



**LAMPIRAN**

```

program forward_sketsa_robot_elbow_manipulator;
(* Program mencari posisi tulang-tulang sendi putar
dan posisi ujung segmen akhir robot elbow manipulator

```

Di susun oleh :

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```

uses crt, graph;
type
    typelarik = array[1..3] of real;

var t, Px, Py, Pz, lx, ly, lz, txb1, tyb1, tzb1 : real ;
    txb2, tyb2, tzb2, txb3, tyb3, tzb3, x, y, z : real ;
    txl3, tyl3, tzl3, t13x, t13y, t13z, t14x, t14y, t14z : real ;
    t23x, t23y, t23z, t24x, t24y, t24z : real ;
    sudut, su, ss, cs, A : typelarik;
    i, j, k, m, a9, a10, b9, b10, h9, h10, r9, r10 : integer ;
    tekan : char ;
    tunggu : boolean ;
    hbx, hby, hbz, hbx1, hby1, hbz1, hbx2, hby2, hbz2, hbx3, hby3, hbz3 :
string[5];
    h13x3, h13y3, h13z3, h14x3, h14y3, h14z3 : string[5];
    h23x, h23y, h23z, h24x, h24y, h24z : string[5];
    hbx1, hby1, hbz1, hpbx, hpby, hpbz : string[5];

```

```

(* prosedur untuk mengkonversi titik pada sistem koordinat*)
(* konversi tulang sendi pertama *)

```

```

procedure konversi1(x, y, z:real);
var r1, r2 :real;
    r3, r4, r5, r6, r7, r8:integer;
begin
    r1:= (x*60) * sin(45/t);
    r2:= (x*60) * cos (45/t);
    r3:= round(r1);
    r4:= round(r2);
    r5:= 240+r3;
    r6:= 280-r4;
    r7:= round(y*60);
    r8:= round(z*60);
    r9:= r6+r7;
    r10:= r5-r8;
    moveto(r9+10, r10);outtext('q1')
end;

```

```

(* konversi tulang sendi kedua *)

```

```

procedure konversi2(x, y, z:real);
var a1, a2 :real;
    a3, a4, a5, a6, a7, a8:integer;
begin
    a1:= (x*60) * sin(45/t);
    a2:= (x*60) * cos (45/t);

```

```

a3:= round(a1);
a4:= round(a2);
a5:= 240+a3;
a6:= 280-a4;
a7:= round(y*60);
a8:= round(z*60);
a9:= a6+a7;
a10:= a5-a8;
moveto(a9+10,a10);outtext('q2')
end;

```

(\* konversi tulang sendi ketiga \*)

```

procedure konversi3(x,y,z:real);
var b1,b2 :real;
    b3,b4,b5,b6,b7,b8:integer;
begin
    b1:= (x*60) * sin(45/t);
    b2:= (x*60) * cos (45/t);
    b3:= round(b1);
    b4:= round(b2);
    b5:= 240+b3;
    b6:= 280-b4;
    b7:= round(y*60);
    b8:= round(z*60);
    b9:= b6+b7;
    b10:= b5-b8;
    moveto(b9+10,b10);outtext('q3')
end;

```

(\* konversi ujung segmen akhir \*)

```

procedure konversiakhir(x,y,z:real);
var h1,h2 :real;
    h3,h4,h5,h6,h7,h8:integer;
begin
    h1:= (x*60) * sin(45/t);
    h2:= (x*60) * cos (45/t);
    h3:=round(h1);
    h4:=round(h2);
    h5:=240+h3;
    h6:=280-h4;
    h7:= round(y*60);
    h8:= round(z*60);
    h9:=h6+h7;
    h10:=h5-h8;
    moveto(h9+10,h10);outtext('P')
end;

```

(\* prosedur untuk membuat sistem koordinat dimensi tiga \*)

