Isil Sonmez

Service Robot Project

This project focuses on a 4 Degree of Freedom (DOF) robotic arm with a gripper. The arm has four revolute joints, allowing it to rotate at each joint and perform various tasks with flexibility. The link lengths are:

- L1=10 units
- L2=20 units
- L3=20 units
- L4=10 units

These lengths define the structure of the arm, balancing reach and stability. The gripper acts as the end effector, making the arm capable of picking and placing objects. This setup is suitable for tasks requiring precise motion and multi-axis movement.

In this project, forward kinematics was used, applying a set of 4 basic transformation matrices. These include rotation about the Z-axis, translation along the Z-axis, rotation about the X-axis, and translation along the X-axis.

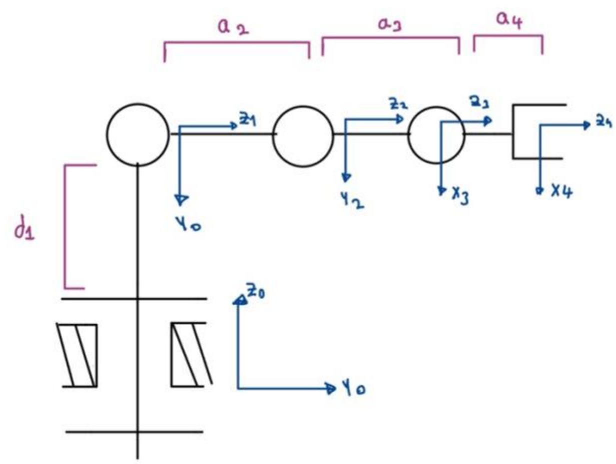
$$Transz = \begin{bmatrix} 1\ 0\ 0\ 0 \\ 0\ 1\ 0\ 0 \\ 0\ 0\ 1\ c \\ 0\ 0\ 0\ 1 \end{bmatrix} \qquad Transx = \begin{bmatrix} 1\ 0\ 0\ a \\ 0\ 1\ 0\ 0 \\ 0\ 0\ 1\ 0 \\ 0\ 0\ 0\ 1 \end{bmatrix}$$

$$Rotx\alpha = \begin{bmatrix} 1 & 0 & 0. & 0 \\ 0 & \cos(a) & -\sin(a) & 0 \\ 0 & \sin(a) & \cos(a) & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \qquad Rotz\theta = \begin{bmatrix} \cos(\theta) & -\sin(\theta) & 0 & 0 \\ \sin(\theta) & \cos(\theta) & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

The fundamental four parameters *ai αi di* and *di* are associated with link i and joint i. These parameters, as represented in the transformation matrices, are referred to in the following order:

a_i	-	Length of a member
α_i	-	Rotation of a member
d_i	-	Offset of a joint
d_i	-	Angle of a joint

1-Forward Kinematics



Joint	θ_i	d_i mm	ai mm	α_i
1	$\Theta var=0$	D1	-	-90
2	-	-	-	$A2var=0$
3	-	D2	-	$A3var=0$
4	-	D3	-	$A4var=0$
5	-	D4	-	-

A1= $Rotz\theta.Transz.Rotx\alpha =$

$$\begin{bmatrix} \cos(0) & -\sin(0) & 0 & 0 \\ \sin(0) & \cos(0) & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} . \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 10 \\ 0 & 0 & 0 & 1 \end{bmatrix} . \begin{bmatrix} 1 & 0 & 0. & 0 \\ 0 & \cos(-90) & -\sin(-90) & 0 \\ 0 & \sin(-90) & \cos(-90) & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} =$$

```
ans =

     1     0     0     0
     0     0     1     0
     0    -1     0    10
     0     0     0     1
```

$$A2 = Rotx\alpha = \begin{bmatrix} 1 & 0 & 0. & 0 \\ 0 & \cos(0) & -\sin(0) & 0 \\ 0 & \sin(0) & \cos(0) & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} =$$

```
1     0     0     0
0     1     0     0
0     0     1     0
0     0     0     1
```

$$A3=TranszRotx\alpha=\begin{bmatrix}1&0&0&0\\0&1&0&0\\0&0&1&20\\0&0&0&1\end{bmatrix}\begin{bmatrix}1&0&0.&0\\0&\cos 0&-\sin(0)&0\\0&\sin(0)&\cos(0)&0\\0&0&0&1\end{bmatrix}.$$

1	0	0	0
0	1	0	0
0	0	1	20
0	0	0	1

$$A4=Transz\,Rotx\alpha=\begin{bmatrix}1&0&0&0\\0&1&0&0\\0&0&1&20\\0&0&0&1\end{bmatrix}\begin{bmatrix}1&0&0.&0\\0&\cos(0)&-\sin(0)&0\\0&\sin(0)&\cos(0)&0\\0&0&0&1\end{bmatrix}.$$

