Лабораторна робота № 2

Виконав студент
Групи КН-21-1
Хижняк Олег
Варіант 33

Мета роботи: розробити програму для емуляції дисплейного модуля.

Етапи виконання лабораторної роботи:

1. Розробити архітектуру і реалізувати програму з графічним інтерфейсом здатну виконувати команди, наведені в лабораторній роботі №1. Обмеження на тип даних і параметри дивися в описі команд в лабораторній роботі №1.

2. Додати в програму, розроблену в п.1 код для реалізації UDP сервера з лабораторної роботи №1. При спільному використанні як графічного інтерфейсу так і роботи з мережею можливо Вам знадобиться використання додаткових потоків виконання (threads).

3. Після проведення інтеграції(п.2) програма повинна мати можливість приймати команди, описані в лабораторній роботі №1, по протоколу UDP і відображати їх в графічному інтерфейсі.

Хід роботи

Лістинг сервера:

Form1.cs:

```
using System;
using System.Collections.Generic;
using System.Drawing;
using System.Linq;
using System.Windows.Forms;
using System.Net;
using System.Net.Sockets;
using System.Threading;
using System.Drawing.Drawing2D;


namespace CSCS2_Forms
{
    public partial class Form1 : Form
    {
        static Int16 rotation = 0;
        static Int16 penWidth = 2;
        static List<Lines> lines = new List<Lines>();
        static List<Pixels> pixels = new List<Pixels>();
        static List<Rectangles> rectangles = new List<Rectangles>();
        static List<Ellipses> ellipses = new List<Ellipses>();
        static List<RoundedRectangle> roundedRectangles = new
        List<RoundedRectangle>();
        static List<Texts> texts = new List<Texts>();
        static List<Pictures> pictures = new List<Pictures>(); public Form1()
        {
            InitializeComponent();
            try
            {
                new Thread(new ThreadStart(ReceiveMessage)).Start();
            }
            catch (Exception ex)
            {
                Console.WriteLine(ex.Message);
            }
        }
        //***********************CLASSES************************
        public class Pixels
        {
            public Int16 x0;
            public Int16 y0;
            public Color argb;
            public Pixels(Int16 _x0, Int16 _y0, Color _argb)
            {
                this.x0 = _x0;
```

```
        this.y0 = _y0;
        this.argb = _argb;
    }
}
public class Lines
{
    public Int16 x0;
    public Int16 y0;
    public Int16 x1;
    public Int16 y1;
    public Color argb;
    public Lines(Int16 _x0, Int16 _y0, Int16 _x1, Int16 _y1, Color _argb)
    {
        this.x0 = _x0;
        this.y0 = _y0;
        this.x1 = _x1;
        this.y1 = _y1;
        this.argb = _argb;
    }
}
public class Rectangles
{
    public Int16 x0;
    public Int16 y0;
    public Int16 w;
    public Int16 h;
    public Color argb;
    public bool isfilled;
    public Rectangles(Int16 _x0, Int16 _y0, Int16 _w, Int16 _h, Color
    _argb, bool _isfilled)
    {
        this.x0 = _x0;
        this.y0 = _y0;
        this.w = _w;
        this.h = _h;
        this.argb = _argb;
        this.isfilled = _isfilled;
    }
}
public class Ellipses
{
    public Int16 x0;
    public Int16 y0;
    public Int16 radius_x; public Int16 radius_y;
    public Color argb;
    public bool isfilled;
    public Ellipses(Int16 _x0, Int16 _y0, Int16 _radius_x, Int16
    _radius_y, Color _argb, bool _isfilled)
    {
        this.x0 = _x0;
        this.y0 = _y0;
        this.radius_x = _radius_x;
        this.radius_y = _radius_y;
        this.argb = _argb;
        this.isfilled = _isfilled;
    }
}
public class RoundedRectangle
```

```
{
    public Int16 x0;
    public Int16 y0;
    public Int16 w;
    public Int16 h;
    public Int16 radius;
    public Color argb;
    public bool isfilled;
    public RoundedRectangle(Int16 _x0, Int16 _y0, Int16 _w, Int16 _h,
    Int16 _radius, Color _argb, bool _isfilled)
    {
        this.x0 = _x0;
        this.y0 = _y0;
        this.w = _w;
        this.h = _h;
        this.radius = _radius;
        this.argb = _argb;
        this.isfilled = _isfilled;
    }
}
public class Texts
{
    public Int16 x0;
    public Int16 y0;
    public Color argb;
    public Int16 fontSize;
    public string text;
    public Texts(Int16 _x0, Int16 _y0, Color _argb, Int16 _fontSize,
    string _text)
    {
        this.x0 = _x0;
        this.y0 = _y0;
        this.argb = _argb;
        this.fontSize = _fontSize;
        this.text = _text;
    }
}
/*public class TextLines : Texts
{
    public List<int[,]> symbols = new List<int[,]>();
    public TextLines(Int16 _x0, Int16 _y0, Color _argb, Int16 _fontSize,
    string _text)
    : base(_x0, _y0, _argb, _fontSize, _text)
    {
        Chars s = new Chars();
        short x = x0;
        foreach (var symbol in text)
        {
            symbols.Add(s.GetCharCoords(symbol, x, y0, fontSize));
            x = Convert.ToInt16(x + fontSize * 0.8);
        }
    }
}*/
public class Pictures
{
    public Int16 x0;
    public Int16 y0;
    public Int16 w;
```

```
            public Int16 h;
            public Color[,] argb;
            public Pictures(Int16 _x0, Int16 _y0, Int16 _w, Int16 _h, Color[,]
            _argb)
            {
                this.x0 = _x0;
                this.y0 = _y0;
                this.w = _w;
                this.h = _h;
                this.argb = _argb;
            }
        }
        //**********************RENDERING***********************
        protected override void OnPaint(PaintEventArgs e)
        {
            Graphics graphics = e.Graphics;
            graphics.SmoothingMode = SmoothingMode.HighQuality;
            graphics.InterpolationMode = InterpolationMode.HighQualityBicubic;
            graphics.TranslateTransform(this.Width / 2, this.Height / 2);
            graphics.RotateTransform(rotation);
            graphics.TranslateTransform(-this.Width / 2, -this.Height / 2);
            foreach (var pixel in pixels.ToArray())
            {
                graphics.FillRectangle(new SolidBrush(pixel.argb), pixel.x0 +
                this.Width / 2, pixel.y0 + this.Height / 2, 1, 1);
            }
            foreach (var line in lines.ToList())
            {
                graphics.DrawLine(new Pen(line.argb, penWidth), line.x0 +
                this.Width / 2, line.y0 + this.Height / 2, line.x1 + this.Width / 2,
line.y1 +
                this.Height / 2);
            }
            foreach (var rectangle in rectangles.ToList())
            {
                if (rectangle.isfilled)
                {
                    graphics.FillRectangle(new SolidBrush(rectangle.argb),
                    rectangle.x0 + this.Width / 2 - rectangle.w / 2, rectangle.y0 +
this.Height / 2 -
                    rectangle.h / 2, rectangle.w, rectangle.h);
        }
        else
        {
            graphics.DrawRectangle(new Pen(rectangle.argb, penWidth),
            rectangle.x0 + this.Width / 2 - rectangle.w / 2, rectangle.y0 +
this.Height / 2 -
            rectangle.h / 2, rectangle.w, rectangle.h);
        }
    }
    foreach (var ellipse in ellipses.ToList())
    {
        if (ellipse.isfilled)
        {
            graphics.FillEllipse(new SolidBrush(ellipse.argb), ellipse.x0
            + this.Width / 2 - ellipse.radius_x / 2, ellipse.y0 + this.Height / 2 -
            ellipse.radius_y / 2, ellipse.radius_x, ellipse.radius_y);
        }
```

```
        else
        {
            graphics.DrawEllipse(new Pen(ellipse.argb, penWidth),
            ellipse.x0 + this.Width / 2 - ellipse.radius_x / 2, ellipse.y0 +
this.Height / 2 -
            ellipse.radius_y / 2, ellipse.radius_x, ellipse.radius_y);
        }
    }
    foreach (var roundedRectangle in roundedRectangles.ToList())
    {
        if (roundedRectangle.isfilled)
        {
            graphics.FillPath(new SolidBrush(roundedRectangle.argb),
            RoundedRect(new Rectangle(roundedRectangle.x0 + this.Width / 2 -
            roundedRectangle.w / 2, roundedRectangle.y0 + this.Height / 2 -
roundedRectangle.h
            / 2, roundedRectangle.w, roundedRectangle.h), roundedRectangle.radius));
        }
        else
        {
            graphics.DrawPath(new Pen(roundedRectangle.argb, penWidth),
            RoundedRect(new Rectangle(roundedRectangle.x0 + this.Width / 2 -
            roundedRectangle.w / 2, roundedRectangle.y0 + this.Height / 2 -
roundedRectangle.h
            / 2, roundedRectangle.w, roundedRectangle.h), roundedRectangle.radius));
        }
    }
    foreach (var text in texts.ToList())
    {
        graphics.DrawString(text.text, new Font("Arial", text.fontSize),
        new SolidBrush(text.argb), text.x0 + this.Width / 2, text.y0 + this.Height /
2,
        new StringFormat());
    }
    foreach (var picture in pictures.ToList())
    {
        graphics.SmoothingMode = SmoothingMode.Default;
        Int16 x = picture.x0;
        Int16 y = picture.y0;
        for (int i = 0; i < picture.h; i++)
        {
            x = picture.x0;
            for (int j = 0; j < picture.w; j++)
            {
                graphics.FillRectangle(new SolidBrush(picture.argb[j, i]),
                x + this.Width / 2, y + this.Height / 2, 3, 3);
                x += 3;
            }
            y += 3;
        }
    }
}
//**********************RECEIVE MESSAGE**********************
private void ReceiveMessage()
{
    int port = 8080;
    CSCS1.Commands commands = new CSCS1.Commands();
    UdpClient receiver = new UdpClient(port);
```

```
    IPEndPoint remoteIp = new IPEndPoint(IPAddress.Any, 0);
    IPEndPoint iPEndPoint;
    byte commandNum;
    byte command;
    Int16 x0, y0;
    Int16 x1, y1;
    Int16 radius;
    string text;
    string hexcolor;
    Color argb;
    try
    {
        while (true)
        {
            byte[] data = receiver.Receive(ref remoteIp);
            commandNum = data[0];
            switch (commandNum)
            {
                case 1:
                    commands.ClearDisplayDecode(data, out command, out
                    hexcolor);
                    Console.WriteLine($"Recieved command: clear display; color: 0x{
hexcolor}; ");
            argb = ColorConvert(hexcolor);
                    DeleteAllGraphics();
                    this.BackColor = argb;
                    Invalidate();
                    break;
                case 2:
                    commands.PixelDecode(data, out command, out x0, out
                    y0, out hexcolor);
                    Console.WriteLine($"Recieved command: draw pixel; x: { x0}; y: {
y0}; color: 0x{ hexcolor}; ");
            argb = ColorConvert(hexcolor);
                    pixels.Add(new Pixels(x0, y0, argb));
                    Invalidate();
                    break;
                case 3:
                    commands.FourNumbersDecode(data, out command, out x0,
                    out y0, out x1, out y1, out hexcolor);
                    Console.WriteLine($"Recieved command: draw line; x0: { x0}; y0:
{ y0}; x1: { x1}; y1: { y1}; color: 0x{ hexcolor}; ");
            argb = ColorConvert(hexcolor);
                    lines.Add(new Lines(x0, y0, x1, y1, argb));
                    Invalidate();
                    break;
                case 4:
                    commands.FourNumbersDecode(data, out command, out x0,
                    out y0, out x1, out y1, out hexcolor);
                    Console.WriteLine($"Recieved command: draw rectangle; x: { x0};
y: { y0}; width: { x1}; height: { y1}; color: 0x{ hexcolor}; ");
            argb = ColorConvert(hexcolor);
                    rectangles.Add(new Rectangles(x0, y0, x1, y1, argb,
                    false));
                    Invalidate();
                    break;
                case 5:
                    commands.FourNumbersDecode(data, out command, out x0,
```

```
                    out y0, out x1, out y1, out hexcolor);
                    Console.WriteLine($"Recieved command: fill rectangle; x: { x0};
y: { y0}; width: { x1}; height: { y1}; color: 0x{ hexcolor}; ");
                argb = ColorConvert(hexcolor);
                    rectangles.Add(new Rectangles(x0, y0, x1, y1, argb,
                    true));
                    Invalidate();
                    break;
                case 6:
                    commands.FourNumbersDecode(data, out command, out x0,
                    out y0, out x1, out y1, out hexcolor);
                    Console.WriteLine($"Recieved command: draw ellipse; x: { x0}; y:
{ y0}; radius x: { x1}; radius y: { y1}; color: 0x{ hexcolor}; ");
                argb = ColorConvert(hexcolor);
                    ellipses.Add(new Ellipses(x0, y0, x1, y1, argb,
                    false));
                    Invalidate();
                    break;
                case 7:
                    commands.FourNumbersDecode(data, out command, out x0,
                 out y0, out x1, out y1, out hexcolor);
                    Console.WriteLine($"Recieved command: fill ellipse; x: { x0}; y:
{ y0}; radius x: { x1}; radius y: { y1}; color: 0x{ hexcolor}; ");
                argb = ColorConvert(hexcolor);
                    ellipses.Add(new Ellipses(x0, y0, x1, y1, argb,
                    true));
                    Invalidate();
                    break;
                case 8:
                    commands.CircleDecode(data, out command, out x0, out
                    y0, out radius, out hexcolor);
                    Console.WriteLine($"Recieved command: draw circle; x: { x0}; y:
{ y0}; radius: { radius}; color: 0x{ hexcolor}; ");
                argb = ColorConvert(hexcolor);
                    ellipses.Add(new Ellipses(x0, y0, radius, radius,
                    argb, false));
                    Invalidate();
                    break;
                case 9:
                    commands.CircleDecode(data, out command, out x0, out
                    y0, out radius, out hexcolor);
                    Console.WriteLine($"Recieved command: fill circle; x: { x0}; y:
{ y0}; radius: { radius}; color: 0x{ hexcolor}; ");
                argb = ColorConvert(hexcolor);
                    ellipses.Add(new Ellipses(x0, y0, radius, radius,
                    argb, true));
                    Invalidate();
                    break;
                case 10:
                    commands.RoundedRectDecode(data, out command, out x0,
                    out y0, out x1, out y1, out radius, out hexcolor);
                    Console.WriteLine($"Recieved command: draw rounded rectangle; x:
{ x0}; y: { y0}; width: { x1}; height: { y1}; radius: { radius}; color: 0x{
hexcolor}; ");
                argb = ColorConvert(hexcolor);
                    roundedRectangles.Add(new RoundedRectangle(x0, y0, x1,
                    y1, radius, argb, false));
                    Invalidate();
```

```
                    break;
                case 11:
                    commands.RoundedRectDecode(data, out command, out x0,
                    out y0, out x1, out y1, out radius, out hexcolor);
                    Console.WriteLine($"Recieved command: fill rounded rectangle; x:
{ x0}; y: { y0}; width: { x1}; height: { y1}; radius: { radius}; color: 0x{
hexcolor}; ");
            argb = ColorConvert(hexcolor);
                    roundedRectangles.Add(new RoundedRectangle(x0, y0, x1,
                    y1, radius, argb, true));
                    Invalidate();
                    break;
                case 12:
                            commands.TextDecode(data, out command, out x0, out y0,
                            out hexcolor, out x1, out y1, out text);
                            Console.WriteLine($"Recieved command: draw text; x: {
x0}; y: { y0}; color: 0x{ hexcolor}; font number: { x1}; length: { y1}; text:{
text}; ");
                    argb = ColorConvert(hexcolor);
                            texts.Add(new Texts(x0, y0, argb, x1, text));
                            Invalidate();
                            break;
                        case 13:
                            commands.ImageDecode(data, out command, out x0, out
                            y0, out x1, out y1, out Color[,] colors);
                            Console.WriteLine($"Recieved command: draw image; x: {
x0}; y: { y0}; width: { x1}; height: { y1}; colors: ");
                    pictures.Add(new Pictures(x0, y0, x1, y1, colors));
Invalidate();
                            break;
                        case 14:
                            rotation =
                            BitConverter.ToInt16(data.Skip(1).Take(2).ToArray(), 0);
                            Console.WriteLine($"Recieved command: set orientation;
rotation angle: { rotation}; ");
                    Invalidate();
                            break;
                        case 15:
                            data =
                            BitConverter.GetBytes(Convert.ToInt16(this.Width));
                            Console.WriteLine($"Recieved command: get width;");
                            iPEndPoint = new IPEndPoint(remoteIp.Address,
                            remoteIp.Port);
                            receiver.Send(data, data.Length, iPEndPoint);
                            break;
                        case 16:
                            data =
                            BitConverter.GetBytes(Convert.ToInt16(this.Height));
                            Console.WriteLine($"Recieved command: get height;");
                            iPEndPoint = new IPEndPoint(remoteIp.Address,
                            remoteIp.Port);
                            receiver.Send(data, data.Length, iPEndPoint);
                            break;
                        case 17:
                            penWidth =
                            BitConverter.ToInt16(data.Skip(1).Take(2).ToArray(), 0);
                            Console.WriteLine($"Recieved command: set pen width;
width: { penWidth}; ");
```

```
            Invalidate();
                    break;
                }
            }
        }
        catch (Exception ex)
        {
            Console.WriteLine(ex.Message);
            Console.ReadLine();
        }
        finally
        {
            receiver.Close();
        }
    }
    //**********************SECONDARY FUNCTIONS**********************
    static void DeleteAllGraphics()
    {
        pixels.Clear();
        lines.Clear();
        rectangles.Clear();
        ellipses.Clear();
        roundedRectangles.Clear();
        texts.Clear();
        pictures.Clear();
    }
    static public Color ColorConvert(string hexcolor)
    {
        Int16 color = Convert.ToInt16(hexcolor, 16);
        string bits = Convert.ToString(color, 2).PadLeft(16, '0');
        int R = Convert.ToInt32(bits.Substring(0, 5).PadRight(8, '0'), 2);
        int G = Convert.ToInt32(bits.Substring(5, 6).PadRight(8, '0'), 2);
        int B = Convert.ToInt32(bits.Substring(11, 5).PadRight(8, '0'), 2);
        return Color.FromArgb(R, G, B);
    }
    public static GraphicsPath RoundedRect(Rectangle bounds, int radius)
    {
        int diameter = radius * 2;
        Size size = new Size(diameter, diameter);
        Rectangle arc = new Rectangle(bounds.Location, size);
        GraphicsPath path = new GraphicsPath();
        if (radius == 0)
        {
            path.AddRectangle(bounds);
            return path;
        }
        // top left arc
        path.AddArc(arc, 180, 90);
        // top right arc
        arc.X = bounds.Right - diameter;
        path.AddArc(arc, 270, 90);
        // bottom right arc
        arc.Y = bounds.Bottom - diameter;
        path.AddArc(arc, 0, 90);
        // bottom left arc
        arc.X = bounds.Left;
        path.AddArc(arc, 90, 90);
        path.CloseFigure();
```