```

procedure fg;
var
    ux,uy:real;
    u,w,d,m:integer;

```

```

begin
  clrscr;
  d:=detect;
  initgraph(d,m,'');
  setcolor(4);
  ux:=240+(240*cos(45/t));
  uy:=280-(240*sin(45/t));
  u:=round(ux);
  w:=round(uy);
  line(280,10,280,240);
  line(280,240,520,240);
  line(280,240,w,u);
  setcolor(15);
  moveto(340,250);outtext('1');
  moveto(400,250);outtext('2');
  moveto(460,250);outtext('3');
  moveto(270,180);outtext('1');
  moveto(270,120);outtext('2');
  moveto(270,60);outtext('3');
  moveto(round(280-(60*sin(45/t)))+5,round(240+(60*cos(45/t))));
  outtext('1');
  moveto(round(280-120*sin(45/t)))+5,round(240+(120*cos(45/t))));
  outtext('2');
  moveto(round(280-180*sin(45/t)))+5,round(240+(180*cos(45/t))));
  outtext('3');
  moveto(280,250);outtext('O');
  moveto(w,u+10);outtext('X');
  moveto(530,250);outtext('Y');
  moveto(280, 1);outtext('Z');
end;

```

(\* prosedur untuk mencari nilai sinus dan cosinus sudut \*)

```

procedure tulang_sendi_putar;
begin
  if(sudut[i] >= 0) and (sudut[i] < 90) then
    begin
      ss[i] :=sin(sudut[i] /t);
      cs[i] :=(cos(sudut[i] /t));
    end;
  if sudut[i] = 90 then
    begin
      ss[i] := sin(sudut[i] /t);
      cs[i] :=-(cos(sudut[i] /t));
    end;
  if(sudut[i] >= 91) and (sudut[i] < 181) then
    begin
      su[i] := 180 - sudut[i];
      ss[i] := sin(su[i] /t);
      cs[i] :=- (cos(su[i] /t));
    end;
end;

```

```

    if(sudut[i] >= 181) and (sudut[i] < 271) then
    begin
        su[i] := sudut[i] - 180 ;
        ss[i] := -( sin(su[i] /t));
        cs[i] := -( cos(su[i] /t));
    end;
    if(sudut[i] >= 271) and (sudut[i] <= 360) then
    begin
        su[i] := 360 - sudut[i] ;
        ss[i] :=-( sin(su[i] /t));
        cs[i] := cos(su[i] /t);
    end;
end;

```

```

procedure sirine(faw,fta:integer);
var fr,fak : integer;
begin

```

```

    fr:=faw;
    repeat
        sound(fr);
        delay(100);
        nosound;
        inc(fr,5);
    until fr > (faw+fta);
    repeat
        sound(fr);
        delay(100);
        nosound;
        dec(fr,8);
    until fr < faw
end;

```

```

procedure sirine01(faw,fta:integer);
var fr,fak : integer;

```

```

begin
    fr:=faw;
    repeat
        sound(fr);
        nosound;
        inc(fr,5);
    until fr > (faw+fta);
    repeat
        sound(fr);
        nosound;
        dec(fr,8);
    until fr < faw
end;

```

```

(* program utama *)

```

```

begin
    clrscr;
    (* input data *)
    sirine(150,50);
    t:= 57.272727273;
    gotoxy(32,1);write('TUGAS AKHIR');

```

```

gotoxy(15,2);write('Matriks Transformasi pada Pergerakan
ROBOT');
gotoxy(15,4);write('F1 - Gambar1. Posisi Awal Robot');
gotoxy(15,5);write('F2 - Gambar2. Posisi Robot Setelah q1
Diputar ');
gotoxy(15,6);write('F3 - Gambar2. Posisi Robot Setelah q2
Diputar ');
gotoxy(15,7);write('F4 - Gambar2. Posisi Akhir Robot ');
gotoxy(15,8);write('Esc - Keluar');

```

```

(* masukan besar masing-masing sudut tulang sendi putar *)

```

```

for i := 1 to 3 do
begin
gotoxy(23,10+i);write('Besar Sudut Ke-',i,' = ');
readln(sudut[i]);
if sudut[i] > 360 then
begin
sudut[i]:= sudut[i]-360;
tulang_sendi_putar;
end;
tulang_sendi_putar;
end;
writeln;

```

