Lab 4 Deliverables

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Group 0102-6

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Contributions (overview)

Adithya: DH tables, lab measurements, FK / measured analysis
Sriman: Report, Python code, DH tables
Brandon: DH tables, lab measurements
Eric: lab measurements

DH table exercise

Assuming angles are in degrees.

2 DoF configuration

link	d	θ	r	α
0	0	θ_1	a_1	0
1	0	θ_2	a_2	0

3 DoF configuration

link	d	θ	r	α
0	0	θ_0	0	0
1	d_2	0	0	-90
2	d_3	0	0	0

6 DoF configuration

link	d	θ	r	α
0	0	θ_1	0	90
1	0	$\theta_2 + 90$	0	-90
2	0	θ_3	D_3	0
3	0	θ_4	L_3	0
4	0	θ_5	L_5	90
5	0	θ_6	L_6	90

UR3e DH table

Assuming angles are in degrees.

link	d	θ	r	α
0	0.15185	θ_0	0.0	90
1	0.0	θ_1	-0.24355	0
2	0.0	θ_2	-0.2132	0
3	0.13105	θ_3	0.0	90
4	0.08535	θ_4	0.0	-90
5	0.0921	θ_5	0.0	0

Lab analysis

Data

point	value	x	y	z
$[-20, -70, 110, -15, 0, 20]$	calculated	0.274	0.263	0.257
(demo point 1)	measured	0.288	0.293	0.269
$[-40, -60, 80, -10, -90, -30]$	calculated	0.221	0.043	0.152
(demo point 2)	measured	0.231	0.062	0.153
$[30, -70, 80, -10, -90, 10]$	calculated	0.103	0.484	0.213
(demo point 3)	measured	0.104	0.504	0.215
$[0, -30, 60, -60, -60, -60]$	calculated	0.332	0.354	0.102
(demo point 4)	measured	0.338	0.381	0.108

Error calculations

demo point	error (m)
1	0.0352
2	0.0215
3	0.0201
4	0.0283

Why Euclidean distance? We used Euclidean distance since the error is in $\mathbb{R}^3$ since it represents the distance between the expected position of the end-effector and the actual values we got. We believe this

is the best way to calculate error as it is the most literal difference between two points.

Sources of error The robot might be positioned somewhere offset from the grid other than the base frame, we might have measured the distances with human error, and we might not have been measuring from the true end-effector point.

`ur3e_df.py` vs. lab measurements

point	value	x	y	z
$[-20, -70, 110, -15, 0, 20]$	calculated	-0.274	-0.138	0.166
(demo point 1)	measured	0.288	0.293	0.269
$[-40, -60, 80, -10, -90, -30]$	calculated	-0.250	0.039	0.222
(demo point 2)	measured	0.231	0.062	0.153
$[30, -70, 80, -10, -90, 10]$	calculated	-0.109	0.214	0.258
(demo point 3)	measured	0.104	0.504	0.215
$[0, -30, 60, -60, -60, -60]$	calculated	-0.369	-0.177	0.053
(demo point 4)	measured	0.338	0.381	0.108

Our code values are not perfect compared to the measured ones. Our x axis value is constantly off by a factor of negative 1. Our y values are off by a constant and so are our z values. This could be because of some new ROS files that cause some bugs. This could also be based on discrepancies in our coordinate axis and grid.

Code

See `ur3e_df.py` and `lab3_exec.py`.