The Best Gift of Gift

To your friend give your loyalty.

To your enemy give your forgiveness.

To your boss give your service.

To a child give a good example.

To your parents give your gratitude and devotion.

To your mate give your love and faithfulness.

To all men and women give your love.

To your God give your life.

LAMPIRAN – A

M-File Optimalisasi dan *Inverse* Kinematik

```
% Inisialisasi
clc;
clear;
disp('_____________________________________________________________');
disp('                                                             ');
disp('           Tugas Akhir Wahyudi C. (0122154)                  ');
disp('Simulasi 3-Dimensi dan Optimalisasi Gerak Robot Pengebor
PCB');
disp('                Jurusan Teknik Elektro                       ');
disp('             Universitas Kristen Maranatha                   ');
disp('_____________________________________________________________');
disp('                                                             ');

% Input titik
ttk_ref=[0 20];
disp('Banyak titik Min=1 dan Max=20');
bt=input('Banyak titik = ');
disp(' ');
disp('Koordinat berkisar antara -9.5<=X<=9.5 & 6.5<=Y<= 15.5')
disp('Satuan koordinat dalam cm dan sudut dalam derajat')
disp(' ');
for i=1:bt
    ttk_koor(i,:)=input('Titik Koordinat [x y] : ');
end
ttk=ttk_koor;

% Optimalisasi Jalur Terpendek
% Mengetahui titik terdekat X + atau -
for h=1:bt
    brs_koor=ttk_koor(h,:);
    x=ttk_ref(:,1)-brs_koor(:,1);
    y=ttk_ref(:,2)-brs_koor(:,2);
    ttk_koor(h,3)=sqrt(x^2+y^2);
end
ttk_sort=sortrows(ttk_koor,3);
ttk_tdk=ttk_sort(1,1);
% Pemilihan x<0
ttk_sort_xneg=sortrows(ttk_koor,1);
for h=1:bt
    if ttk_sort_xneg(h,1)<0
       xneg(h,:)=ttk_sort_xneg(h,:);
    end
end
nxneg=size(xneg,1);
% Pemilihan x>=0
ttk_sort_xpos=flipdim(ttk_sort_xneg,1);
for h=1:bt
    if ttk_sort_xpos(h,1)>=0
       xpos(h,:)=ttk_sort_xpos(h,:);
    end
end
nxpos=size(xpos,1);
% Optimalisasi
if ttk_tdk<0;
   % Optimalisasi -
   for i=1:nxneg
       for j=1:(nxneg+1-i)
           brs_koor=xneg(j,:);
```

```
            x=ttk_ref(:,1)-brs_koor(:,1);
            y=ttk_ref(:,2)-brs_koor(:,2);
            xneg(j,3)=sqrt(x^2+y^2);
        end
        ttk_sort=sortrows(xneg,3);
        if i>(nxneg-1)
           xy(i,:)=xneg(1,1:2);
        else
           xy(i,:)=ttk_sort(1,1:2);
        end
        ttk_ref=xy(i,:);
        xneg=ttk_sort(2:(nxneg+1-i),:);
    end
    % Optimalisasi +
    for i=1:nxpos
        for j=1:(nxpos+1-i)
            brs_koor=xpos(j,:);
            x=ttk_ref(:,1)-brs_koor(:,1);
            y=ttk_ref(:,2)-brs_koor(:,2);
            xpos(j,3)=sqrt(x^2+y^2);
        end
        ttk_sort=sortrows(xpos,3);
        if i>(nxpos-1)
           xy(i+nxneg,:)=xpos(1,1:2);
        else
           xy(i+nxneg,:)=ttk_sort(1,1:2);
        end
        ttk_ref=xy(i+nxneg,:);
        xpos=ttk_sort(2:(nxpos+1-i),:);
    end
else
    % Optimalisasi +
    for i=1:nxpos
        for j=1:(nxpos+1-i)
            brs_koor=xpos(j,:);
            x=ttk_ref(:,1)-brs_koor(:,1);
            y=ttk_ref(:,2)-brs_koor(:,2);
            xpos(j,3)=sqrt(x^2+y^2);
        end
        ttk_sort=sortrows(xpos,3);
        if i>(nxpos-1)
           xy(i,:)=xpos(1,1:2);
        else
           xy(i,:)=ttk_sort(1,1:2);
        end
        ttk_ref=xy(i,:);
        xpos=ttk_sort(2:(nxpos+1-i),:);
    end
    % Optimalisasi -
    for i=1:nxneg
        for j=1:(nxneg+1-i)
            brs_koor=xneg(j,:);
            x=ttk_ref(:,1)-brs_koor(:,1);
            y=ttk_ref(:,2)-brs_koor(:,2);
            xneg(j,3)=sqrt(x^2+y^2);
        end
        ttk_sort=sortrows(xneg,3);
        if i>(nxneg-1)
```

```
          xy(i+nxpos,:)=xneg(1,1:2);
       else
          xy(i+nxpos,:)=ttk_sort(1,1:2);
       end
       ttk_ref=xy(i+nxpos,:);
       xneg=ttk_sort(2:(nxneg+1-i),:);
   end
end

% Perhitungan Inverse Kinematik
for k=1:bt
    x=xy(k,1);
    y=xy(k,2);
    a=10;
    r=sqrt(x^2+y^2);
    beta=acos(r/(2*a))*180/pi;
    b=sqrt(4*a^2+r^2-4*a*r*cos(beta*pi/180));
    if ((6.5<=y) & (y<=15.5))
        if ((0<=x) & (x<=9.5))
            alfa=atan(x/y)*180/pi;
            theta1=alfa-beta;
            theta2=acos(1-(b^2/(2*a^2)))*180/pi;
        elseif ((-9.5<=x) & (x<0))
            alfa=atan(-x/y)*180/pi;
            theta1=-alfa+beta;
            theta2=-acos(1-(b^2/(2*a^2)))*180/pi;
        else
            disp('Ada koordinat yang diluar workspace');
            break
        end
    else
        disp('Ada koordinat yang diluar workspace');
        break
    end
    T1(k,:)=[theta1];
    T2(k,:)=[theta2];
end

% Input ke SimMechanics
tm=4*bt+2;
ta=[0:2:tm]';
tb=[0:2:tm]';
tc=[0:1:tm]';
% Bentuk array t1
t1(1,:)=0;
for i=1:bt
    t1(2*i,:)=T1(i);
    t1(2*i+1,:)=T1(i);
end
t1(bt*2+2,:)=0;
% Bentuk array t2
t2(1,:)=0;
for i=1:bt
    t2(2*i,:)=T2(i);
    t2(2*i+1,:)=T2(i);
end
t2(bt*2+2,:)=0;
% Bentuk array t3
```

