ภาคผนวก ค

โค๊ดโปรแกรมควบคุมของ C#

```
using System;
using System.Collections.Generic;
using System.ComponentModel;
using System.Data;
using System.Drawing;
using System.Linq;
using System.Text;
using System.Windows.Forms;
using System.IO.Ports;
using System.IO;
using Extreme.Mathematics;
using Extreme.Mathematics.LinearAlgebra;
namespace Serial_Port
{
    public partial class Form1 : Form
    {
        SerialPort Port = new SerialPort();
        StreamWriter txt = new StreamWriter("Position.txt");
        int line = 0, counter = 1, i = 1;
        string[] R = new string[100];
        OpenFileDialog Open;
        int sp;
        double a1 = 47.003;
        double d2 = 65;
        double a2 = 290;
        double a3 = 8.3;
        double a4 = 189;
        double a5 = 5;
        double d3 = 0;
        double d4 = 110;
        double d6 = 145;
```

```
        double r11 = 1;
        double r13 = 0;
        double r21 = 0;
        double r23 = 0;
        double r31 = 0;
        double r33 = -1;
        double Px;
        double Py;
        double Pz;
        double K, fee, seta1, seta2, seta3, seta4, seta5, seta6, s23, c23, seta23, s5, c5,
s6, c6, seta2_n, seta3_n, seta5_n;
        public Form1()
        {
            InitializeComponent();
            Send.Enabled = false;
            Disconnect.Enabled = false;
            reset.Enabled = false;
            ang1.Enabled = false;
            ang2.Enabled = false;
            ang3.Enabled = false;
            ang4.Enabled = false;
            ang5.Enabled = false;
            ang6.Enabled = false;
            Speed.Enabled = false;
            radioButton1.Enabled = false;
            radioButton2.Enabled = false;
            Addpoint.Enabled = false;
            StopAdd.Enabled = false;
            lineNumber.Enabled = false;
            comboBox2.Enabled = false;
            strout.Enabled = false;
```

```
            Play.Enabled = false;
            Pause.Enabled = false;
            Stop.Enabled = false;
            autoModeToolStripMenuItem.Enabled = false;
            Send2.Enabled = false;
            numericUpDown1.Enabled = false;
            numericUpDown2.Enabled = false;
            numericUpDown3.Enabled = false;
        }
        private void Send_Click_1(object sender, EventArgs e)   (ฟังชันที่2>บทที่ 3>หน้า67)
        {
            seta1 = ang1.Value * 16340;
            seta2_n = ang2.Value * 8170;
            seta3_n = ang3.Value * 3268;
            seta4 = ang4.Value * 760;
            seta5_n = ang5.Value * 1520;
            seta6 = ang6.Value * 143;
            if (Speed.Value == 0)
            {
                sp = 0;
            }
            else
            sp = 11 - Speed.Value;
            Port.Write("[" + seta1.ToString() + "," + seta2_n.ToString() + "," +
seta3_n.ToString() + "," + seta4.ToString() + "," + seta5_n.ToString() + "," +
seta6.ToString() + "," + sp.ToString() + "]");
            textBox1.Text = "[" + seta1.ToString() + "," + seta2_n.ToString() + "," +
seta3_n.ToString() + "," + seta4.ToString() + "," + seta5_n.ToString() + "," +
seta6.ToString() + "," + sp.ToString() + "]";
            forward_kinematic();
        }
```

```
