VDR3: T505 Model-Based Systems Quadruped

Milton Bouchard, Michael Dina, Onoriode Onokpise, Jackson Raines, and Zachary Shapiro

Department of Mechanical Engineering, FSU-FAMU

EML 4551C

Dr. McConomy

November 29, 2022

Summary of Previous Work

We were initially approached by CISCOR to develop a tool that aids in the design of quadrupedal robots using knowledge gained from previously built CISCOR robots. With this objective in mind, we defined our key goals. Our tool must assist new quadrupedal robot development, return critical robot parameters, reduce the development time of new robots, and act as a database of knowledge for robot development. After completing the functional decomposition, we defined the targets and metrics of our project. With these in mind, we proceeded through the Concept generation and selection phases. The result of this process is our final concept, the Systems Composer GUI, which we will continue to develop moving forward.

Current Work

When not completing the weekly assignments, our current team meetings consist of refining the motor model that was developed by hand and getting that model imported to System Composer. With this reduced-order model, we can approximate the motor torque required for a robot with simple legs like those used by RHex. For this calculation, we use the stride frequency and mass of the robot to calculate points on an angular velocity vs. torque graph. The points are determined from the torque and angular velocity requirements while in stance and flight. It is possible to use a midpoint on the curve to calculate power and approximate the size of our motors. The motor mass is approximately 20% of the total mass.

Future Work

As we continue to improve our motor model, we will analyze more advanced mathematical models, such as the spring-loaded inverted pendulum (SLIP) model and the Jacobian model, to make our calculations more accurate for real-world robotic applications. The

SLIP model represents the mechanics of the center of mass of the limbs of animals and legged robots. We will also use the motor requirements to determine the necessary battery.

Once we complete our refined motor model and learn more about Systems Composer, we will begin researching and implementing a more approachable user interface. We will be using MATLAB's GUI creation tools to build a user interface to interact with our model and for the user to input data. After we verify that the interface is functional with the model, we will field test a prototype with some students and faculty in the CISCOR lab. Based on their feedback, we will continue to work on and tweak the user interface for our tool.

Potential Challenges

A variety of potential challenges have been identified going into the spring semester as the work shifts from developing models to building them within our software packages. It has become clear that each of the software packages we are using, specifically Systems Composer and Simulink, has extensive capabilities and a steep learning curve. Being able to utilize the software effectively will take time, which is a very finite resource as April approaches. To prevent this from becoming too large of a task to handle in the spring, our team is planning on meeting over the break virtually and focusing on continuing the software learning process without the distractions of school and other mid-semester responsibilities.

The other major challenge is going to be proper testing to verify the values returned from the various simulation models. The work put into the program means nothing if the values produced cannot be confirmed to be beneficial to the robotic development process. The most difficult physical measurement to calculate will be the force at the foot of the robot. The testing method is still being developed, as it is unclear whether a torque spring will be able to get a true reading or if a different piece of equipment such as a pressure sensor will be effective.