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LAMPIRAN

Lampiran 2 Program Delphi Simulasi Invers Kinematika menggunakan metode kartesius

```
unit Unit1;
```

```
interface
```

```
uses
```

```
Winapi.Windows, Winapi.Messages, System.SysUtils, System.Variants, System.Classes,  
Vcl.Graphics,
```

```
Vcl.Controls, Vcl.Forms, Vcl.Dialogs, Vcl.StdCtrls, math, Vcl.ExtCtrls;
```

```
type
```

```
TForm1 = class(TForm)
```

```
  ScrollBar1: TScrollBar;
```

```
  ScrollBar2: TScrollBar;
```

```
  ScrollBar3: TScrollBar;
```

```
  Button2: TButton;
```

```
  Button3: TButton;
```

```
  Image1: TImage;
```

```
  Image2: TImage;
```

```
  Button5: TButton;
```

```
  Memo1: TMemo;
```

```
  Label1: TLabel;
```

```
  Label3: TLabel;
```

```
  Button6: TButton;
```

```
  Label4: TLabel;
```

```
  Label5: TLabel;
```

```
  Label6: TLabel;
```

```
  Label7: TLabel;
```

```
  Label8: TLabel;
```

```
  Label9: TLabel;
```

```
Label2: TLabel;
Edit1: TEdit;
Edit2: TEdit;
Edit3: TEdit;
Edit4: TEdit;
Edit5: TEdit;
Edit6: TEdit;
Edit7: TEdit;
Edit8: TEdit;
Edit9: TEdit;
Edit10: TEdit;
Edit11: TEdit;
Edit12: TEdit;
Edit13: TEdit;
Edit14: TEdit;
Edit15: TEdit;
Edit16: TEdit;
Edit17: TEdit;
Edit18: TEdit;
procedure FormShow(Sender: TObject);
procedure Button5Click(Sender: TObject);
procedure ScrollBar1Change(Sender: TObject);
procedure ScrollBar2Change(Sender: TObject);
procedure ScrollBar3Change(Sender: TObject);
procedure Button6Click(Sender: TObject);
procedure Button3Click(Sender: TObject);
procedure Button2Click(Sender: TObject);
private
  { Private declarations }
public
  { Public declarations }
end;

var
  Form1: TForm1;
```

V,W,X,Y : integer;

implementation

{\$R *.dfm}

procedure TForm1.Button2Click(Sender: TObject); //SEGITIGA TRAY

var

//Lenght

l1,l2,l3 : integer;

//trigono

cos1,cos2,cos3,sin1,sin2,sin3,tan1,tan2,tan3 : real;

//teta

teta1,teta2,teta3,teta22,teta21 : real;

//koordinat

Py,Px,Pz ,x1,y1,x2,y2: real;

gx1,gy1,gx2,gy2,gx3,gy3,gx4,gy4,gx5,gy5,gx6,gy6,gx7,gy7 : integer;

//bebas

D,r: real;

a,b,c3,s3,e ,a1,b1,a2,b2,a3,b3: real;

begin

 //konstant

 l1 := 40;

 l2 := 50;

 l3 := 60;

 //Input

 Px := 30;

 Py := 30;

 Pz := 30;

 r := sqrt (sqr (Px) + sqr (Py));

 //teta1

 teta1 := ArcTan (Py / Px);

 teta1 := RadToDeg (teta1);

 //teta3

```

c3 := ((sqr (Px) + sqr (Py) + sqr (Pz - l1) - sqr (l2) - sqr (l3)) / (2 * l2 * l3));
s3 := sqrt (1 - sqr (c3));
teta3 := ArcTan (s3 / c3);
teta3 := RadToDeg (teta3);

```

```

//teta2
teta2 := ArcTan ((l3 * s3) / (l2 + (l3 * c3)));
teta2 := RadToDeg (teta2);

```

```

x1 := (Cos (PI * (teta2 / 180)) * l2);
y1 := (Sin (PI * (teta2 / 180)) * l2);
y1 := y1 + l1 ;

