WEEK 5

This week we will look into the State spaces details of kinematics for a robot manipulator. This will help us understand the trajectory generation for the robotic arm in much more detail. After that we will look into collision-free trajectory generation and collision avoidance for a 2D robot manipulator

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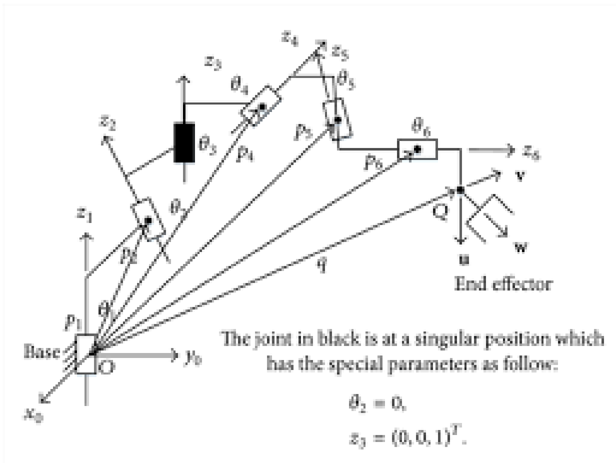
ROBOT KINEMATICS

Robot kinematics applies geometry to the study of the movement of multi-degree of freedom kinematic chains that form the structure of robotic systems. The emphasis on geometry means that the links of the robot are modeled as rigid bodies and its joints are assumed to provide pure rotation or translation. Robot kinematics studies the relationship between the dimensions and connectivity of kinematic chains and the position, velocity and acceleration of each of the links in the robotic system, in order to plan and control movement and to compute actuator forces and torques. The relationship between mass and inertia properties, motion, and the associated forces and torques is studied as part of robot dynamics. The robot kinematics concepts related to both open and closed kinematics chains. Forward kinematics is distinguished from inverse kinematics.



ROBOT DYNAMICS

Mathematical models of a robot's dynamics provide a description of why things move when forces are generated in and applied on the system. They play an important role for both simulation and control. Robot dynamics studies the relation between robot motion and forces and moments acting on the robot. The two popular methods to dynamics equation of a system are Newton-Euler Method and Langrangian method.

two possible goals:

1. Given motion variables (e.g. $\vec{\theta}, \dot{\vec{\theta}}, \ddot{\vec{\theta}}$ or $\vec{x}, \dot{\vec{x}}, \ddot{\vec{x}}$), what joint torques ($\vec{\tau}$) or end-effector forces ($\vec{f}$) would have been the cause? *(this is inverse dynamics)*

2. Given joint torques ($\vec{\tau}$) or end-effector forces ($\vec{f}$), what motions (e.g. $\vec{\theta}, \dot{\vec{\theta}}, \ddot{\vec{\theta}}$ or $\vec{x}, \dot{\vec{x}}, \ddot{\vec{x}}$) would result? *(this is forward dynamics)*

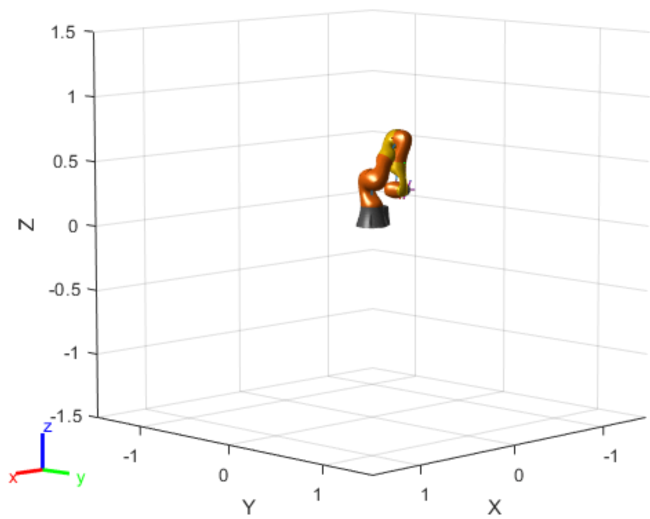
RESOURCES

- Robot Kinematics reading material - This is an extensive explanation of Robot Kinematics in written text with some examples
- For people that like videos - You can follow this playlist upto Lecture 32.
- Robot Dynamics - reading text
- Robot Dynamics - video Video number 25-27.
- Trajectory Generation for Manipulators - video

TUTORIAL ON CHECKING MANIPULATOR SELF COLLISIONS USING COLLISION MESHES

Follow the MATLAB tutorial for checking collisions and generating trajectories for KUKA® IIWA-14 serial manipulator

[Check for Manipulator Self Collisions Using Collision Meshes - MATLAB & Simulink - MathWorks India]()

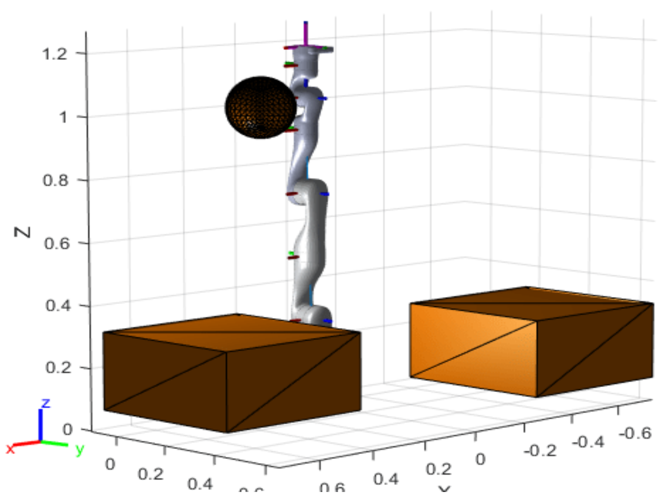


ASSIGNMENT

You need to understand and follow this tutorial([Check for Environmental Collisions with Manipulators]) and then **replicate** the simulation (you can use the same robot given in the tutorial) with a bit of change in obstacles :

```
platform1 = collisionBox(1,0.5,0.25);
platform1.Pose = trvec2tform([-1 0.4 0.2]);
platform2 = collisionBox(1.0,0.5,0.25);
platform2.Pose = trvec2tform([1.0 0.2 0.2]);
lightFixture = collisionSphere(0.1);
lightFixture.Pose = trvec2tform([.2 0 1]);
lightFixture = collisionSphere(0.1);
lightFixture.Pose = trvec2tform([0.2 0 1]);
lightFixture = collisionSphere(0.1);
lightFixture.Pose = trvec2tform([-0.2 0 1]);
```

Note: You will have to make some changes in parts of the code according to the above changes made in obstacle, Please dont copy paste the exact tutorial.



Deadline for this “Final Assignment” is **17th August EOD.** This is a hard and final deadline and no further extensions will be given.

For people that missed out on previous assignments you can submit them now until this deadline - if you want to be considered for getting the certificate.