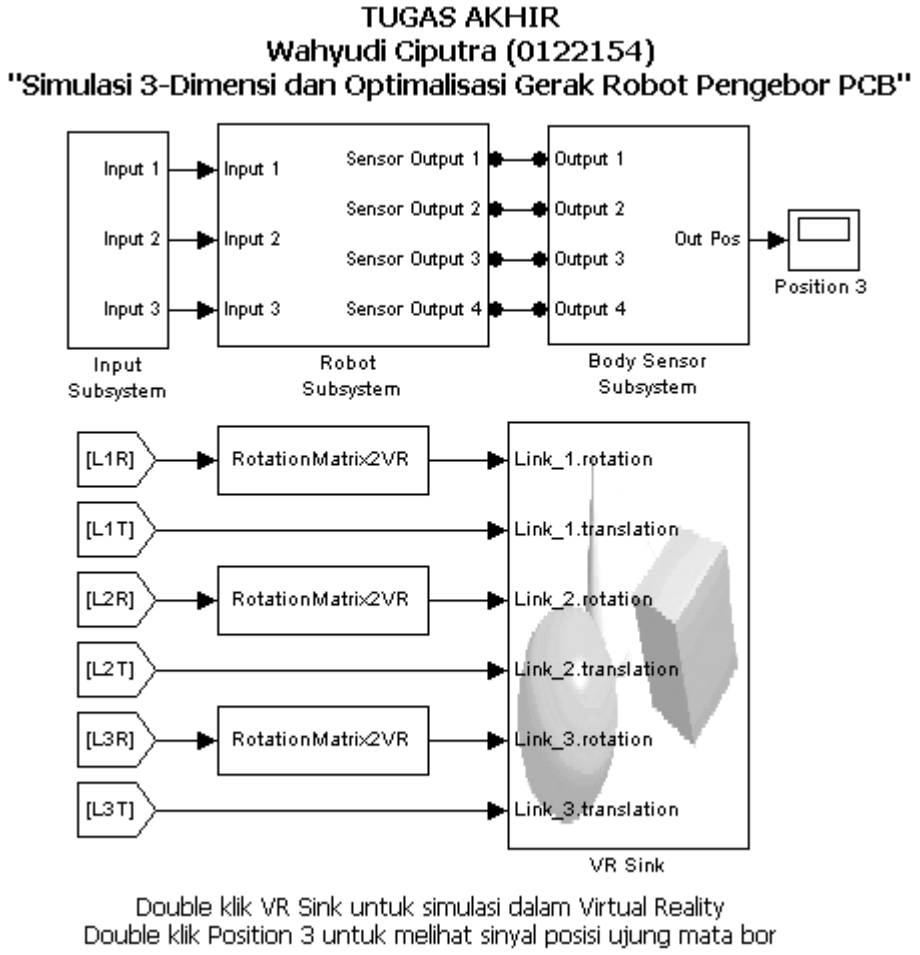
```
t3(1,:)=0;
for i=1:bt
    t3(4*i-2,:)=0;
    t3(4*i-1,:)=0;
    t3(4*i,:)=1080;
    t3(4*i+1,:)=0;
end
t3(bt*4+2,:)=0;
t3(bt*4+3,:)=0;

% Tampilan
Titik_Awal_____Titik_Optimal_____Sudut_T1_dan_T2 = [ttk xy T1 T2]
plot(xy(:,1),xy(:,2))
TA_SimModel
disp('_____________________________________________________________');
disp(' ');
```