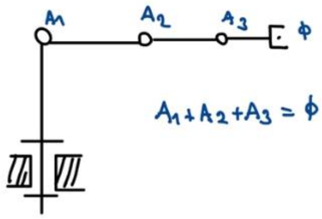
1	0	0	0
0	1	0	0
0	0	1	20
0	0	0	1

$$A5=Transz=\begin{bmatrix}1&0&0&0\\0&1&0&0\\0&0&1&10\\0&0&0&1\end{bmatrix}$$

T=A1.A2.A3.A4.A5=

1	0	0	0
0	0	1	50
0	−1	0	10
0	0	0	1

1-Inverse Kinematic



T[1,1]= Cos(θ1)=1
θ1=0
Simplified equations
T[2,4]=20*cos(a2 + a3) + 20*cos(a2) + 10*cos(a2 + a3 + a4)=50
T[3,2]=-cos(a2 + a3 + a4)=-1
T[3,4]=20*sin(a2 + a3) + 20*sin(a2) + 10*sin(a2 + a3 + a4) + 10=10

We are summing first equation and second equation for simplifying.
20*cos(a2 + a3) + 20*cos(a2) + 10*cos(a2 + a3 + a4)=50
10*-cos(a2 + a3 + a4)=-10 (we expand this equation with 10)

We observe this equation from previous calculation.
20*cos(a2 + a3) + 20*cos(a2)=40

cos(a2)=1
cos(a2 + a3)=1

We found and put the proper values.
a2=0
a3 =0

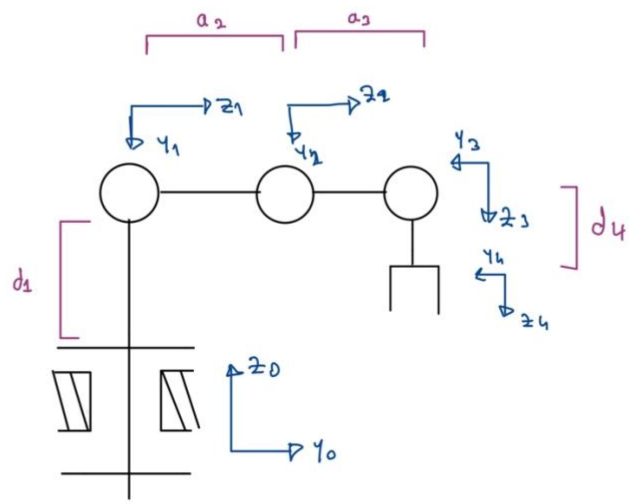
We put the values to first equation to get a4.
T[2,4]=20*cos(a2 + a3) + 20*cos(a2) + 10*cos(a2 + a3 + a4)=50
a4=0

For proving our values, We are testing the values with third equation.
T[3,4]=20*sin(a2 + a3) + 20*sin(a2) + 10*sin(a2 + a3 + a4) + 10=10

T[3,4]=20*sin(0 +0) + 20*sin(0) + 10*sin(0+0+0) + 10=10
10=10
Our values are correct

A1+a2+a3=0

2-Forward Kinematics



Joint	θ_i	d_i mm	ai mm	α_i
1	$\theta var=0$	D1	-	-90
2	-	-	-	A2var=0
3	-	D2	-	A3var=0
4	-	D3	-	A4var=-90
5	-	D4	-	-

A1= $Rotz\theta. Transz. Rotx\alpha =$

$$\begin{bmatrix} \cos(\theta 1) & -\sin(\theta 1) & 0 & 0 \\ \sin(\theta 1) & \cos(\theta 1) & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} . \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 10 \\ 0 & 0 & 0 & 1 \end{bmatrix} . \begin{bmatrix} 1 & 0 & 0. & 0 \\ 0 & \cos(-90) & -\sin(-90) & 0 \\ 0 & \sin(-90) & \cos(-90) & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} =$$

```
ans =

     1     0     0     0
     0     0     1     0
     0    -1     0    10
     0     0     0     1
```

$$A2 = Rotx\alpha = \begin{bmatrix} 1 & 0 & 0. & 0 \\ 0 & \cos(0) & -\sin(0) & 0 \\ 0 & \sin(0) & \cos(0) & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

```
     1     0     0     0
     0     1     0     0
     0     0     1     0
     0     0     0     1
```

$$A3 = Transz Rotx\alpha = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 20 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0. & 0 \\ 0 & \cos(0) & -\sin(0) & 0 \\ 0 & \sin(0) & \cos(0) & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}.$$

1	0	0	0
0	1	0	0
0	0	1	20
0	0	0	1

$$A4 = Transz\ Rotx\alpha = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 20 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0. & 0 \\ 0 & \cos(-90) & -\sin(-90) & 0 \\ 0 & \sin(-90) & \cos(-90) & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} =$$

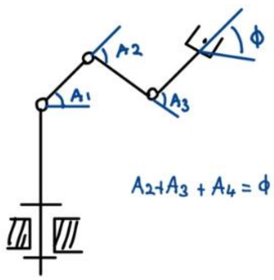
1	0	0	0
0	0	1	0
0	−1	0	20
0	0	0	1

$$A5 = Transz = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 10 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