```

```

//IMAGE
Image2.Canvas.Pen.Color := clGreen; //proses Image1 L1
Image2.Canvas.Pen.Width := 5;
Image2.Canvas.MoveTo (V,W);
Image2.Canvas.LineTo (V,W - l1 );

```

```

gx1 := round (x1);
gy1 := round (y1);
Image2.Canvas.Pen.Color := clRed; //proses Image1 L2
Image2.Canvas.Pen.Width := 5;
Image2.Canvas.MoveTo (V,W - l1);
Image2.Canvas.LineTo (V + gx1,W - gy1 );

```

```

gx2 := round (r);
gy2 := round (Pz);
Image2.Canvas.Pen.Color := clBlue; //proses Image1 L3
Image2.Canvas.Pen.Width := 5;
Image2.Canvas.MoveTo (V + gx1 ,W - gy1 );
Image2.Canvas.LineTo (V + gx2,W - gy2);

```

```

//SEGITIGA

```

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```

gx3 := round (42);
gy3 := round (30);
Image2.Canvas.Pen.Color := clYellow; //proses trayektori
Image2.Canvas.Pen.Width := 6;
Image2.Canvas.MoveTo (V + gx3 ,W - gy3 );
Image2.Canvas.LineTo (V + gx3,W - gy3);

gx4 := round (64);
gy4 := round (30);
Image2.Canvas.Pen.Color := clYellow; //proses trayektori
Image2.Canvas.Pen.Width := 6;
Image2.Canvas.MoveTo (V + gx3 ,W - gy3 );
Image2.Canvas.LineTo (V + gx4,W - gy4);

gx5 := round (53);
gy5 := round (50);
Image2.Canvas.Pen.Color := clYellow; //proses trayektori
Image2.Canvas.Pen.Width := 6;
Image2.Canvas.MoveTo (V + gx4 ,W - gy4 );
Image2.Canvas.LineTo (V + gx5,W - gy5);

gx6 := round (42);
gy6 := round (30);
Image2.Canvas.Pen.Color := clYellow; //proses trayektori
Image2.Canvas.Pen.Width := 6;
Image2.Canvas.MoveTo (V + gx5 ,W - gy5 );
Image2.Canvas.LineTo (V + gx6,W - gy6);

end;

procedure TForm1.Button3Click(Sender: TObject); //PERSEGI TRAY
var
//Lenght
l1,l2,l3 : integer;

```

```

//trigono
cos1,cos2,cos3,sin1,sin2,sin3,tan1,tan2,tan3 : real;
//teta
teta1,teta2,teta3,teta22,teta21 : real;
//koordinat
Py,Px,Pz ,x1,y1,x2,y2: real;
gx1,gy1,gx2,gy2,gx3,gy3,gx4,gy4,gx5,gy5,gx6,gy6,gx7,gy7 : integer;
//bebas
D,r: real;
a,b,c3,s3,e ,a1,b1,a2,b2,a3,b3: real;
begin
  //konstant
  l1 := 40;
  l2 := 50;
  l3 := 60;
  //Input
  Px := 30;
  Py := 30;
  Pz := 30;

  r := sqrt (sqr (Px) + sqr (Py));
  //teta1
  teta1 := ArcTan (Py / Px);
  teta1 := RadToDeg (teta1);
  //teta3
  c3 := ((sqr (Px) + sqr (Py) + sqr (Pz - l1) - sqr (l2) - sqr (l3)) / (2 * l2 * l3));
  s3 := sqrt (1 - sqr (c3));
  teta3 := ArcTan (s3 / c3);
  teta3 := RadToDeg (teta3);

  //teta2
  teta2 := ArcTan ((l3 * s3) / (l2 + (l3 * c3)));
  teta2 := RadToDeg (teta2);

```



```

x1 := (Cos (PI * (teta2 / 180)) * l2);
y1 := (Sin (PI * (teta2 / 180)) * l2);
y1 := y1 + l1 ;

```

