Morphing Tank-to-Leg Modality for Exploratory Lunar Vehicles

Introduction

Problem Statement:

The goal of this project is to design a novel locomotion modality for NASA's autonomous lunar rover to tackle the unique challenges posed by the complex environment found at the lunar south pole. The focus is on overcoming the challenges associated with the traversal of steep slopes and icy surfaces. The modality will have to traverse terrain up to 36° to successfully ascend and descend crater walls found around the lunar south pole[4]. Within craters, the modality will have to maneuver through icy patches and endure temperatures as low as -243°C[4]. The modality must prove itself dependable, effective, and efficient in functionality and particulate contamination prevention and mitigation.

Overall Approach:

A morphing modality design resolves issues that would likely be faced on the complex environment of the lunar south pole. Implementing four continuous track tank treads that can extend into legs enables reliable navigation of a variety of terrains.

For flatter environments, such as those found in crater basins, the modality operates in "tank mode" with all four continuous tracks to traverse icy and jagged surfaces. For environments with steep slopes, such as crater walls, the morphing modality adopts "quadruped mode" or "leg mode". Given each appendage operates independently, the "tank" and "leg" modes can also be used simultaneously in "combination mode." For example, the front two can be in "leg mode" while the back two are in "tank mode," thereby enabling the safe traversal of unique lunar environments.

