Parameter Identification Plan

Team 03 - Legged + Materials (Foldable Robotics)
Kevin Abhishek
Mohammad Zaki Patel
Shih-Heng Chen

1.

Link material	Fiber glass / Cardboard
Hinge material	Polyester sheet / Vinyl sheets
Misc materials	M2 Nuts and bolts to fasten hinges and secure actuator to mechanism

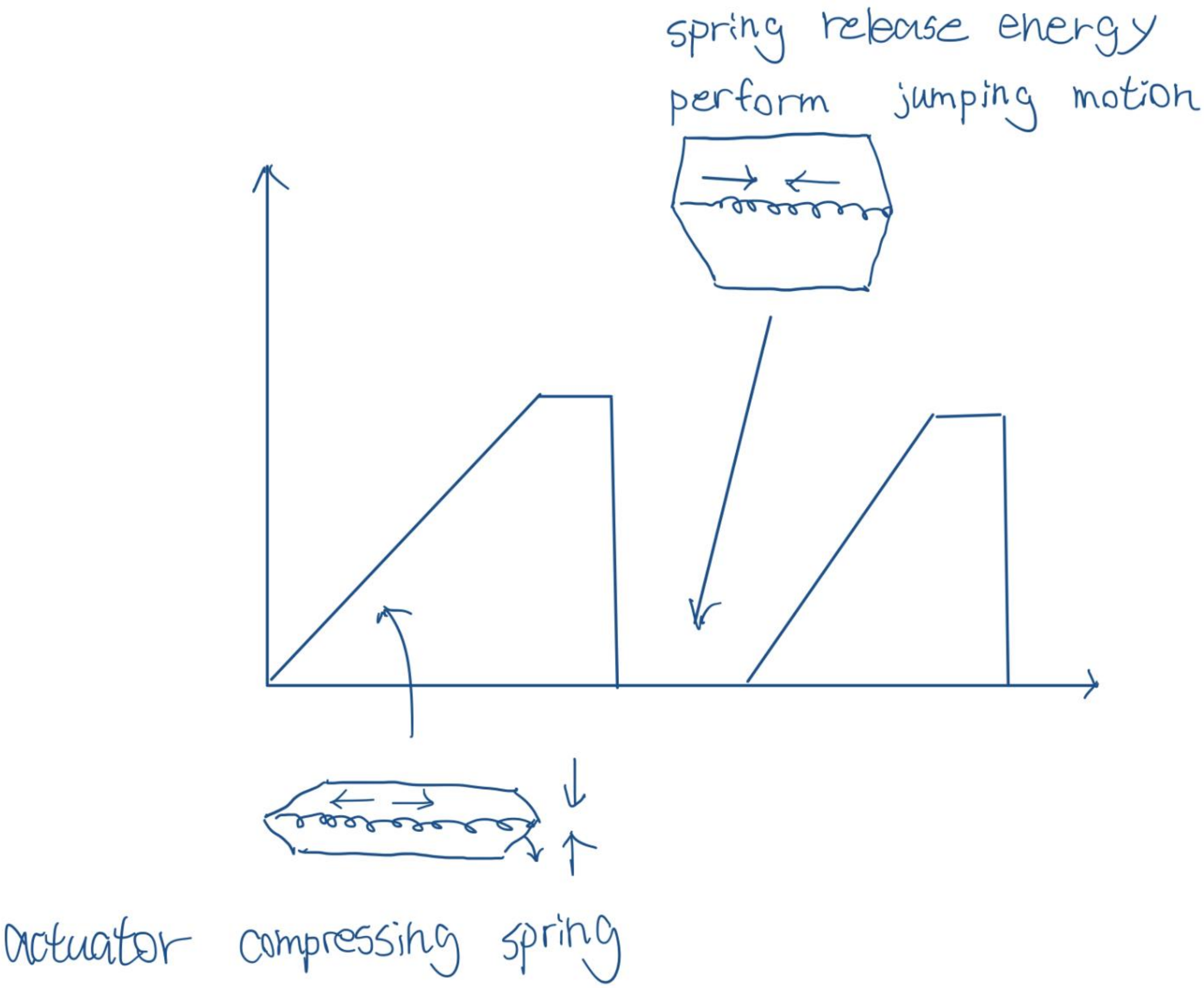
2.

Task	Zaki	Joseph	Kevin
Material selection/collection		X	
Input signal & Actuator modeling	X		
Link/Joint stiffiness			X
Prototype manufacturing		X	
Experiment data collection	X	X	X
Python Simulation	X		X
Reporting	X	X	X

Actuator modeling:
The actuator envisioned is a simple 1 DOF linear actuator that acts on either the base plates or the opposing hinges of the sarrus mechanism. Maximum force requirements from the actuator would be determined based on the final actuator-link arrangement.

Input signal specifications: Our simulation will undergo the following tests:

a) Stiffness test: Here, an energy storing component will be used in the sarrus mechanism as shown below. The first set of inputs will be to induce a deflection in the mechanism from its equilibrium position and then obtain force outputs during said deflection.



b) Force test: Here, the actuators will be set to provide a constant torque at the actuating joints. The output will be the force of contraction obtained across the two bases of the sarrus element.

Link/Joint Stiffness: The energy storing component in our mechanism will be a torsional spring (joint stiffness) or a linear spring (constituting of a link stiffness) at the middle of the mechanism. FEA methods will also help us confirm the joint/link stiffness requirements for our model.

These parameters will be first tuned from the simulated model (from the pynamics implementation). Materials to be used when constructing our element model will be dependent on these parameters.

3. We are planning to use solidworks to design different layers for our mechanism. We will manufacturing the prototype using foldable robotics techniques like laser cutting and lamination. We plan to have 3 layers in our mechanism. The first will be the base, followed by a layer of our hinge material and then finally the top layer to add more stiffness to our mechanism. Task distribution has been outlined in section 2.

4. System-level data collection

For our system level data we would like to test out the following parameters to validate our system:

Joint Velocity of the sarrus mechanism - we would like to observe at what velocity our joints will be moving in order to achieve the desired motion.

Plan - Using 3D motion capture data to calculate the position and then differentiating it to find the velocity of the robot movement.

Force Output data - Calculating how much force is required to be applied for contraction / expansion motion on the base and top link.

Plan - Using load cells that will be connected to the top link of the mechanism. The linear actuator will generate the motion and we will be calculating how much force is required to bring the base and top together.

Stiffness - Calculating the overall stiffness of the system.

Plan - We will be using 3D motion detection sensors and load cells together on our mechanism. When the linear actuation generates motion we will capture position and force output data acting on the load cell. Later we can plot the position against force data and the slope will give us the stiffness value.

5. The methods to perform further simulation tasks have been described in section 2. The desired parameters that we would like to extract from the simulation are:

a) Actuator properties
b) Link/Joint stiffness properties

We have already determined forces and stiffness required to replicate muscle characteristics from the biomechanics study. We will not have to translate these properties to that of the sarrus element. After this, we will target the stiffness property by simulating compliant bending stiffness for the sarrus joints (joint stiffness). This property would also allow us to select the right material to be used for the hinges. Following stiffness, we would then study actuator properties by simulaing torque producing components at the base joints. We would need to repeat the above steps to gradually optimize the geometry of our simulated model and obtain actuator properties.

6. Reporting tasks -

a) Completing the assignment / writing the report (simulation combined with report in jupyter notebook).
b) Updating the website.