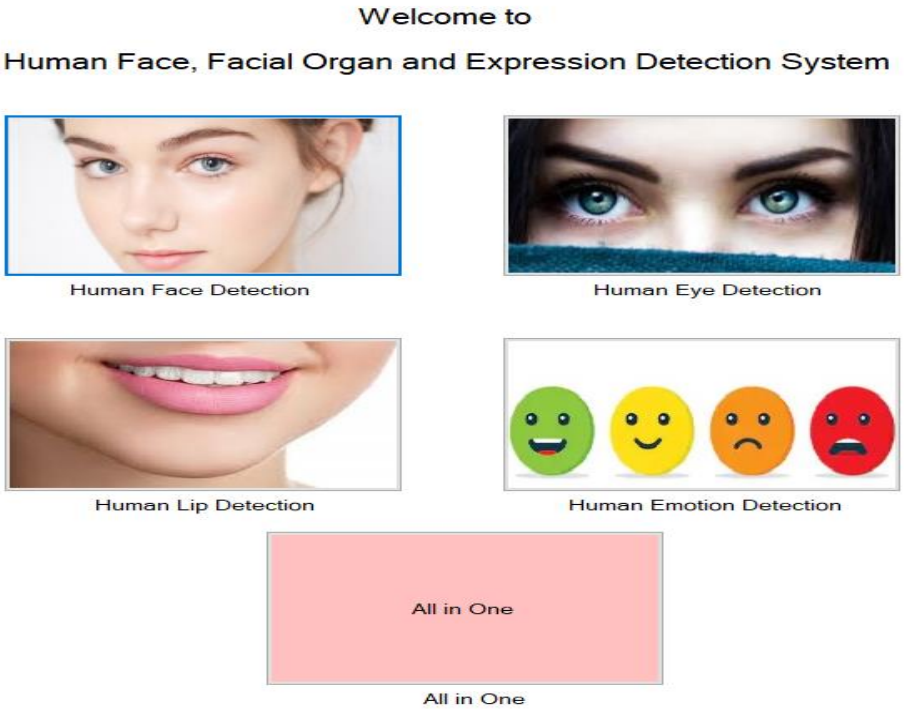


Figure 5.2: Home page

5.2.3 Human Face Detection

In our system a user can select any photo and our system will identify is it a photo of human beings or not. If it is not containing human face, it says, not human face and if it contains human face, it identifies the face part and display in the separate area.