LAMPIRAN – B

Model Sistem *SimMechanics*

SimMechanics Model

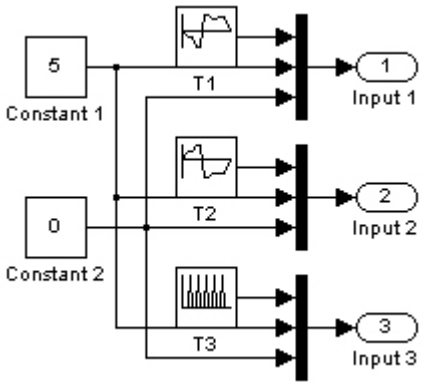


Simulation Parameters

Start time : 0.0

Stop time : tm

Input Subsystem



T1 Parameters

Vector of output values : t1

Vector of time values : ta

Sample time : 0.1

T2 Parameters

Vector of output values : t2

Vector of time values : tb

Sample time : 0.1

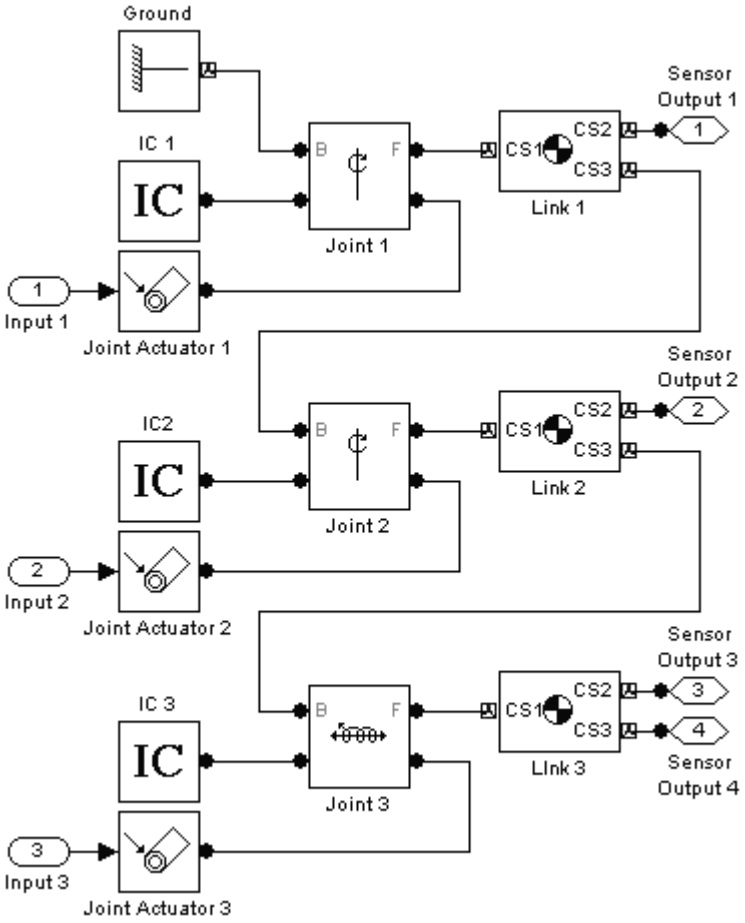
T3 Parameters

Vector of output values : t3

Vector of time values : tc

Sample time : 0.1

Robot Subsystem



Ground Parameters

Location : [0 0 75] mm

IC 1 (Initial Condition) Parameters

Actuation

Primitive	Position	Units	Velocity	Units
R1	0	deg	0	deg/s

IC 2 (Initial Condition) Parameters

Actuation

Primitive	Position	Units	Velocity	Units
R1	0	deg	0	deg/s

IC 3 (Initial Condition) Parameters

Actuation

Primitive	Position	Units	Velocity	Units
R1	0	deg	0	deg/s

Joint Actuator 1 Parameters

Connected to primitive : R1

Motion

Apply rotational motion (revolute only)

Angle : deg

Angular velocity : deg/s

Angular acceleration : deg/s^2

Joint Actuator 2 Parameters

Connected to primitive : R1

Motion

Apply rotational motion (revolute only)

Angle : deg

Angular velocity : deg/s

Angular acceleration : deg/s^2

Joint Actuator 3 Parameters

Connected to primitive : R1

Motion

Apply rotational motion (revolute only)

Angle : deg

Angular velocity : deg/s

Angular acceleration : deg/s^2

Joint 1 Parameters

Axes

Name	Primitive	Axis of Rotation [x y z]	Reference csys
R1	Revolute	[0 0 -1]	WORLD

Joint 2 Parameters

Axes

Name	Primitive	Axis of Rotation [x y z]	Reference csys
R1	Revolute	[0 0 -1]	WORLD

Joint 3 Parameters

Axes

Name	Primitive	Axis of Rotation [x y z]	Reference csys
R1	Revolute	[0 0 -1]	WORLD

Pitch Parameters

Pitch : 5

Units (per revolution) : mm

Link 1 Parameters

Mass Properties

Mass : 300 gr

Inertia : [2725 0 0; 0 625 0; 0 0 2900] gr*cm^2

Body Coordinate System

Name	Origin Position Vector [x, y, z]	Units	Translated from Origin of
CG	[0 50 75]	mm	WORLD
CS1	[0 0 75]	mm	WORLD
CS2	[0 50 105]	mm	WORLD
CS3	[0 100 75]	mm	WORLD