```

(* Masukan panjang-panjang segmen *)

```

```

for i:= 1 to 3 do
begin
gotoxy(23,13+i); write('Panjang Segmen Ke-',i,' = ');
readln(A[i]);
end;

```

```

(* Proses data *)

```

```

txb1:=0;
tyb1:=0;
tzb1:=0;
txb2:=0;
tyb2:=0;
tzb2:=A[1];
txb3:=A[2];
tyb3:=0;
tzb3:=A[1];
txl3:=A[2]*cs[1]*cs[2];
tyl3:=A[2]*ss[1]*cs[2];
tzl3:=A[1]-(A[2]*ss[2]);
Px:=(A[3]*cs[3]*cs[1]*cs[2]) -
(A[3]*ss[3]*cs[1]*ss[2])+(A[2]*cs[1]*cs[2]) ;
Py:=(A[3]*cs[3]*ss[1]*cs[2]) -
(A[3]*ss[3]*ss[1]*ss[2])+(A[2]*ss[1]*cs[2]) ;
Pz:=(- (A[3]*cs[3]*ss[2])) - (A[3]*cs[2]*ss[3])-(A[2]*ss[2])+A[1];
lx:= A[2]+A[3];
ly:= 0;
lz:= A[1];
t13x:=(A[2]*cs[1]);

```

```

t13y:=(A[2]*ss[1]);
t13z:=A[1];
t14x:=(A[3]+A[2])*cs[1];
t14y:=(A[3]+A[2])*ss[1];
t14z:=t13z;
t23x:=A[2]*(cs[1]*cs[2]);
t23y:=A[2]*(ss[1]*cs[2]);
t23z:=A[1]-(A[2]*ss[2]);
t24x:=(A[3]+A[2])*cs[1]*cs[2];
t24y:=(A[3]*ss[1]*cs[2])+(A[2]*ss[1]*cs[2]);
t24z:=A[1]-(A[2]*ss[2])-(A[3]*ss[2]);

```

(\* menampilkan hasil \*)

```

tunggu:=true;
while tunggu do
begin
if keypressed then
begin
tekan := readkey;
case tekan of

```

(\* posisi awal robot \*)

```

#59:begin
sirine(150,50);
fg;
konversi1(txb1,tyb1,tzb1);
konversi2(txb2,tyb2,tzb2);
konversi3(txb3,tyb3,tzb3);
konversiakhir(lx,ly,lz);
setcolor(1);
line(280,240,a9,a10);
line(a9,a10,b9,b10);
line(b9,b10,h9,h10);
putpixel(r9,r10,15);
putpixel(a9,a10,15);
putpixel(b9,b10,15);
putpixel(h9,h10,15);
setcolor(15);
str(txb1,hbx1);
str(tyb1,hby1);
str(tzb1,hbz1);
str(txb2,hbx2);
str(tyb2,hby2);
str(tzb2,hbz2);
str(txb3,hbx3);
str(tyb3,hby3);
str(tzb3,hbz3);
str(lx,hbx);
str(ly,hby);
str(lz,hbz);
outtextxy(1,1,'Koordinat posisi awal robot');
outtextxy(1,10,'q1 ('+hbz1+', '+hby1+', '+hbz1+')');
outtextxy(1,20,'q2 ('+hbz2+', '+hby2+', '+hbz2+')');
outtextxy(1,30,'q3 ('+hbz3+', '+hby3+', '+hbz3+')');

```

```

outtextxy(1,40,'p ('+hbx+', '+hby+', '+hbz+')');
moveto(240,435);outtext('Gambar.1');
moveto(200,450);outtext('Posisi Awal Robot');
moveto(25,470);outtext('F1-> Gambar.1');
moveto(150,470);outtext('F2-> Gambar.2');
moveto(275,470);outtext('F3-> Gambar.3');
moveto(400,470);outtext('F4-> Gambar.4');
moveto(525,470);outtext('Esc-> Keluar');
end;

```

(\* posisi robot setelah di putar tulang sendi pertama \*)

