Лабораторна робота № 3

Виконав студент

Групи кн21-1

Кончич Даніїл

Варіант 14

Мета роботи: реалізувати клієнтську частину бібліотеки для управління дисплейним модулем.

Етапи виконання лабораторної роботи:

1. Використовуючи інтерфейс бібліотеки GraphicsLib, реалізувати на мові програмування C++ програму для взаємодії з емулятором дисплейного модуля, який був розроблений в лабораторній роботі №2.

2. Інтерфейс бібліотеки GraphicsLib не змінювати.

Хід роботи:

Лістинг клієнту:

```
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;
        }
    }
```

```
}


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 = 1001;
            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":
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                                        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)}");
        }
    }
}
```

Лістинг серверу:

```
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 = 1001;
           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)
          { }
      }
  }


  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
      }
  }

  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());
          }
      }
  }
```

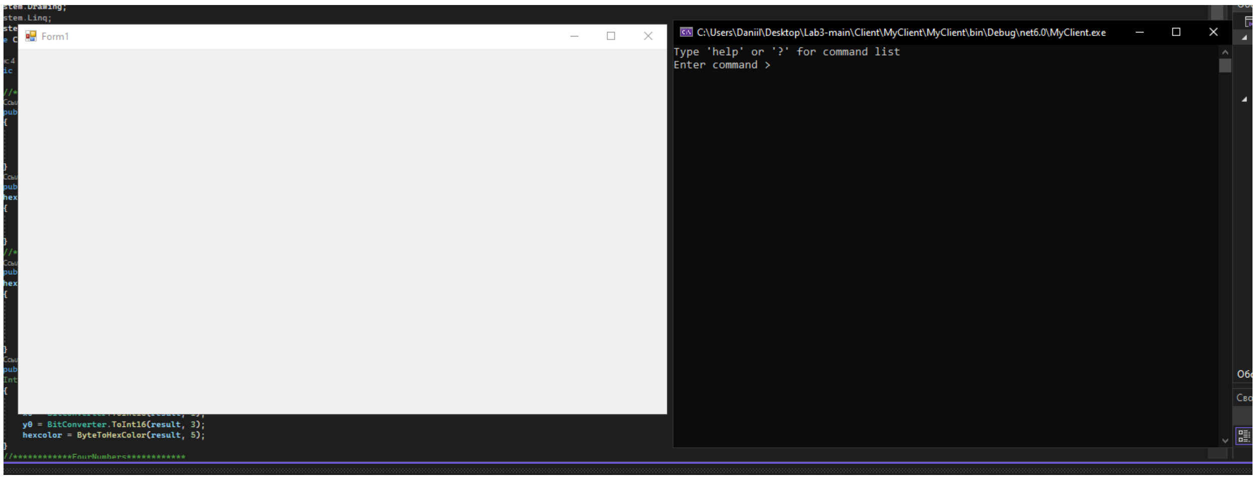
Unit Test:

```
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 };
```

```csharp
        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
```