```
//IMAGE
```

```
Image2.Canvas.Pen.Color := clGreen; //proses Image1 L1
```

```
Image2.Canvas.Pen.Width := 5;
```

```
Image2.Canvas.MoveTo (V,W);
```

```
Image2.Canvas.LineTo (V,W - l1 );
```

```
gx1 := round (x1);
```

```
gy1 := round (y1);
```

```
Image2.Canvas.Pen.Color := clRed; //proses Image1 L2
```

```
Image2.Canvas.Pen.Width := 5;
```

```
Image2.Canvas.MoveTo (V,W - l1);
```

```
Image2.Canvas.LineTo (V + gx1,W - gy1 );
```

```
gx2 := round (r);
```

```
gy2 := round (Pz);
```

```
Image2.Canvas.Pen.Color := clBlue; //proses Image1 L3
```

```
Image2.Canvas.Pen.Width := 5;
```

```
Image2.Canvas.MoveTo (V + gx1 ,W - gy1 );
```

```
Image2.Canvas.LineTo (V + gx2,W - gy2);
```

```
//PERSEGI
```

```
gx3 := round (42);
```

```
gy3 := round (30);
```

```
Image2.Canvas.Pen.Color := clYellow; //proses trayektori
```

```
Image2.Canvas.Pen.Width := 6;
```

```
Image2.Canvas.MoveTo (V + gx3 ,W - gy3 );
```

```
Image2.Canvas.LineTo (V + gx3,W - gy3);
```

```
gx4 := round (42);
```

```
gy4 := round (50);
```

```
Image2.Canvas.Pen.Color := clYellow; //proses trayektori
```

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```

Image2.Canvas.Pen.Width := 6;
Image2.Canvas.MoveTo (V + gx3 ,W - gy3 );
Image2.Canvas.LineTo (V + gx4,W - gy4);

gx5 := round (63);
gy5 := round (50);
Image2.Canvas.Pen.Color := clYellow; //proses trayektori
Image2.Canvas.Pen.Width := 6;
Image2.Canvas.MoveTo (V + gx4 ,W - gy4 );
Image2.Canvas.LineTo (V + gx5,W - gy5);

gx6 := round (63);
gy6 := round (30);
Image2.Canvas.Pen.Color := clYellow; //proses trayektori
Image2.Canvas.Pen.Width := 6;
Image2.Canvas.MoveTo (V + gx5 ,W - gy5 );
Image2.Canvas.LineTo (V + gx6,W - gy6);

gx7 := round (43);
gy7 := round (30);
Image2.Canvas.Pen.Color := clYellow; //proses trayektori
Image2.Canvas.Pen.Width := 6;
Image2.Canvas.MoveTo (V + gx6 ,W - gy6 );
Image2.Canvas.LineTo (V + gx7,W - gy7);
end;

procedure TForm1.Button5Click(Sender: TObject);    //PROSES
var
//Lenght
l1,l2,l3 : integer;
//trigono
cos1,cos2,cos3,sin1,sin2,sin3,tan1,tan2,tan3 : real;
//teta
teta1,teta2,teta3,teta22,teta21 : real;
//koordinat

```

```

Py,Px,Pz ,x1,y1,x2,y2: real;
gx1,gy1,gx2,gy2,gx3,gy3 : integer;
//bebas
D,r: real;
a,b,c3,s3,e : real;
dik,dis,Data : String;

begin
//konstant
l1 := 40;
l2 := 50;
l3 := 60;
//Input
Px := StrToFloat (Edit1.Text);
Py := StrToFloat (Edit2.Text);
Pz := StrToFloat (Edit3.Text);

r := sqrt (sqr (Px) + sqr (Py));
//teta1
teta1 := ArcTan (Py / Px);
teta1 := RadToDeg (teta1);
//teta3
c3 := ((sqr (Px) + sqr (Py) + sqr (Pz - l1) - sqr (l2) - sqr (l3)) / (2 * l2 * l3));
s3 := sqrt (1 - sqr (c3));
teta3 := ArcTan (s3 / c3);
teta3 := RadToDeg (teta3);

//teta2
teta2 := ArcTan ((l3 * s3) / (l2 + (l3 * c3)));
teta2 := RadToDeg (teta2);

//OUTPUT

