Team 4 ASME University Rover Challenge

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Project Background

The University Rover Challenge (URC) is the world's premier robotics competition for college students. Held annually in the desert of southern Utah in the United States, URC challenges student teams to design and build the next generation of Mars rovers that will one day work alongside astronauts exploring the Red Planet.

2017 URC Group Photo

Project Objective

The objective for this rover is to design, build, and test a Mars Rover capable of controlling an onboard robotic arm that performs various dexterous movements, remote control using a teleoperated base station and navigate autonomously around a course that closely resembles that of the Mars planet environment.

Team

2021-22 Mars Rover Team

System Level Requirements

The requirements below are set by URC. The rover's capabilities will continue to change as next year's team will continue working on the Mars Rover.

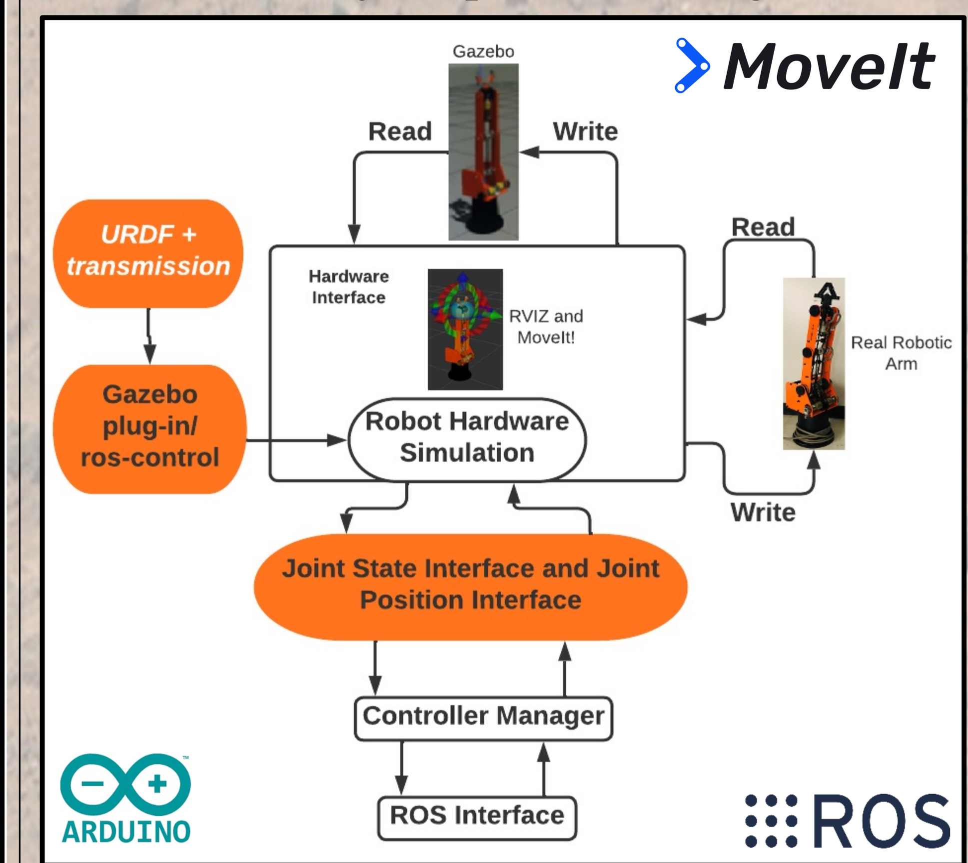
Requirements	Specifications/Needs	Capability
Rover Dimensions	1.2 m x 1.2 m x 1.2 m	Complies
Rover Deployment Weight	50 kg	TBD
Overall Weight	70 kg	TBD
Kill Switch	Kill Switch	Complies
Communication Distance	1.2 km	3.2 km
Frequency	900 MHz, 2.4 GHz	2.4 GHz
Battery Time	60 min	TBD
Robot Arm	5 DOF	Complies
Weather Conditions	100°F, Dusty (Protection Required)	TBD
Budget Limit	$18,000 ($2,039.14 past team)	Complies
Arm Load Capacity	5kg	2.2kg

Acknowledgements: Dr. He Shen, Dr. Michael Thorburn, Aren Petrossian, ASME Rover Robotics Club