```

#60:begin
sirine(100,50);
j:=-1;
repeat
sirine01(150,50);
cleardevice;
j:=j+1;
txb1:=0;
tyb1:=0;
tzb1:=0;
txb2:=0;
tyb2:=0;
tzb2:=A[1];
t13x:=A[2]*cos(j/t);
t13y:=A[2]*sin(j/t);
t13z:=A[1];
t14x:=(A[3]+A[2])*cos(j/t);
t14y:=(A[3]+A[2])*sin(j/t);
t14z:=A[1];
konversi1(txb1,tyb1,tzb1);
konversi2(txb2,tyb2,tzb2);
konversi3(t13x,t13y,t13z);
konversiakhir(t14x,t14y,t14z);
setcolor(1);
line(280,240,a9,a10);
line(a9,a10,b9,b10);
line(b9,b10,h9,h10);
putpixel(280,240,15);
putpixel(a9,a10,15);
putpixel(b9,b10,15);
putpixel(h9,h10,15);
delay(25);
until j = sudut[1];
fg;
txb1:=0;
tyb1:=0;
tzb1:=0;
txb2:=0;
tyb2:=0;
tzb2:=A[1];
t13x:=A[2]*cos(j/t);
t13y:=A[2]*sin(j/t);
t13z:=A[1];
t14x:=(A[3]+A[2])*cos(j/t);

```



```

t14y:=(A[3]+A[2])*sin(j/t);
t14z:=A[1];
konversi1(txb1,tyb1,tzb1);
konversi2(txb2,tyb2,tzb2);
konversi3(t13x,t13y,t13z);
konversiakhir(t14x,t14y,t14z);
setcolor(1);
line(280,240,a9,a10);
line(a9,a10,b9,b10);
line(b9,b10,h9,h10);
putpixel(r9,r10,15);
putpixel(a9,a10,15);
putpixel(b9,b10,15);
putpixel(h9,h10,15);
setcolor(15);
str(txb1,hbx1);
str(tyb1,hby1);
str(tzb1,hbz1);
str(txb2,hbx2);
str(tyb2,hby2);
str(tzb2,hbz2);
str(t13x:5:2,h13x3);
str(t13y:5:2,h13y3);
str(t13z:5:2,h13z3);
str(t14x:5:2,h14x3);
str(t14y:5:2,h14y3);
str(t14z:5:2,h14z3);
outtextxy(1,1,'Koordinat Gambar.2');
outtextxy(1,10,'q1 ('+hbx1+', '+hby1+', '+hbz1+')');
outtextxy(1,20,'q2 ('+hbx2+', '+hby2+', '+hbz2+')');
outtextxy(1,30,'q3 ('+ h13x3+', '+h13y3+', '+h13z3+')');
outtextxy(1,40,'p ('+ h14x3+', '+h14y3+', '+h14z3+')');
moveto(240,435);outtext('Gambar.2');
moveto(200,450);outtext('Posisi Robot Setelah q1 Diputar');
moveto(25,470);outtext('F1-> Gambar.1');
moveto(150,470);outtext('F2-> Gambar.2');
moveto(275,470);outtext('F3-> Gambar.3');
moveto(400,470);outtext('F4-> Gambar.4');
moveto(525,470);outtext('Esc-> Keluar');
end;

```

(\* posisi robot setelah di putar tulang sendi pertama dan kedua \*)

```

#61:begin
sirine(100,50);
k:=-1;
repeat
cleardevice;
sirine01(250,50);
k:=k+1;
txb1:=0;
tyb1:=0;
tzb1:=0;
txb2:=0;
tyb2:=0;

```