Link 2 Parameters

Mass Properties

Mass : 300 gr

Inertia : [2725 0 0; 0 625 0; 0 0 2900] gr*cm^2

Body Coordinate System

Name	Origin Position Vector [x, y, z]	Units	Translated from Origin of
CG	[0 150 75]	mm	WORLD
CS1	[0 100 75]	mm	WORLD
CS2	[0 150 75]	mm	WORLD
CS3	[0 200 75]	mm	WORLD

Link 3 Parameters

Mass Properties

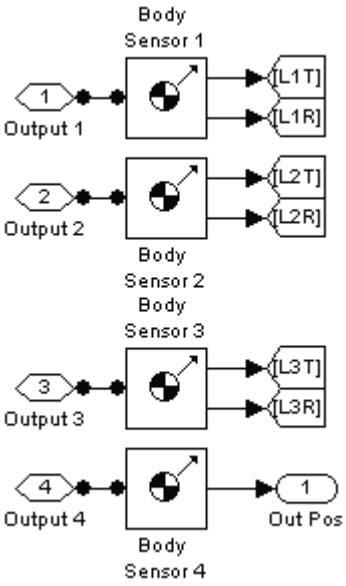
Mass : 180 gr

Inertia : [780 0 0; 0 780 0; 0 0 90] gr*cm^2

Body Coordinate System

Name	Origin Position Vector [x, y, z]	Units	Translated from Origin of
CG	[0 200 75]	mm	WORLD
CS1	[0 200 75]	mm	WORLD
CS2	[0 200 75]	mm	WORLD
CS3	[0 200 20]	mm	WORLD

Body Sensor Subsystem



Body Sensor 1 Parameters

With respect to coordinate system : Absolute (WORLD)

[x;y;z] Position : cm

[3 x 3] Rotation matrix

Body Sensor 2 Parameters

With respect to coordinate system : Absolute (WORLD)

[x;y;z] Position : cm

[3 x 3] Rotation matrix

Body Sensor 3 Parameters

With respect to coordinate system : Absolute (WORLD)