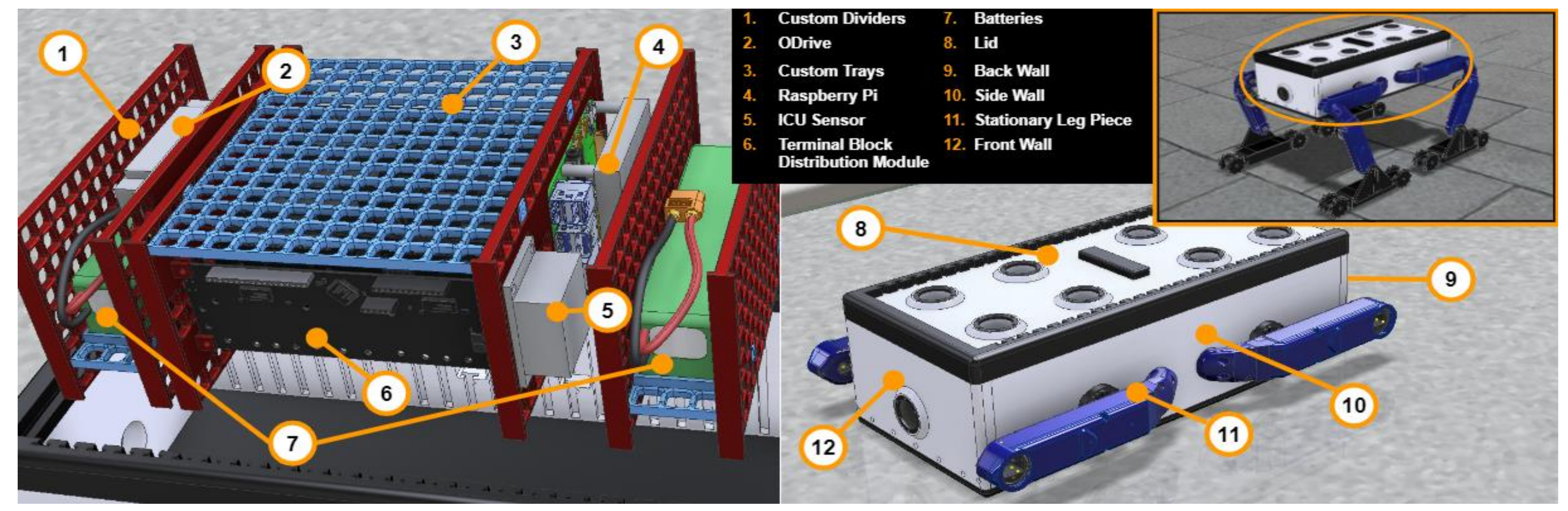
Tank Mode

Quadruped Mode

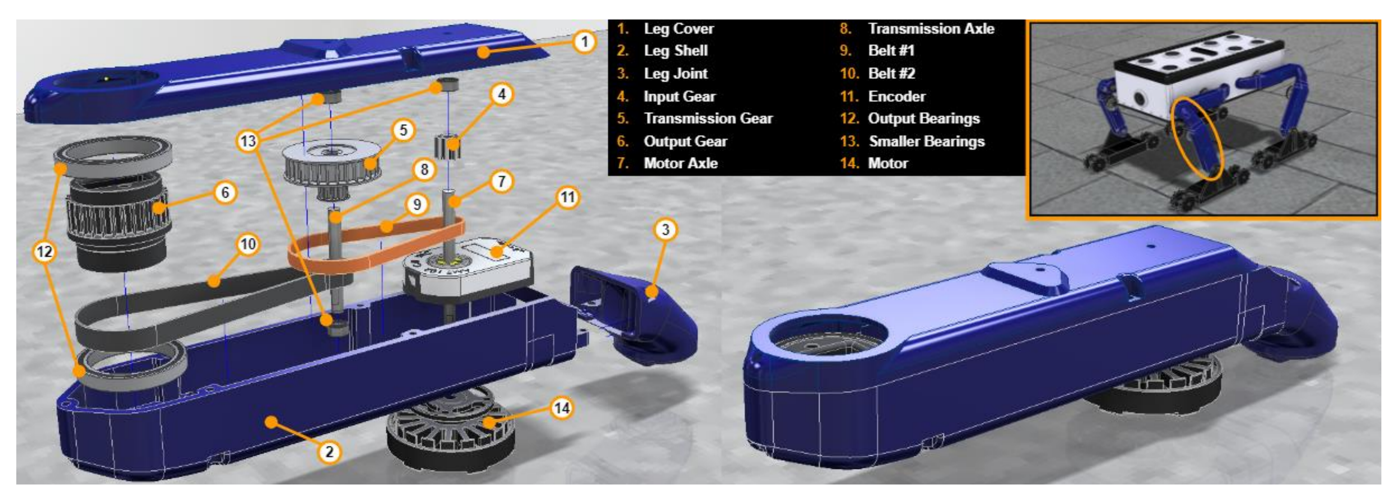
Combination Mode

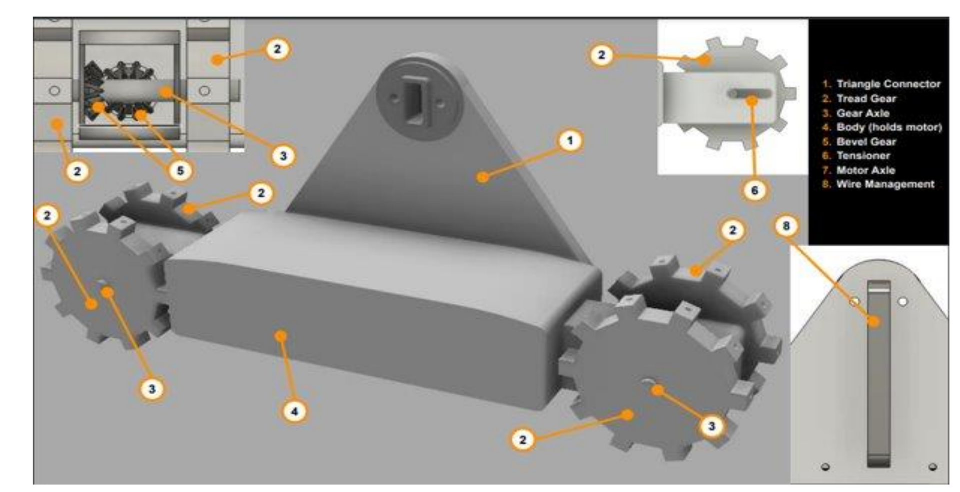
Project Description

Prototype Full Body Design:

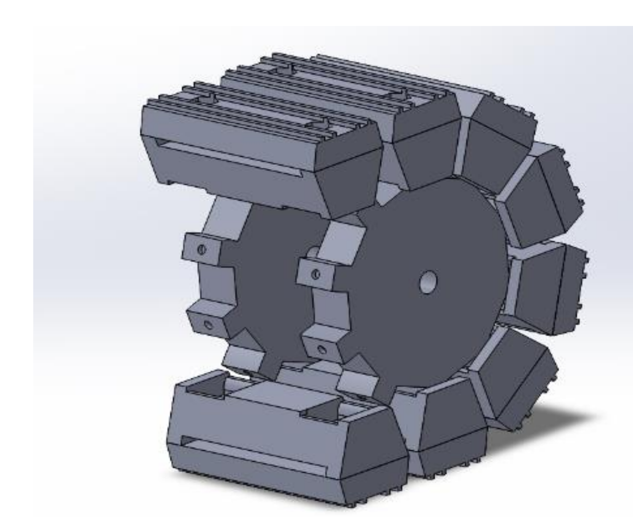


Leg:





Tread:



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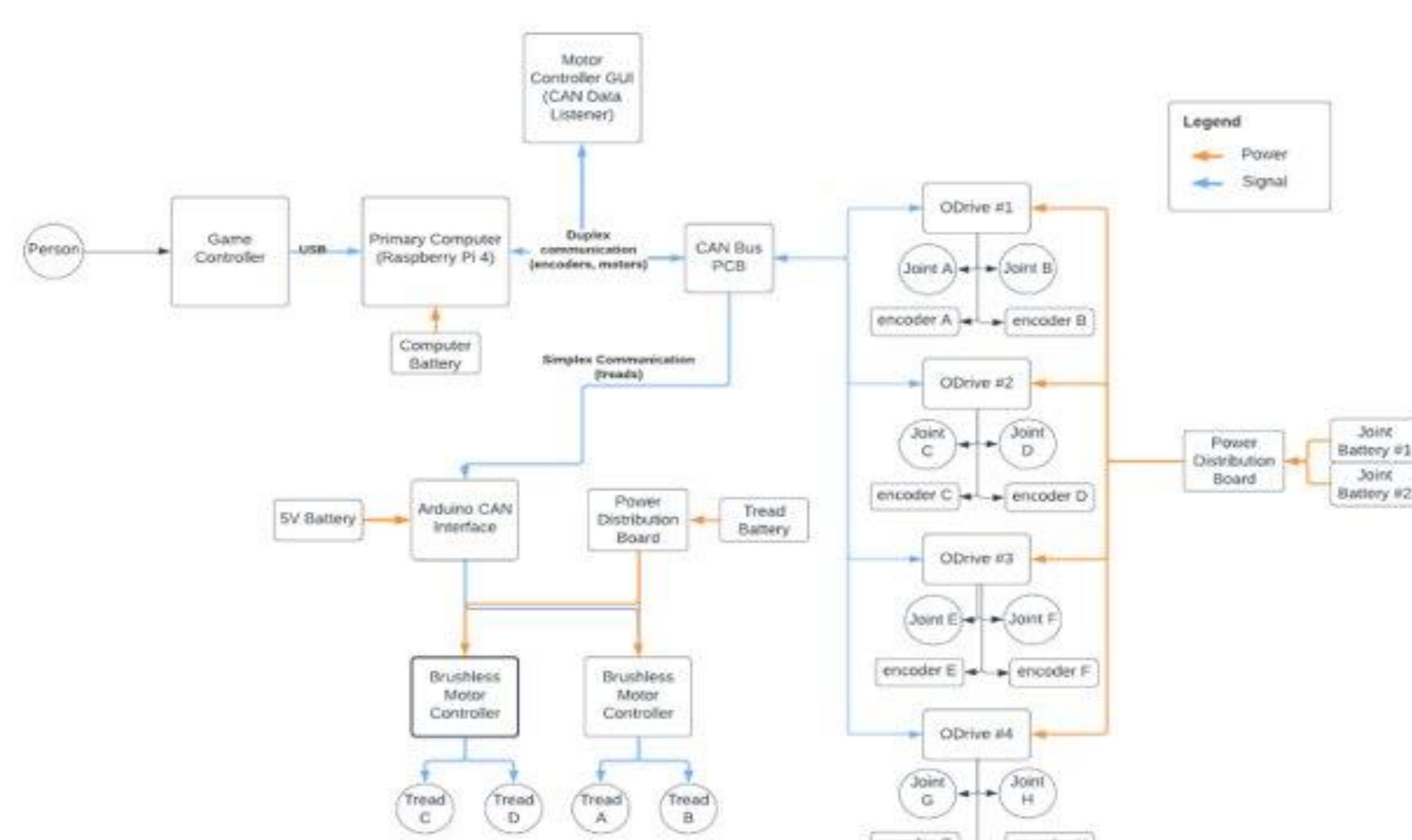

Future Plans

A great deal of time has been spent ensuring the software to hardware connectivity is strong so when further prototype testing becomes possible, the tests will be evaluated with a strong foundation in the functionality of the software and hardware itself. The testing that is planned to take place includes a qualitative analysis of how the rover and modality function in the miniature slope lab that was built. This will consist of the rover driving in safe sand at slopes that range from 0° to 36°. Qualitative testing will also be conducted in environments that consist of outdoor, rocky terrain, as well as on an ice rink to test performance in icy, slippery conditions. There will also be a drawbar pull test to analyze the performance of the rover.

Although the Big Idea Challenge is formally ending, this project will continue at UConn. A dedicated and permanent lab space has been created at the University of Connecticut for our protype, test bed, and students. This project will remain in the hands of undergraduate students who are interested in learning about robotics and large impact projects and who want to gain experience furthering the prototype.

The Team

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