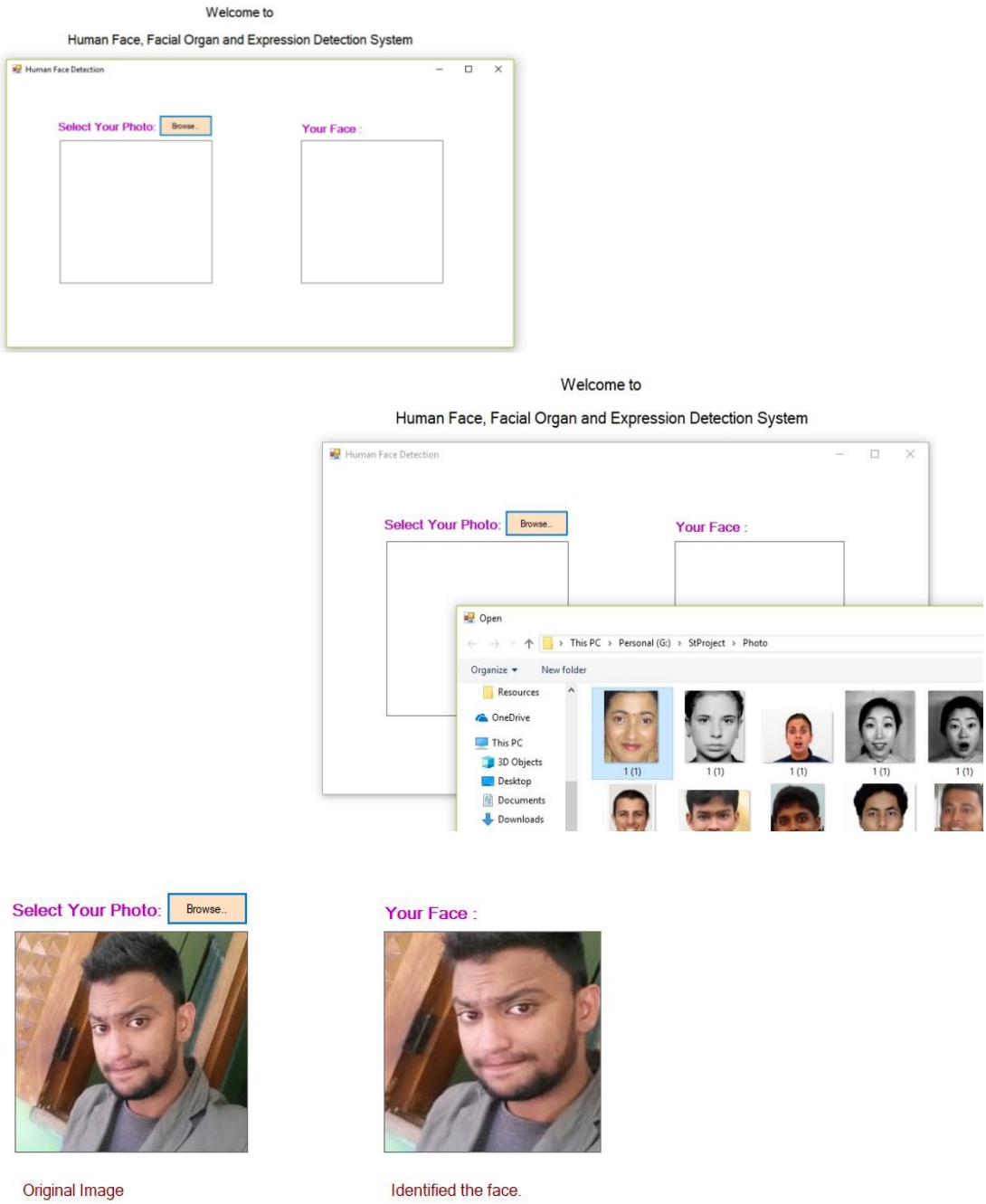


Figure 5.3: Identified human face

5.2.4 Human Eye Detection

In our system, a user can select any photo and our system will identify is it a photo of human beings or not. If it contains human face, it identifies the eye and display in the separate area.