```

```
Edit16.Text := FloatToStr (teta1);
Edit17.Text := FloatToStr (teta2);
Edit18.Text := FloatToStr (teta3);
Edit4.Text := IntToStr (round (teta1));
Edit5.Text := IntToStr (round (teta2));
Edit6.Text := IntToStr (round (teta3));

//itung IMAGE
//L2
x1 := (Cos (PI * (teta2 / 180)) * l2);
y1 := (Sin (PI * (teta2 / 180)) * l2);
y1 := y1 + l1 ;

//MEMO
dik := Edit1.Text + ', ' + Edit2.Text + ', ' + Edit3.Text;
dis := ' | ' + Edit4.Text + ' | ' + Edit5.Text + ' | ' + Edit6.Text;
Data := dik + dis;
Memo1.Lines.Add(Data) ;

//Display Data
Edit8.Text := FloatToStr (e);

//IMAGE
Image2.Canvas.Pen.Color := clGreen; //proses Image1 L1
```

```
Image2.Canvas.Pen.Width := 5;
Image2.Canvas.MoveTo (V,W);
Image2.Canvas.LineTo (V,W - l1 );

gx1 := round (x1);
gy1 := round (y1);
Image2.Canvas.Pen.Color := clRed; //proses Image1 L2
Image2.Canvas.Pen.Width := 5;
Image2.Canvas.MoveTo (V,W - l1);
Image2.Canvas.LineTo (V + gx1,W - gy1 );

gx2 := round (r);
gy2 := round (Pz);
Image2.Canvas.Pen.Color := clBlue; //proses Image1 L2
Image2.Canvas.Pen.Width := 5;
Image2.Canvas.MoveTo (V + gx1 ,W - gy1 );
Image2.Canvas.LineTo (V + gx2,W - gy2);

end;

procedure TForm1.Button6Click(Sender: TObject);
begin
Image1.Canvas.Pen.Color := clWhite;
Image1.Canvas.Pen.Width := 2;
Image1.Canvas.Pen.Style := psSolid;
```

```
Image1.Canvas.Rectangle (0,0,Image1.Width,Image1.Height);
Form1.FormShow (NIL) ;
```

```
Image2.Canvas.Pen.Color := clWhite;
Image2.Canvas.Pen.Width := 2;
Image2.Canvas.Pen.Style := psSolid;
```

```
Image2.Canvas.Rectangle (0,0,Image2.Width,Image2.Height);
Form1.FormShow (NIL) ;
end;
```

```
procedure TForm1.FormShow(Sender: TObject);
```

```
begin
```

```
    V := Image1.Width div 2;           //Atas
```

```
    W := Image1.Height div 2;
```

```
Image1.Canvas.Pen.Color := clBlack;
```

```
Image1.Canvas.Pen.Style := psDOT;
```

```
Image1.Canvas.Pen.Width := 1;
```

```
Image1.Canvas.MoveTo (V,0);
```

```
Image1.Canvas.LineTo (V,Image1.Height);
```

```
Image1.Canvas.MoveTo (0,W);
```

```
Image1.Canvas.LineTo (Image1.Width, W);
```

```
    X := Image1.Width div 2;           //Samping
```

```
    Y := Image1.Height div 2;
```

```
Image2.Canvas.Pen.Color := clBlack;
```

```
Image2.Canvas.Pen.Style := psDOT;
```

```
Image2.Canvas.Pen.Width := 1;
```

```
Image2.Canvas.MoveTo (X,0);
```

```
Image2.Canvas.LineTo (X,Image2.Height);
```

```
Image2.Canvas.MoveTo (0,Y);
```

```
Image2.Canvas.LineTo (Image2.Width, Y);
```

```
end;
```

```
procedure TForm1.ScrollBar1Change(Sender: TObject);  
begin  
Edit1.Text := IntToStr (ScrollBar1.Position);  
end;
```

```
procedure TForm1.ScrollBar2Change(Sender: TObject);  
begin  
Edit2.Text := IntToStr (ScrollBar2.Position);  
end;
```

```
procedure TForm1.ScrollBar3Change(Sender: TObject);  
begin  
Edit3.Text := IntToStr (ScrollBar3.Position);  
end;
```

```
end.
```