```

tzb2:=A[1];
t23x:=A[2]*(cs[1]*cos(k/t));
t23y:=A[2]*(ss[1]*cos(k/t));
t23z:=A[1]-(A[2]*sin(k/t));
t24x:=(A[3]+A[2])*(cs[1]*cos(k/t));
t24y:=(A[3]+A[2])*(ss[1]*cos(k/t));
t24z:=A[1]-((A[2]+A[3])*sin(k/t));
konversi1(txb1,tyb1,tzb1);
konversi2(txb2,tyb2,tzb2);
konversi3(t23x,t23y,t23z);
konversiakhir(t24x,t24y,t24z);
setcolor(1);
line(280,240,a9,a10);
line(a9,a10,b9,b10);
line(b9,b10,h9,h10);
putpixel(r9,r10,15);
putpixel(a9,a10,15);
putpixel(b9,b10,15);
putpixel(h9,h10,15);
delay(25);
until k = sudut[2];
fg;
txb1:=0;
tyb1:=0;
tzb1:=0;
txb2:=0;
tyb2:=0;
tzb2:=A[1];
t23x:=A[2]*(cs[1]*cs[2]);
t23y:=A[2]*(ss[1]*cs[2]);
t23z:=A[1]-(A[2]*ss[2]);
t24x:=(A[3]+A[2])*cs[1]*cs[2];
t24y:=(A[3]*ss[1]*cs[2])+(A[2]*ss[1]*cs[2]);
t24z:=A[1]-((A[2]+A[3])*ss[2]);
konversi1(txb1,tyb1,tzb1);
konversi2(txb2,tyb2,tzb2);
konversi3(t23x,t23y,t23z);
konversiakhir(t24x,t24y,t24z);
setcolor(1);
line(280,240,a9,a10);
line(a9,a10,b9,b10);
line(b9,b10,h9,h10);
putpixel(r9,r10,15);
putpixel(a9,a10,15);
putpixel(b9,b10,15);
putpixel(h9,h10,15);
setcolor(15);
str(txb1,hbx1);
str(tyb1,hby1);
str(tzb1,hbz1);
str(txb2,hbx2);
str(tyb2,hby2);
str(tzb2,hbz2);
str(t23x:5:2,h23x);
str(t23y:5:2,h23y);
str(t23z:5:2,h23z);

```

```

str(t24x:5:2,h24x);
str(t24y:5:2,h24y);
str(t24z:5:2,h24z);
outtextxy(1,1,'Koordinat Gambar.3');
outtextxy(1,10,'q1 ('+hbx1+', '+hby1+', '+hbz1+')');
outtextxy(1,20,'q2 ('+hbx2+', '+hby2+', '+hbz2+')');
outtextxy(1,30,'q3 ('+h23x+', '+h23y+', '+h23z+')');
outtextxy(1,40,'p ('+h24x+', '+h24y+', '+h24z+')');
moveto(240,435);outtext('Gambar.3');
moveto(200,450);outtext('Posisi Robot Setelah q2 Diputar');
moveto(25,470);outtext('F1-> Gambar.1');
moveto(150,470);outtext('F2-> Gambar.2');
moveto(275,470);outtext('F3-> Gambar.3');
moveto(400,470);outtext('F4-> Gambar.4');
moveto(525,470);outtext('Esc-> Keluar');
end;

```

(\* posisi robot setelah di putar tulang sendi pertama, kedua dan ketiga \*)

```

#62:begin
sirine(100,50);
m:=-1;
repeat
cleardevice;
sirine01(200,50);
m:=m+1;
txb1:=0;
tyb1:=0;
tzb1:=0;
txb2:=0;
tyb2:=0;
tzb2:=A[1];
txl3:=A[2]*cs[1]*cs[2];
tyl3:=A[2]*ss[1]*cs[2];
tzl3:=A[1]-(A[2]*ss[2]);
Px:=(A[3]*cos(m/t)*cs[1]*cs[2])-(
(A[3]*sin(m/t)*cs[1]*ss[2])+(A[2]*cs[1]*cs[2]) ;
Py:=(A[3]*cos(m/t)*ss[1]*cs[2])-(
(A[3]*sin(m/t)*ss[1]*ss[2])+(A[2]*ss[1]*cs[2]) ;
Pz:=(-(A[3]*cos(m/t)*ss[2]))-(A[3]*cs[2]*sin(m/t))-
(A[2]*ss[2])+A[1] ;
konversi1(txb1,tyb1,tzb1);
konversi2(txb2,tyb2,tzb2);
konversi3(txl3,tyl3,tzl3);
konversiakhir(px,py,pz);
setcolor(1);
line(280,240,a9,a10);
line(a9,a10,b9,b10);
line(b9,b10,h9,h10);
putpixel(r9,r10,15);
putpixel(a9,a10,15);
putpixel(b9,b10,15);
putpixel(h9,h10,15);
delay(25);
until m = sudut[3];

```