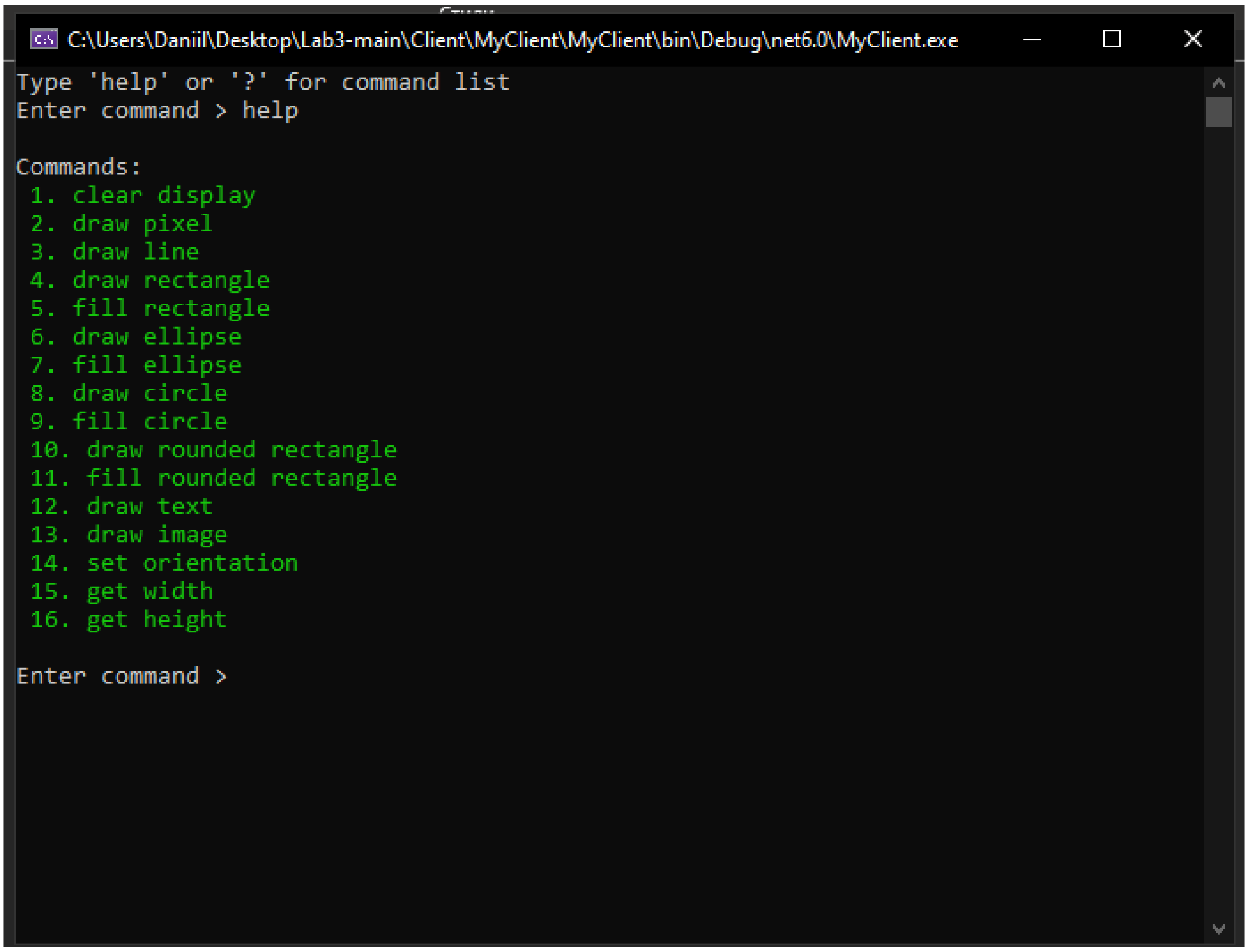
```
                byte[] result = command.PixelEncode(commandNum, x0, y0, hexcolor);
                // Assert
                CollectionAssert.AreEqual(resultExpect, result);
                /***** Decode *****/
                // Arrange
                byte[] message = { 2, 12, 0, 20, 0, 233, 215 };
                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);
            }
        }
    }
```

Демонстрація програми:

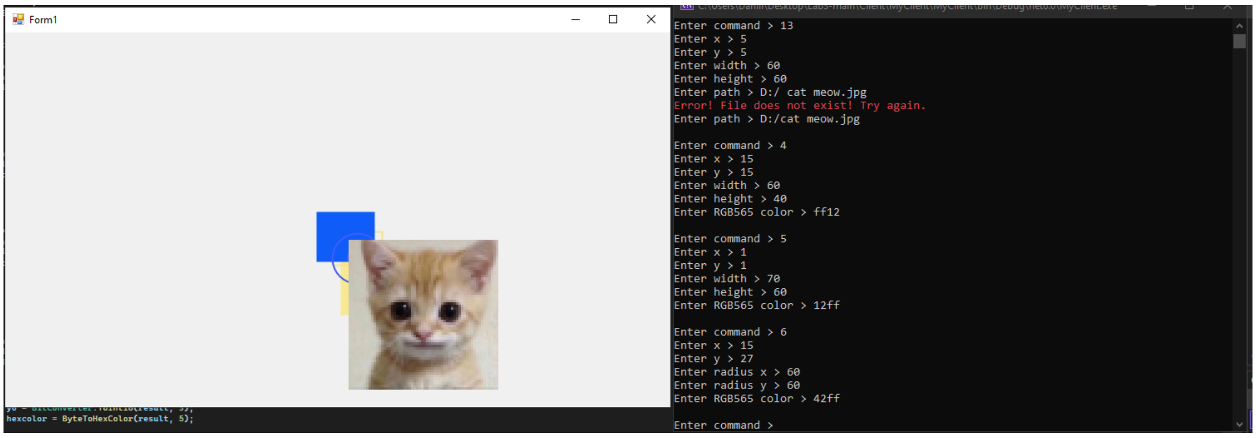


```
C:\Users\Daniil\Desktop\Lab3-main\Client\MyClient\MyClient\bin\Debug\net6.0\MyClient.exe
Type 'help' or '?' for command list
Enter command >
```