private void Connect_Click(object sender, EventArgs e) (ฟังชันที่ 1>บทที่ 3>หน้า67)
{
    if (Port.IsOpen)
    {
        MessageBox.Show ("โปรดตรวจสอบการเชื่อมต่อพอร์ตอนุกรม","Error
Communication",MessageBoxButtons.OK,MessageBoxIcon.Exclamation);
    }
    Port.PortName = comboBox1.Text;
    Port.BaudRate = 9600;
    Port.Open();
    Send.Enabled = true;
    Disconnect.Enabled = true;
    Connect.Enabled = false;
    reset.Enabled = true;
    ang1.Enabled = true;
    ang2.Enabled = true;
    ang3.Enabled = true;
    ang4.Enabled = true;
    ang5.Enabled = true;
    ang6.Enabled = true;
    Speed.Enabled = true;
    radioButton1.Enabled = true;
    radioButton2.Enabled = true;
    Addpoint.Enabled = true;
    StopAdd.Enabled = true;
    autoModeToolStripMenuItem.Enabled = false;
    Send2.Enabled = true;
    numericUpDown1.Enabled = true;
    numericUpDown2.Enabled = true;
    numericUpDown3.Enabled = true;
}
```

```
private void Disconnect_Click(object sender, EventArgs e)
{
    Port.Close();
    Disconnect.Enabled = false;
    Connect.Enabled = true;
    Send.Enabled = false;
    radioButton1.Enabled = false;
    radioButton2.Enabled = false;
    reset.Enabled = false;
    Addpoint.Enabled = false;
    StopAdd.Enabled = false;
    ang1.Enabled = false;
    ang2.Enabled = false;
    ang3.Enabled = false;
    ang4.Enabled = false;
    ang5.Enabled = false;
    ang6.Enabled = false;
    Speed.Enabled = false;
    lineNumber.Enabled = false;
    comboBox2.Enabled = false;
    strout.Enabled = false;
    Play.Enabled = false;
    Pause.Enabled = false;
    Stop.Enabled = false;
    autoModeToolStripMenuItem.Enabled = false;
    Send2.Enabled = false;
    numericUpDown1.Enabled = false;
    numericUpDown2.Enabled = false;
    numericUpDown3.Enabled = false;
}
private void Exit_Click(object sender, EventArgs e)
```

```
   Port.Close();
    txt.Close();
    Close();
}
private void ang1_Scroll(object sender, EventArgs e)
{
    txt1.Text = "แกนที่ 1 = " + ang1.Value.ToString() + " องศา";
}
private void reset_Click(object sender, EventArgs e)
{
    ang1.Value = 0;
    ang2.Value = 0;
    ang3.Value = 0;
    ang4.Value = 0;
    ang5.Value = 0;
    ang6.Value = 0;
    label_value();
}
private void ang2_Scroll(object sender, EventArgs e)
{
    label_value();
}
private void ang3_Scroll_1(object sender, EventArgs e)
{
    label_value();
}
private void ang4_Scroll_1(object sender, EventArgs e)
{
    label_value();
}
private void ang5_Scroll_1(object sender, EventArgs e)
```

```
        {
            label_value();
        }
        private void ang6_Scroll_1(object sender, EventArgs e)
        {
            label_value();
        }
private void button1_Click_1(object sender, EventArgs e)        (ฟังชันที่4>บทที่3>หน้า67)
       {
            txt.WriteLine(textBox1.Text);
            i++;
            Addpoint.Text = "Add Point " + i.ToString();
        }
        private void button2_Click_1(object sender, EventArgs e)
        {
            txt.Close();
        }
private void autoModeToolStripMenuItem_Click(object sender, EventArgs e) (ฟังชันที่ 5
        {                                                                    >บทที่3>หน้า68 )
            Open = new OpenFileDialog();
