Introduction:

In this project, we are tasked with programming a 7-degree-of-freedom robot arm (LBR iiwa 7 R800, KUKA) to move a rectangular shape and position it on top of a rectangular target in its workspace. The robot arm is mounted on a base and holds an adapter that has a camera on one side and a rectangular shape on the other. The exact location and orientation of the target are computed using an Aruco marker, which is captured by the camera. The goal is to create a trajectory in joint space that will move the robot from its starting configuration to place the rectangular shape as close as possible to the target without hitting the surface or table on which the target is placed. We are given the starting configuration of the robot arm and the position and orientation of the Aruco marker reference system with respect to the camera reference system. We must ensure that the entire robot motion lasts exactly 10 seconds and does not exceed the angular position and angular velocity limits of all the robot joints.

Methodology:

Firstly, we start by finding the homogeneous transformation of the target with respect to the base using the given DH parameters and robot and end effector measurements.

Tb2t=Tb2e*Te2c*Tc2a*Ta2t*Te2f

Once the final pose is computed, the next step is to find the Qfinal joint angles, which will help us achieve our desired goal. For that, we use inverse kinematics using analytical jocobian. To find the inverse Jacobian, there are two things to be done: finding the geometrical Jacobian and the T(A) matrix. After that, we do the inverse kinematics using analytical Jacobian until we get to Qfinal. While doing this, there has to be a check on joint angles, limitations, and velocities, and if going for a six-degree order polynomial, there has to be a check on acceleration limits.

Finally, after finding the set of joint angles required to reach from q1 to qf, we need to build a joint trajectory.

Conclusion:

We have to verify the Qf by building a transformation matrix with that and comparing it with the transformation matrix that we derived at the beginning. If it's the same, then the rectangular shape will land on the target properly. And the text file, which contains the joint angles for the trajectory, should be verified to see if they are not exceeding the joint limit or not. If everything is correct, then we will get the desired result.

Result:

Qf=[1.1377 -1.6854 2.0098 -1.1581 -1.6623 -1.0852 1.3974] in rad