T=A1.A2.A3.A4.A5

1	0	0	0
0	−1	0	40
0	0	−1	0
0	0	0	1

2-Inverse kinematics



T[1,1]= Cos(θ1)=1
θ1=0
Simplified equations
[2,4]=20*cos(a2 + a3) + 20*cos(a2) + 10*cos(a2 + a3 + a4)=40
T[3,2]=-cos(a2 + a3 + a4)=0
T[3,4]=20*sin(a2 + a3) + 20*sin(a2) + 10*sin(a2 + a3 + a4) + 10=0

We are summing first equation and second equation for simplifying.
20*cos(a2 + a3) + 20*cos(a2) + 10*cos(a2 + a3 + a4)=40
10*-cos(a2 + a3 + a4)=0 (we expand this equation with 10)

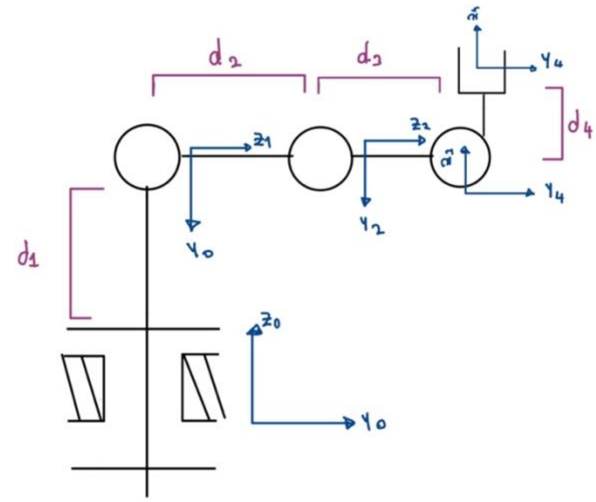
We observe this equation from previous calculation
20*cos(a2 + a3) + 20*cos(a2)=40
cos(a2)=1
cos(a2 + a3)=1

We found and put the proper values.
a2=0
a3 =0

We put the values to first equation to get a4.
T[2,4]=20*cos(a2 + a3) + 20*cos(a2) + 10*cos(a2 + a3 + a4)=40
a4=-90 or a4=-90

For proving our values, We are testing the values with third equation.
First we try a4=-90 .
T[3,4]=20*sin(0+ 0) + 20*sin(0) + 10*sin(0 + 0 -90) + 10=0
0=0
Our values are correct
Secondly, we try a4=-90
20 = 0
So a4=-90 is **not correct**
A1+a2+a3=-90

3-Forward Kinematics



Joint	θ_i	d_i mm	*ai mm*	α_i
1	$\theta var=0$	D1	-	-90
2	-	-	-	*A2var=0*
3	-	D2	-	*A3var=0*
4	-	D3	-	*A4var=90*
5	-	D4	-	-

A1= $Rotz\theta . Transz . Rotx\alpha =$

$$\begin{bmatrix} \cos(0) & -\sin(0) & 0 & 0 \\ \sin(0) & \cos(0) & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} . \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 10 \\ 0 & 0 & 0 & 1 \end{bmatrix} . \begin{bmatrix} 1 & 0 & 0. & 0 \\ 0 & \cos(-90) & -\sin(-90) & 0 \\ 0 & \sin(-90) & \cos(-90) & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} =$$

```
ans =

     1     0     0     0
     0     0     1     0
     0    -1     0    10
     0     0     0     1
```

$$A2 = Rotx\alpha = \begin{bmatrix} 1 & 0 & 0. & 0 \\ 0 & \cos(0) & -\sin(0) & 0 \\ 0 & \sin(0) & \cos(0) & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}]$$

1	0	0	0
0	1	0	0
0	0	1	0
0	0	0	1

$$A3=TranszRotx\alpha=\left[\begin{bmatrix}1\ 0\ 0\ 0\\0\ 1\ 0\ 0\\0\ 0\ 1\ 20\\0\ 0\ 0\ 1\end{bmatrix}\begin{matrix}1 & 0 & 0. & 0\\0 & \cos(0) & -\sin(0) & 0\\0 & \sin(0) & \cos(0) & 0\\0 & 0 & 0 & 1\end{matrix}\right].$$

1	0	0	0
0	1	0	0
0	0	1	20
0	0	0	1

$$A4=Transz\ Rotx\alpha=\begin{bmatrix}1\ 0\ 0\ 0\\0\ 1\ 0\ 0\\0\ 0\ 1\ 20\\0\ 0\ 0\ 1\end{bmatrix}\begin{bmatrix}1 & 0 & 0. & 0\\0 & \cos(90) & -\sin(90) & 0\\0 & \sin(90) & \cos(90) & 0\\0 & 0 & 0 & 1\end{bmatrix}=$$