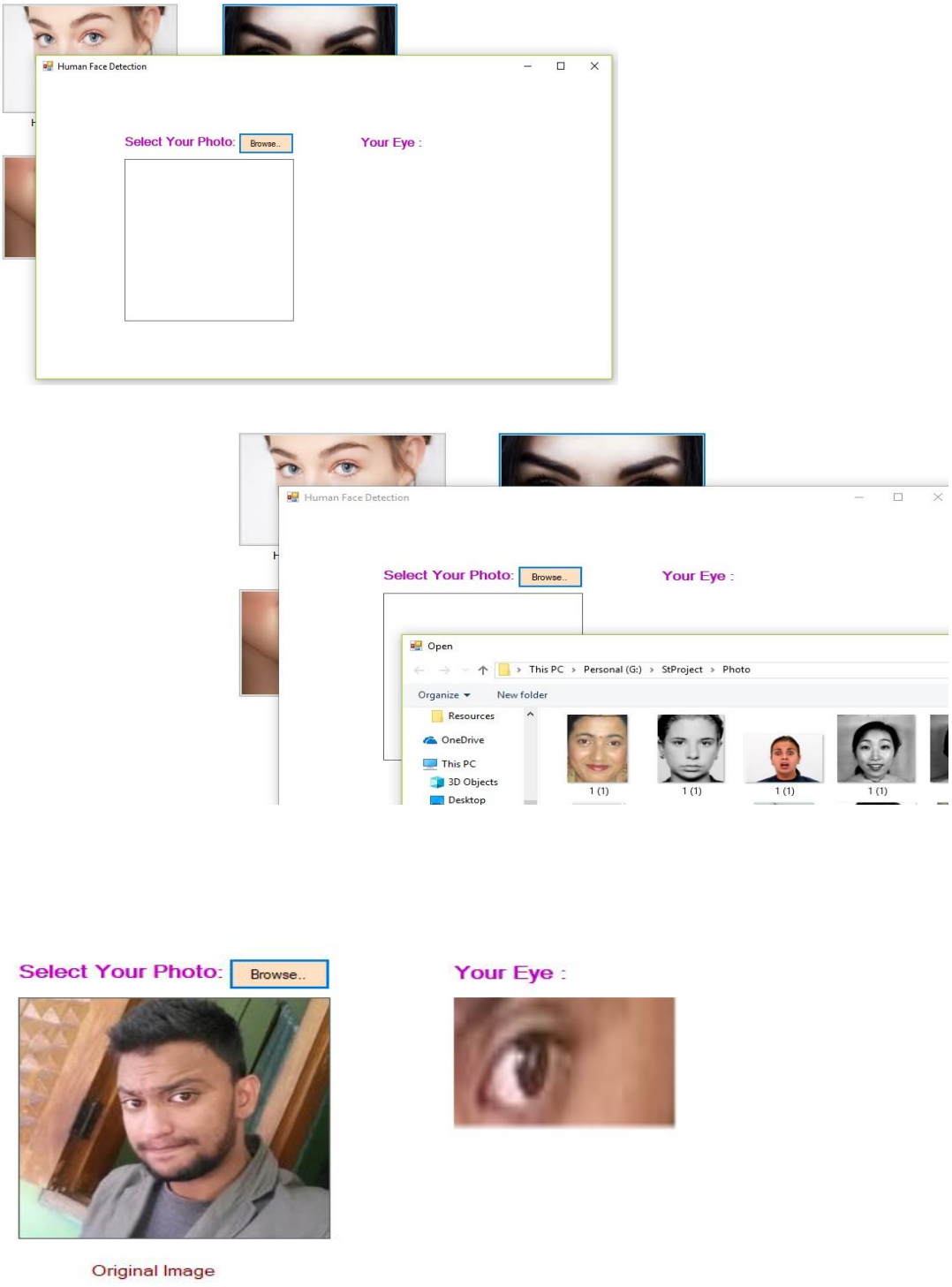


Figure 5.4: Identified eye

5.2.5 Human Lip Detection:

In our system, a user can select any photo and our system will identify is it a photo of human beings or not. If it contains human face, it identifies the lip and display in the separate area.