[x;y;z] Position : cm

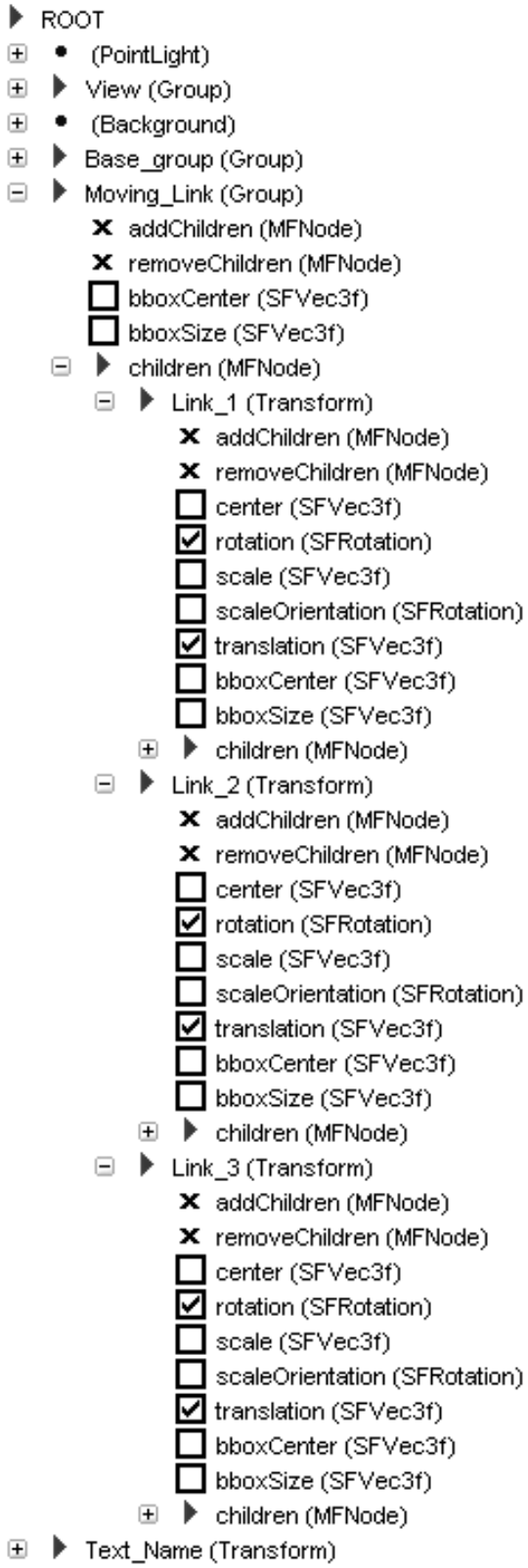
[3 x 3] Rotation matrix

Body Sensor 4 Parameters

With respect to coordinate system : Absolute (WORLD)

[x;y;z] Position : cm

Parameter : VR Sink



LAMPIRAN – C

VRML Robot Pengebor PCB

VRML Utama

```
#VRML V2.0 utf8

#Created with V-Realm Builder v2.0
#Integrated Data Systems Inc.
#www.ids-net.com


PointLight {
	ambientIntensity	1
	attenuation	1 0 0
	color	0.69 0.69 0.69
	intensity	0.5
	location	6.0139 19.7699 17.7285
	radius 10
}
DEF View Group {
	children [
	    DEF Main_View Viewpoint {
		orientation	0.246325 0.529044 0.812057  2.55229
		position	22.0819 32.7132 14.6487
		description	"Main View"
	    }

	    DEF PCB_View_1 Viewpoint {
		fieldOfView	0.785398
		orientation	0.289573 0.414839 0.862587  2.31161
		position	17.6471 18.1501 12.1661
		description	"PCB View 1"
	    }

	    DEF PCB_View_2 Viewpoint {
		orientation	0.587568 0.573904 0.570437  2.0893
		position	23.8757 10.1348 0.893763
		description	"PCB View 2"
	    }

	    DEF Top_View Viewpoint {
		orientation	-0.0266894 0.173057 0.98455  3.13562
		position	-1.50021 21.2792 39.1354
		description	"Top View"
	    }
	]
}
Background {
	groundAngle	[ 0.9, 1.5, 1.57 ]
	groundColor	[ 0.0955383 0.098599 0.49,
			  0.368258 0.486251 0.58,
			  0.661837 0.69 0.69,
			  0.801668 0.823029 0.84 ]
	skyAngle	[ 0.1, 1.2, 1.57 ]
	skyColor	[ 0.619592 0.92 0.92,
			  0.571441 0.693793 0.83,
			  0.222549 0.390234 0.7,
			  0.60094 0.662637 0.69 ]
}
DEF Base_group Group {
	children [
	    DEF Ground Transform {
		translation	0 10 -1
		children Shape {
			appearance	Appearance {
				material DEF Blue_Plastic Material {
					ambientIntensity	0.1
```

```
                                diffuseColor    0.00200167 0.0121456
                                                0.8
                                specularColor   1 1 1
                        }

                }

                geometry Box {
                        size     20 24 2
                }

        }
}

DEF PCB Transform {
        translation     0 11 1
        scale    1 1.00001 1.00001
        children Shape {
                appearance      Appearance {
                        material DEF Green Material {
                                ambientIntensity       0.1
                                diffuseColor    0.0065239 0.8
                                                0.0942574
                        }

                }

                geometry Box {
                        size     20 10 0.2
                }

        }
}

DEF PCB_Side_1 Transform {
        translation     0 16.5 0.75
        children Shape {
                appearance      Appearance {
                        material DEF Medium_Blue_Metal Material {