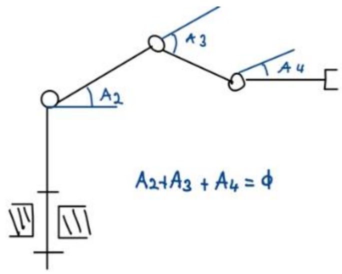
1	0	0	0
0	0	1	0
0	1	0	20
0	0	0	1

$$A5=Transz=\begin{bmatrix}1 & 0 & 0 & 0\\0 & 1 & 0 & 0\\0 & 0 & 1 & 10\\0 & 0 & 0 & 1\end{bmatrix}$$

T=A1.A2.A3.A4.A5

1	0	0	0
0	1	0	40
0	0	1	20
0	0	0	1

3-Inverse Kinematics



T[1,1]= Cos(θ1)=1
θ1=0

Simplified equations

T[2,4]=20*cos(a2 + a3) + 20*cos(a2) + 10*cos(a2 + a3 + a4)=40
T[3,2]=-cos(a2 + a3 + a4)=0
T[3,4]=20*sin(a2 + a3) + 20*sin(a2) + 10*sin(a2 + a3 + a4) + 10=20

We are summing first equation and second equation for simplifying.

20*cos(a2 + a3) + 20*cos(a2) + 10*cos(a2 + a3 + a4)=40
10*-cos(a2 + a3 + a4)=0.   (we expand this equation with 10)

We observe this equation from previous calculation

20*cos(a2 + a3) + 20*cos(a2)=40

cos(a2)=1
cos(a2 + a3)=1

We found and put the proper values.

a2=0
a3 =0

We put the values to first equation to get a4.

T[2,4]=20*cos(a2 + a3) + 20*cos(a2) + 10*cos(a2 + a3 + a4)=40

a4=90
or
a4=-90

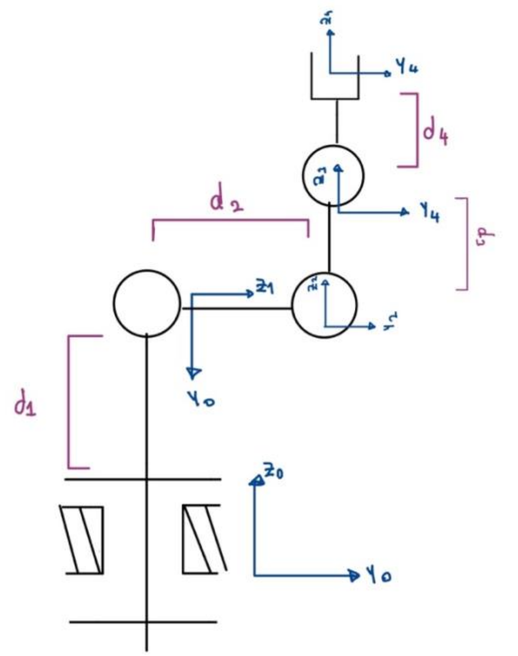
For proving our values, We are testing the values with third equation.
T[3,4]=20*sin(a2 + a3) + 20*sin(a2) + 10*sin(a2 + a3 + a4) + 10=20

T[3,4]=20*sin(0 + 0) + 20*sin(0) + 10*sin(0+ 0 +90) + 10=20
20=20

Our values are correct

A1+a2+a3=90

4-Forward Kinematics



Joint	θ_i	d_i mm	ai mm	α_i
1	$\theta var=0$	D1	-	-90
2	-	-	-	*A2var=0*
3	-	D2	-	*A3var=90*
4	-	D3	-	*A4var=0*
5	-	D4	-	-

A1= $Rotz\theta . Transz. Rotx\alpha =$

$$\begin{bmatrix} \cos(0) & -\sin(0) & 0 & 0 \\ \sin(0) & \cos(0) & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} . \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 10 \\ 0 & 0 & 0 & 1 \end{bmatrix} . \begin{bmatrix} 1 & 0 & 0. & 0 \\ 0 & \cos(-90) & -\sin(-90) & 0 \\ 0 & \sin(-90) & \cos(-90) & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} =$$

```
ans =

     1     0     0     0
     0     0     1     0
     0    -1     0    10
     0     0     0     1
```

$$A2 = Rotx\alpha = \begin{bmatrix} 1 & 0 & 0. & 0 \\ 0 & \cos(0) & -\sin(0) & 0 \\ 0 & \sin(0) & \cos(0) & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}]$$

1	0	0	0
0	1	0	0
0	0	1	0
0	0	0	1

$$A3 = TranszRotx\alpha = \begin{bmatrix} 1\ 0\ 0\ 0 \\ 0\ 1\ 0\ 0 \\ 0\ 0\ 1\ 20 \\ 0\ 0\ 0\ 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0. & 0 \\ 0 & \cos(90) & -\sin(90) & 0 \\ 0 & \sin(90) & \cos(90) & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}.$$

1	0	0	0
0	0	1	0
0	1	0	20
0	0	0	1

$$A4 = TranszRotx\alpha = \begin{bmatrix} 1\ 0\ 0\ 0 \\ 0\ 1\ 0\ 0 \\ 0\ 0\ 1\ 20 \\ 0\ 0\ 0\ 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0. & 0 \\ 0 & \cos(0) & -\sin(0) & 0 \\ 0 & \sin(0) & \cos(0) & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}.$$