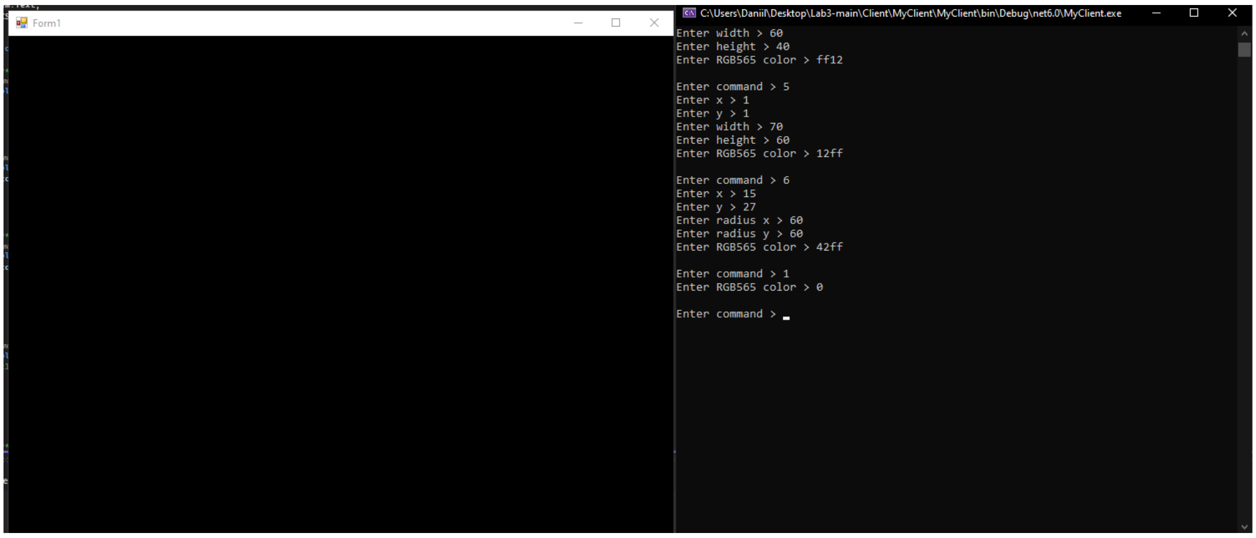
```
y0 = BitConverter.ToInt16(result, 3);
hexcolor = ByteToHexColor(result, 5);
}
//************FourNumbers************
```


C:\Users\Daniil\Desktop\Lab3-main\Client\MyClient\MyClient\bin\Debug\net6.0\MyClient.exe

```
Type 'help' or '?' for command list
Enter command > help

Commands:
 1. clear display
 2. draw pixel
 3. draw line
 4. draw rectangle
 5. fill rectangle
 6. draw ellipse
 7. fill ellipse
 8. draw circle
 9. fill circle
 10. draw rounded rectangle
 11. fill rounded rectangle
 12. draw text
 13. draw image
 14. set orientation
 15. get width
 16. get height

Enter command >
```



```
Enter command > 13
Enter x > 5
Enter y > 5
Enter width > 60
Enter height > 60
Enter path > D:/ cat meow.jpg
Error! File does not exist! Try again.
Enter path > D:/cat meow.jpg

Enter command > 4
Enter x > 15
Enter y > 15
Enter width > 60
Enter height > 40
Enter RGB565 color > ff12

Enter command > 5
Enter x > 1
Enter y > 1
Enter width > 70
Enter height > 60
Enter RGB565 color > 12ff

Enter command > 6
Enter x > 15
Enter y > 27
Enter radius x > 60
Enter radius y > 60
Enter RGB565 color > 42ff

Enter command >
```



```
C:\Users\Daniil\Desktop\Lab3-main\Client\MyClient\MyClient\bin\Debug\net6.0\MyClient.exe
Enter width > 60
Enter height > 40
Enter RGB565 color > ff12

Enter command > 5
Enter x > 1
Enter y > 1
Enter width > 70
Enter height > 60
Enter RGB565 color > 12ff

Enter command > 6
Enter x > 15
Enter y > 27
Enter radius x > 60
Enter radius y > 60
Enter RGB565 color > 42ff

Enter command > 1
Enter RGB565 color > 0

Enter command > _
```

Висновок: реалізував клієнтську частину бібліотеки для управління дисплейним модулем, використовуючи інтерфейс бібліотеки GraphicsLib.