Lampiran 2 Gambar Aplikasi Final

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INVERS KINEMATIKA

TOP VIEW

SIDE VIEW

INPUT

30

30

30

OUTPUT

45

79

-46

TRAYEKTORI

Memo1
30, 30, 30 || 45 | 79 | -46

No	Px	Py	Pz	P _x ²	P _y ²	(P _x - L ₁) ²	L ₂	L ₃	C ₁	C ₂	S ₁	θ ₁	θ ₂	θ ₃	L1= 40	L2= 50	L3= 60
1	40	41	40	1600	1681	0	2500	3600	-0.47	0.2207	0.8827	45.707	67.619	-61.98			
2	41	42	41	1681	1764	1	2500	3600	-0.442	0.1956	0.8968	45.69	66.444	-63.75			
3	42	43	42	1764	1849	4	2500	3600	-0.414	0.1712	0.9103	45.674	65.259	-65.55			
4	43	44	43	1849	1936	9	2500	3600	-0.384	0.1477	0.9231	45.659	64.064	-67.4			
5	44	45	44	1936	2025	16	2500	3600	-0.354	0.1252	0.9353	45.644	62.854	-69.28			
6	45	46	45	2025	2116	25	2500	3600	-0.322	0.1039	0.9466	45.63	61.639	-71.2			
7	46	47	46	2116	2209	36	2500	3600	-0.29	0.084	0.9571	45.616	60.409	-73.15			
8	47	48	47	2209	2304	49	2500	3600	-0.256	0.0657	0.9666	45.603	59.165	-75.15			
9	48	49	48	2304	2401	64	2500	3600	-0.222	0.0492	0.9751	45.591	57.907	-77.18			
10	49	50	49	2401	2500	81	2500	3600	-0.186	0.0347	0.9825	45.579	56.634	-79.26			

	program			manual			selisih		
	θ ₁	θ ₂	θ ₃	θ ₁	θ ₂	θ ₃	θ ₁	θ ₂	θ ₃
46	68	-62		45.707	67.6191	-61.9765	0.2927	0.3809	0.0235
46	66	-64		45.69	66.4442	-63.7471	0.3098	0.4442	0.2529
46	65	-66		45.674	65.2592	-65.5541	0.326	0.2592	0.4459
46	64	-67		45.659	64.0638	-67.3976	0.3415	0.0638	0.3976
46	63	-69		45.644	62.8537	-69.278	0.3563	0.1463	0.278
46	62	-71		45.63	61.6393	-71.1959	0.3705	0.3607	0.1959
46	60	-73		45.616	60.4088	-73.152	0.3839	0.4088	0.152
46	59	-75		45.603	59.1651	-75.1473	0.3969	0.1651	0.1473
46	58	-77		45.591	57.9071	-77.1832	0.4094	0.0929	0.1832
46	57	-79		45.579	56.6337	-79.2611	0.4213	0.3663	0.2611

rata"selisih / nilai program

	θ ₁	θ ₂	θ ₃
0.0064	0.0056	0.00038	
0.0067	0.00673	0.00395	
0.0071	0.00399	0.00676	
0.0074	0.001	0.00593	
0.0077	0.00318	0.00403	
0.0081	0.00582	0.00276	
0.0083	0.00681	0.00208	
0.0086	0.64407	0.00196	
0.0089	0.0016	0.00238	
0.0092	0.00643	0.00331	
avg	0.0078	0.06852	0.00335
%	0.7844	6.85224	0.3354