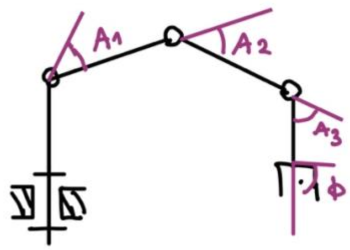
1	0	0	0
0	1	0	0
0	0	1	20
0	0	0	1

$$A5 = Transz = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 10 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

T=A1.A2.A3.A4.A5

1	0	0	0
0	1	0	40
0	0	1	20
0	0	0	1

4-Inverse Kinematics



T[1,1]= Cos(θ1)=1
θ1=0
Simplified equations
T[2,4]=20*cos(a2 + a3) + 20*cos(a2) + 10*cos(a2 + a3 + a4)=40
T[3,2]=-cos(a2 + a3 + a4)=0
T[3,4]=20*sin(a2 + a3) + 20*sin(a2) + 10*sin(a2 + a3 + a4) + 10=20

We are summing first equation and second equation for simplifying.
20*cos(a2 + a3) + 20*cos(a2) + 10*cos(a2 + a3 + a4)=40
10*-cos(a2 + a3 + a4)=0. (we expand this equation with 10)

We observe this equation from previous calculation
20*cos(a2 + a3) + 20*cos(a2)=40
cos(a2)=1
cos(a2 + a3)=1

We found and put the proper values.
a2=0
a3 =0

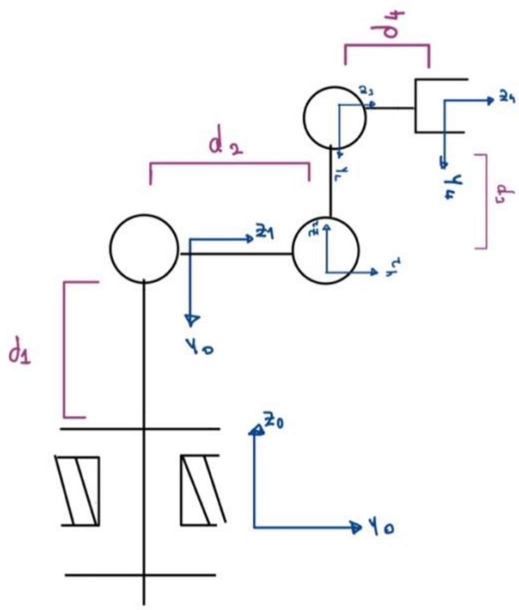
We put the values to first equation to get a4.
T[2,4]=20*cos(a2 + a3) + 20*cos(a2) + 10*cos(a2 + a3 + a4)=40
a4=90
or
a4=-90

For proving our values, We are testing the values with third equation.
T[3,4]=20*sin(a2 + a3) + 20*sin(a2) + 10*sin(a2 + a3 + a4) + 10=20
T[3,4]=20*sin(0 + 0) + 20*sin(0) + 10*sin(0+ 0 +90) + 10=20

20=20

Our values are correct
A1+a2+a3=90

5-Forward Kinematics



Joint	θ_i	d_i mm	ai mm	α_i
1	$\theta var=0$	D1	-	-90
2	-	-	-	$A2var=0$
3	-	D2	-	$A3var=90$
4	-	D3	-	$A4var=-90$
5	-	D4	-	-

A1= $Rotz\theta . Transz. Rotx\alpha =$

$$\begin{bmatrix} \cos(\theta 1) & -\sin(\theta 1) & 0 & 0 \\ \sin(\theta 1) & \cos(\theta 1) & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} . \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 10 \\ 0 & 0 & 0 & 1 \end{bmatrix} . \begin{bmatrix} 1 & 0 & 0. & 0 \\ 0 & \cos(-90) & -\sin(-90) & 0 \\ 0 & \sin(-90) & \cos(-90) & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} =$$

```
ans =

     1     0     0     0
     0     0     1     0
     0    -1     0    10
     0     0     0     1
```

$$A2 = Rotx\alpha = \begin{bmatrix} 1 & 0 & 0. & 0 \\ 0 & \cos(0) & -\sin(0) & 0 \\ 0 & \sin(0) & \cos(0) & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

1	0	0	0
0	1	0	0
0	0	1	0
0	0	0	1

$$A3 = TranszRotx\alpha = \begin{bmatrix} 1\ 0\ 0\ 0 \\ 0\ 1\ 0\ 0 \\ 0\ 0\ 1\ 20 \\ 0\ 0\ 0\ 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0. & 0 \\ 0 & \cos(90) & -\sin(90) & 0 \\ 0 & \sin(90) & \cos(90) & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} =.$$