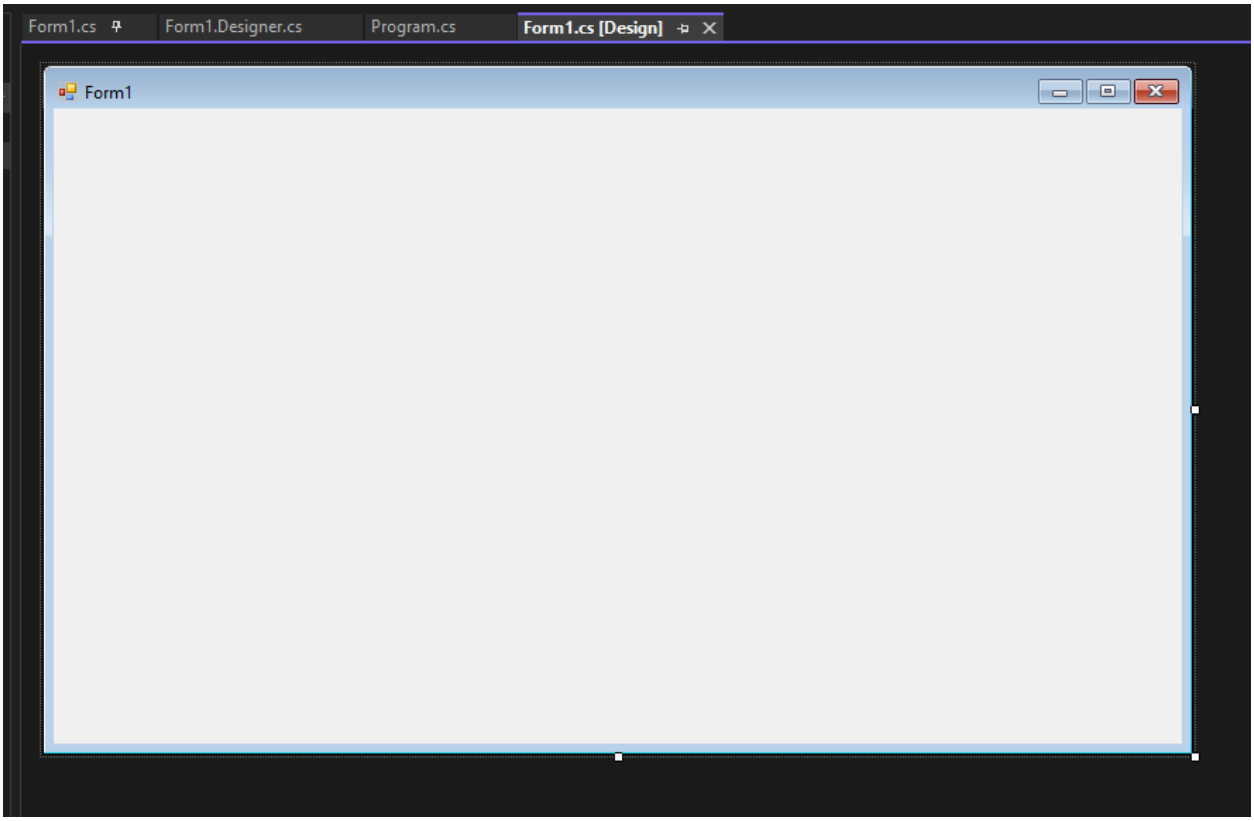
```
            return path;
        }
        private void Form1_Resize(object sender, EventArgs e)
        {
            Invalidate();
        }
        private void Form1_Load(object sender, EventArgs e)
        { }
    }
}
```