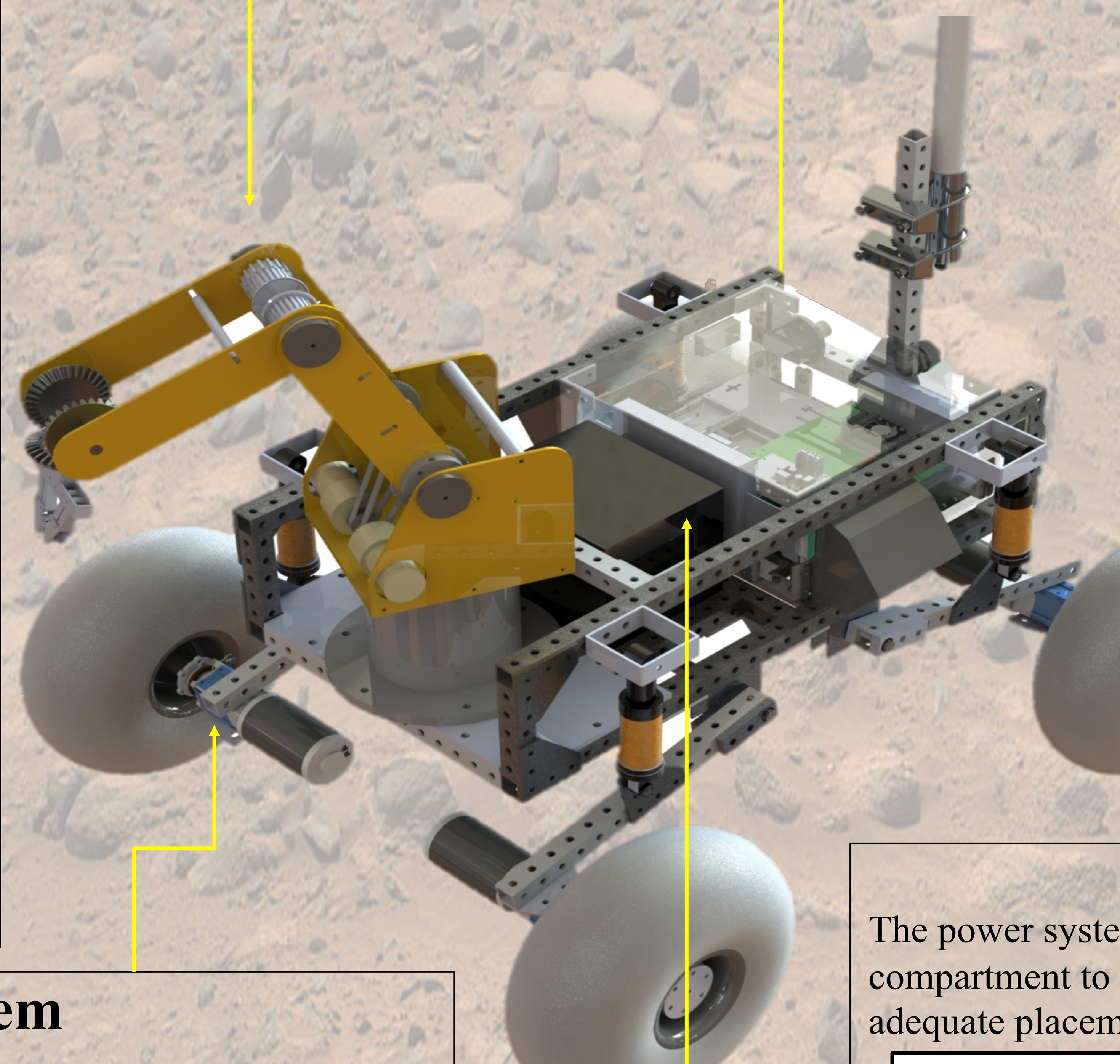
Overall Design Approach

Robotic Arm

The SCORBOT-ER III is controlled using the RVIZ GUI and MoveIt! software to send joint angles in ticks to the motor encoders that control the arm joint positions using PID's.

