Assignment2 AE21B024

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1 Inverse Kinematics

The simulation robotic arm in coppeliasim software.

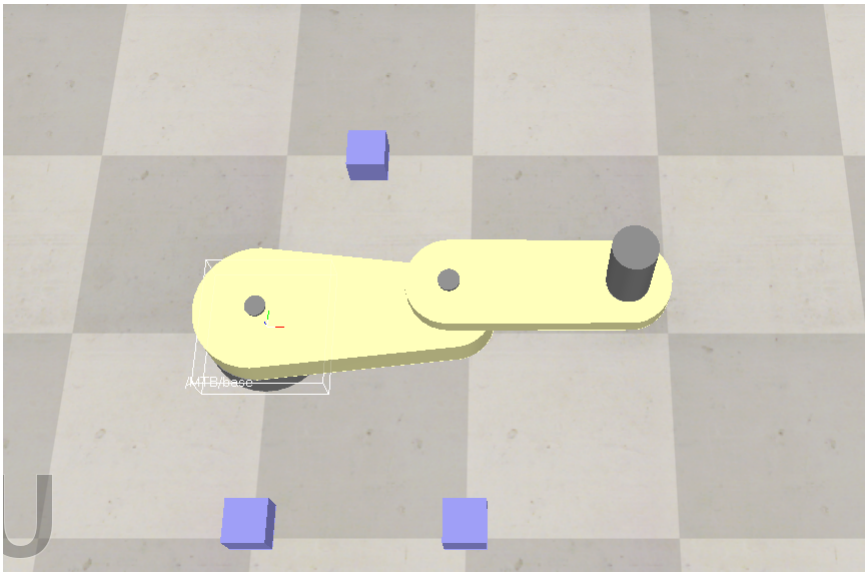

Figure 1: Caption

The equations used to perform the task:

$$Cos(\theta_2) = \frac{X_d^2 + y_d^2 - l_1^2 - l_2^2}{2l_1 l_2} \tag{1}$$

l_1 and l_2 are given as 0.475 and 0.4005 respectively.

$$M = l_1 + l_2 cos(\theta_2) \tag{2}$$

$$N = l_2 sin(\theta_2) \tag{3}$$

$$\gamma = atan2(N, M) \tag{4}$$

$$\theta_1 = atan2(y_d/x_d) - \gamma \tag{5}$$

The inverse kinematics code to calculate the joint angles required for desired end-effector positions.

```python
def inv_kin_fn(goal_position):
    #Compute joint angles [in degrees] to reach desired position [in meters]
    x_desired = goal_position[0]
    y_desired = goal_position[1]

    theta_2 = math.acos((x_desired**2 + y_desired**2 - 0.467**2 - 0.4005**2) / 0.374)

    if(math.cos(theta_2*(180/math.pi)) > 1 or math.cos(theta_2*(180/math.pi)) < -1):
        print("(xd,yd) is out of workspace!")

    M = 0.467 + 0.4005*math.cos(theta_2)
    N = 0.4005*math.sin(theta_2)

    gamma = math.atan2(N,M)
    theta_1 = math.atan2(y_desired,x_desired) - gamma

    theta_1 = theta_1*(180/math.pi)
    theta_2 = theta_2*(180/math.pi)

    print("Desired joint angles",[theta_1, theta_2])
    return [theta_1, theta_2]
```

Figure 2: Caption

Iterations	Joint angles (goal-1)	Joint angles (goal-2)
Iteration-1	(17.5,105.86)	(-140.31,114.12)

