RLSC HOMEWORK
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Question A

	Comf. 0		Comf. 1	
Target	Right	Left	Right	Left
0	5.82451	8.99951	16.8063	22.959
1	9.17662	11.3567	17.5662	22.279
2	12.4921	10.9045	21.3594	17.496
3	12.7239	7.71526	24.8795	13.1674
4	10.1816	4.71255	25.6641	15.0823
5	7.33507	3.85035	21.5217	15.8701
6	5.49207	4.58414	17.9371	16.4608
7	4.79806	6.32103	16.7372	19.4292

Question B

When computing the IK solution for reaching the target, what we essentially do is to iteratively minimize a cost function that we define. In this case, we solve the problem using one of two different cost functions: one consists on computing the difference between the position of the goal and the current position of the end effector plus the difference between the next joint angles and the current ones; the other cost function adds an extra cost term based on the difference between the next joint angles and the comfort joint angles.

That means that if no comfort pose is taken into account, our IK solution will entail moving from a start position to the target in the most direct and efficient way possible. That means that the final pose obtained might be a bit unorthodox or awkward. Instead, if a comfort pose is taken into consideration for the cost function, a more "human-like" pose should be obtained. Also, another important point is that regardless of the start position, all IK solutions will converge to a similar set of values, as we can see on the following tables:

Final joint values using comfort pose

1	2	3
0.24587	0.23502	0.240348
0.071579	0.0795094	0.0729247
0.909172	0.916161	0.918756
1.55946	1.57326	1.57193
0.777479	0.7778	0.778926
1.17122	1.15739	1.15298
-0.00048722	-0.000451373	-0.000505376

Final joint values without comfort pose

1	2	3
0.793555	-0.309781	0.887967
-1.11794	0.871896	-1.26226
0.602446	0.989627	0.333611
1.76633	2.06693	2.34364
0.26804	1.24022	-1.24035
0.873961	0.296507	-0.635243
-0.00186961	0.00150013	-0.00128267

The following figures show how both approaches differ in terms of final pose for reaching the same target from the same start position:

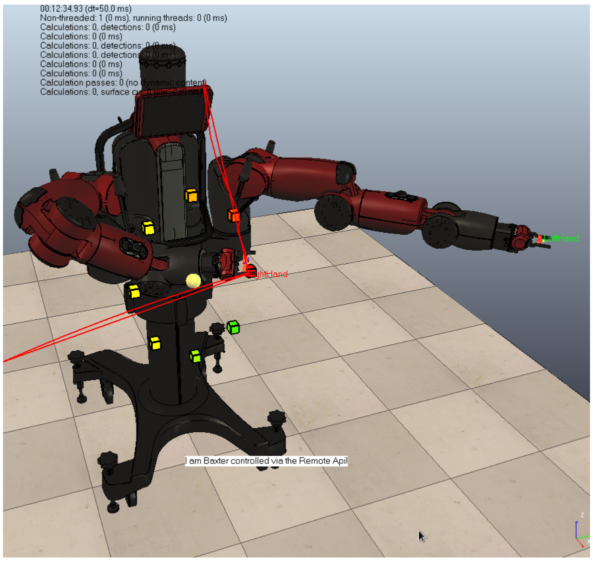

Figure 1: Approaching the target accounting for a comfort pose

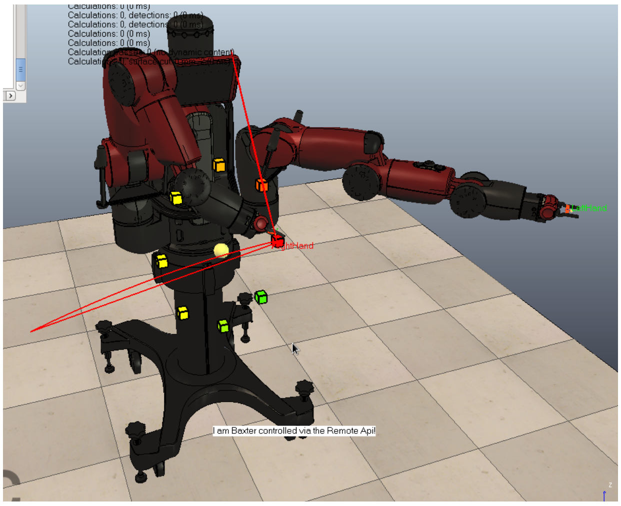

Figure 2: Approaching the target without accounting for any comfort pose

Question C

To run PCA on the computed joint angles for each task (the difference of their values between the start and target), we first subtract the mean of each dimension (out of the 7 dimensions of the joint space) on the aforementioned joint angle values. Then, we compute the Singular Value Decomposition of the 24x7 matrix that we have (24 tasks, 7 joints per task), from which we can obtain the eigenvalues (7) and eigenvectors (24x7) of the matrix.

If we compare the values of the eigenvalues relative to each other we can see how relevant each dimension is compared to the others. In our case, the eigenvalues obtained are (from higher to lower): 7.60104, 4.05193, 1.51817, 1.28732, 0.92887, 0.498156, 0.00116878. From that we see that there are two dimensions that are very relevant to the task, as they have a considerably higher value as compared to the other ones. Another fact that can be observed is that one dimension of the space is barely relevant at all.

If we compute the relevance of the largest eigenvalues we can see that the first 3 eigenvalues account for an 83% of the space. If we take the first 4 we will cover 91% of the variance for the 24 different tasks we have computed. As a last note, the 24 computed tasks don't take into account a comfort pose.