```

fg;
txb1:=0;
tyb1:=0;
tzb1:=0;
txb2:=0;
tyb2:=0;
tzb2:=A[1];
txl3:=A[2]*cs[1]*cs[2];
tyl3:=A[2]*ss[1]*cs[2];
tzl3:=A[1]-(A[2]*ss[2]);
Px:=(A[3]*cs[3]*cs[1]*cs[2])-(
(A[3]*ss[3]*cs[1]*ss[2])+(A[2]*cs[1]*cs[2]) ;
Py:=(A[3]*cs[3]*ss[1]*cs[2])-(
(A[3]*ss[3]*ss[1]*ss[2])+(A[2]*ss[1]*cs[2]) ;
Pz:=(-(A[3]*cs[3]*ss[2]))-(A[3]*cs[2]*ss[3])-(A[2]*ss[2])+A[1]
;
konversi1 (txb1, tyb1, tzb1);
konversi2 (txb2, tyb2, tzb2);
konversi3 (txl3, tyl3, tzl3);
konversiakhir (px, py, pz);
setcolor (1);
line (280, 240, a9, a10);
line (a9, a10, b9, b10);
line (b9, b10, h9, h10);
putpixel (r9, r10, 15);
putpixel (a9, a10, 15);
putpixel (b9, b10, 15);
putpixel (h9, h10, 15);
setcolor (15);
str (txb1, hbx1);
str (tyb1, hby1);
str (tzb1, hbz1);
str (txb2, hbx2);
str (tyb2, hby2);
str (tzb2, hbz2);
str (txl3:5:2, hbx1);
str (tyl3:5:2, hby1);
str (tzl3:5:2, hbz1);
str (px:5:2, hpbx);
str (py:5:2, hpby);
str (pz:5:2, hpbz);
outtextxy (1, 1, 'Koordinat posisi akhir robot');
outtextxy (1, 10, 'q1 ('+hbx1+', '+hby1+', '+hbz1+')');
outtextxy (1, 20, 'q2 ('+hbx2+', '+hby2+', '+hbz2+')');
outtextxy (1, 30, 'q3 ('+hbx1+', '+hby1+', '+hbz1+')');
outtextxy (1, 40, 'p ('+hpbx+', '+hpby+', '+hpbz+')');
moveto (240, 435); outtext ('Gambar4');
moveto (200, 450); outtext ('Posisi Akhir Robot');
moveto (25, 470); outtext ('F1-> Gambar.1');
moveto (150, 470); outtext ('F2-> Gambar.2');
moveto (275, 470); outtext ('F3-> Gambar.3');
moveto (400, 470); outtext ('F4-> Gambar.4');
moveto (525, 470); outtext ('Esc-> Keluar');
end;

```

(\* Keluar dari program \*)

```
#27:begin
cleardevice;
sirine(200,50);
setcolor(1);
settextstyle(sansseriffont,horizdir,2);
outtextxy(400,440,'SONY DWI PRIHATNO');
settextstyle(sansseriffont,horizdir,4);
outtextxy(75,100,'TERIMA KASIH TELAH MENCOBA');
outtextxy(75,150,'BRAVO MATEMATIKA KOMPUTER');
outtextxy(75,200,'SEMOGA SUKSES SELALU');
delay(3500);SIRINE(200,50); exit;END;
end;
end;
end;
end.
```