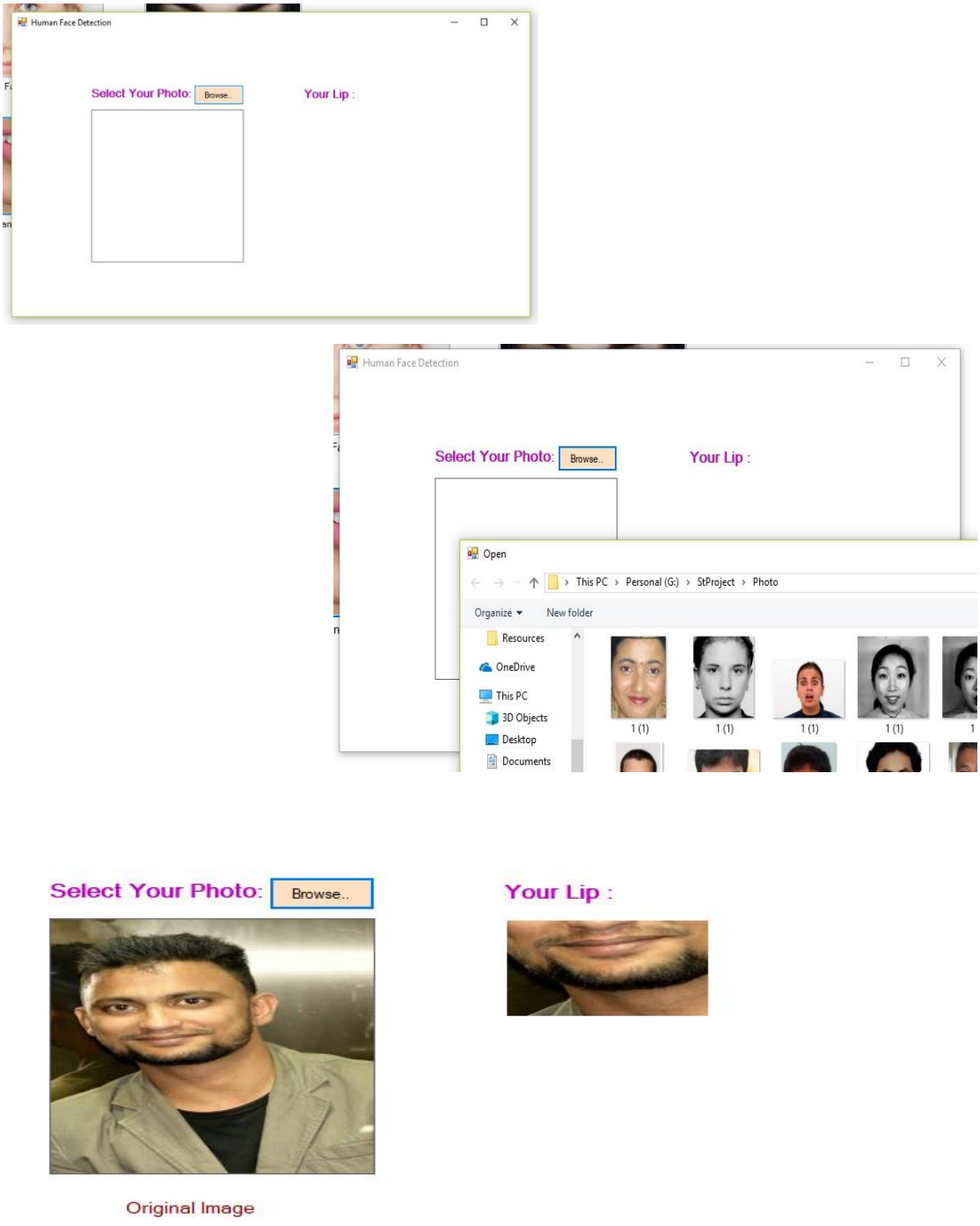


Figure 5.5: Identified lip

5.2.6 Human Emotion Detection:

In our system, a user can select any photo and our system will identify is it a photo of human beings or not. If it contains human face, it identifies the lip and eye and considering both of this then it identifies the human facial expression and convert it into smile, sad, surprise and normal expression.