1	0	0	0
0	0	1	0
0	1	0	20
0	0	0	1

$$A4 = Transz\ Rotx\alpha = \begin{bmatrix} 1\ 0\ 0\ 0 \\ 0\ 1\ 0\ 0 \\ 0\ 0\ 1\ 20 \\ 0\ 0\ 0\ 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0. & 0 \\ 0 & \cos(-90) & -\sin(-90) & 0 \\ 0 & \sin(-90) & \cos(-90) & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} =$$

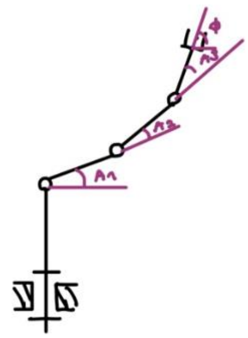
1	0	0	0
0	0	1	0
0	−1	0	20
0	0	0	1

$$A5 = Transz = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 10 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

T=A1.A2.A3.A4.A5

1	0	0	0
0	0	1	30
0	−1	0	30
0	0	0	1

5-Inverse Kinematics

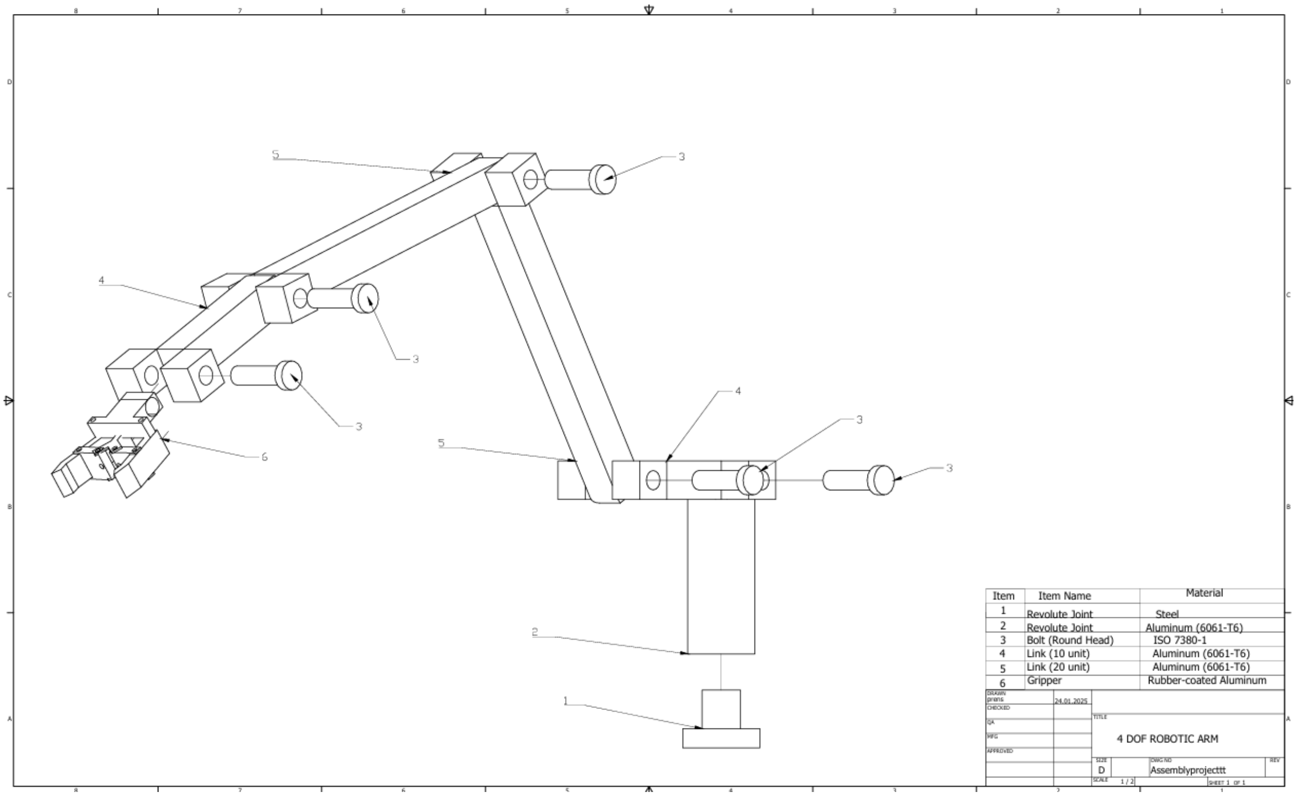


T[1,1]= Cos(θ1)=1
θ1=0
Simplified equations
T[2,4]=20*cos(a2 + a3) + 20*cos(a2) + 10*cos(a2 + a3 + a4)=30
T[3,2]=-cos(a2 + a3 + a4)=-1
T[3,4]=20*sin(a2 + a3) + 20*sin(a2) + 10*sin(a2 + a3 + a4) + 10=30

