LAMPIRAN A

PROGRAM ARDUINO

Program Robot Manipulator dengan Komunikasi Intranet menggunakan Teori Kinematika Invers

Memasukkan Library

```
#include <SPI.h>
#include <Ethernet.h>
#include <ServoShield.h>
#define L1 10.500      //tinggi base
#define L2 12.500      //panjang shoulder ke elbow
#define L3 12.00        //panjang elbow ke wrist
#define L4 11.00          //panjang wrist ke gripper
```

Deklarasi Variabel

```
//konversi float ke long
#define ftl(x) ((x)>=0?(long)((x)+0.5):(long)((x)-0.5))
//deklarasi variabel servo
#define BAS_SERVO 0
/* Shoulder Servo HS-5745-MG */
#define SHL_SERVO 1
/* Elbow Servo HITec HS-5745-MG */
#define ELB_SERVO 2
/* Wrist servo HS-645MG */
#define WRI_SERVO 3
/* Wrist rotate servo HS-485HB */
#define WRO_SERVO 4
/* Gripper servo HS-422 */
#define GRI_SERVO 5

#define SHL_SERVO2 6
float L2_sq = L2*L2;
float L3_sq = L3*L3;
ServoShield servos;                        //ServoShield
```

Deklarasi alamat IP

```
byte mac[] = { 0x90, 0xA2, 0xDA, 0x0D, 0x78, 0xEC };
byte ip[] = { 192, 168, 3, 50 }; // ip di lan
byte gateway[] = { 192, 168, 1, 1 }; // internet akses via router
byte subnet[] = { 255, 255, 255, 0 }; //subnetmask
Server server(80); //server port
String readString;
String xawal = String(100);
String yawal = String(100);
String zawal = String(100);
String xakhir = String(100);
String yakhir = String(100);
```

```
String zakhir = String(100);
String flag = String(2);
int a1 = 0;
int b1 = 0;
int a2 = 0;
int b2 = 0;
int a3 = 0;
int b3 = 0;
int a4 = 0;
int b4 = 0;
int a5 = 0;
int b5 = 0;
int a6 = 0;
int b6 = 0;
int a7 = 0;
int b7 = 0;
int q=0;
int m=0;
int n=0;
int t=0;
int k=0;
int u=0;
int xinisialisasi =0;
int yinisialisasi =0;
int zinisialisasi =0;
float fxawal,fyawal,fzawal,fxakhir,fyakhir,fzakhir,xawalinput;
int solusi = 0;
unsigned int ixawal,iyawal,izawal,ixakhir,iyakhir,izakhir;
void setup(){
  Ethernet.begin(mac, ip, gateway, subnet);
  server.begin();
  Serial.begin(9600);
  servos.setbounds( BAS_SERVO, 900, 2100 );
  servos.setbounds( SHL_SERVO, 1000, 2100 );
  servos.setbounds( ELB_SERVO, 900, 2100 );
  servos.setbounds( WRI_SERVO, 600, 2400 );
  servos.setbounds( WRO_SERVO, 600, 2400 );
  servos.setbounds( GRI_SERVO, 600, 2400 );
  /**/
  servos.start();                          //Start the servo shield
  //posisi awal
  servo_park();
}
```

Program Utama

```
void loop()
{
  int sensorValue = analogRead(A0);
  // Create a client connection
  Client client = server.available();
  if (client) {
    while (client.connected()) {
      if (client.available()) {
        char c = client.read();
//membaca karakter dari request HTTP
//menyimpan pembacaaan pada variabel string
          readString += c;
```