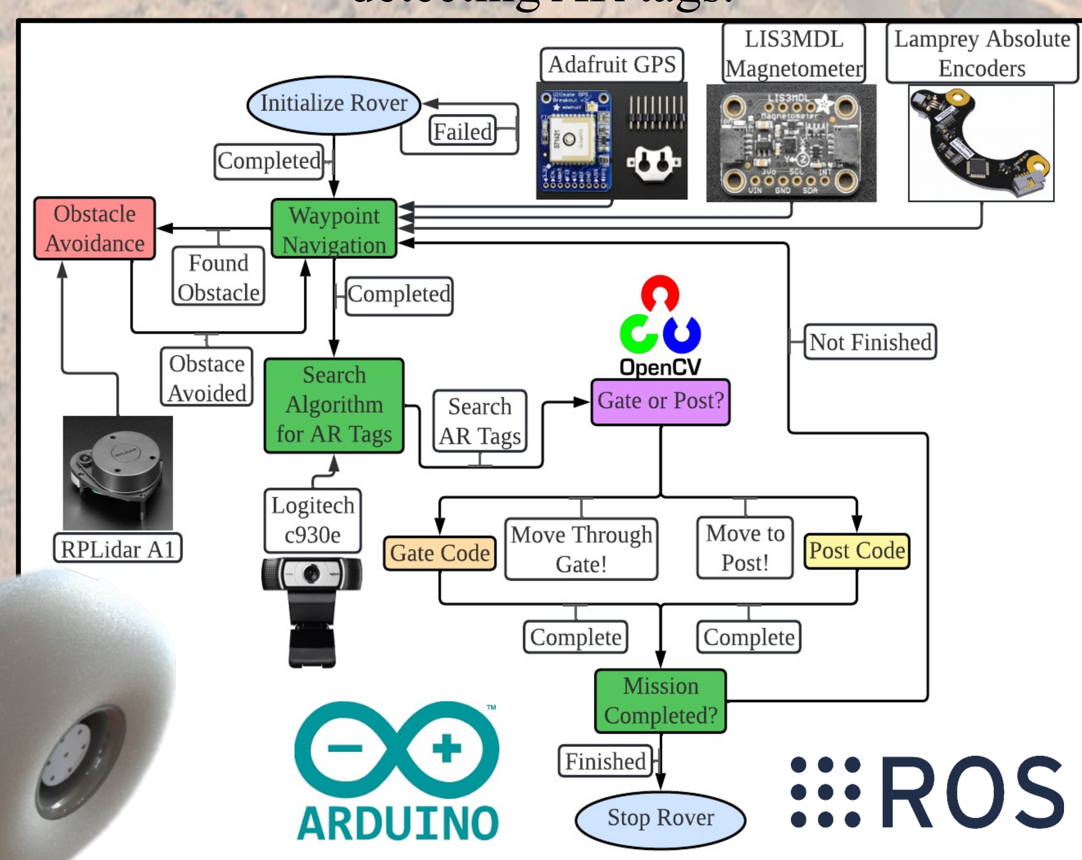


Robotic arm -MoveIt & Gazebo to Hardware integration



Autonomous Driving

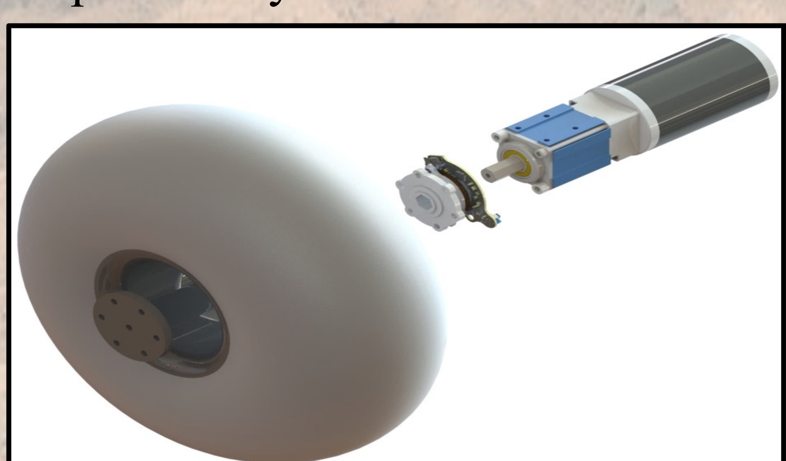
Autonomous Navigation used to drive between two GPS locations while avoiding obstacles and detecting AR tags.



Auto Navigation Software Architecture

Drive System

The drive system consists of 4 brushed DC motors with 16:1 planetary gearboxes attached for greater torque. An independent radius arm suspension system is used for ride smoothness over rocky terrain.