                                ambientIntensity       0.1
                                diffuseColor    0.180392 0.576471
                                                0.870588
                                specularColor   1 1 1
                        }

                }

                geometry Box {
                        size     20 1 1.5
                }

        }
}

DEF PCB_Side_2 Transform {
        translation     0 5.5 0.75
        children Shape {
                appearance      Appearance {
                        material Material {
                                ambientIntensity       0.1
                                diffuseColor    0.180392 0.576471
                                                0.870588
                                specularColor   1 1 1
                        }
```

```
                        }

                        geometry Box {
                               size     20 1 1.5
                        }

                  }
            }

            DEF Link_0 Transform {
                  translation     0 0 6
                  scale    1 0.999999 1
                  children Inline {
                        url      "link0.wrl"
                  }
            }
      ]
}
DEF Moving_Link Group {
      children [
            DEF Link_1 Transform {
                  translation     0 5 10.5
                  children Inline {
                        url      "link1.wrl"
                  }
            }

            DEF Link_2 Transform {
                  translation     0 15 7.5
                  children Inline {
                        url      "link2.wrl"
                  }
            }

            DEF Link_3 Transform {
                  translation     0 20 7.5
                  children Inline {
                        url      "link3.wrl"
                  }
            }
      ]
}
DEF Text_Name Transform {
      translation  5.5 20.5 0.5
      rotation     0 0 1  3.14159
      children Shape {
            appearance   Appearance {
                  material     DEF Orange_Plastic Material {
                        ambientIntensity    0.1
                        diffuseColor  0.9 0.55237 0.00733938
                        emissiveColor 0.27 0.27 0.27
                        specularColor 1 0.359171 0.457029
                  }

            }

            geometry     Text {
                  string "TA Yudi"
                  fontStyle    FontStyle {
                        family "SANS"
                        horizontal   TRUE
                        leftToRight  TRUE
                        size   3.5
```

```
                        topToBottom   TRUE
                }

                length 2.5
                maxExtent    0
        }

    }
}
```