Form1.Designer.cs:

```
namespace CSCS2_Forms
{
    partial class Form1
    {
        /// <summary>
        /// Обязательная переменная конструктора.
        /// </summary>
        private System.ComponentModel.IContainer components = null;

        /// <summary>
        /// Освободить все используемые ресурсы.
        /// </summary>
        /// <param name="disposing">истинно, если управляемый ресурс должен быть
удален; иначе ложно.</param>
        protected override void Dispose(bool disposing)
        {
            if (disposing && (components != null))
            {
                components.Dispose();
            }
            base.Dispose(disposing);
        }

        #region Код, автоматически созданный конструктором форм Windows

        /// <summary>
        /// Требуемый метод для поддержки конструктора — не изменяйте
        /// содержимое этого метода с помощью редактора кода.
        /// </summary>
        private void InitializeComponent()
        {
            this.components = new System.ComponentModel.Container();
            this.AutoScaleMode = System.Windows.Forms.AutoScaleMode.Font;
            this.ClientSize = new System.Drawing.Size(800, 450);
            this.Text = "Form1";
        }

        #endregion
    }
}
```

Program.cs:

```
using CSCS2_Forms;
using System;
using System.Collections.Generic;
using System.Linq;
using System.Threading.Tasks;
using System.Windows.Forms;

namespace ServerApp
{
    internal static class Program
    {
        /// <summary>
        /// Главная точка входа для приложения.
        /// </summary>
        [STAThread]
        static void Main()
        {
            Application.EnableVisualStyles();
            Application.SetCompatibleTextRenderingDefault(false);
            Application.Run(new Form1());
        }
    }
}
```



Лістинг клієнта:

Program.cs:

```
using System;
using System.Linq;
using System.Net;
using System.Net.Sockets;
using System.IO;
namespace CSCS1
{
    class SendProgram
    {
        static void Main(string[] args)
        {
            SendMessage();
        }
        private static void SendMessage()
        {
            string remoteAddress = "127.0.0.1";
            int port = 8080;
            Commands commands = new Commands();
            UdpClient sender = new UdpClient(0);
            IPEndPoint endPoint = new IPEndPoint(IPAddress.Parse(remoteAddress),
            port);
            Int16 x0, y0;
            Int16 x1, y1;
            Int16 radius;
            string text;
            string hexcolor;
            try
            {
                Console.WriteLine("Type 'help' or '?' for command list");
                while (true)
                {
                    Console.Write("Enter command > ");
                    string commandText = Console.ReadLine();
                    byte[] commandbyte = new byte[1];
                    byte[] result = new byte[1] { 0 };
                    switch (commandText)
                    {
                        case "1":
                        case "clear display":
                            commandbyte[0] = 1;
                            hexcolor = ReadHexColor();
                            result = commands.ClearDisplayEncode(commandbyte[0],
                            hexcolor);
                            sender.Send(result, result.Length, endPoint);
                            break;
                        case "2":
                        case "draw pixel":
                            commandbyte[0] = 2;
                            x0 = ReadNumber("x", false);
                            y0 = ReadNumber("y", false);
                            hexcolor = ReadHexColor();
                            result = commands.PixelEncode(commandbyte[0], x0, y0,
```

```
            hexcolor);
            sender.Send(result, result.Length, endPoint);
            break;
        case "3":
        case "draw line":
            commandbyte[0] = 3;
            x0 = ReadNumber("x0", false);
            y0 = ReadNumber("y0", false);
            x1 = ReadNumber("x1", false);
            y1 = ReadNumber("y1", false);
            hexcolor = ReadHexColor();
            result = commands.FourNumbersEncode(commandbyte[0],
            x0, y0, x1, y1, hexcolor);
            sender.Send(result, result.Length, endPoint);
            break;
        case "4":
        case "draw rectangle":
            commandbyte[0] = 4; x0 = ReadNumber("x", false);
            y0 = ReadNumber("y", false);
            x1 = ReadNumber("width", true);
            y1 = ReadNumber("height", true);
            hexcolor = ReadHexColor();
            result = commands.FourNumbersEncode(commandbyte[0],
            x0, y0, x1, y1, hexcolor);
            sender.Send(result, result.Length, endPoint);
            break;
        case "5":
        case "fill rectangle":
            commandbyte[0] = 5;
            x0 = ReadNumber("x", false);
            y0 = ReadNumber("y", false);
            x1 = ReadNumber("width", true);
            y1 = ReadNumber("height", true);
            hexcolor = ReadHexColor();
            result = commands.FourNumbersEncode(commandbyte[0],
            x0, y0, x1, y1, hexcolor);
            sender.Send(result, result.Length, endPoint);
            break;
        case "6":
        case "draw ellipse":
            commandbyte[0] = 6;
            x0 = ReadNumber("x", false);
            y0 = ReadNumber("y", false);
            x1 = ReadNumber("radius x", true);
            y1 = ReadNumber("radius y", true);
            hexcolor = ReadHexColor();
            result = commands.FourNumbersEncode(commandbyte[0],
            x0, y0, x1, y1, hexcolor);
            sender.Send(result, result.Length, endPoint);
            break;
        case "7":
        case "fill ellipse":
            commandbyte[0] = 7;
            x0 = ReadNumber("x", false);
            y0 = ReadNumber("y", false);
            x1 = ReadNumber("radius x", true);
            y1 = ReadNumber("radius y", true);
            hexcolor = ReadHexColor();
```

```
                result = commands.FourNumbersEncode(commandbyte[0],
                x0, y0, x1, y1, hexcolor);
                sender.Send(result, result.Length, endPoint);
                break;
            case "8":
            case "draw circle":
                commandbyte[0] = 8;
                x0 = ReadNumber("x", false);
                y0 = ReadNumber("y", false);
                radius = ReadNumber("radius", true);
                hexcolor = ReadHexColor();
                result = commands.CircleEncode(commandbyte[0], x0, y0,
                radius, hexcolor);
                sender.Send(result, result.Length, endPoint);
                break;
            case "9":
            case "fill circle":
                commandbyte[0] = 9;
                x0 = ReadNumber("x", false);
                y0 = ReadNumber("y", false);
                radius = ReadNumber("radius", true);
                hexcolor = ReadHexColor();
                result = commands.CircleEncode(commandbyte[0], x0, y0,
                radius, hexcolor);
                sender.Send(result, result.Length, endPoint);
                break;
            case "10":
            case "draw rounded rectangle":
                commandbyte[0] = 10;
                x0 = ReadNumber("x", false);
                y0 = ReadNumber("y", false);
                x1 = ReadNumber("width", true);
                y1 = ReadNumber("height", true);
                radius = ReadNumber("radius", true);
                hexcolor = ReadHexColor();
                result = commands.RoundedRectEncode(commandbyte[0],
                x0, y0, x1, y1, radius, hexcolor);
                sender.Send(result, result.Length, endPoint);
                break;
            case "11":
            case "fill rounded rectangle":
                commandbyte[0] = 11;
                x0 = ReadNumber("x", false);
                y0 = ReadNumber("y", false);
                x1 = ReadNumber("width", true);
                y1 = ReadNumber("height", true);
                radius = ReadNumber("radius", true);
                hexcolor = ReadHexColor();
                result = commands.RoundedRectEncode(commandbyte[0],
                x0, y0, x1, y1, radius, hexcolor);
                sender.Send(result, result.Length, endPoint);
                break;
            case "12":
            case "draw text":
                commandbyte[0] = 12;
                x0 = ReadNumber("x", false);
                y0 = ReadNumber("y", false);
                hexcolor = ReadHexColor();
```

```
                            x1 = ReadNumber("font number", true);
                            Console.Write("Enter text > ");
                            text = Console.ReadLine();
                            y1 = Convert.ToInt16(text.Length);
                            result = commands.TextEncode(commandbyte[0], x0, y0,
                            hexcolor, x1, y1, text);
                            sender.Send(result, result.Length, endPoint);
                            break;
                        case "13":
                        case "draw image":
                            commandbyte[0] = 13;
                            x0 = ReadNumber("x", false);
                            y0 = ReadNumber("y", false);
                            x1 = ReadNumber("width", true);
                            y1 = ReadNumber("height", true);
                            text = ReadPath(); result =
commands.ImageEncode(commandbyte[0], x0, y0,
                             x1, y1, text);
                            sender.Send(result, result.Length, endPoint);
                            break;
                        case "14":
                        case "set orientation":
                            commandbyte[0] = 14;
                            x0 = ReadNumber("rotation angle", false);
                            result =
                            commandbyte.Concat(BitConverter.GetBytes(x0)).ToArray();
                            sender.Send(result, result.Length, endPoint);
                            break;
                        case "15":
                        case "get width":
                            commandbyte[0] = 15;
                            sender.Send(commandbyte, commandbyte.Length,
                            endPoint);
                            RecieveMessage(sender, endPoint);
                            break;
                        case "16":
                        case "get height":
                            commandbyte[0] = 16;
                            sender.Send(commandbyte, commandbyte.Length,
                            endPoint);
                            RecieveMessage(sender, endPoint);
                            break;
                        case "17":
                        case "set pen width":
                            commandbyte[0] = 17;
                            x0 = ReadNumber("width", true);
                            result =
                            commandbyte.Concat(BitConverter.GetBytes(x0)).ToArray();
                            sender.Send(result, result.Length, endPoint);
                            break;
                        case "help":
                        case "?":
                            Console.WriteLine("\nCommands:");
                            Console.ForegroundColor = ConsoleColor.Green;
                            Console.WriteLine(" 1. clear display");
                            Console.WriteLine(" 2. draw pixel");
                            Console.WriteLine(" 3. draw line");
                            Console.WriteLine(" 4. draw rectangle");
```

```
                            Console.WriteLine(" 5. fill rectangle");
                            Console.WriteLine(" 6. draw ellipse");
                            Console.WriteLine(" 7. fill ellipse");
                            Console.WriteLine(" 8. draw circle");
                            Console.WriteLine(" 9. fill circle");
                            Console.WriteLine(" 10. draw rounded rectangle");
                            Console.WriteLine(" 11. fill rounded rectangle");
                            Console.WriteLine(" 12. draw text");
                            Console.WriteLine(" 13. draw image");
                            Console.WriteLine(" 14. set orientation");
                            Console.WriteLine(" 15. get width");
                            Console.WriteLine(" 16. get height");
                            Console.ResetColor();
                            break;
                        default:
                            Console.ForegroundColor = ConsoleColor.Red;
Console.WriteLine("Error! Unknown operation! Tryagain.");
                             Console.ResetColor();
                            break;
                    }
                    Console.WriteLine();
                }
            }
            catch (Exception ex)
            {
                Console.WriteLine(ex.Message);
                Console.ReadLine();
            }
            finally
            {
                sender.Close();
            }
        }
        public static bool IsStringInHex(string text)
        {
            return System.Text.RegularExpressions.Regex.IsMatch(text, @"\A\b[0-9afA-
F]+\b\Z");
        }
        private static string ReadHexColor()
        {
            string str;
            while (true)
            {
                Console.Write("Enter RGB565 color > ");
                str = Console.ReadLine();
                if (IsStringInHex(str) && str.Length <= 4)
                {
                    break;
                }
                else
                {
                    Console.ForegroundColor = ConsoleColor.Red;
                    Console.WriteLine("Error! Data is not hexadecimal! Try again.");
                    Console.ResetColor();
                }
            }
            return str;
        }
```

```
        private static Int16 ReadNumber(string text, bool onlyPositive = false)
        {
            string str;
            Int16 number;
            while (true)
            {
                Console.Write($"Enter {text} > ");
                str = Console.ReadLine();
                try
                {
                    number = Int16.Parse(str);
                    if (onlyPositive)
                    {
                        if (number < 0)
                        {
                            Console.ForegroundColor = ConsoleColor.Red;
                            Console.WriteLine("Error! Bad data! (range 0 to 32767)
Try again.");Console.ResetColor();
                        }
                        else { break; }
                    }
                    else { break; }
                }
                catch
                {
                    Console.ForegroundColor = ConsoleColor.Red;
                    Console.WriteLine("Error! Bad data! (range -32768 to 32767) Try
again.");
                    Console.ResetColor();
                }
            }
            return Convert.ToInt16(str);
        }
        private static string ReadPath()
        {
            string str;
            while (true)
            {
                Console.Write("Enter path > ");
                str = Console.ReadLine();
                if (File.Exists(str) && IsImage(str))
                {
                    break;
                }
                else
                {
                    Console.ForegroundColor = ConsoleColor.Red;
                    Console.WriteLine("Error! File does not exist! Try again.");
                    Console.ResetColor();
                }
            }
            return @"" + str;
        }
        public static bool IsImage(string path)
        {
            return System.Text.RegularExpressions.Regex.IsMatch(path,
            @"^.*\.(jpg|JPG|gif|GIF|png|PNG)$");
        }
```

```
        public static void RecieveMessage(UdpClient sender, IPEndPoint endPoint)
        {
            byte[] data = sender.Receive(ref endPoint);
            Console.WriteLine($"Recieved value: {BitConverter.ToInt16(data, 0)}");
        }
    }
}
```