            Open.DefaultExt = "*.txt";
            Open.Filter = "Text File (.txt)| *.txt";
            if (Open.ShowDialog() == DialogResult.OK)
            {
                MessageBox.Show("คุณได้เปิดไฟล์" + Open.FileName, "Open File",
MessageBoxButtons.OK, MessageBoxIcon.Information);
            }
            label17.Text = Open.FileName;
            StreamReader reader = new StreamReader(Open.FileName);
            System.IO.StreamReader file = new System.IO.StreamReader(Open.FileName);
            readdata.Text = reader.ReadToEnd();
```

```
            reader.Close();
            while ((R[line] = file.ReadLine()) != null)
            {
                line++;
            }
            file.Close();
            lineNumber.Text = line.ToString();
        }
        private void Speed_Scroll(object sender, EventArgs e)
        {
            label14.Text = "ความเร็ว = "+Speed.Value.ToString();
        }
        private void Play_Click(object sender, EventArgs e)        (ฟังชันที่ 7>บทที่3>หน้า68)
        {
            timer1.Interval = Convert.ToInt32(comboBox2.Text);
            timer1.Enabled = true;
            Play.Enabled = false;
            Pause.Enabled = true;
            Stop.Enabled = true;
        }
        private void Pause_Click(object sender, EventArgs e)     (ฟังชันที่ 8>บทที่3>หน้า68)
        {
            timer1.Enabled = false;
            Play.Enabled = true;
            Pause.Enabled = false;
            Stop.Enabled = true;
        }
        private void Stop_Click(object sender, EventArgs e)       (ฟังชันที่ 9>บทที่3>หน้า68)
{
            timer1.Enabled = false;
            counter = 1;
```

```
        Play.Enabled = true;
        Pause.Enabled = false;
        Stop.Enabled = false;
    }
    private void timer1_Tick(object sender, EventArgs e)      (ฟังชันที่ 6>บทที่3>หน้า68)
{
        do
        {
            strout.Text = R[counter - 1].ToString();
            Port.Write(strout.Text);
            if (counter == line)
            {
                counter = 0;
            }
            counter++;
        } while (counter < 0);
    }
    private void radioButton1_CheckedChanged(object sender, EventArgs e)
    {
        reset.Enabled = true;
        Send.Enabled = true;
        Addpoint.Enabled = true;
        StopAdd.Enabled = true;
        ang1.Enabled = true;
        ang2.Enabled = true;
        ang3.Enabled = true;
        ang4.Enabled = true;
        ang5.Enabled = true;
        ang6.Enabled = true;
        Speed.Enabled = true;
        lineNumber.Enabled = false;
```

```
    comboBox2.Enabled = false;
    strout.Enabled = false;
    Play.Enabled = false;
    Pause.Enabled = false;
    Stop.Enabled = false;
    autoModeToolStripMenuItem.Enabled = false;
    Send2.Enabled = true;
    numericUpDown1.Enabled = true;
    numericUpDown2.Enabled = true;
    numericUpDown3.Enabled = true;
}
private void radioButton2_CheckedChanged(object sender, EventArgs e)
{
    reset.Enabled = false;
    Send.Enabled = false;
    Addpoint.Enabled = false;
    StopAdd.Enabled = false;
    ang1.Enabled = false;
    ang2.Enabled = false;
    ang3.Enabled = false;
    ang4.Enabled = false;
    ang5.Enabled = false;
    ang6.Enabled = false;