Link 0

```
#VRML V2.0 utf8

#Created with V-Realm Builder v2.0
#Integrated Data Systems Inc.
#www.ids-net.com


DEF L1 Transform {
    translation  0 0 -0.5
    rotation     1 0 0  1.5708
    scale  1 0.999999 1
    children Shape {
        appearance   Appearance {
            material     DEF Gray_Plastic Material {
                ambientIntensity    0.1
                specularColor 1 1 1
            }

        }

        geometry     Cylinder {
            height 7
            radius 2
            bottom TRUE
        }

    }
}
DEF L2 Transform {
    translation  0 0 -5
    children Shape {
        appearance   Appearance {
            material     DEF Black_Plastic Material {
                ambientIntensity    1
                diffuseColor  0 0 0
                shininess    0.1
                specularColor 1 1 1
            }

        }

        geometry     Box {
            size   4 4 2
        }

    }
}
DEF L3 Transform {
    translation  2 0 -5
    rotation     1 0 0  1.5708
    children Shape {
```

```
              appearance    Appearance {
                     material      DEF Black_Plastic Material {
                            ambientIntensity    1
                            diffuseColor  0 0 0
                            shininess     0.1
                            specularColor 1 1 1
                     }

              }

              geometry      Cylinder {
                     height 2
                     radius 2
              }

       }
}
DEF L4 Transform {
       translation   -2 0 -5
       rotation      1 0 0  1.5708
       children Shape {
              appearance    Appearance {
                     material      DEF Black_Plastic Material {
                            ambientIntensity    1
                            diffuseColor  0 0 0
                            shininess     0.1
                            specularColor 1 1 1
                     }

              }

              geometry      Cylinder {
                     height 2
                     radius 2
              }

       }
}
```