MyCommands.cs:

```
using System;
using System.Drawing;
using System.Linq;
using System.Text;
namespace CSCS1
{
    public class Commands
    {
        //************ClearDisplay************
        public byte[] ClearDisplayEncode(byte command, string hexcolor)
        {
            byte[] commandbyte = { command };
            Int16 color = Convert.ToInt16(hexcolor, 16);
            return commandbyte.Concat(BitConverter.GetBytes(color)).ToArray();
        }
        public void ClearDisplayDecode(byte[] result, out byte command, out string
        hexcolor)
        {
            command = result[0];
            hexcolor = ByteToHexColor(result, 1);
        }
        //************Pixel************
        public byte[] PixelEncode(byte command, Int16 x0, Int16 y0, string
        hexcolor)
        {
            byte[] commandbyte = { command };
            Int16 color = Convert.ToInt16(hexcolor, 16);
            return

commandbyte.Concat(BitConverter.GetBytes(x0)).Concat(BitConverter.GetBytes(y0)).Conc
at(BitConverter.GetBytes(color)).ToArray();
        }
        public void PixelDecode(byte[] result, out byte command, out Int16 x0, out
        Int16 y0, out string hexcolor)
        {
            command = result[0];
            x0 = BitConverter.ToInt16(result, 1);
            y0 = BitConverter.ToInt16(result, 3);
            hexcolor = ByteToHexColor(result, 5);
        }
        //************FourNumbers************
        public byte[] FourNumbersEncode(byte command, Int16 x0, Int16 y0, Int16
        x1, Int16 y1, string hexcolor)
        {
            byte[] commandbyte = { command };
            Int16 color = Convert.ToInt16(hexcolor, 16);
            return
```

```
commandbyte.Concat(BitConverter.GetBytes(x0)).Concat(BitConverter.GetBytes(y0)).Conc
at(BitConverter.GetBytes(x1)).Concat(BitConverter.GetBytes(y1)).Concat(BitConverter.
GetBytes(color)).ToArray();
        }
        public void FourNumbersDecode(byte[] result, out byte command, out Int16
        x0, out Int16 y0, out Int16 x1, out Int16 y1, out string hexcolor)
        {
            command = result[0];
            x0 = BitConverter.ToInt16(result, 1);
            y0 = BitConverter.ToInt16(result, 3);
            x1 = BitConverter.ToInt16(result, 5);
            y1 = BitConverter.ToInt16(result, 7);
            hexcolor = ByteToHexColor(result, 9);
        }
        //************Circle************
        public byte[] CircleEncode(byte command, Int16 x0, Int16 y0, Int16 radius,
        string hexcolor)
        {
            byte[] commandbyte = { command };
            Int16 color = Convert.ToInt16(hexcolor, 16);
            return

commandbyte.Concat(BitConverter.GetBytes(x0)).Concat(BitConverter.GetBytes(y0)).Conc
at(BitConverter.GetBytes(radius)).Concat(BitConverter.GetBytes(color)).ToArray()
        ;
        }
        public void CircleDecode(byte[] result, out byte command, out Int16 x0,
        out Int16 y0, out Int16 radius, out string hexcolor)
        {
            command = result[0];
            x0 = BitConverter.ToInt16(result, 1);
            y0 = BitConverter.ToInt16(result, 3);
            radius = BitConverter.ToInt16(result, 5);
            hexcolor = ByteToHexColor(result, 7);
        }
        //************RoundedRect************
        public byte[] RoundedRectEncode(byte command, Int16 x0, Int16 y0, Int16
        x1, Int16 y1, Int16 radius, string hexcolor)
        {
            byte[] commandbyte = { command };
            Int16 color = Convert.ToInt16(hexcolor, 16);
            return

commandbyte.Concat(BitConverter.GetBytes(x0)).Concat(BitConverter.GetBytes(y0)).Conc
at(BitConverter.GetBytes(x1)).Concat(BitConverter.GetBytes(y1)).Concat(BitConverter.
GetBytes(radius)).Concat(BitConverter.GetBytes(color)).ToArray();
        }
        public void RoundedRectDecode(byte[] result, out byte command, out Int16
       x0, out Int16 y0, out Int16 x1, out Int16 y1, out Int16 radius, out string
       hexcolor)
        {
            command = result[0];
            x0 = BitConverter.ToInt16(result, 1);
            y0 = BitConverter.ToInt16(result, 3);
            x1 = BitConverter.ToInt16(result, 5);
            y1 = BitConverter.ToInt16(result, 7);
            radius = BitConverter.ToInt16(result, 9);
```

```
            hexcolor = ByteToHexColor(result, 11);
        }
        //************Text************
        public byte[] TextEncode(byte command, Int16 x0, Int16 y0, string
        hexcolor, Int16 x1, Int16 y1, string text)
        {
            byte[] commandbyte = { command };
            Int16 color = Convert.ToInt16(hexcolor, 16);
            return

commandbyte.Concat(BitConverter.GetBytes(x0)).Concat(BitConverter.GetBytes(y0)).Conc
at(BitConverter.GetBytes(color)).Concat(BitConverter.GetBytes(x1)).Concat(BitConvert
er.GetBytes(y1)).Concat(Encoding.Unicode.GetBytes(text)).ToArray();
        }
        public void TextDecode(byte[] result, out byte command, out Int16 x0, out
        Int16 y0, out string hexcolor, out Int16 x1, out Int16 y1, out string text)
        {
            command = result[0];
            x0 = BitConverter.ToInt16(result, 1);
            y0 = BitConverter.ToInt16(result, 3);
            hexcolor = ByteToHexColor(result, 5);
            x1 = BitConverter.ToInt16(result, 7);
            y1 = BitConverter.ToInt16(result, 9);
            text = Encoding.Unicode.GetString(result.Skip(11).Take(y1 *
            2).ToArray());
        }
        //************Image************
        public byte[] ImageEncode(byte command, Int16 x0, Int16 y0, Int16 x1,
        Int16 y1, string data)
        {
            byte[] commandbyte = { command };
            Color[] colors = ColorsEncode(new Bitmap(data, true), x1, y1);
            byte[] byteColors = ColorsToByte(colors);
            return

commandbyte.Concat(BitConverter.GetBytes(x0)).Concat(BitConverter.GetBytes(y0)).Conc
at(BitConverter.GetBytes(x1)).Concat(BitConverter.GetBytes(y1)).Concat(byteColors).T
oArray();
        }
        public void ImageDecode(byte[] result, out byte command, out Int16 x0, out
        Int16 y0, out Int16 x1, out Int16 y1, out Color[,] colors)
        {
            command = result[0];
            x0 = BitConverter.ToInt16(result, 1);
            y0 = BitConverter.ToInt16(result, 3);
            x1 = BitConverter.ToInt16(result, 5);
            y1 = BitConverter.ToInt16(result, 7);
            colors = ByteToColors(result.Skip(9).Take(x1 * y1 * 4).ToArray(), x1,
            y1);
        }
        //**********************SECONDARY FUNCTIONS**********************
        public static string ByteToHexColor(byte[] value, int startIndex)
        {
            Int16 color = BitConverter.ToInt16(value, startIndex);
            return color.ToString("X");
        }
        public static Color[] ColorsEncode(Bitmap source, Int16 w, Int16 h)
        {
```

```
            Bitmap bmp = new Bitmap(source, w, h); Color[] result = new Color[w *
h];
            int counter = 0;
            for (int i = 0; i < h; i++)
            {
                for (int j = 0; j < w; j++)
                {
                    result[counter] = bmp.GetPixel(j, i);
                    counter++;
                }
            }
            return result;
        }
        public static byte[] ColorsToByte(Color[] colors)
        {
            int length = colors.Length;
            byte[] result = new byte[0];
            byte[] Combine(byte[] first, byte[] second)
            {
                byte[] ret = new byte[first.Length + second.Length];
                Buffer.BlockCopy(first, 0, ret, 0, first.Length);
                Buffer.BlockCopy(second, 0, ret, first.Length, second.Length);
                return ret;
            }
            for (int i = 0; i < length; i++)
            {
                result = Combine(result,
                BitConverter.GetBytes(colors[i].ToArgb()));
            }
            return result;
        }
        public static Color[,] ByteToColors(byte[] byteColors, Int16 w, Int16 h)
        {
            Color[,] result = new Color[w, h];
            int counter = 0;
            for (int i = 0; i < h; i++)
            {
                for (int j = 0; j < w; j++)
                {
                    result[j, i] = Color.FromArgb(BitConverter.ToInt32(byteColors,
                    4 * counter));
                    counter++;
                }
            }
            return result;
        }
    }
}
```