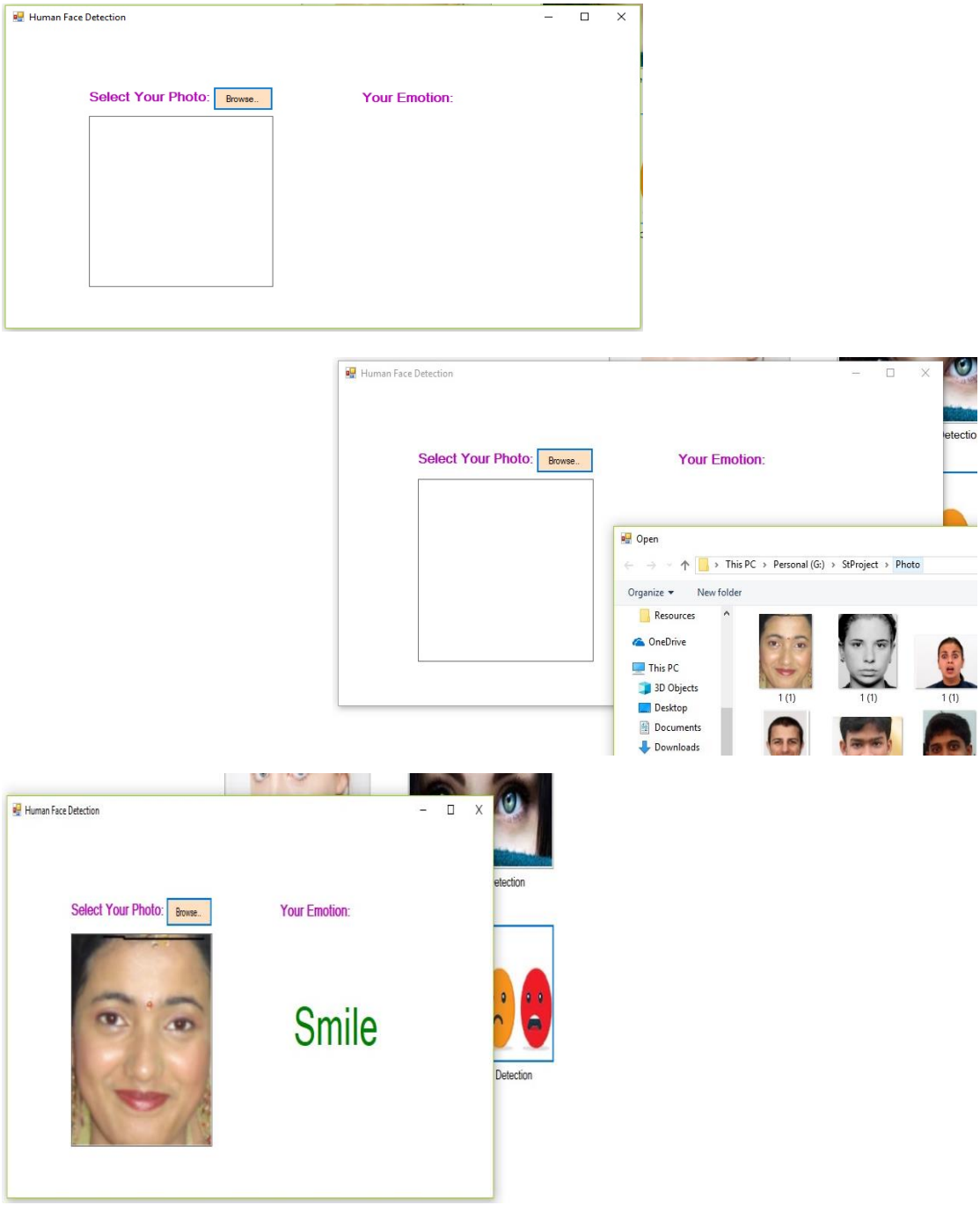
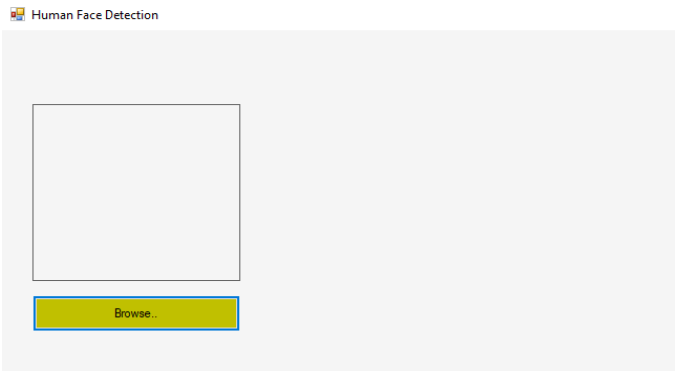


Figure 5.6: Identified emotion

5.2.7 ALL IN ONE:

In our system, a user can select any photo and our system will identify is it a photo of human beings or not. If it contains human face then all the functions are working at a time by taking only one input.