    Speed.Enabled = false;
    lineNumber.Enabled = true;
    comboBox2.Enabled = true;
    strout.Enabled = true;
    Play.Enabled = true;
    Pause.Enabled = true;
    Stop.Enabled = true;
    autoModeToolStripMenuItem.Enabled = true;
```

```
        Send2.Enabled = false;
        numericUpDown1.Enabled = false;
        numericUpDown2.Enabled = false;
        numericUpDown3.Enabled = false;
    }
    private void button1_Click_2(object sender, EventArgs e)
    {
        inverse_kinematic();
        ang1.Value = Convert.ToInt32(seta1);
        ang2.Value = Convert.ToInt32(seta2_n);
        ang3.Value = Convert.ToInt32(seta3_n);
        ang4.Value = Convert.ToInt32(seta4);
        ang5.Value = Convert.ToInt32(seta5_n);
        ang6.Value = Convert.ToInt32(seta6);
        label_value();
        seta1 = Convert.ToInt64(seta1) * 16340;
        seta2_n = Convert.ToInt64(seta2_n) * 8170;
        seta3_n = Convert.ToInt64(seta3_n) * 3268;
        seta4 = Convert.ToInt64(seta4) * 760;
        seta5_n = Convert.ToInt64(seta5_n) * 1520;
        seta6 = Convert.ToInt64(seta6) * 143;
        if (Speed.Value == 0)
        {
            sp = 0;
        }
        else
            sp = 11 - Speed.Value;
        Port.Write("[" + seta1.ToString() + "," + seta2_n.ToString() + "," +
seta3_n.ToString() + "," + seta4.ToString() + "," + seta5_n.ToString() + "," +
seta6.ToString() + "," + sp.ToString() + "]");
```

```
            textBox1.Text = "[" + seta1.ToString() + "," + seta2_n.ToString() + "," +
seta3_n.ToString() + "," + seta4.ToString() + "," + seta5_n.ToString() + "," +
seta6.ToString() + "," + sp.ToString() + "]";
        }
        private void forward_kinematic()                    (ฟังชันที่ 3>บทที่3>หน้า67)
        {
            Matrix T0_1 = Matrix.Create(new double[,]
                                    {
                                            {Math.Cos(ang1.Value*Math.PI/180) , -
Math.Sin(ang1.Value*Math.PI/180) , 0 , 0},
                                            {Math.Sin(ang1.Value*Math.PI/180) ,
Math.Cos(ang1.Value*Math.PI/180) , 0 , 0},
                                            {0 , 0 , 1 , 0},
                                            {0 , 0 , 0 , 1}
                                    });
            Matrix T1_2 = Matrix.Create(new double[,]
                                    {
                                            {Math.Cos(ang2.Value*Math.PI/180) , -
Math.Sin(ang2.Value*Math.PI/180) , 0 , a1},
                                            {0 , 0 , 1 , d2},
                                            {-Math.Sin(ang2.Value*Math.PI/180) , -
Math.Cos(ang2.Value*Math.PI/180) , 0 , 0},
                                            {0 , 0 , 0 , 1}
                                    });
            Matrix T2_3 = Matrix.Create(new double[,]
                                    {
                                            {Math.Cos(ang3.Value*Math.PI/180) , -
Math.Sin(ang3.Value*Math.PI/180) , 0 , a2},
                                            {Math.Sin(ang3.Value*Math.PI/180) ,
Math.Cos(ang3.Value*Math.PI/180) , 0 , 0},
                                            {0 , 0 , 1 , 0},
```

```
                {0 , 0 , 0 , 1}
            });
