# Forward Kinematics – FK module

In typical manipulators, the position of the effector is not measured directly. The position is determined on the basis of measurements taken at each joint of the kinematic chain. Measurements are converted to a Cartesian position using forward kinematics.

In robotics, a frequently used method of solving a forward problem is the Denavit-Hartenberg notation. It assumes that each joint has one degree of freedom, and its operation can be described by the value of the angle of rotation or displacement, depending on the type of the considered joint (rotational or prismatic). In the D-H notation, the position of the next two coordinate systems is determined using the following four parameters:

• θ - angle between the X axes, determined around the Z axis,

• d - the distance between the X axes, determined along the Z axis,

• a - distance between the Z axes, determined along the X axis,

• α - the angle between the Z axes, determined around the X axis.

Among mentioned parameters, d and a are constants defined by the structure of the members. The parameters θ and α, on the other hand, may be variable.

FK is a module that performs forward kinematics calculations with the use of Denavit - Hartenberg notation. The function that performs kinematics calculations requires the introduction of input variables regarding the angles of rotation of individual joints and the dimensions of the effector. Then, based on the system diagram with marked coordinate systems and shifts (Fig. 1.1), the DH table is being created.
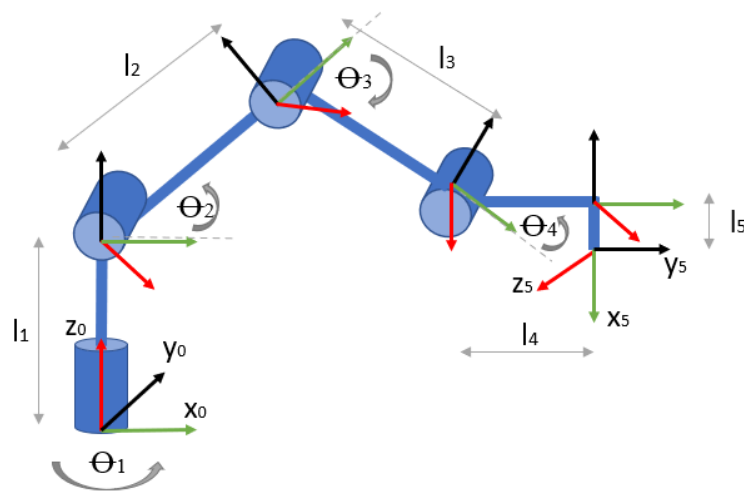
Rys. 1.1 DH notation - layout scheme

The DH table created on the basis of the presented scheme has been included in table 1.1.

Tabela 1.1 DH table

L.p.	Θ	d	a	α
0	Θ_1	l_1	0	90
1	Θ_2	0	l_2	0
2	Θ_3	0	l_3	0
3	Θ_4	0	l_4	0
4	-90°	0	l_5	0

Then, on the basis of the created table, homogeneous transformation matrices for the ends of individual links are determined. The function also determines the orientations of the effector in space.

Bibliography

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