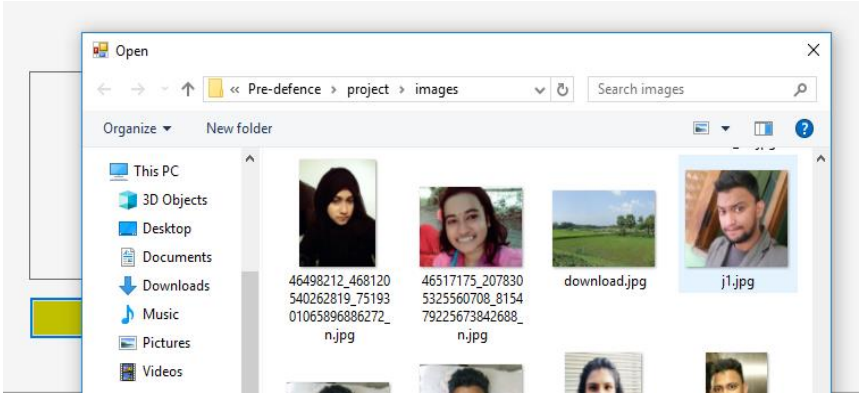


Figure 5.7: All in one

CHAPTER 6
CONCLUSION

6.1 Goal

Actually, we have a goal to enhance communication between human and computer by using facial expression. This is very important to identify human emotion to communicate with him and proceed any activity effectively and automatically. In our project, we can identify human face, eye, lip and expression or emotion very effectively.

6.2 Limitations

There is some limitation of our system also which are as bellow:

1. Our system cannot identify the gender of human face.
2. Our system cannot identify the degree of emotions.

6.3 Future development

We will incorporate following things in future:

1. Can identify the gender of human face.
2. Can identify the degree of Emotions in percentage (%).

6.4 Conclusion

In conclusion, we can say, our motive is to identify different organs of human faces so that we can identify the emotion from the facial expression. We believe, we can do it successfully. But we also identify some limitation and also hope we can overcome it in near future.

APPENDIX

For Login:

```
using System;
using System.Collections.Generic;
using System.ComponentModel;
using System.Data;
using System.Drawing;
using System.Linq;
using System.Text;
using System.Threading.Tasks;
using System.Windows.Forms;

namespace sobel_filtering
{
   public partial class Login : Form
   {
      public Login()
      {
         InitializeComponent();
      }

      private void btnLogin_Click(object sender, EventArgs e)
      {
         checkLogin();
      }

      void checkLogin()
      {
         if (txtUserId.Text == "Admin" && txtPassword.Text == "admin121")
         {
            Home home = new Home();
            home.Show();
```

```
        }
        else
        {
            MessageBox.Show("Invalid User ID and Password");
```

For Home Page (Menu):

```
using System;
using System.Collections.Generic;
using System.ComponentModel;
using System.Data;
using System.Drawing;
using System.Linq;
using System.Text;
using System.Threading.Tasks;
using System.Windows.Forms;

namespace sobel_filtering
{
    public partial class Home : Form
    {
        public Home()
        {
            InitializeComponent();
        }

        private void button1_Click(object sender, EventArgs e)
        {
            Face aface = new Face();
            aface.Show();
        }

        private void button2_Click(object sender, EventArgs e)
        {
```

```
    Eye1 aEye = new Eye1();
    aEye.Show();
}

private void button3_Click(object sender, EventArgs e)
{
    Lip1 aLip = new Lip1();
    aLip.Show();
}

private void button4_Click(object sender, EventArgs e)
{
    Emotion1 aEmotion = new Emotion1();
    aEmotion.Show();
}

private void Home_Load(object sender, EventArgs e)
```

For Identifying Face, Eye & Lip:

```
using System;
using System.Collections.Generic;
using System.ComponentModel;
using System.Data;
using System.Drawing;
using System.Text;
using System.Windows.Forms;
using Inversion;
using System.IO;
using System.Data.OleDb;
using System.Drawing.Imaging;
using System.Threading;

using CSharpFilters;
```

```
namespace sobel_filtering
{
   public partial class Face : Form
   {
      string _dataBasePath = "";
      string save_file, extension;
      string file_name;
      private LogicalOperator processing;
      Bitmap b;
      string crop_image;
      int bLength;
      int xp, xq, yp, yq, spq;
      int lip_wx, lip_wy;
      Bitmap Bit;
      Bitmap undo_picture;//for undoing image
      bool delay_process = true;
```