Unit Test:

```
using Microsoft.VisualStudio.TestTools.UnitTesting;
using System;
namespace CSCS1
{
    [TestClass]
    public class UnitTest1
    {
        Commands command = new Commands();
        [TestMethod]
        public void Command1Test1()
        {
            /***** Encode *****/
            // Arrange
            byte commandNum = 1;
            string hexcolor = "59FF";
            byte[] resultExpect = { 1, 255, 89 };
            // Act
            byte[] result = command.ClearDisplayEncode(commandNum, hexcolor);
            // Assert
            CollectionAssert.AreEqual(resultExpect, result);
            /***** Decode *****/
            // Arrange
            byte[] message = { 1, 68, 236 };
            string hexcolorExpect = "EC44";
            byte commandExpect = 1;
            // Act
            command.ClearDisplayDecode(message, out byte commandResult, out string
            hexcolorResult);
            // Assert
            Assert.AreEqual(commandExpect, commandResult);
            Assert.AreEqual(hexcolorExpect, hexcolorResult);
        }
        [TestMethod]
        public void Command1Test2()
        {
            /***** Decode *****/
            // Arrange
            byte[] messageEmpty = { };
            string hexcolorExpect = "EC44";
            byte commandExpect = 1;
            // Act
            command.ClearDisplayDecode(messageEmpty, out byte commandResultEmpty,
            out string hexcolorResultEmpty);
            // Assert
            Assert.AreEqual(commandExpect, commandResultEmpty);
            Assert.AreEqual(hexcolorExpect, hexcolorResultEmpty);
        }
        [TestMethod]
        public void Command1Test3()
        {
            /***** Decode *****/
            // Arrange
            byte[] messageShort = { 1, 68 };
            string hexcolorExpect = "EC44";
            byte commandExpect = 1;
```

```
            // Act
            command.ClearDisplayDecode(messageShort, out byte commandResultShort,
            out string hexcolorResultShort);
            // Assert
            Assert.AreEqual(commandExpect, commandResultShort);
            Assert.AreEqual(hexcolorExpect, hexcolorResultShort);
        }
        [TestMethod]
        public void Command1Test4()
        {
            /***** Decode *****/
            // Arrange
            byte[] messageLong = { 1, 68, 236, 20, 8 };
            string hexcolorExpect = "EC44";
            byte commandExpect = 1;
            // Act
            command.ClearDisplayDecode(messageLong, out byte commandResultLong,
            out string hexcolorResultLong);
            // Assert
            Assert.AreEqual(commandExpect, commandResultLong);
            Assert.AreEqual(hexcolorExpect, hexcolorResultLong);
        }
        [TestMethod]
        public void Command2Test1()
        {
            /***** Encode *****/
            // Arrange
            byte commandNum = 2;
            Int16 x0 = 50;
            Int16 y0 = 35;
            string hexcolor = "1D6C";
            byte[] resultExpect = { 2, 50, 0, 35, 0, 108, 29 };
            // Act
            byte[] result = command.PixelEncode(commandNum, x0, y0, hexcolor);
            // Assert
            CollectionAssert.AreEqual(resultExpect, result);
            /***** Decode *****/
            // Arrange
            byte[] message = { 2, 12, 0, 20, 0, 233, 215 };
            byte commandExpect = 2;
            Int16 x0Expect = 12;
            Int16 y0Expect = 20;
            string hexcolorExpect = "D7E9";
            // Act
            command.PixelDecode(message, out byte commandResult, out Int16
            x0Result, out Int16 y0Result, out string hexcolorResult);
            // Assert
            Assert.AreEqual(commandExpect, commandResult); Assert.AreEqual(x0Expect,
x0Result);
            Assert.AreEqual(y0Expect, y0Result);
            Assert.AreEqual(hexcolorExpect, hexcolorResult);
        }
        [TestMethod]
        public void Command2Test2()
        {
            /***** Decode *****/
            // Arrange
            byte[] messageEmpty = { };
```

```
            byte commandExpect = 2;
            Int16 x0Expect = 12;
            Int16 y0Expect = 20;
            string hexcolorExpect = "D7E9";
            // Act
            command.PixelDecode(messageEmpty, out byte commandResultEmpty, out
            Int16 x0ResultEmpty, out Int16 y0ResultEmpty, out string
hexcolorResultEmpty);
            // Assert
            Assert.AreEqual(commandExpect, commandResultEmpty);
            Assert.AreEqual(x0Expect, x0ResultEmpty);
            Assert.AreEqual(y0Expect, y0ResultEmpty);
            Assert.AreEqual(hexcolorExpect, hexcolorResultEmpty);
        }
        [TestMethod]
        public void Command2Test3()
        {
            /***** Decode *****/
            // Arrange
            byte[] messageShort = { 2, 12, 0 };
            byte commandExpect = 2;
            Int16 x0Expect = 12;
            Int16 y0Expect = 20;
            string hexcolorExpect = "D7E9";
            // Act
            command.PixelDecode(messageShort, out byte commandResultShort, out
            Int16 x0ResultShort, out Int16 y0ResultShort, out string
hexcolorResultShort);
            // Assert
            Assert.AreEqual(commandExpect, commandResultShort);
            Assert.AreEqual(x0Expect, x0ResultShort);
            Assert.AreEqual(y0Expect, y0ResultShort);
            Assert.AreEqual(hexcolorExpect, hexcolorResultShort);
        }
        [TestMethod]
        public void Command2Test4()
        {
            /***** Decode *****/
            // Arrange
            byte[] messageLong = { 2, 12, 0, 20, 0, 233, 215, 24, 45 };
            byte commandExpect = 2;
            Int16 x0Expect = 12;
            Int16 y0Expect = 20;
            string hexcolorExpect = "D7E9";
            // Act
            command.PixelDecode(messageLong, out byte commandResultLong, out Int16
            x0ResultLong, out Int16 y0ResultLong, out string hexcolorResultLong);
            // Assert
            Assert.AreEqual(commandExpect, commandResultLong);
            Assert.AreEqual(x0Expect, x0ResultLong); Assert.AreEqual(y0Expect,
y0ResultLong);
            Assert.AreEqual(hexcolorExpect, hexcolorResultLong);
        }
        [TestMethod]
        public void Command3Test1()
        {
            /***** Encode *****/
            // Arrange
```

```
            byte commandNum = 3;
            Int16 x0 = 40;
            Int16 y0 = 31;
            Int16 x1 = 62;
            Int16 y1 = 39;
            string hexcolor = "2A28";
            byte[] resultExpect = { 3, 40, 0, 31, 0, 62, 0, 39, 0, 40, 42 };
            // Act
            byte[] result = command.FourNumbersEncode(commandNum, x0, y0, x1, y1,
            hexcolor);
            // Assert
            CollectionAssert.AreEqual(resultExpect, result);
            /***** Decode *****/
            // Arrange
            byte[] message = { 3, 42, 0, 55, 0, 34, 0, 75, 0, 232, 40 };
            byte commandExpect = 3;
            Int16 x0Expect = 42;
            Int16 y0Expect = 55;
            Int16 x1Expect = 34;
            Int16 y1Expect = 75;
            string hexcolorExpect = "28E8";
            // Act
            command.FourNumbersDecode(message, out byte commandResult, out Int16
            x0Result, out Int16 y0Result, out Int16 x1Result, out Int16 y1Result,
out string
            hexcolorResult);
            // Assert
            Assert.AreEqual(commandExpect, commandResult);
            Assert.AreEqual(x0Expect, x0Result);
            Assert.AreEqual(y0Expect, y0Result);
            Assert.AreEqual(x1Expect, x1Result);
            Assert.AreEqual(y1Expect, y1Result);
            Assert.AreEqual(hexcolorExpect, hexcolorResult);
        }
        [TestMethod]
        public void Command3Test2()
        {
            /***** Decode *****/
            // Arrange
            byte[] messageEmpty = { };
            byte commandExpect = 3;
            Int16 x0Expect = 42;
            Int16 y0Expect = 55;
            Int16 x1Expect = 34;
            Int16 y1Expect = 75;
            string hexcolorExpect = "28E8";
            // Act
            command.FourNumbersDecode(messageEmpty, out byte commandResultEmpty,
            out Int16 x0ResultEmpty, out Int16 y0ResultEmpty, out Int16
x1ResultEmpty, out
            Int16 y1ResultEmpty, out string hexcolorResultEmpty);// Assert
            Assert.AreEqual(commandExpect, commandResultEmpty);
            Assert.AreEqual(x0Expect, x0ResultEmpty);
            Assert.AreEqual(y0Expect, y0ResultEmpty);
            Assert.AreEqual(x1Expect, x1ResultEmpty);
            Assert.AreEqual(y1Expect, y1ResultEmpty);
            Assert.AreEqual(hexcolorExpect, hexcolorResultEmpty);
        }
```

```
        [TestMethod]
        public void Command3Test3()
        {
            /***** Decode *****/
            // Arrange
            byte[] messageShort = { 3, 42, 0, 55, 0, 34 };
            byte commandExpect = 3;
            Int16 x0Expect = 42;
            Int16 y0Expect = 55;
            Int16 x1Expect = 34;
            Int16 y1Expect = 75;
            string hexcolorExpect = "28E8";
            // Act
            command.FourNumbersDecode(messageShort, out byte commandResultShort,
            out Int16 x0ResultShort, out Int16 y0ResultShort, out Int16
x1ResultShort, out
            Int16 y1ResultShort, out string hexcolorResultShort);
            // Assert
            Assert.AreEqual(commandExpect, commandResultShort);
            Assert.AreEqual(x0Expect, x0ResultShort);
            Assert.AreEqual(y0Expect, y0ResultShort);
            Assert.AreEqual(x1Expect, x1ResultShort);
            Assert.AreEqual(y1Expect, y1ResultShort);
            Assert.AreEqual(hexcolorExpect, hexcolorResultShort);
        }
        [TestMethod]
        public void Command3Test4()
        {
            /***** Decode *****/
            // Arrange
            byte[] messageLong = { 3, 42, 0, 55, 0, 34, 0, 75, 0, 232, 40, 84, 22
};
            byte commandExpect = 3;
            Int16 x0Expect = 42;
            Int16 y0Expect = 55;
            Int16 x1Expect = 34;
            Int16 y1Expect = 75;
            string hexcolorExpect = "28E8";
            // Act
            command.FourNumbersDecode(messageLong, out byte commandResultLong, out
            Int16 x0ResultLong, out Int16 y0ResultLong, out Int16 x1ResultLong, out
Int16
            y1ResultLong, out string hexcolorResultLong);
            // Assert
            Assert.AreEqual(commandExpect, commandResultLong);
            Assert.AreEqual(x0Expect, x0ResultLong);
            Assert.AreEqual(y0Expect, y0ResultLong);
            Assert.AreEqual(x1Expect, x1ResultLong);
            Assert.AreEqual(y1Expect, y1ResultLong);
            Assert.AreEqual(hexcolorExpect, hexcolorResultLong);
        }
        [TestMethod]
        public void Command4Test1()
        {
            /***** Encode *****/
            // Arrange
            byte commandNum = 4;
            Int16 x0 = 32;
```

```
            Int16 y0 = 54;
            Int16 radius = 10;
            string hexcolor = "4240";
            byte[] resultExpect = { 4, 32, 0, 54, 0, 10, 0, 64, 66 };
            // Act
            byte[] result = command.CircleEncode(commandNum, x0, y0, radius,
            hexcolor);
            // Assert
            CollectionAssert.AreEqual(resultExpect, result);
            /***** Decode *****/
            // Arrange
            byte[] message = { 4, 67, 0, 95, 0, 18, 0, 255, 255 };
            byte commandExpect = 4;
            Int16 x0Expect = 67;
            Int16 y0Expect = 95;
            Int16 radiusExpect = 18;
            string hexcolorExpect = "FFFF";
            // Act
            command.CircleDecode(message, out byte commandResult, out Int16
            x0Result, out Int16 y0Result, out Int16 radiusResult, out string
hexcolorResult);
            // Assert
            Assert.AreEqual(commandExpect, commandResult);
            Assert.AreEqual(x0Expect, x0Result);
            Assert.AreEqual(y0Expect, y0Result);
            Assert.AreEqual(radiusExpect, radiusResult);
            Assert.AreEqual(hexcolorExpect, hexcolorResult);
        }
        [TestMethod]
        public void Command4Test2()
        {
            /***** Decode *****/
            // Arrange
            byte[] messageEmpty = { };
            byte commandExpect = 4;
            Int16 x0Expect = 67;
            Int16 y0Expect = 95;
            Int16 radiusExpect = 18;
            string hexcolorExpect = "FFFF";
            // Act
            command.CircleDecode(messageEmpty, out byte commandResultEmpty, out
            Int16 x0ResultEmpty, out Int16 y0ResultEmpty, out Int16
radiusResultEmpty, out
            string hexcolorResultEmpty);
            // Assert
            Assert.AreEqual(commandExpect, commandResultEmpty);
            Assert.AreEqual(x0Expect, x0ResultEmpty);
            Assert.AreEqual(y0Expect, y0ResultEmpty);
            Assert.AreEqual(radiusExpect, radiusResultEmpty);
            Assert.AreEqual(hexcolorExpect, hexcolorResultEmpty);
        }
        [TestMethod]
        public void Command4Test3()
        {
            /***** Decode *****/
            // Arrange
            byte[] messageShort = { 4, 67, 0, 95, 0, 18 };
            byte commandExpect = 4;
```

```
            Int16 x0Expect = 67;
            Int16 y0Expect = 95;
            Int16 radiusExpect = 18;
            string hexcolorExpect = "FFFF";
            // Act
            command.CircleDecode(messageShort, out byte commandResultShort, out
            Int16 x0ResultShort, out Int16 y0ResultShort, out Int16
radiusResultShort, out
            string hexcolorResultShort);
            // Assert
            Assert.AreEqual(commandExpect, commandResultShort);
            Assert.AreEqual(x0Expect, x0ResultShort);
            Assert.AreEqual(y0Expect, y0ResultShort);
            Assert.AreEqual(radiusExpect, radiusResultShort);
            Assert.AreEqual(hexcolorExpect, hexcolorResultShort);
        }
        [TestMethod]
        public void Command4Test4()
        {
            /***** Decode *****/
            // Arrange
            byte[] messageLong = { 4, 67, 0, 95, 0, 18, 0, 255, 255, 95, 0 };
            byte commandExpect = 4;
            Int16 x0Expect = 67;
            Int16 y0Expect = 95;
            Int16 radiusExpect = 18;
            string hexcolorExpect = "FFFF";
            // Act
            command.CircleDecode(messageLong, out byte commandResultLong, out
            Int16 x0ResultLong, out Int16 y0ResultLong, out Int16 radiusResultLong,
out string
            hexcolorResultLong);
            // Assert
            Assert.AreEqual(commandExpect, commandResultLong);
            Assert.AreEqual(x0Expect, x0ResultLong);
            Assert.AreEqual(y0Expect, y0ResultLong);
            Assert.AreEqual(radiusExpect, radiusResultLong);
            Assert.AreEqual(hexcolorExpect, hexcolorResultLong);
        }
        [TestMethod]
        public void Command5Test1()
        {
            /***** Encode *****/
            // Arrange
            byte commandNum = 5;
            Int16 x0 = 3;
            Int16 y0 = 6;
            Int16 x1 = 2;
            Int16 y1 = 11;
            Int16 radius = 10;
            string hexcolor = "34E7";
            byte[] resultExpect = { 5, 3, 0, 6, 0, 2, 0, 11, 0, 10, 0, 231, 52 };
            // Act
            byte[] result = command.RoundedRectEncode(commandNum, x0, y0, x1, y1,
            radius, hexcolor);// Assert
            CollectionAssert.AreEqual(resultExpect, result);
            /***** Decode *****/
            // Arrange
```

```
            byte[] message = { 5, 44, 0, 12, 0, 34, 0, 56, 0, 18, 0, 225, 154 };
            byte commandExpect = 5;
            Int16 x0Expect = 44;
            Int16 y0Expect = 12;
            Int16 x1Expect = 34;
            Int16 y1Expect = 56;
            Int16 radiusExpect = 18;
            string hexcolorExpect = "9AE1";
            // Act
            command.RoundedRectDecode(message, out byte commandResult, out Int16
            x0Result, out Int16 y0Result, out Int16 x1Result, out Int16 y1Result,
out Int16
            radiusResult, out string hexcolorResult);
            // Assert
            Assert.AreEqual(commandExpect, commandResult);
            Assert.AreEqual(x0Expect, x0Result);
            Assert.AreEqual(y0Expect, y0Result);
            Assert.AreEqual(x1Expect, x1Result);
            Assert.AreEqual(y1Expect, y1Result);
            Assert.AreEqual(radiusExpect, radiusResult);
            Assert.AreEqual(hexcolorExpect, hexcolorResult);
        }
        [TestMethod]
        public void Command5Test2()
        {
            /***** Decode *****/
            // Arrange
            byte[] messageEmpty = { };
            byte commandExpect = 5;
            Int16 x0Expect = 44;
            Int16 y0Expect = 12;
            Int16 x1Expect = 34;
            Int16 y1Expect = 56;
            Int16 radiusExpect = 18;
            string hexcolorExpect = "9AE1";
            // Act
            command.RoundedRectDecode(messageEmpty, out byte commandResultEmpty,
            out Int16 x0ResultEmpty, out Int16 y0ResultEmpty, out Int16
x1ResultEmpty, out
            Int16 y1ResultEmpty, out Int16 radiusResultEmpty, out string
hexcolorResultEmpty);
            // Assert
            Assert.AreEqual(commandExpect, commandResultEmpty);
            Assert.AreEqual(x0Expect, x0ResultEmpty);
            Assert.AreEqual(y0Expect, y0ResultEmpty);
            Assert.AreEqual(x1Expect, x1ResultEmpty);
            Assert.AreEqual(y1Expect, y1ResultEmpty);
            Assert.AreEqual(radiusExpect, radiusResultEmpty);
            Assert.AreEqual(hexcolorExpect, hexcolorResultEmpty);
        }
        [TestMethod]
        public void Command5Test3()
        {
            /***** Decode *****/
            // Arrange
            byte[] messageShort = { 5, 44, 0, 12, 0, 34, 0 };
            byte commandExpect = 5; Int16 x0Expect = 44;
            Int16 y0Expect = 12;
```

