Industry Projects Submission 1

ME 639 - Introduction to Robotics

IIT Gandhinagar

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

Series-Elastic Actuator and Controller Unit

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

Traditionally, for assembly line or fixed tasks, rigid manipulators were used. Such a robot works well in a structured environment. However the field of robotics is going in the direction where the robot deals with interaction with humans/ unknown environment. In order to keep this interaction safe, the need for different kinds of actuators is realized. Series elastic actuator (SEA) suffice these requirements. The key part of SEA is that the stiffness element (spring) comes into the actuation loop. The SEA system comes with the benefits of low mechanical impedance output, passive mechanical energy storage, tolerance to impact loads, increased peak output etc.

In order to design SEA, one needs to decide design parameters like the maximum torque, nominal torque, output speed, force bandwidth etc. This will help us design different elements in SEAs. The key outcomes of the project must consist of the following: Designs, Control scheme, Mathematical model, Simulation, Specification of each component of hardware etc.

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

We will fix a tentative output parameter. Mathematical modelling of the system will be done and governing equations of motions will be generated. Subsequently, simulation of the mathematical model will be done. On selection of appropriate design variables, detailed design of each element of SEA will be performed. Control scheme will be selected and implemented based on project requirements. Finally, check or validation of the desired objectives will be done.

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

1. No major assumptions made in the conceptual design phase.

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

We need a few design parameters to be fixed with industry partners to start the conceptual design.

1. Power to weight ratio
2. Force bandwidth
3. Position tracking accuracy and bandwidth
4. Desired mechanical output impedance
5. Maximum impact load desired
6. Back-drivability
7. What is expected in controller unit

Expected list of Deliverables (check all that apply) (Y) = Yes (N) = No

- A brief explanation of the concept (including type of robot, number of links and joints, and other such details (Y)
- Figures/drawings/sketches showing the concept (Y)
- Relevant equations of the robotics solution (Y)
- Codes incorporating the solution (Y)
- Representative plots/or other representative results from the codes (Y)
- CAD drawings (If time permits)
- Explanation of the solution and the results (Y)
- Statement about limitations and future recommendations (Y)

A Highly Tentative Sketch of the Problem and Expected Solution

Below chart gives our general roadmap which we will be opting in this project, outcomes are discussed in detail.