For Face:

```
      public Face()
      {
         InitializeComponent();
         processing = new LogicalOperator();
      }

      public Bitmap black_and_white(Image Im)
      {
         Bitmap b = (Bitmap)Im;
         int A, B, C, c;
         int limit = 110;

         for (int i = 1; i < b.Height; i++)   // loop for the image pixels height
         {
```

```
            for (int j = 1; j < b.Width; j++)  // loop for the image pixels width
            {
                Color col;
                col = b.GetPixel(j, i);

                A = Convert.ToInt32(col.R);
                B = Convert.ToInt32(col.G);
                C = Convert.ToInt32(col.B);
                if (A > limit || B > limit || C > limit)
                    c = 255;
                else
                    c = 0;

                if (c == 0)
                    b.SetPixel(j, i, Color.Black);
                else
                    b.SetPixel(j, i, Color.White);
            }
        }
        return b;
    }
private void YCbCr_Click(object sender, EventArgs e)
    {
        double c = 0, cb = 0, cr = 255;
        Bitmap bb = (Bitmap)pictureBox1.Image.Clone();
        Bitmap bb1 = new Bitmap(pictureBox1.Image.Size.Width,
pictureBox1.Image.Size.Height);
        int min_x = bb.Width + 5;
        int max_x = 0;
        int max_y = 0;
        int min_y = bb.Height + 5;

        cr_start = 140;
```

```
        cr_end = 170;
        cb_start = 105;
        cb_end = 150;

        for (int i = 1; i < bb.Width - 1; i++)
           for (int j = 1; j < bb.Height - 1; j++)
           {
              c = 0.257 * Convert.ToDouble(bb.GetPixel(i, j).R) + 0.504 *
bb.GetPixel(i, j).G + 0.098 * bb.GetPixel(i, j).B + 16;
              cb = 0.148 * Convert.ToDouble(bb.GetPixel(i, j).R) - 0.291 *
Convert.ToDouble(bb.GetPixel(i, j).G) + 0.439 * Convert.ToDouble(bb.GetPixel(i,
j).B) + 128;
              cr = 0.439 * Convert.ToDouble(bb.GetPixel(i, j).R) - 0.368 *
Convert.ToDouble(bb.GetPixel(i, j).G) - 0.071 * Convert.ToDouble(bb.GetPixel(i,
j).B) + 128;

              if ((cr > cr_start && cr < cr_end) && (cb > cb_start && cb < cb_end))
              {
                 bb1.SetPixel(i, j, Color.Black);
              }
              else bb1.SetPixel(i, j, Color.White);
           }

        pictureBox2.Image = (Bitmap)bb1;
        MessageBox.Show("Finished....");
     }
```

For Eye:

```
     public Bitmap connected_eye(Bitmap bit)
     {
        Bit = bit;
        int capacity = Bit.Height * Bit.Width;
        queue_i = new Queue<int>(capacity);
```

```
        queue_j = new Queue<int>(capacity);

        countt = new int[capacity];
        visited = new bool[Bit.Width + 5][];

        #region initialization of visited boolean array
        for (int i = 0; i < Bit.Width + 5; i++)
        {
            visited[i] = new bool[Bit.Height + 5];
            for (int j = 0; j < Bit.Height + 5; j++)
                visited[i][j] = false;
        }
        #endregion
        big = new int[Bit.Width + 5][];

        #region initialization of count region array
        for (int i = 0; i < Bit.Width + 5; i++)
        {
            big[i] = new int[Bit.Height + 5];
            for (int j = 0; j < Bit.Height + 5; j++)
                big[i][j] = 0;
        }
        #endregion
    }
```