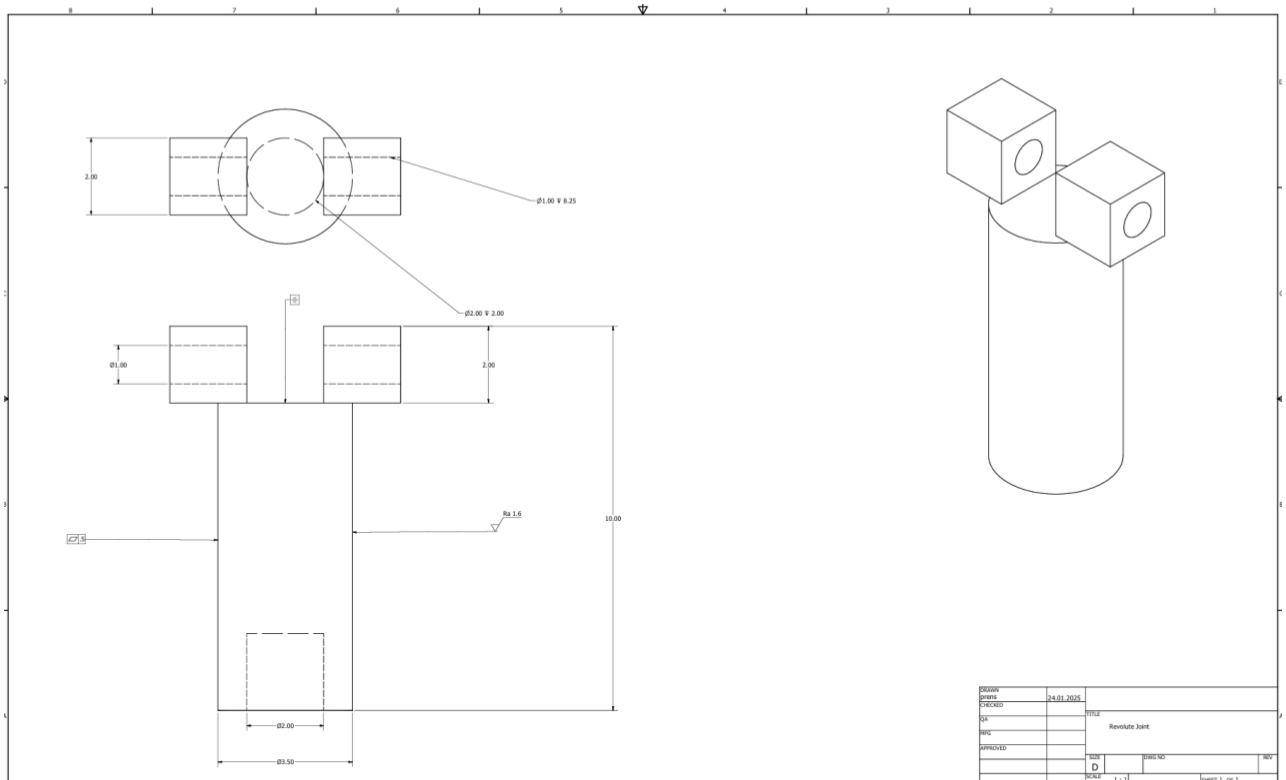
We are summing first equation and second equation for simplifying.
20*cos(a2 + a3) + 20*cos(a2) + 10*cos(a2 + a3 + a4)=30
10*-cos(a2 + a3 + a4)=-10.   (we expand this equation with 10)