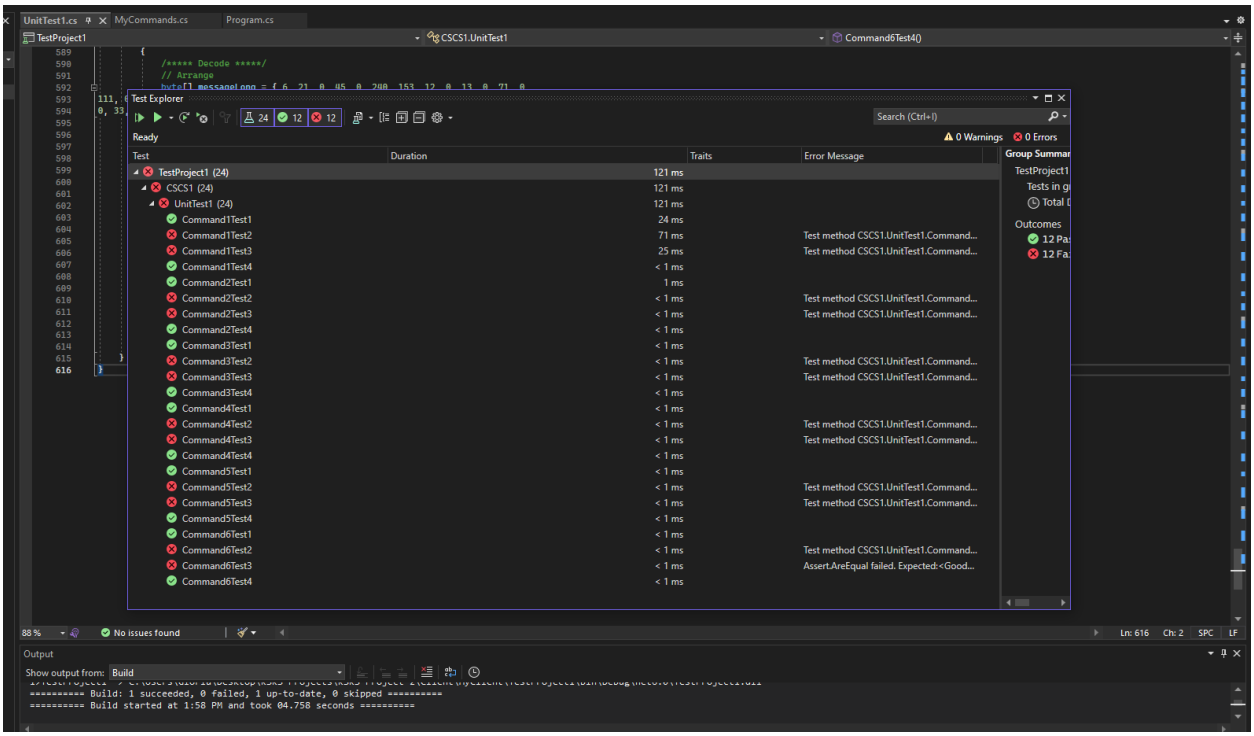
```
            Int16 x1Expect = 34;
            Int16 y1Expect = 56;
            Int16 radiusExpect = 18;
            string hexcolorExpect = "9AE1";
            // Act
            command.RoundedRectDecode(messageShort, out byte commandResultShort,
            out Int16 x0ResultShort, out Int16 y0ResultShort, out Int16
x1ResultShort, out
            Int16 y1ResultShort, out Int16 radiusResultShort, out string
hexcolorResultShort);
            // Assert
            Assert.AreEqual(commandExpect, commandResultShort);
            Assert.AreEqual(x0Expect, x0ResultShort);
            Assert.AreEqual(y0Expect, y0ResultShort);
            Assert.AreEqual(x1Expect, x1ResultShort);
            Assert.AreEqual(y1Expect, y1ResultShort);
            Assert.AreEqual(radiusExpect, radiusResultShort);
            Assert.AreEqual(hexcolorExpect, hexcolorResultShort);
        }
        [TestMethod]
        public void Command5Test4()
        {
            /***** Decode *****/
            // Arrange
            byte[] messageLong = { 5, 44, 0, 12, 0, 34, 0, 56, 0, 18, 0, 225, 154,
19, 57 };
            byte commandExpect = 5;
            Int16 x0Expect = 44;
            Int16 y0Expect = 12;
            Int16 x1Expect = 34;
            Int16 y1Expect = 56;
            Int16 radiusExpect = 18;
            string hexcolorExpect = "9AE1";
            // Act
            command.RoundedRectDecode(messageLong, out byte commandResultLong, out
            Int16 x0ResultLong, out Int16 y0ResultLong, out Int16 x1ResultLong, out
Int16
            y1ResultLong, out Int16 radiusResultLong, out string
hexcolorResultLong);
            // Assert
            Assert.AreEqual(commandExpect, commandResultLong);
            Assert.AreEqual(x0Expect, x0ResultLong);
            Assert.AreEqual(y0Expect, y0ResultLong);
            Assert.AreEqual(x1Expect, x1ResultLong);
            Assert.AreEqual(y1Expect, y1ResultLong);
            Assert.AreEqual(radiusExpect, radiusResultLong);
            Assert.AreEqual(hexcolorExpect, hexcolorResultLong);
        }
        [TestMethod]
        public void Command6Test1()
        {
            /***** Encode *****/
            // Arrange
            byte commandNum = 6;
            Int16 x0 = 43;
            Int16 y0 = 12;
            string hexcolor = "04E0";
            Int16 x1 = 14;
```

```
            string text = "Hello, World!";
            Int16 y1 = Convert.ToInt16(text.Length); byte[] resultExpect = { 6, 43,
0, 12, 0, 224, 4, 14, 0, 13, 0, 72, 0,
101, 0, 108, 0, 108, 0, 111, 0, 44, 0, 32, 0, 87, 0, 111, 0, 114, 0, 108, 0, 100,
0, 33, 0 };
            // Act
            byte[] result = command.TextEncode(commandNum, x0, y0, hexcolor, x1,
            y1, text);
            // Assert
            CollectionAssert.AreEqual(resultExpect, result);
            /***** Decode *****/
            // Arrange
            byte[] message = { 6, 21, 0, 45, 0, 240, 153, 12, 0, 13, 0, 71, 0,
111, 0, 111, 0, 100, 0, 32, 0, 77, 0, 111, 0, 114, 0, 110, 0, 105, 0, 110, 0, 103,
0, 33, 0 };
            byte commandExpect = 6;
            Int16 x0Expect = 21;
            Int16 y0Expect = 45;
            string hexcolorExpect = "99F0";
            Int16 x1Expect = 12;
            Int16 y1Expect = 13;
            string textExpect = "Good Morning!";
            // Act
            command.TextDecode(message, out byte commandResult, out Int16
            x0Result, out Int16 y0Result, out string hexcolorResult, out Int16
x1Result, out
            Int16 y1Result, out string textResult);
            // Assert
            Assert.AreEqual(commandExpect, commandResult);
            Assert.AreEqual(x0Expect, x0Result);
            Assert.AreEqual(y0Expect, y0Result);
            Assert.AreEqual(hexcolorExpect, hexcolorResult);
            Assert.AreEqual(x1Expect, x1Result);
            Assert.AreEqual(y1Expect, y1Result);
            Assert.AreEqual(textExpect, textResult);
        }
        [TestMethod]
        public void Command6Test2()
        {
            /***** Decode *****/
            // Arrange
            byte[] messageEmpty = { };
            byte commandExpect = 6;
            Int16 x0Expect = 21;
            Int16 y0Expect = 45;
            string hexcolorExpect = "99F0";
            Int16 x1Expect = 12;
            Int16 y1Expect = 13;
            string textExpect = "Good Morning!";
            // Act
            command.TextDecode(messageEmpty, out byte commandResultEmpty, out
            Int16 x0ResultEmpty, out Int16 y0ResultEmpty, out string
hexcolorResultEmpty, out
            Int16 x1ResultEmpty, out Int16 y1ResultEmpty, out string
textResultEmpty);
            // Assert
            Assert.AreEqual(commandExpect, commandResultEmpty);
            Assert.AreEqual(x0Expect, x0ResultEmpty);
```