Link **1**

```
#VRML V2.0 utf8

#Created with V-Realm Builder v2.0
#Integrated Data Systems Inc.
#www.ids-net.com


DEF L1 Transform {
       translation   0 0 0
       children Shape {
              appearance    Appearance {
                     material      Material {
                            ambientIntensity    0.1
                            specularColor 1 1 1
                     }

              }

              geometry      Box {
                     size   4 10 3
              }
```

```
	}
}
DEF L2 Transform {
	translation  0 5 -1.5
	rotation     1 0 0  1.5708
	children Shape {
		appearance   Appearance {
			material     Material {
				ambientIntensity    0.1
				specularColor 1 1 1
			}

		}

		geometry     Cylinder {
			height 6
			radius 2
		}

	}
}
DEF L3 Transform {
	translation  0 -5 0
	rotation     1 0 0  1.5708
	children Shape {
		appearance   Appearance {
			material     Material {
				ambientIntensity    0.1
				specularColor 1 1 1
			}

		}

		geometry     Cylinder {
			height 3
			radius 2
		}

	}
}
```

Link 2

```
#VRML V2.0 utf8

#Created with V-Realm Builder v2.0
#Integrated Data Systems Inc.
#www.ids-net.com


DEF L1 Transform {
	translation  0 0 0
	children Shape {
		appearance   Appearance {
			material     Material {
				ambientIntensity    0.1
				specularColor 1 1 1
			}

		}

		geometry     Box {
			size   4 10 3
```

```
            }

      }
}
DEF L2 Transform {
      translation  0 5 0
      rotation     1 0 0  1.5708
      children Shape {
            appearance   Appearance {
                  material     Material {
                        ambientIntensity    0.1
                        specularColor 1 1 1
                  }

            }

            geometry     Cylinder {
                  height 3
                  radius 2
            }

      }
}
```

Link 3

```
#VRML V2.0 utf8

#Created with V-Realm Builder v2.0
#Integrated Data Systems Inc.
#www.ids-net.com


DEF L1 Transform {
      translation  0 0 0.5
      rotation     1 0 0  1.5708
      children Shape {
            appearance   Appearance {
                  material     DEF Red_Plastic Material {
                        ambientIntensity    0.1
                        diffuseColor  1 0.0408163 0.0408163
                        specularColor 0.984314 0.984314 0.984314
                  }

            }

            geometry     Cylinder {
                  height 6
                  radius 1
            }

      }
}
DEF L2 Transform {
      children Transform {
            translation  0 9.55014e-007 -3
            rotation     -1 0 0  1.5708
            scale  0.999999 0.999999 0.999999
            children Shape {
                  appearance   Appearance {
                        material     DEF Brown_Plastic Material {
                              ambientIntensity    0.5
                              diffuseColor  0.33 0.284281 0.110734
```

```
                                shininess    0.1
                                specularColor 1 1 1
                        }

                }

                geometry     Cone {
                        bottomRadius 0.95
                        height 2
                }

        }
    }
}
DEF L3 Transform {
    translation  0 0 -4.25
    rotation     1 0 0  1.5708
    children Shape {
        appearance   Appearance {
            material     DEF White_Plastic Material {
                ambientIntensity    0.1
                diffuseColor 1 1 1
                specularColor 1 1 1
            }

        }

        geometry     Cylinder {
            height 2
            radius 0.1
            bottom TRUE
        }

    }
}
DEF L4 Transform {
    children []
}
DEF L5 Transform {
    translation  0 0 -5.375
    rotation     -1 0 0  1.5708
    children Shape {
        appearance   Appearance {
            material     DEF White_Plastic Material {
                ambientIntensity    0.1
                diffuseColor 1 1 1
                specularColor 1 1 1
            }

        }

        geometry     Cone {
            bottomRadius 0.1
            height 0.25
        }

    }
}
```