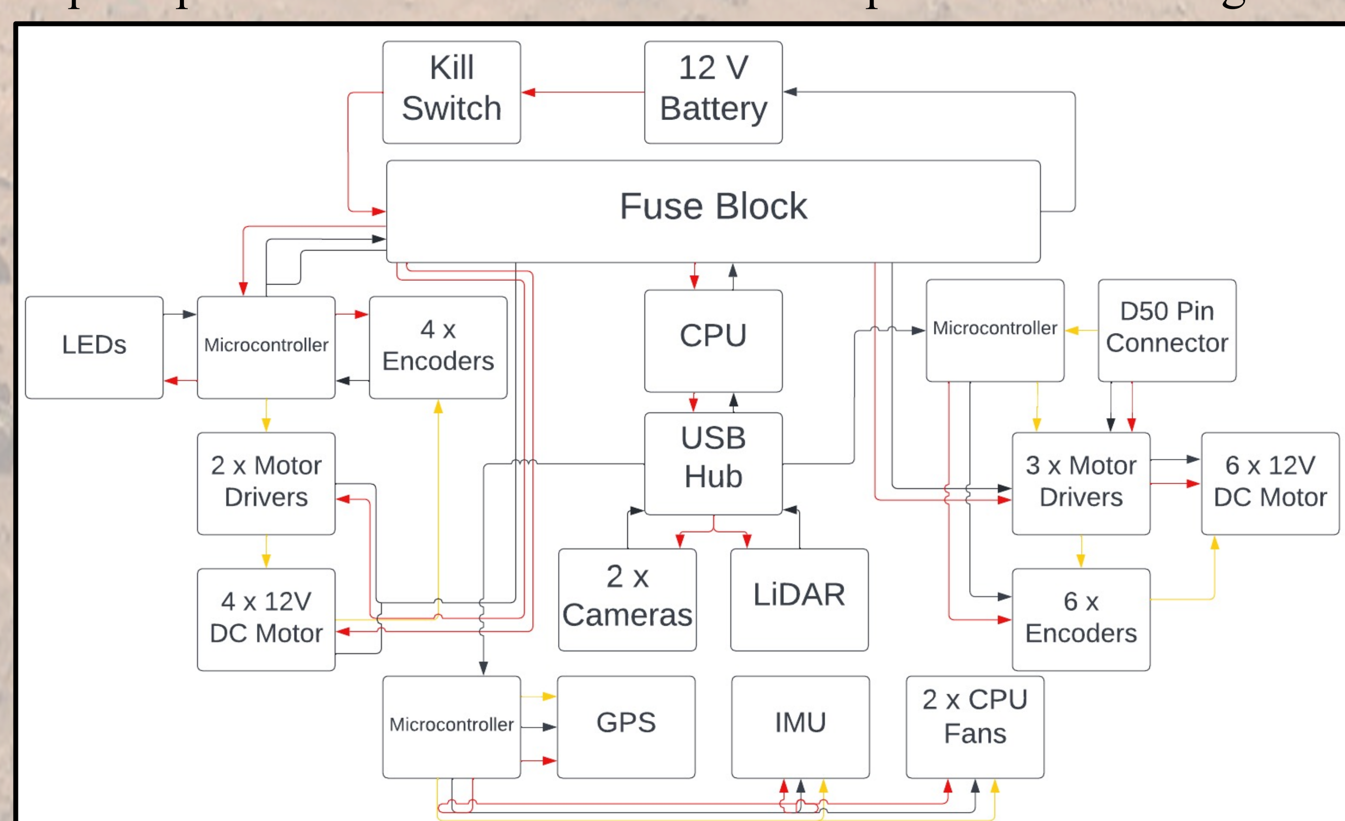


Drive System – Exploded View

Suspension Axle– Exploded View

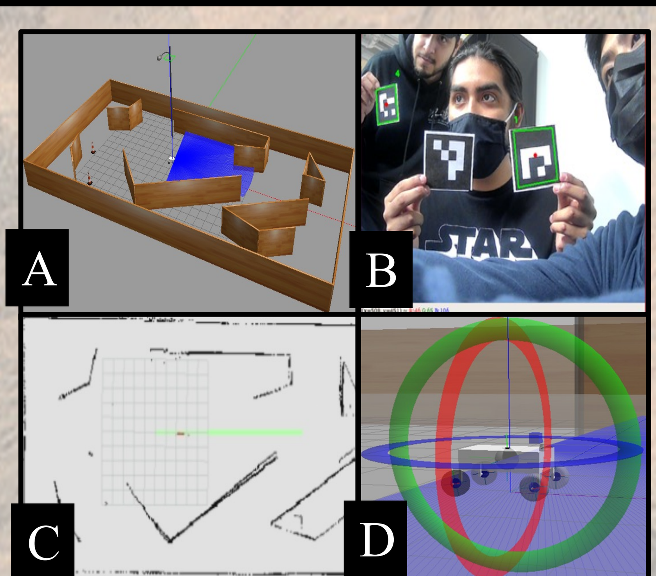
Power System

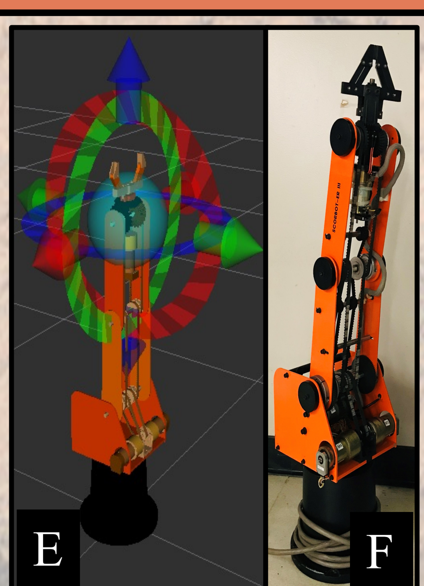
The power system has fuses, battery monitor, and a custom acrylic compartment to house electronics. CFD analysis is used to determine adequate placement of the electronics and optimize air cooling.

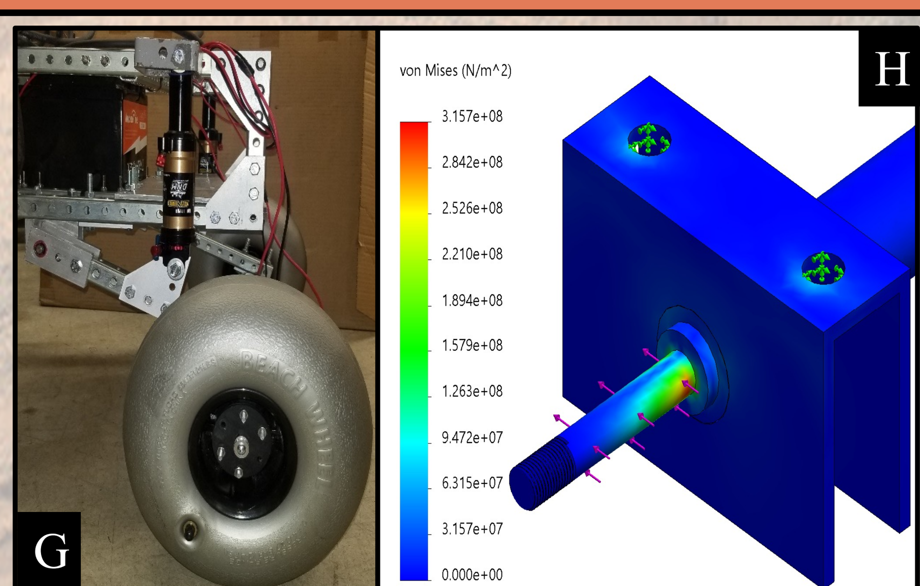


Electrical Block Diagram

Results







Simulation (A) Open CV (B) Navigation (C) Rover Model (D)

Simulation planning (E) Real Arm movement (F)

Completed Suspension (G) FEA Simulation (H)

Major Conclusions

- Suspension has been modified to an operational configuration
- Robotic arm hardware and software is fully operational, but the arm is not strong enough to perform in URC.
- Base-station and rover Wi-Fi pairing was successful
- The custom electronics compartment design and manufacturing was successful
- CFD thermal analysis was successful in analyzing temperature distribution and airflow
- Power wiring has been upgraded for higher current
- State Machines completed, Teleoperation operational, Waypoint Navigation in progress