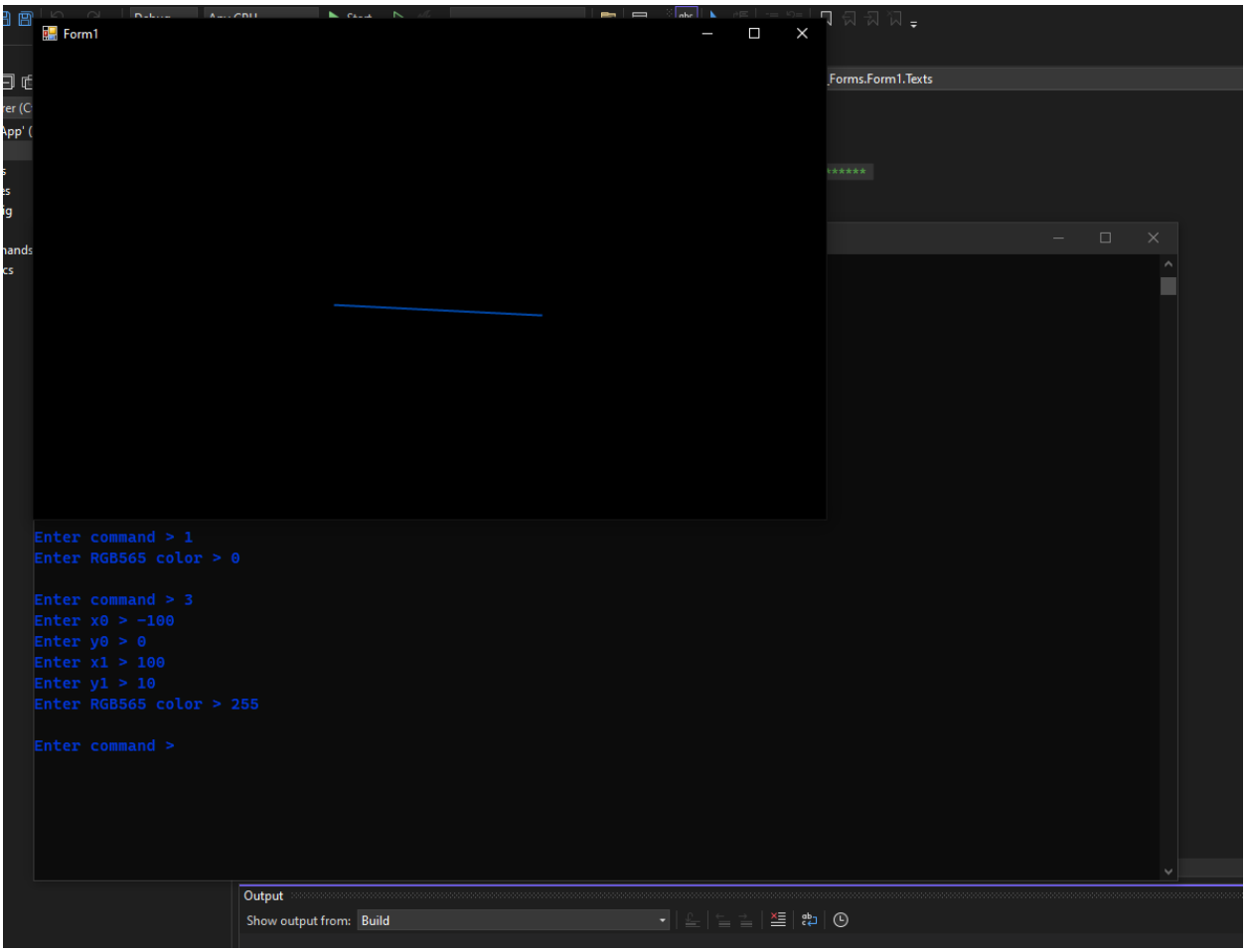
```
            Assert.AreEqual(y0Expect, y0ResultEmpty);
            Assert.AreEqual(hexcolorExpect, hexcolorResultEmpty);
            Assert.AreEqual(x1Expect, x1ResultEmpty); Assert.AreEqual(y1Expect,
y1ResultEmpty);
            Assert.AreEqual(textExpect, textResultEmpty);
        }
        [TestMethod]
        public void Command6Test3()
        {
            /***** Decode *****/
            // Arrange
            byte[] messageShort = { 6, 21, 0, 45, 0, 240, 153, 12, 0, 13, 0, 71,
0, 111, 0, 111, 0, 100, 0, 32, 0, 77, 0, 111, 0, 114, 0, 110, 0, 105 };
            byte commandExpect = 6;
            Int16 x0Expect = 21;
            Int16 y0Expect = 45;
            string hexcolorExpect = "99F0";
            Int16 x1Expect = 12;
            Int16 y1Expect = 13;
            string textExpect = "Good Morning!";
            // Act
            command.TextDecode(messageShort, out byte commandResultShort, out
            Int16 x0ResultShort, out Int16 y0ResultShort, out string
hexcolorResultShort, out
            Int16 x1ResultShort, out Int16 y1ResultShort, out string
textResultShort);
            // Assert
            Assert.AreEqual(commandExpect, commandResultShort);
            Assert.AreEqual(x0Expect, x0ResultShort);
            Assert.AreEqual(y0Expect, y0ResultShort);
            Assert.AreEqual(hexcolorExpect, hexcolorResultShort);
            Assert.AreEqual(x1Expect, x1ResultShort);
            Assert.AreEqual(y1Expect, y1ResultShort);
            Assert.AreEqual(textExpect, textResultShort);
        }
        [TestMethod]
        public void Command6Test4()
        {
            /***** Decode *****/
            // Arrange
            byte[] messageLong = { 6, 21, 0, 45, 0, 240, 153, 12, 0, 13, 0, 71, 0,
111, 0, 111, 0, 100, 0, 32, 0, 77, 0, 111, 0, 114, 0, 110, 0, 105, 0, 110, 0, 103,
0, 33, 0, 110, 0, 105, 0, 110, 0, 103, 0, 33, 0 };
            byte commandExpect = 6;
            Int16 x0Expect = 21;
            Int16 y0Expect = 45;
            string hexcolorExpect = "99F0";
            Int16 x1Expect = 12;
            Int16 y1Expect = 13;
            string textExpect = "Good Morning!";
            // Act
            command.TextDecode(messageLong, out byte commandResultLong, out Int16
            x0ResultLong, out Int16 y0ResultLong, out string hexcolorResultLong, out
Int16
            x1ResultLong, out Int16 y1ResultLong, out string textResultLong);
            // Assert
            Assert.AreEqual(commandExpect, commandResultLong);
            Assert.AreEqual(x0Expect, x0ResultLong);
```

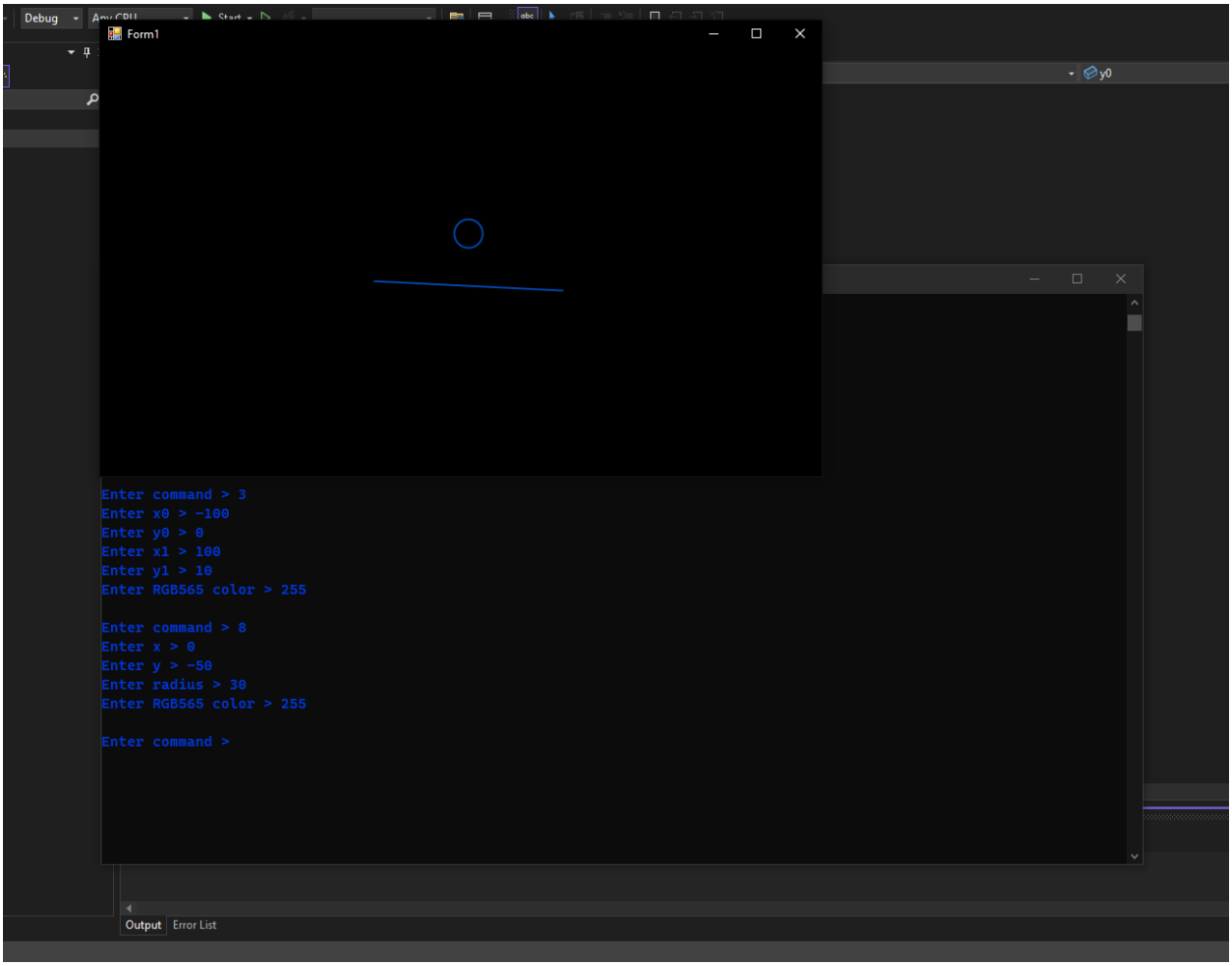
```
            Assert.AreEqual(y0Expect, y0ResultLong);
            Assert.AreEqual(hexcolorExpect, hexcolorResultLong);
            Assert.AreEqual(x1Expect, x1ResultLong);
            Assert.AreEqual(y1Expect, y1ResultLong);
            Assert.AreEqual(textExpect, textResultLong);
        }
    }
}
```

