Parameter Identification Plan:

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	Matthew	Nathan	Shubang	Viraj
Link/Joint Materials			X	X
Actuators	X			
Mass/Inertia Properties			X	X
Testing Rig	X	X		
Final Link Stiffness	X			X
Characterize rigid link stiffnesses			X	X
Friction Coefficients of Ground		X		
Define Input Controls Based On Desired Gait in Pynamics	X	X		
Extract Theoretical Torques from Pynamics		X	X	

1. Identify and discuss the materials you plan to use in fabrication. Decide who will be obtaining those materials and distributing them.

   As a starting point we would prefer working with the materials available in the Innovation Hub, namely mount board, plastic sheet and heat-activated adhesive.

Depending on the outcomes of the initial prototypes and the output from the dynamic simulation we might switch to harder materials like fiberglass for the outer tough layer.

2. Identify and Discuss the various parameters you plan to model in your simulation, including
   - Actuator modeling - **Motor modeling would be done thru modeling the torque and EMF equations in python or MATLAB**
   - Input signal specification - **The motor I/P signal can be simulated in the microcontroller application (Arduino in this case)**
   - Mass and inertia properties - **Mass properties would be accounted for in the dynamic simulation with the help of Pynamics.**
   - Link and/or joint stiffness- **Solidworks/Ansys would be the go to method for simulating the stiffness of the links. Joint stiffness can be accounted for in the python (pynamics) code by approximating a spring and damper model as done in class.**
   - Damping - **Damping should be handled by the python code, just as mentioned above, the connection between links can be approximately simulated by adding a spring and damper in between. Any independent dampers added can be simulated in a similar fashion.**
   - Friction- **Friction can be modeled by multiplying the normal force at the end effector by the (assumed/approximated) coefficient of friction.**

   Discuss your plans for experimentally obtaining each of those values, and the model you would like to use for describing each phenomenon.

   The validation testing ideas as of now are to capture a video of the 5 bar mechanism that defines the leg, while in motion. By analyzing the video and tracing the pixels of the end effector we should be able to verify the motor characteristics, input signal processing and link and joint stiffness.

   Another method of testing would be load cells/high sensitivity weighing scales. By fixing the five bar mechanism above the scale we would be able to get a quantitative output of the contact forces thereby better understanding the contact behavior (friction and damping)

   For the mass and inertia properties a more holistic approach would be followed i.e. a simplistic model having two legs would be ,as shown in figure. And test the stability of the entire model while in operation.

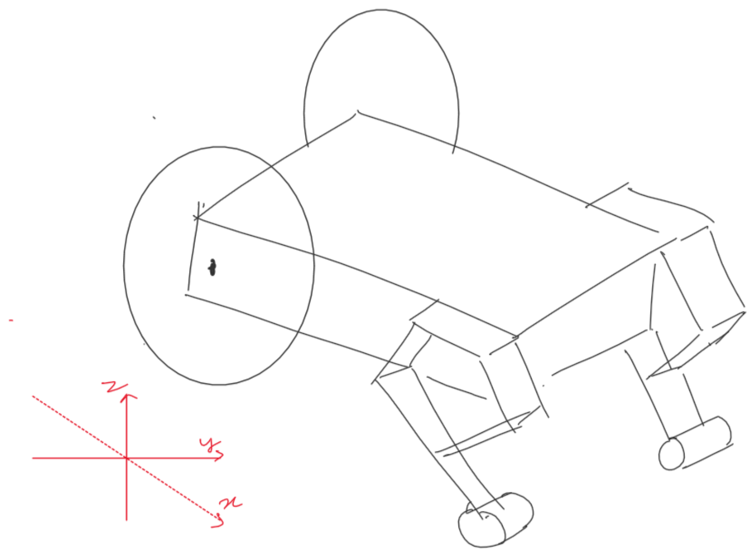

Fig- Chariot model of the quadruped

3. Identify and Discuss how you plan to prototype your system and assign one person to do that

We plan to prototype two five-bar leg devices using a 5-layer laminate technique. This will require a laser cutter to cut each of the five layers, an alignment table to align the layers, and a heat press to activate the adhesive layers and bond the structure together. Each five-bar will be fabricated as six rectangular links hinged to one another, and the final short rectangle will be rigidly attached to the first with a staple or screw to close the loop. The springy end effector link will be attached using this same connection. Viraj will primarily work on this prototype.

The rear wheeled base will be constructed using 3D-printing and laser-cutting techniques in order to create a simple testing platform. Matthew will primarily work on this prototype.

4. Identify and Discuss how you plan to collect system-level motion or force data, including
    - method (IMU, video, discrete joint sensors, force/torque sensing)
    - data extraction approach

The team's current plan for data collection is to utilize video to analyze the velocity of the robot over various terrains, for various final link stiffnesses. The team may also utilize an onboard IMU to extract information regarding the accelerations of the robot.

5. Identify and Discuss your plan for shared simulation tasks
    ○ which of you will be updating the code
    ○ adding model fitting routines
    ○ filtering, interpolating and otherwise massaging input data.

The team is planning on implementing the discovered mass and inertia data from the initial prototyping phase to update the Pynamics code. Additional link stiffness information will be added to extract the relative torques on each motor as the robot moves through the chosen gait.

6. Finally, identify and discuss any reporting tasks that may be needed
    ○ compiling information into a report (may be combined with the simulation if using Jupyter)

Jupyter notebook / Google Colab will be used to report the results of the Pynamics simulations for the required motor control angles and torques, as well as the results of any stiffness simulations / calculations. It will also be used to report testing and evaluation information once the team has finished prototyping.

7. Split each of these tasks to the individuals on your team, and come up with at least one deliverable for each person for the remainder of the week.

See the table above for individual member assignments and tasks.