Proses pembacaan perintah dari GUI VB 6.0

```
        if (c == '\n') {
           Serial.println(readString);
   if (readString.indexOf("a") >= 0) {
      a1 = readString.indexOf('a');
      b1 = readString.indexOf('b');

      if (readString.charAt(a1+1) == '-'){
        xawal = readString.substring(a1+2,b1);
        xinisialisasi=1;
      }
      else {
        xawal = readString.substring(a1+1, b1);
        xinisialisasi=0;
      }
      Serial.println(xawal);
     }
      if (readString.indexOf("c") >= 0) {
      a2 = readString.indexOf('c');
      b2 = readString.indexOf('d');
      yawal = readString.substring(a2+1, b2);
    Serial.println(yawal);
    }
       if (readString.indexOf("e") >= 0) {
      a3 = readString.indexOf('e');
      b3 = readString.indexOf('f');
      zawal = readString.substring(a3+1, b3);
    Serial.println(zawal);
   }
//      if (readString.indexOf("g") >= 0) {
//      a4 = readString.indexOf('g');
```

```
//      b4 = readString.indexOf('h');
//      xakhir = readString.substring(a4+1, b4);
//      Serial.println(xakhir);
//     }
//      if (readString.indexOf("i") >= 0) {
//      a5 = readString.indexOf('i');
//      b5 = readString.indexOf('j');
//      yakhir = readString.substring(a5+1, b5);
//    Serial.println(yakhir);
//    }
//       if (readString.indexOf("k") >= 0) {
//      a6 = readString.indexOf('k');
//      b6 = readString.indexOf('l');
//      zakhir = readString.substring(a6+1, b6);
//    Serial.println(zakhir);
//   }

    ixawal=xawal.toInt();
    iyawal=yawal.toInt();
    izawal=zawal.toInt();
    fxawal=(float)ixawal;
    fyawal=(float)iyawal;
    fzawal=(float)izawal;
    if (xinisialisasi == 1){
      xawalinput = 0 - fxawal ;
    }
    else if (xinisialisasi==0){
      xawalinput=fxawal;
    }
//    ixakhir=xakhir.toInt();
//    iyakhir=yakhir.toInt();
//    izakhir=zakhir.toInt();
      //Serial.println("minus");
//    fxakhir=(float)ixakhir;
//    fyakhir=(float)iyakhir;
//    fzakhir=(float)izakhir;
```

Program untuk Menggerakkan Robot

```
      if(readString.indexOf("f") >=0)
          {
//      servos.setposition( GRI_SERVO, 900 );
//      delay(1000);
    Serial.println(xawalinput);
      set_arm( xawalinput , fyawal, fzawal, 0 );
      delay(3000);
```

```
//      servos.setposition( GRI_SERVO, 1500 );
//      delay(1000);
//      set_arm( fxakhir, fyakhir, fzakhir, 0 );
//      delay(1000);
      //servo_park();
      //delay(3000);
          }
     if (solusi==2){
     client.print("xt");
     Serial.println("xt");
     //client.print("s");
     //Serial.println("xs");
      }
     else if (solusi==1) {
     client.print("xs");
     Serial.println("xs");
     servo_park();
      }
```

Program Buka Gripper Robot

```
  if(readString.indexOf("o") >=0)
{
   servos.setposition( GRI_SERVO, 900 );
}
```

Program Menutup Gripper Robot dan Mengirim nilai Sensor

```
  if(readString.indexOf("l") >=0)
  {
  String sensorV=String(sensorValue);
 client.print(sensorV);
  Serial.println(sensorV);
   servos.setposition( GRI_SERVO, 1600 );
  }
      readString="";
          }
      }
    }
  }
}
```