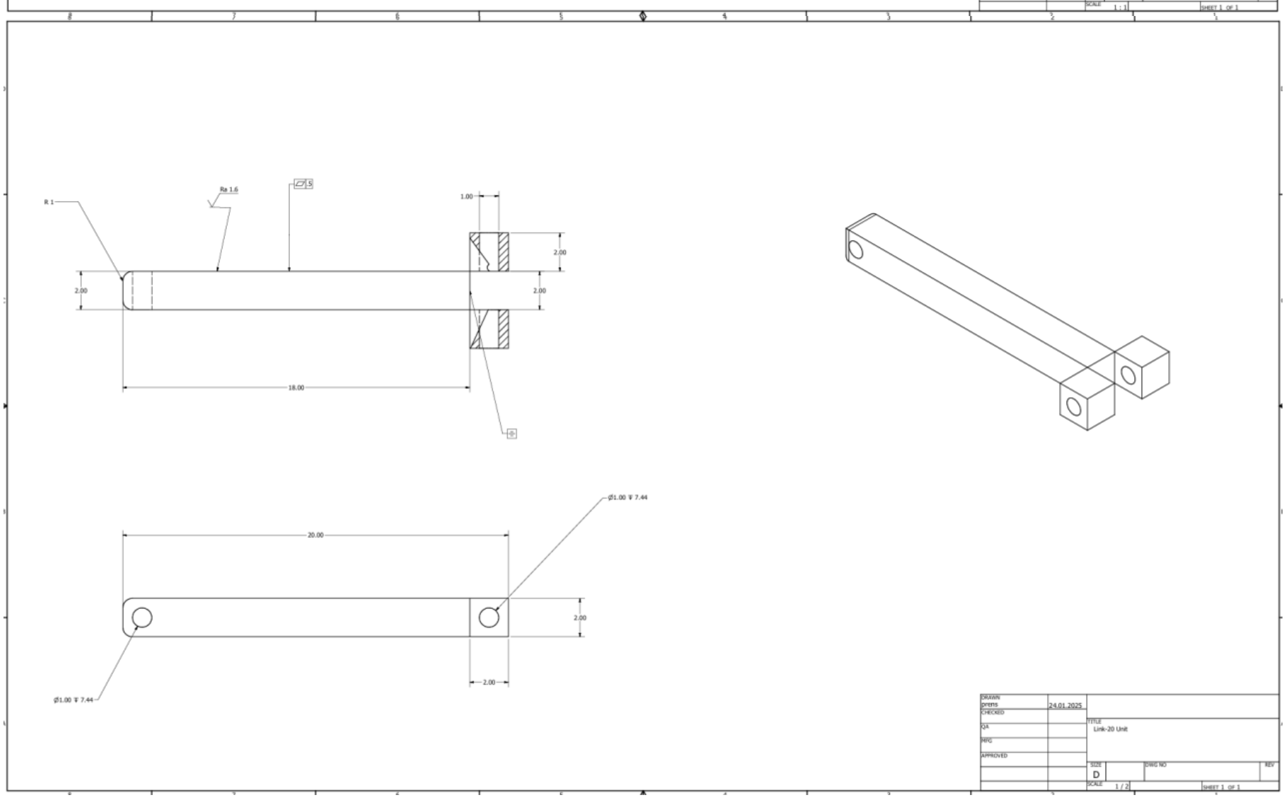
We observe this equation from previous calculation
20*cos(a2 + a3) + 20*cos(a2)=20
cos(a2)=1
cos(a2 + a3)=0
or
cos(a2)=0
cos(a2 + a3)=1
We found and put the proper values.
a2=0 a3 =90
or
a2=90 a3=90
We put the values to first equation to get a4.
T[2,4]=20*cos(a2 + a3) + 20*cos(a2) + 10*cos(a2 + a3 + a4)=30
a4=-90
When we put a2=90 and a3=90. They do not fit the equation because;
T[2,4]=-20 + 0+ 10*cos(180+ a4)=30
10*cos(180+ a4)=40 (This calculation can not be done.)
For proving our values, We are testing the values with third equation.
T[3,4]=20*sin(a2 + a3) + 20*sin(a2) + 10*sin(a2 + a3 + a4) + 10=20
T[3,4]=20*sin(0 + 90) + 20*sin(0) + 10*sin(0+ 90+-90) + 10=30
30=30
Our values are correct
A1+a2+a3=0

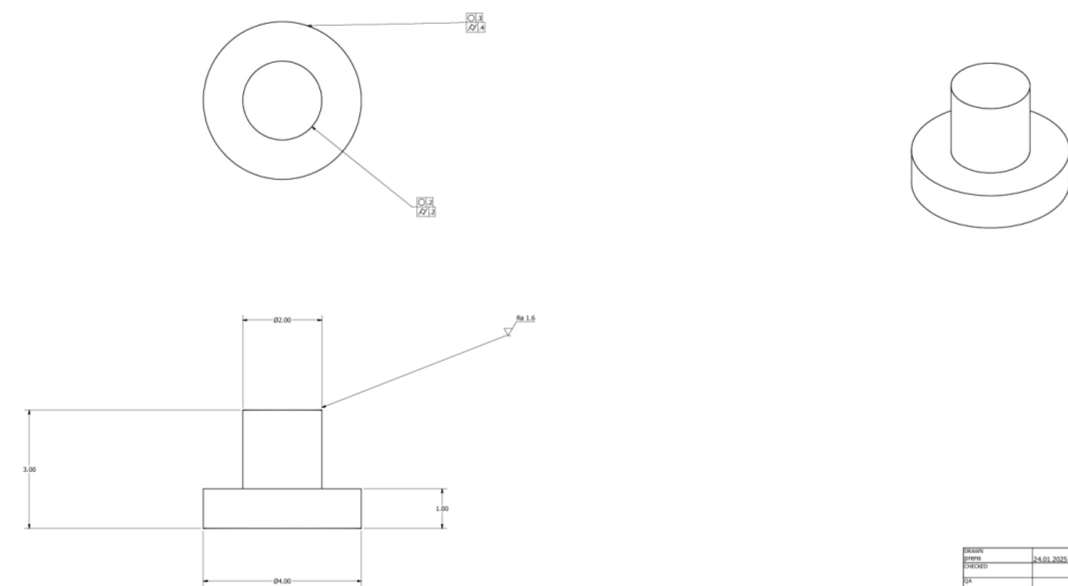
Assembly Drawing



Manufacturing Drawing







DRAWN prens	24.01.2025				
CHECKED		TITLE Revolute Joint			
QA					
MFG					
APPROVED					
		SIZE D		DWG NO	REV
		SCALE 1 : 1		SHEET 1 OF 1	