

Technique 1

As a part of the preliminary test, a low fidelity prototype of the flexible wheel design was created. This design was then driven on testbed with fine, grainy material, and its performance was compared to that of a rigid wheel of similar dimensions. The low-fidelity prototype was created using an inflated circular balloon, while the rigid wheel was a cardboard cylinder of similar dimensions. Each wheel type was then attached to a cardboard base and motorized using SG90 micro servos so that they could be driven on the granular terrain. Each wheel was driven 3 times on the testbed and during each test the slippage and sinkage of the vehicle was measured. Slippage is defined as the $\frac{\text{Wheel Velocity} - \text{Vehicle Velocity}}{\text{Wheel Velocity}}$. Sinkage is the distance from the bottom of the wheel to the top of the terrain. The wheel's velocity was measured by recording the individual wheel spinning for 5 seconds then counting the number of revolutions made by slowing down the video in CapCut. The vehicle velocity on the testbed was measured using a Vernier GoMotion sensor. This was done to demonstrate that a flexible wheel would perform better on granular terrain than a rigid wheel, thus verifying that the idea behind the final prototype would work.

Technique 2

Prior to building the final prototype for the wheel, a tensile test was conducted using Fusion 360 to determine the most suitable material for the design. The design required a material that would displace the most when subjected to a certain amount of force, without plastically deforming so that wheel would be able to drastically increase its contact area with the ground but return to its original shape when the load on it was removed. This test was done by creating a CAD model of the expanded version of the wheel, measuring the displacement, yield strength, and safety factor of the material when subjected to 200N of load. A total of 20 materials were tested in these simulations.

Technique 3

After deciding on the material to be used in the final prototype, the last step was creating a higher-fidelity version of this design that could autonomously adjust the wheel's geometry. Unlike the low-fidelity prototype, this version would actively use data collected from an accelerometer module to make decisions about how the wheel changes its shape. The final prototype was created using materials such as Arduinos, batteries, and servos from the Mass Academy makerspace. Other parts of the wheel, such as the hubs and the linear actuators, were 3D printed using the Bambu 3D printers at the FRC Team 190 workshop. The circuitry connecting the accelerometer module to the servos that would alter the wheel geometry was built with the help of Mass Academy senior Noah Proctor. This step still isn't complete due to issues with the Arduino and its Motor Module. When the final prototype is built, it will be tested on loose soil, ideally Martian soil simulant or fine Fillite particles.

Statistical Tests

It was determined that no statistical test would be needed for the data collected from these experiments. Since statistical tests are used to determine if measurements occurred randomly, conducting these tests for this project seemed unnecessary because the same values aren't repeatedly being measured. In the low-fidelity prototype test, each wheel was tested only 3 times, and the rigid wheel had a vehicle velocity of 0 in every test. The rigid wheel failed completely and a statistical test unnecessary because the average velocity for both wheels has a dramatic difference. The lack of trials in these tests further negates the reliability of a statistical test. In the tensile test, the displacement, yield strength and safety factor were the same each time a material was simulated. There weren't multiple data points to test to see if they were randomly generated.