Sub Program Inverse Kinematics

```
void set_arm( float x, float y, float z, float grip_angle_d )
{
 float grip_angle_r = radians( grip_angle_d );    //grip angle in
radians for use in calculations
  /* Base angle and radial distance from x,y coordinates */
  float bas_angle_r = atan2( x, y );
  float rdist = sqrt(( x * x ) + ( y * y ));
```

```
  /* rdist is y coordinate for the arm */
  y = rdist;
  /* Grip offsets calculated based on grip angle */
  float grip_off_z = ( sin( grip_angle_r )) * L4;
  float grip_off_y = ( cos( grip_angle_r )) * L4;
  /* Wrist position */
  float wrist_z = ( z - grip_off_z ) - L1;
  float wrist_y = y - grip_off_y;
  /* Shoulder to wrist distance ( AKA sw ) */
  float s_w = ( wrist_z * wrist_z ) + ( wrist_y * wrist_y );
  float s_w_sqrt = sqrt( s_w );
  /* s_w angle to ground */
  //float a1 = atan2( wrist_y, wrist_z );
  float a1 = atan2( wrist_z, wrist_y );
  /* s_w angle to humerus */
  float a2 = acos((( L2_sq - L3_sq ) + s_w ) / ( 2 * L2 * s_w_sqrt
));
  /* shoulder angle */
  float shl_angle_r = a1 + a2;
  float shl_angle_d = degrees( shl_angle_r );
  /* elbow angle */
  float elb_angle_r = acos(( L2_sq + L3_sq - s_w ) / ( 2 * L2 * L3
));
  float elb_angle_d = degrees( elb_angle_r );
  float elb_angle_dn = -( 180.0 - elb_angle_d );
  /* wrist angle */
  float wri_angle_d = ( grip_angle_d - elb_angle_dn ) - shl_angle_d;

  /* Servo pulses */
  float bas_servopulse = 1500.0 - (( degrees( bas_angle_r )) * 11.11
);
  float shl_servopulse = 500 + (shl_angle_d * 11.11);//1500.0 - ((
shl_angle_d - 90.0 ) * 6.6 );
  float elb_servopulse = 2350 - (elb_angle_d * 11.11);//1500.0 -  ((
elb_angle_d - 90.0 ) * 6.6 )
  float wri_servopulse = 1500 + ( wri_angle_d  * 11.11 );

int pulsabase = 0;
int pulsashoulder = 0;
int pulsaelbow=0;
int pulsawrist=0;
pulsabase=(int)bas_servopulse;
pulsashoulder=(int)shl_servopulse;
pulsaelbow=(int)elb_servopulse;
pulsawrist=(int)wri_servopulse;
```

```
Serial.println(pulsabase);
Serial.println(pulsashoulder);
Serial.println(pulsaelbow);
Serial.println(pulsawrist);
////bila tidak ada solusi
  if ( pulsabase >= 2100){
   solusi=1;
   bas_servopulse=2100;
  }
  else if (pulsabase <= 900)
  {
   bas_servopulse=900;
    solusi=1;
  }
  else if (pulsashoulder  <= 500)
  {
    shl_servopulse=900;
    solusi=1;
  }
  else if (pulsashoulder  >= 2100)
  {
    shl_servopulse=2100;
  solusi=1;
  }
  else if (pulsawrist <= 900)
 {
   wri_servopulse=900;
  solusi=1;
 }
 else if (pulsawrist  >= 2100)
{
  wri_servopulse=2100;
 solusi=1;
}
else if (pulsaelbow <= 900)
{
  elb_servopulse=900;
  solusi=1;
}
else if (pulsaelbow >= 2100)
{
  //elb_servopulse=2100;
  solusi=1;
}
else {
```

```
  solusi=2;
}

  /* Set servos */
  servos.setposition( BAS_SERVO, ftl( bas_servopulse ));
  servos.setposition( WRI_SERVO, ftl( wri_servopulse ));
  servos.setposition( SHL_SERVO, ftl( shl_servopulse ));
  servos.setposition( SHL_SERVO2, ftl( shl_servopulse ));
  servos.setposition( ELB_SERVO, ftl( elb_servopulse ));
}
```

Posisi Awal

```
void servo_park()
{
  servos.setposition( BAS_SERVO, 1500 );
  servos.setposition( SHL_SERVO, 1500 );
  servos.setposition( ELB_SERVO, 1350 );
  servos.setposition( WRI_SERVO, 1500 );
  servos.setposition( WRO_SERVO, 1500);
  servos.setposition( GRI_SERVO, 1500 );
  return;
}
```