For Lip:

```
    public Bitmap connected_lips(Bitmap bit)
    {
        Bit = bit;
        int capacity = Bit.Height * Bit.Width;
        queue_i = new Queue<int>(capacity);
        queue_j = new Queue<int>(capacity);
```

```
        countt = new int[capacity];
        visited = new bool[Bit.Width + 5][];

        #region initialization of visited boolean array
        for (int i = 0; i < Bit.Width + 5; i++)
        {
            visited[i] = new bool[Bit.Height + 5];
            for (int j = 0; j < Bit.Height + 5; j++)
                visited[i][j] = false;
        }
        #endregion
        big = new int[Bit.Width + 5][];

        #region initialization of count region array
        for (int i = 0; i < Bit.Width + 5; i++)
        {
            big[i] = new int[Bit.Height + 5];
            for (int j = 0; j < Bit.Height + 5; j++)
                big[i][j] = 0;
        }
        #endregion

        int max = 0, max_bit = 0;
        count_region = 1;
        for (int i = 0; i < Bit.Width; i++)
        {
            for (int j = 0; j < Bit.Height; j++)
            {
                if (!visited[i][j] && (Bit.GetPixel(i, j).R == 0 && Bit.GetPixel(i, j).G ==
0 && Bit.GetPixel(i, j).B == 0))
                {
                    countt[count_region] = 0;
                    //MessageBox.Show(i+" "+j+" ");
```

```
                BFS(i, j);
                if (max < countt[count_region])
                {
                    max = countt[count_region];
                    max_bit = count_region;
                    //MessageBox.Show(max+" ");
                }
                count_region++;
            }

        private void lip_location(Bitmap b)
        {
            //////Bitmap b = new Bitmap(pictureBox2.Image);
            int w = b.Width;
            int h = b.Height;
            int ys1 = h, ye1 = h - 1, ys2 = h, ye2 = h - 1;
            int i, j, k;
            int mid = 0, max = 0;

            for (i = 0; i < h; i++)
            {
                b.SetPixel(0, i, Color.White);
                b.SetPixel(1, i, Color.White);
                b.SetPixel(w - 1, i, Color.White);
                b.SetPixel(w - 2, i, Color.White);
            }
            for (i = w / 4; i < w - (w / 4); i++)
            {
                for (j = spq; j < h; j++)
                    if (b.GetPixel(i, j).R == 0 && b.GetPixel(i, j).B == 0 && b.GetPixel(i,
j).G == 0)
                        break;
```

```
            if (max < (j - spq))
            {
                max = j - spq;
                mid = i;
            }
        }
        int tp1 = mid - 5, tp2 = mid + 5, mp1 = h - 1, mp2 = h - 1;
        for (i = w / 8; i < w - (w / 8); i++)
        {
            for (j = spq; j < h; j++)
                if (b.GetPixel(i, j).R == 0 && b.GetPixel(i, j).B == 0 && b.GetPixel(i,
j).G == 0)
                    break;
            if (i <= mid)
            {
                if (j - 1 < ys1)
                    ys1 = j - 1;
                if (i >= mid / 2)
                    if (mp1 > j)
                    { tp1 = i; mp1 = j; }
            }
            else
            {
                if (j - 1 < ys2)
                    ys2 = j - 1;
                if (i <= mid + (w - mid) / 2)
                    if (mp2 > j)
                    { tp2 = i; mp2 = j; }
```

For Emotion:

```
    public Emotion()
    {
        InitializeComponent();
```

```
    }
        public Image face(Image Im)
    {
        Bitmap b = (Bitmap)Im;
        int i, j, k, w, w_f = 0;
        w = b.Width / 2;
        for (i = 0; i < b.Height; i++)
        {
            if (b.GetPixel(w, i).R != 0 && b.GetPixel(w, i).R != 0 && b.GetPixel(w, i).R
!= 0 && w_f == 1)
            {
                break;
            }
            if (w_f == 0)
                if (b.GetPixel(w, i).R == 0 && b.GetPixel(w, i).R == 0 && b.GetPixel(w,
i).R == 0)
                    w_f = 1;
        }
      if (flag_person == -1)
        {
            query = "insert into Person ( Name , Smile , Normal, Surprise, Sad ) values
('" + textBox2.Text + "',";
            query += smile + "," + normal + "," + surprise + "," + sad + ");";
            myCommand.CommandText = query;
            reader = myCommand.ExecuteReader();
            reader.Close();
        }
        else
        {
            query = "update Person set Smile = " + smile + ", Normal = " + normal + ",
Surprise = " + surprise;
            query += ", Sad = " + sad + " where Name ='" + textBox2.Text + "';";
            myCommand.CommandText = query;
```

```
            reader = myCommand.ExecuteReader();
            reader.Close();
        }
        AI = new int[16];
        Bitmap b = new Bitmap(pictureBox8.Image);
        bezier_position(b);
            if (emo == 0)
                MessageBox.Show("Smile");
            else if (emo == 1)
                MessageBox.Show("Normal");
            else if (emo == 2)
                MessageBox.Show("Surprise");
            else if (emo == 3)
                MessageBox.Show("Sad");
            }
        }
    }
```

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