        Matrix T3_4 = Matrix.Create(new double[,]
            {
                {Math.Cos(ang4.Value*Math.PI/180) , -
Math.Sin(ang4.Value*Math.PI/180) , 0 , a3},
                {0 , 0 , 1 , d4},
                {-Math.Sin(ang4.Value*Math.PI/180) , -
Math.Cos(ang4.Value*Math.PI/180) , 0 , 0},
                {0 , 0 , 0 , 1}
            });
        Matrix T4_5 = Matrix.Create(new double[,]
            {
                {Math.Cos(ang5.Value*Math.PI/180) , -
Math.Sin(ang5.Value*Math.PI/180) , 0 , a4},
                {0 , 0 , -1 , 0},
                {Math.Sin(ang5.Value*Math.PI/180) ,
Math.Cos(ang5.Value*Math.PI/180) , 0 , 0},
                {0 , 0 , 0 , 1}
            });
        Matrix T5_6 = Matrix.Create(new double[,]
            {
                {Math.Cos(ang6.Value*Math.PI/180) , -
Math.Sin(ang6.Value*Math.PI/180) , 0 , a5},
                {0 , 0 , 1 , d6},
                {-Math.Sin(ang6.Value*Math.PI/180) , -
Math.Cos(ang6.Value*Math.PI/180) , 0 , 0},
                {0 , 0 , 0 , 1}
            });
        Matrix T0_6;
        T0_6 = T0_1 * T1_2 * T2_3 * T3_4 * T4_5 * T5_6;
```

```
            numericUpDown1.Value = Convert.ToDecimal(T0_6[0, 3]);
            numericUpDown2.Value = Convert.ToDecimal(T0_6[1, 3]);
            numericUpDown3.Value = Convert.ToDecimal(T0_6[2, 3]);
        }
        private void inverse_kinematic()
        {
            Px = Convert.ToDouble(numericUpDown1.Value);
            Py = Convert.ToDouble(numericUpDown2.Value);
            Pz = Convert.ToDouble(numericUpDown3.Value);
            //หาองศาที่ 1
            fee = (180 / Math.PI) * Math.Atan2(Py, Px);
            seta1 = fee - (180 / Math.PI) * Math.Atan2(d3, Math.Sqrt((Px * Px) + (Py * Py) -
(d3 * d3)));
            //หาองศาที่ 3
            K = (((Px * Px) + (Py * Py) + (Pz * Pz) - (a2 * a2) - (a3 * a3) - (d3 * d3) - (d4 *
d4)) / (2 * a2));
            seta3 = (180 / Math.PI) * Math.Atan2(a3, d4);// -(180 / Math.PI) *
Math.Atan2(K, Math.Sqrt((a3 * a3) + (d4 * d4) - (K * K)));
            seta3_n = seta3 - 4.9;
            //หาองศาที่ 2
            s23 = ((-a3 - a2 * Math.Cos(seta3 * Math.PI / 180) * Pz) + (Math.Cos(seta1 *
Math.PI / 180) * Px + Math.Sin(seta1 * Math.PI / 180) * Py) * (a2 * Math.Sin(seta3 *
Math.PI / 180) - d4)) / (Pz * Pz + ((Math.Cos(seta1 * Math.PI / 180) * Px +
Math.Sin(seta1 * Math.PI / 180) * Py) * (Math.Cos(seta1 * Math.PI / 180) * Px +
Math.Sin(seta1 * Math.PI / 180) * Py)));
            c23 = ((a2 * Math.Sin(seta3 * Math.PI / 180) - d4) * Pz + (a3 + a2 *
Math.Cos(seta3 * Math.PI / 180)) * (Math.Cos(seta1 * Math.PI / 180) * Px +
Math.Sin(seta1 * Math.PI / 180) * Py)) / (Pz * Pz + ((Math.Cos(seta1 * Math.PI / 180) *
Px + Math.Sin(seta1 * Math.PI / 180) * Py) * (Math.Cos(seta1 * Math.PI / 180) * Px +
Math.Sin(seta1 * Math.PI / 180) * Py)));
```

```
seta23 = (180 / Math.PI) * Math.Atan2(((-a3 - a2 * Math.Cos(seta3 * Math.PI / 180) * Pz) + (Math.Cos(seta1 * Math.PI / 180) * Px + Math.Sin(seta1 * Math.PI / 180) * Py) * (a2 * Math.Sin(seta3 * Math.PI / 180) - d4)), ((a2 * Math.Sin(seta3 * Math.PI / 180) - d4) * Pz + (a3 + a2 * Math.Cos(seta3 * Math.PI / 180)) * (Math.Cos(seta1 * Math.PI / 180) * Px + Math.Sin(seta1 * Math.PI / 180) * Py)));