LAMPIRAN B
PROGRAM VISUAL BASIC

Proses Pengiriman Data Koordinat Objek

```
Private Sub Command1_Click()

'Dim xakhir As String
'Dim yakhir As String
'Dim zakhir As String
Dim xawal As String
Dim yawal As String
Dim zawal As String
Dim angle As Double
Dim X1 As Double, Y1 As Double
Dim X2 As Double, Y2 As Double
Dim Xi As Double, Yi As Double, Zi As Double
Dim Ri As Double

'L1 = 650
'L2 = 50
'L3 = 50
'L4 = 50
'L1su = 10.5
'L2su = 12.5
'L3su = 12
'L4su = 11
'Dim xakhir As String
'Dim yakhir As String
'Dim zakhir As String
xawal = "a" + Text1.Text + "b"
yawal = "c" + Text2.Text + "d"
zawal = "e" + Text3.Text + "f"
'xakhir = "g" + Text4.Text + "h"
'yakhir = "i" + Text5.Text + "j"
'zakhir = "k" + Text6.Text + "l"
Winsock1.SendData (xawal & vbCrLf)
Winsock1.SendData (yawal & vbCrLf)
Winsock1.SendData (zawal & vbCrLf)
'Winsock1.SendData (xakhir & vbCrLf)
'Winsock1.SendData (yakhir & vbCrLf)
'Winsock1.SendData (zakhir & vbCrLf)
Picture2.Line (0, 500)-(4500, 500), vbRed

  X1 = 2250
  Y1 = 500
  'Ri = 1000
  Xi = CDbl(Text1.Text)
  Yi = CDbl(Text2.Text)
  zd = 22 * 70
  'Zi = CDbl(Text3.Text)
  angle = Atan2(Yi, Xi)
   Ri = (Sqr(Xi * Xi + Yi * Yi)) * 35
  'Angle = CDbl(Text1.Text) / 180 * 3.14159625  ' Convert to radians
```

```
X2 = X1 + Cos(angle) * Ri
Y2 = Y1 + Sin(angle) * Ri

 Picture2.Line (X1, Y1)-(X2, Y2), vbBlue
 'x4 = Sin(0) * L4
 'y4 = Cos(0) * L4
 'x33 = 1500 - (x4 - Ri)
 'y33 = 1500 - ((zd - y4) - L1)
 'x4hi = Cos(0) * L4su
 'y4hi = Sin(0) * L4su
 'x3 = (x4hi - (Sqr(Xi * Xi + Yi * Yi)))
 'y3 = ((Zi - y4hi) - L1su)
 'sw = Sqr((x3 * x3) + (y3 * y3))
 'L2s = L2su * L2su
 'L3s = L3su * L3su
 'a1 = Atan2(y3, x3)
 'a2 = acos((L2s - L3s + sw) / (2 * L2su * sw))
 'angle1 = a1 + a2
 'angle2 = acos((L2s + L3s - sw) / (2 * L2su * L3))
 'angle3 = (0 - (180 - angle2) - angle3)
   'If angle1 < 90 Then
 'angle1s = angle1
 'xs = 1500 + Cos(angle1s) * L1
 'ys = 1500 + Sin(angle1s) * L1
 'ElseIf angle1 > 90 Then
 'angle1s = angle1 - 90
 'xs = 1500 - Sin(angle1s) * L1
 'ys = 1500 - Cos(angle1s) * L1
 ' ElseIf angle2 > 90 Then
 'angle2s = angle2
 'xe = xs + Cos(angle2s) * L2
 'ye = ys + Cos(angle2s) * L2
 'ElseIf angle2 < 90 Then
 'angle2s = angle2 - 90
 'xe = xs - Sin(angle2s) * L2
 'ye = ys - Sin(angle2s) * L2
 'ElseIf angle3 < 90 Then
 'angle3s = angle3
 'xw = xe + Sin(angle3s) * L3
 'yw = ye + Cos(angle3s) * L3
 'ElseIf angle3 > 90 Then
 'angle3s = angle3 - 90
 'xw = xe + Cos(angle3s) * L3
 'yw = ye - Sin(angle3s) * L3
 'End If
 'xs = 1500 - Cos(angle1) * L1
 'ys = 1500 + Sin(angle1) * L1
 'xe = xs + Cos(angle2) * L2
 'ye = ys - Sin(angle2) * L2
 'xw = x3 + Cos(angle3) * L4
 'yw = y3 - Sin(angle3) * L4
```

```
  'Text4.Text = angle1
  'Text5.Text = angle2
  'Text6.Text = angle3
  'Picture1.Line (1500, 1500)-(x33, y33), vbGreen
  'Picture1.Line (xs, ys)-(xe, ye), vbBlue
  'Picture1.Line (xe, ye)-(xw, yw), vbRed
End Sub
```

