PROJECT PROPOSAL

Modeling and Analysis of a 6-DOF Robotic Arm Manipulator

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Abstract

Motor control in humans has always acted as an inspiration in manipulator design and control. The primary aim of this project is to design and model a humanoid 6-DOF robotic arm manipulator with a gripper as an end-effector.

The manipulator consists entirely of revolute joints making it a 6R manipulator. It will be modeled according to the Denavit-Hartenberg parameters and the shape is based on the human arm. It will primarily be comprised of primitive solids and revolute joints. The manipulator will consider the joint constraints as seen in the human arm. The end effector will be modeled as a gripper. The forward/ inverse kinematics and the jacobian will be calculated, and the model will be simulated using MATLAB/Simulink.

I. Introduction

"*The most that can be expected from any model is that it can supply a useful approximation to reality: All models are wrong; some models are useful*"

– George E.P. Box: *Statistics for Experimenters*, 2005

The behavior of many robotic systems can be expressed as an analytical model as it plays an essential role in the design and implementation of the robotic manipulator. While these mathematical models are simplistic in nature, useful information such as the Forward and Inverse Kinematics, the Manipulator Jacobian etc., can be found using an accurate model.

Humanoid Robotic Arms have many uses in complex tasks such as rehabilitation, human motion assistance, automation of household work etc. Therefore, modeling a humanoid robotic arm is important for understanding the capabilities and limits of such a design.

II. Objective

1. Priority: To model and analyze a 6-DOF (6R) Robotic arm manipulator and derive the forward/inverse kinematics and manipulator jacobian.

2. If time permits, to make a simple model of a human finger (4-DOF 4R)

III. Scope of Work

The primary scope of work is to build a simple analytical model of a humanoid robot arm with a gripper as an end effector. The forward and inverse kinematics will be derived, and the equations will be based purely on the geometry, i.e., the dynamics/forces and other real-time constraints such as friction, gravity etc. will not be considered.

Computing the forward/inverse kinematics and jacobian:

Firstly, a diagrammatic representation will be done on paper, following which the DH Parameters are calculated. The dimensions of the arm will follow the ratio of lengths as found in its human counterpart, as well as the joint constraints. After the DH parameters are found, the transformation matrices are constructed in order, which results in the final transformation matrix from the origin, which is the shoulder, to the end-effector. This will result in the forward/inverse kinematic equations, as well as the required information to compute the jacobian.

After completion of the above task, if time permits, I would like to attempt to model the human finger in continuation, to fully model the human arm, in the same order as followed for the robot arm.

IV. Timeline

No.	Task	Date of Completion
1.	Proposal Completion	11/08/2017
2	Forward Kinematics	11/11/2017
3.	Inverse Kinematics	11/13/2017
4.	Manipulator Jacobian	11/15/2017
5.	MATLAB/Simulink Implementation and attempt Scope 2	11/30/2017
6.	Project Report	12/03/2017
7.	Project Submission	12/15/2017

References

1. Robot Dynamics and Control: Mark W. Spong, M. Vidyasagar

2. Simscape Multibody Documentation