Industry Projects Submission 1

ME 639 - Introduction to Robotics

IIT Gandhinagar

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We attest to the stated collaboration policy: We understand that all sorts of collaboration are allowed. However, plagiarism will not be tolerated. If we use material from other sources (or from friends), we will cite them appropriately.

Join Impedance Control for an existing Exoskeleton

Statement of Our Understanding of the Project (in 200-300 words)

Impedance control helps in dynamic control of a robot i.e. it relates to force and position. Basically what we understand is that impedance control enables a system to behave completely like another system. The main crux being the fact the dynamics of the original system are completely negated using a loop. This nullifies all the dynamics of the system. The next step is the modeling of the system as desired. It is basically how the robot behaves with the environment according to the dynamics we impose on the system. For example, a 1R manipulator when equipped with impedance control can act as a torsional spring with the damping and stiffness we want. A blindfolded person should be able to feel the manipulator is attached to the torsional spring. The control is so subtle that the person (environment) can feel the change in stiffness and damping as well. The manipulator can also be designed to move at a particular speed indefinitely i.e. without any friction once an impulse is given to the system.

In the problem statement specified, we intend to make a manipulator which can effectively perform impedance control. Given the manipulator will be used for gait trajectory positioning, it will be in contact with the environment. The environment interacts with the robot to give feedback to the user regarding the environmental forces and also how the user interacts with the manipulator.

Tentative Approach and Tools we May Need to Use (not more than 3-4 sentences)

We are thinking of dividing the project into two phases. We will start with modeling impedance control for one motor (1 DoF) in MATLAB. We will try to gain familiarity with the basics of impedance control and the exoskeleton model. In the second phase, we will expand our model for the 2 DoF system to achieve the required trajectories.

Key Assumptions Made in Approaching the Problem (in the enumerated list from)

1. We will use a 1R robot as a 1 DOF System.
2. Similarly, a 2R robot will be used for the 2 DOF System.
3. Ideal environmental conditions will be considered.

Key Questions to Clarify the Requirement of the Project (in enumerated list form)

1. Information about the current exoskeleton and required trajectories.
2. How 2R (2 DOF System) will be used in the exoskeleton?
3. Should we consider only end-effector impedance control or all the points on the manipulator?

Expected list of Deliverables (check all that apply)

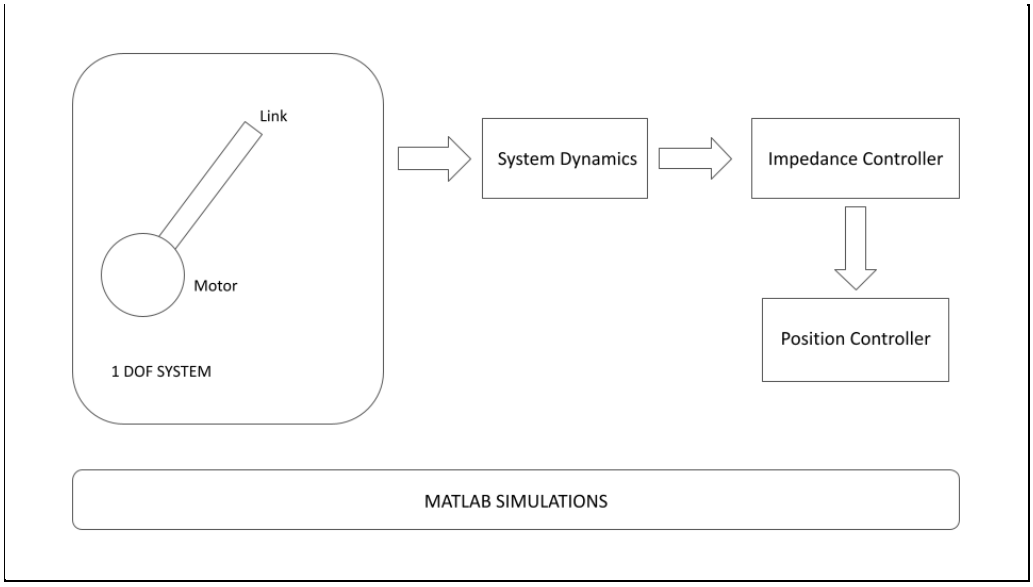
- ☑ A brief explanation of the concept (including the type of robot, number of links and joints, and other such details
- ☑ Figures/drawings/sketches showing the concept
- ☑ Relevant equations of the robotics solution
- ☑ Codes incorporating the solution
- ☑ Representative plots/or other representative results from the codes

- ☐ CAD drawings
- ☑ Explanation of the solution and the results
- ☑ Statement about limitations and future recommendations

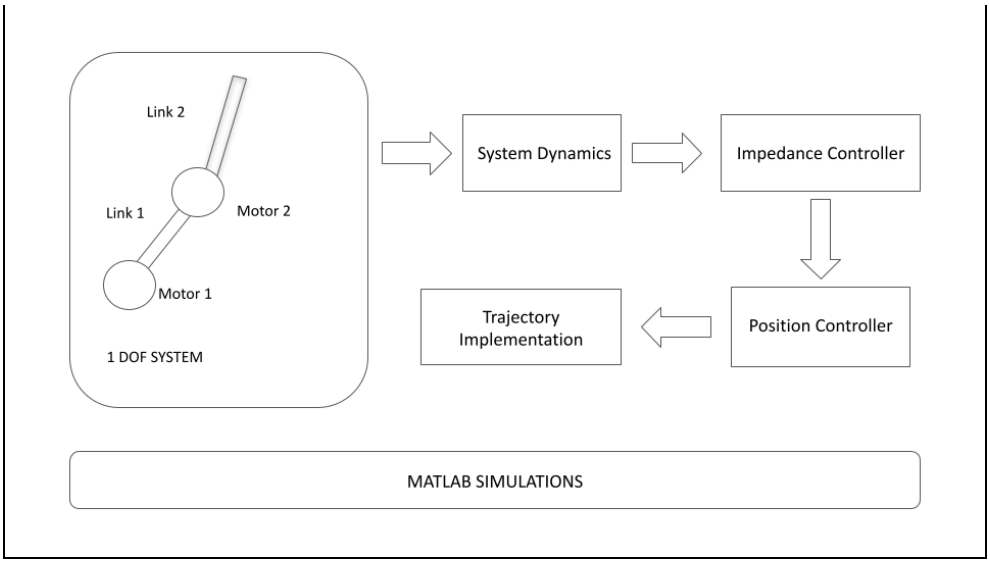
Others (list as many as needed)

A Highly Tentative Sketch of the Problem and Expected Solution

PHASE 1



PHASE 2


Link 2
Link 1
Motor 2
Motor 1
1 DOF SYSTEM
System Dynamics
Impedance Controller
Position Controller
Trajectory Implementation
MATLAB SIMULATIONS