Perintah Buka Gripper

```
Private Sub Command2_Click()
Dim strOpen As String
strOpen = "open"
Winsock1.SendData (strOpen & vbCrLf)
Text7.Text = ""
End Sub
```

Perintah Tutup Gripper

```
Private Sub Command3_Click()
Dim strClose As String
strClose = "close"
Winsock1.SendData (strClose & vbCrLf)

End Sub
Public Function acos(ByVal x As Double) As Double
acos = Atan2(Sqr(1 - x * x), x)
End Function

 Public Function Atan2(ByVal y As Double, ByVal x As Double) As
Double
 Dim Pi As Double
Pi = 3.14159265358979
    If y > 0 Then
      If x >= y Then
        Atan2 = Atn(y / x)
      ElseIf x <= -y Then
        Atan2 = Atn(y / x) + Pi
      Else
        Atan2 = Pi / 2 - Atn(x / y)
      End If
    Else
      If x >= -y Then
        Atan2 = Atn(y / x)
      ElseIf x <= y Then
        Atan2 = Atn(y / x) - Pi
      Else
        Atan2 = -Atn(x / y) - Pi / 2
      End If
    End If

  End Function
```

```
Private Sub Command4_Click()
Unload Me
End Sub
```

Program Koneksi ke alamat IP Arduino dan Tampilan Kamera PC Tablet

```
Private Sub Form_Load()
Winsock1.Connect "192.168.3.50.", "80"
Text7.Text = ""
Text4.Text = ""
Dim alamat As String
alamat = "http://192.168.43.1:8080/js.html"
WebBrowser1.Navigate (alamat)
'jsfs.html
End Sub

Private Sub Winsock1_Connect()
MsgBox "Connection established"
End Sub
```

Program Baca Nilai Sensor dan Hasil Inverse Kinematics

```
Private Sub Winsock1_DataArrival(ByVal bytesTotal As Long)
Dim strSensor As String
Dim solusi As String
Dim sensor As String
Dim w As Integer
Dim wi As Integer
Dim g As Integer
'strSensor = String(bytesTotal + 2, Chr$(0))
Winsock1.GetData strSensor, vbString, bytesTotal
g = InStr(strSensor, "x")
w = InStr(strSensor, "s")
wi = InStr(strSensor, "t")
If g = 0 Then
Text7.Text = Text7.Text & _
            strSensor
'Text4.Text = g
'ElseIf InStr(strSensor, "x") <= 0 Then

'solusi = Mid$(strSensor, 1, 1)
ElseIf wi = 2 Then
'Label6.Caption = "OUTRANGE"
Text7.Text = ""
Text4.Text = "Ada Solusi"
ElseIf w = 2 Then
'Label6.Caption = "INRANGE"
Text7.Text = ""
Text4.Text = "tidak ada solusi"
End If
```

```
End Sub

Private Sub Winsock1_Error(ByVal Number As Integer, Description As
String, ByVal Scode As Long, ByVal Source As String, ByVal HelpFile
As String, ByVal HelpContext As Long, CancelDisplay As Boolean)
Winshock1.Close
End Sub
```