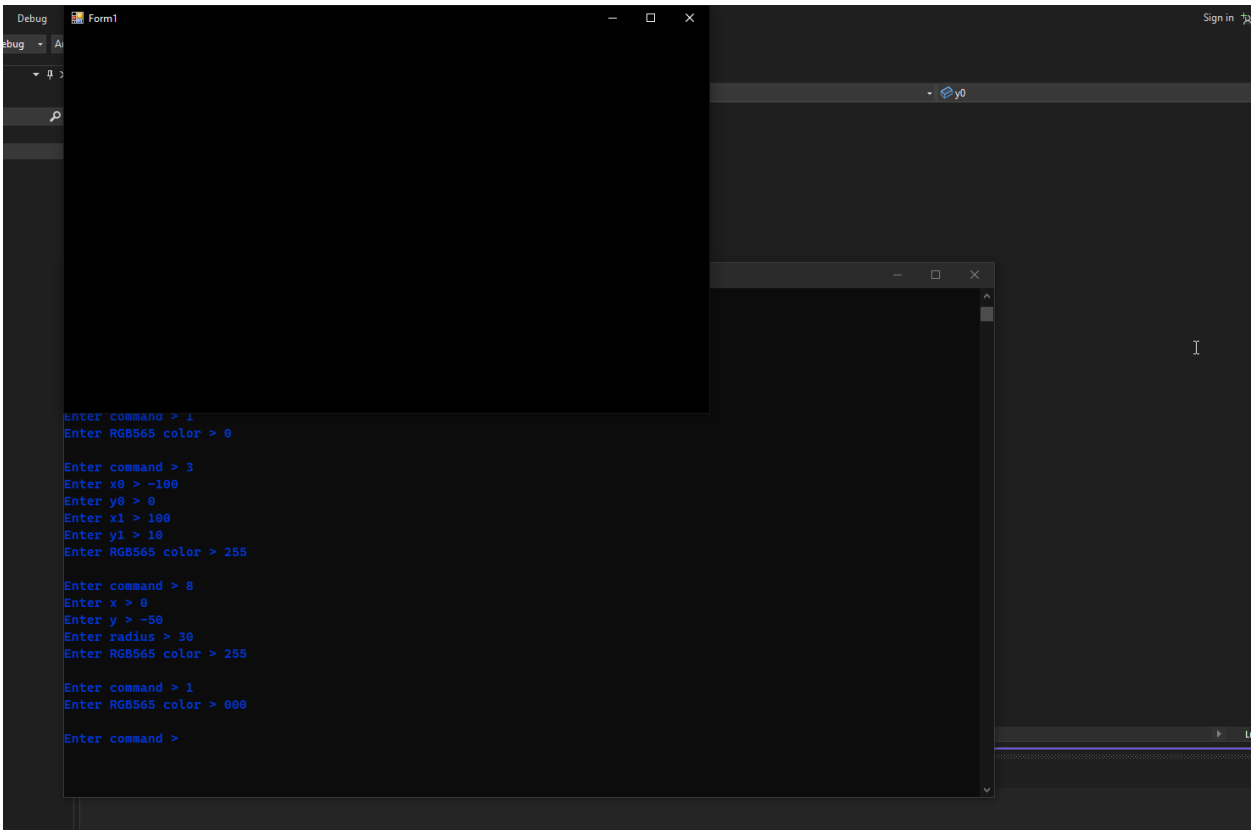
Запускаємо тести:

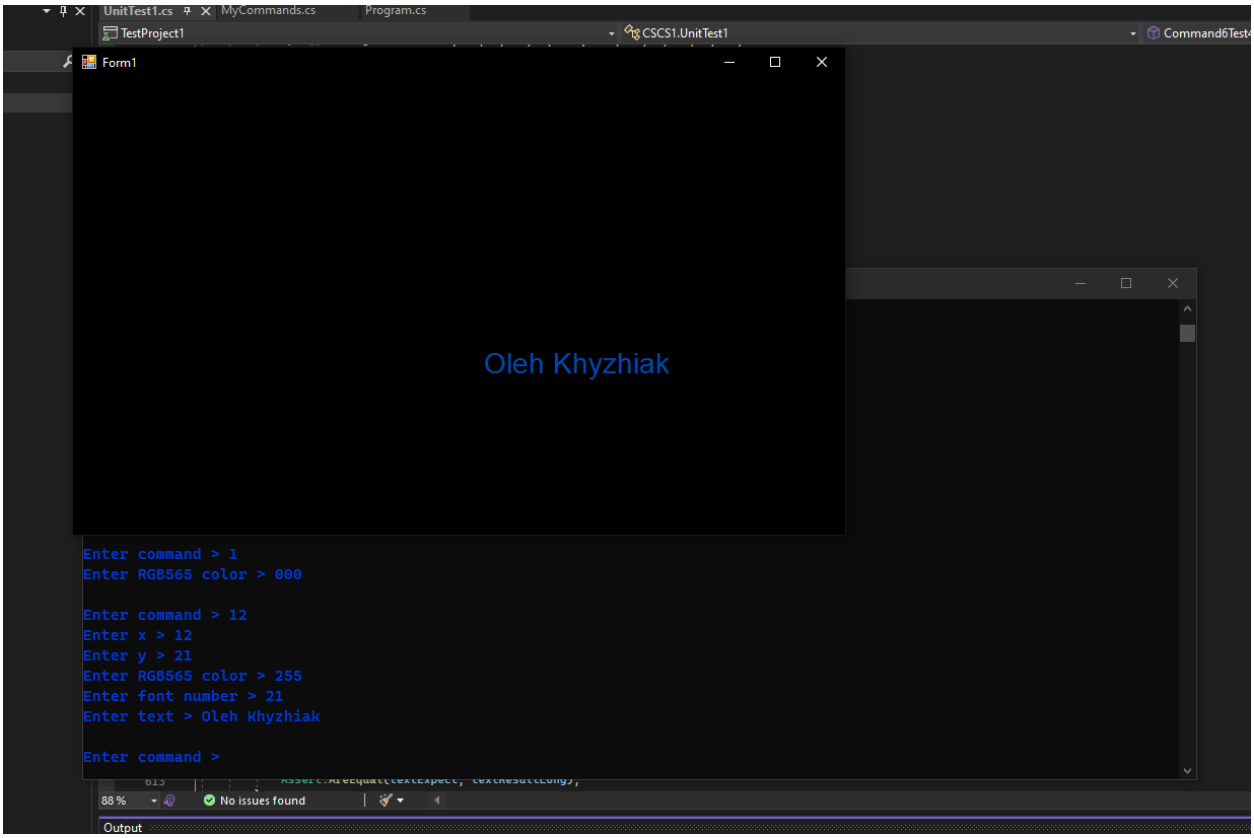


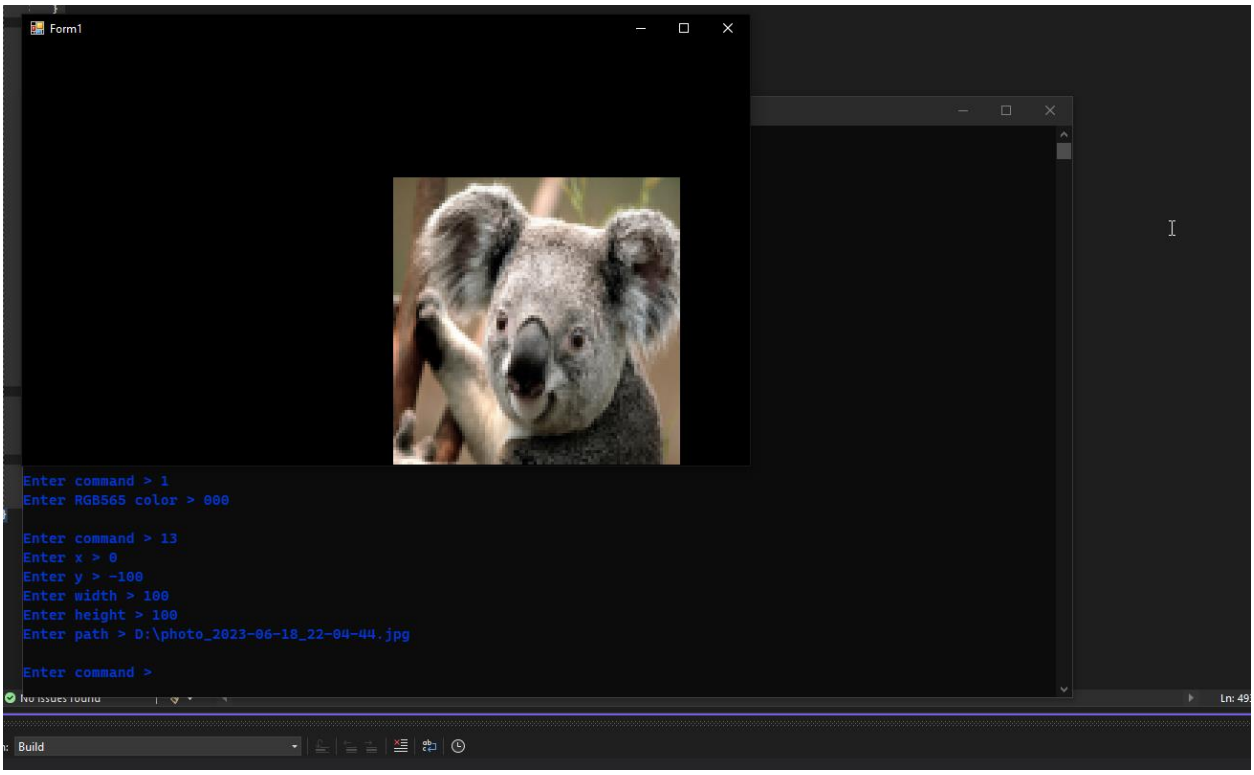
Перевіримо роботу команд деяких команд:


Form1
Forms.Form1.Texts
Enter command > 1
Enter RGB565 color > 0
Enter command > 3
Enter x0 > -100
Enter y0 > 0
Enter x1 > 100
Enter y1 > 10
Enter RGB565 color > 255
Enter command >
Output
Show output from: Build


Debug
Form1
y0
Enter command > 3
Enter x0 > -100
Enter y0 > 0
Enter x1 > 100
Enter y1 > 10
Enter RGB565 color > 255
Enter command > 8
Enter x > 0
Enter y > -50
Enter radius > 30
Enter RGB565 color > 255
Enter command >
Output
Error List


Debug
Form1
Sign in
y0
Enter command > 1
Enter RGB565 color > 0
Enter command > 3
Enter x0 > -100
Enter y0 > 0
Enter x1 > 100
Enter y1 > 10
Enter RGB565 color > 255
Enter command > 8
Enter x > 0
Enter y > -50
Enter radius > 30
Enter RGB565 color > 255
Enter command > 1
Enter RGB565 color > 000
Enter command >


UnitTest1.cs
MyCommands.cs
Program.cs
TestProject1
CSCS1.UnitTest1
Form1
Oleh Khyzhiak
Enter command > 1
Enter RGB565 color > 000
Enter command > 12
Enter x > 12
Enter y > 21
Enter RGB565 color > 255
Enter font number > 21
Enter text > Oleh Khyzhiak
Enter command >
88 %
No issues found
Output


Form1
Enter command > 1
Enter RGB565 color > 000
Enter command > 13
Enter x > 0
Enter y > -100
Enter width > 100
Enter height > 100
Enter path > D:\photo_2023-06-18_22-04-44.jpg
Enter command >
Build

Висновок: розробив програму для емуляції дисплейного модуля.