

# Industry Projects Submission 1

ME 639 - Introduction to Robotics

IIT Gandhinagar

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Group Name: Top Guns

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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.

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## **Series Elastic Actuator Unit and Controller**

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

The project involves development of a compliant mechanism that can work in an unstructured environment. The compliant mechanism is basically a series elastic actuator which must include a motor and its controller. There is an elastic element between the load and the mechanical source/motor. It must also have some positional control mechanism. In an unstructured environment force/torque control have numerous challenges such as friction and noise in the force sensor and dynamics of the model gets disturbed by the external forces and as a result the dynamic model is more difficult to control. Thus series elastic actuators with force control are used to render the dynamic response against the external force. These have advantages over rigid actuators such as low mechanical output impedance, tolerance to impact loads, increased power output and passive mechanical energy storage. These advantages enable the application of SEAs in legged actuation systems, robotic grasping mechanisms etc which are highly dependent on precise force control. It must also include a position control using a type of Hall Effect Sensor. Spring Length Calculation is to be incorporated using some optical sensor. The controller design of a series elastic actuator is most often performed within the passivity framework as it ensures the safety of interaction with unstructured environments.

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

1. Design of the Actuator- SolidWorks or Fusion 360
2. Design of the Controller-Simulink
3. Simulation of the Actuator-Simscape or Hyperworks for visualisation

#### Key Assumptions Made in Approaching the Problem (in enumerated list form)

1. Unstructured environment
2. Single DOF system
3. Uniform stiffness of the spring

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

1. The mechanism required for the end effector or the arm of the manipulator with a simple grasper or both( wrist + arm are SEA).
2. DOF of the system/manipulator( wrist + arm)
3. Revolute/Prismatic joints
4. Applications (Where are we planning to use this actuator?)

#### Expected list of Deliverables (check all that apply)

- ☒ ~~A brief explanation of the concept (including 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)
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  - ☐ \_\_\_\_\_
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#### A Highly Tentative Sketch of the Problem and Expected Solution

This can only be provided after clarification from the Industry about the application part.