Table 1: Caption

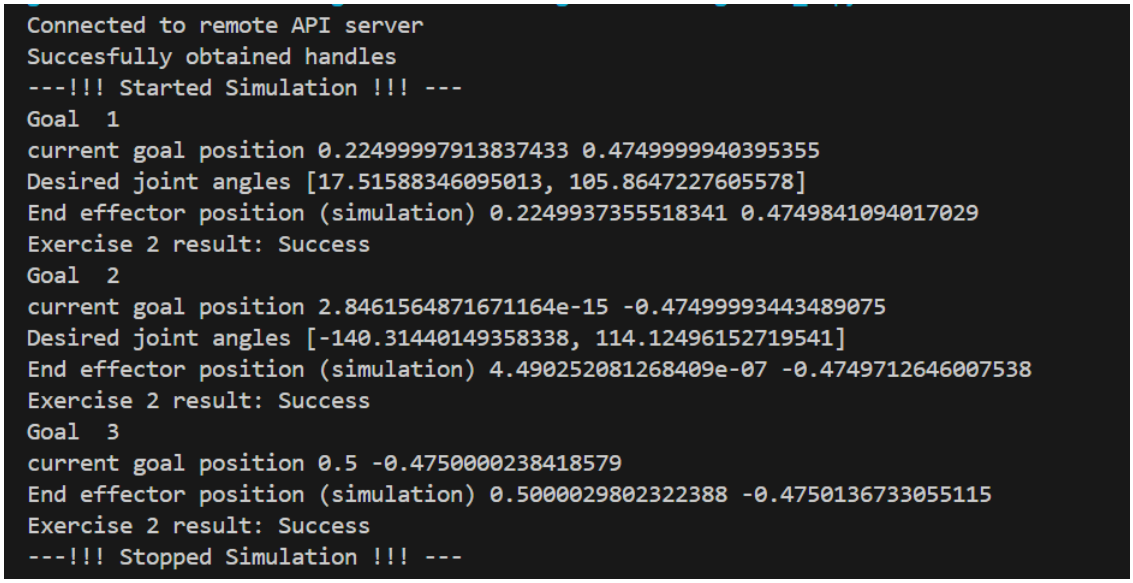

Figure 3: Iteration-1

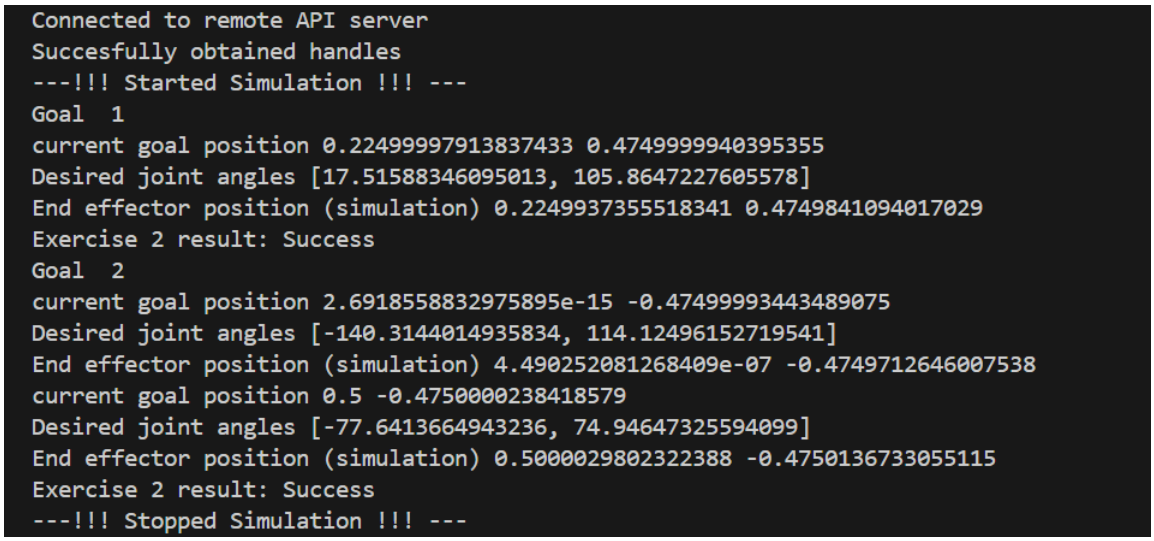

Figure 4: Iteration-2

```
Connected to remote API server
Succesfully obtained handles
---!!! Started Simulation !!! ---
Goal  1
current goal position 0.22499997913837433 0.4749999940395355
Desired joint angles [17.51588346095013, 105.8647227605578]
End effector position (simulation) 0.2249937355518341 0.4749841094017029
Exercise 2 result: Success
Goal  2
current goal position 3.0253444013346323e-15 -0.47499993443489075
Desired joint angles [-140.31440149358335, 114.12496152719541]
Goal  3
current goal position 0.5 -0.4750000238418579
Desired joint angles [-77.6413664943236, 74.94647325594099]
End effector position (simulation) 0.5000029802322388 -0.4750136733055115
Exercise 2 result: Success
---!!! Stopped Simulation !!! ---
```

Figure 5: Iteration-3