seta2 = seta23 - seta3;
seta2_n = 2 + seta2;
//หาองศาที่ 4
s23 = ((-a3 - a2 * Math.Cos(seta3 * Math.PI / 180) * Pz) + (Math.Cos(seta1 * Math.PI / 180) * Px + Math.Sin(seta1 * Math.PI / 180) * Py) * (a2 * Math.Sin(seta3 * Math.PI / 180) - d4)) / (Pz * Pz + ((Math.Cos(seta1 * Math.PI / 180) * Px + Math.Sin(seta1 * Math.PI / 180) * Py) * (Math.Cos(seta1 * Math.PI / 180) * Px + Math.Sin(seta1 * Math.PI / 180) * Py)));
c23 = ((a2 * Math.Sin(seta3 * Math.PI / 180) - d4) * Pz + (a3 + a2 * Math.Cos(seta3 * Math.PI / 180)) * (Math.Cos(seta1 * Math.PI / 180) * Px + Math.Sin(seta1 * Math.PI / 180) * Py)) / (Pz * Pz + ((Math.Cos(seta1 * Math.PI / 180) * Px + Math.Sin(seta1 * Math.PI / 180) * Py) * (Math.Cos(seta1 * Math.PI / 180) * Px + Math.Sin(seta1 * Math.PI / 180) * Py)));
seta4 = 180 - (180 / Math.PI) * Math.Atan2((-r13 * Math.Sin(seta1 * Math.PI / 180)) + (r23 * Math.Cos(seta1 * Math.PI / 180)), (-r13 * Math.Cos(seta1 * Math.PI / 180) * c23) - (r23 * Math.Sin(seta1 * Math.PI / 180) * c23) + (r33 * s23));
//หาองศาที่ 5
s5 = r13 * (Math.Cos(seta1 * Math.PI / 180) * c23 * Math.Cos(seta4 * Math.PI / 180) + Math.Sin(seta1 * Math.PI / 180) * Math.Sin(seta4 * Math.PI / 180)) + r23 * (Math.Sin(seta1 * Math.PI / 180) * c23 * Math.Cos(seta4 * Math.PI / 180) - Math.Cos(seta1 * Math.PI / 180) * Math.Sin(seta4 * Math.PI / 180)) - r33 * (s23 * Math.Cos(seta4 * Math.PI / 180));
c5 = r13 * (-Math.Cos(seta1 * Math.PI / 180) * s23) + r23 * (-Math.Sin(seta1 * Math.PI / 180) * s23) + r33 * (-c23);
seta5 = (180 / Math.PI) * Math.Atan2(-s5, c5);
seta5_n = seta5 + 3;
```

```
            //หาองศาที่ 6
            s6 = -r11 * (Math.Cos(seta1 * Math.PI / 180) * c23 * Math.Sin(seta4 * Math.PI /
180) - Math.Sin(seta1 * Math.PI / 180) * Math.Cos(seta4 * Math.PI / 180)) - r21 *
(Math.Sin(seta1 * Math.PI / 180) * c23 * Math.Sin(seta4 * Math.PI / 180) +
Math.Cos(seta1 * Math.PI / 180) * Math.Cos(seta4 * Math.PI / 180)) + r31 * (s23 *
Math.Sin(seta4 * Math.PI / 180));
            c6 = r11 * ((Math.Cos(seta1 * Math.PI / 180) * c23 * Math.Cos(seta4 * Math.PI
/ 180) + Math.Sin(seta1 * Math.PI / 180) * Math.Sin(seta4 * Math.PI / 180)) *
Math.Cos(seta5 * Math.PI / 180) - Math.Cos(seta1 * Math.PI / 180) * s23 *
Math.Sin(seta5 * Math.PI / 180)) + r21 * ((Math.Sin(seta1 * Math.PI / 180) * c23 *
Math.Cos(seta4 * Math.PI / 180) - Math.Cos(seta1 * Math.PI / 180) * Math.Sin(seta4 *
Math.PI / 180)) * Math.Cos(seta5 * Math.PI / 180) - Math.Sin(seta1 * Math.PI / 180) *
s23 * Math.Sin(seta5 * Math.PI / 180)) - r31 * (s23 * Math.Cos(seta4 * Math.PI / 180) *
Math.Cos(seta5 * Math.PI / 180) + c23 * Math.Sin(seta5 * Math.PI / 180));
            seta6 = (180 / Math.PI) * Math.Atan2(s6, c6);
        }
        private void label_value()
        {
            txt1.Text = "แกนที่ 1 = " + ang1.Value.ToString() + " องศา";
            txt2.Text = "แกนที่ 2 = " + ang2.Value.ToString() + " องศา";
            txt3.Text = "แกนที่ 3 = " + ang3.Value.ToString() + " องศา";
            txt4.Text = "แกนที่ 4 = " + ang4.Value.ToString() + " องศา";
            txt5.Text = "แกนที่ 5 = " + ang5.Value.ToString() + " องศา";
            txt6.Text = "แกนที่ 6 = " + ang6.Value.ToString() + " องศา";
        }
    }
}
```