SPACE*L*
Simulated Lunar Rover Project

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Introduction

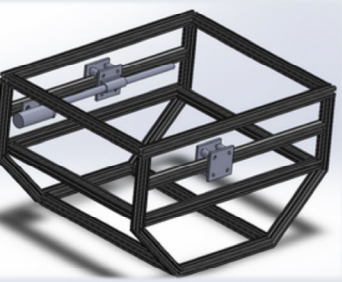
Recently, the growth of commercial space projects and public interest has reignited the motivation for manned missions out of low-Earth orbit, where previously remotely operated probes and rovers were utilized exclusively. Prominently, substantial plans are now in motion to establish a permanent human presence on the Moon. Our hypothesis is that rovers will continue to play a vital role in the success of such missions, because it will be imperative that astronauts take on only as much risk as necessary, and that they do not waste their time on tasks that could be done by a robot. In this project, a conceptual prototype lunar rover is proposed under the design motivation of supplementing and enhancing tasks of lunar construction, exploration, and science.

Objectives

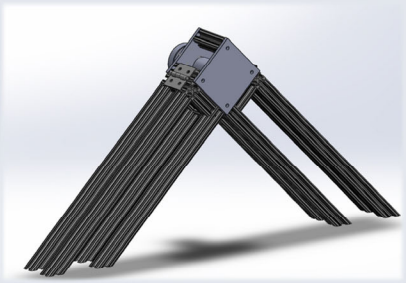
1) The rover shall be resilient and all-terrain, which defines as: capable of traversing 30-degree slopes, ledges up to half the rover height, and able to self-right if flipped over.
2) The rover shall be modular, reconfigurable for sensor systems, science payloads, storage space, surplus resources, and robotics addons. These modules shall be supported by centralized power and data ports.
3) The rover shall include fixed modules which guarantee the following features: back-up battery power, high-bandwidth radio, terrain mapping, video feed, and local computation support for all features.
4) The rover shall be semi-autonomous, which defines as: completing tasks without human input such as: pathing through complex terrain, docking to a charging station, and safely operating near astronauts.

Design

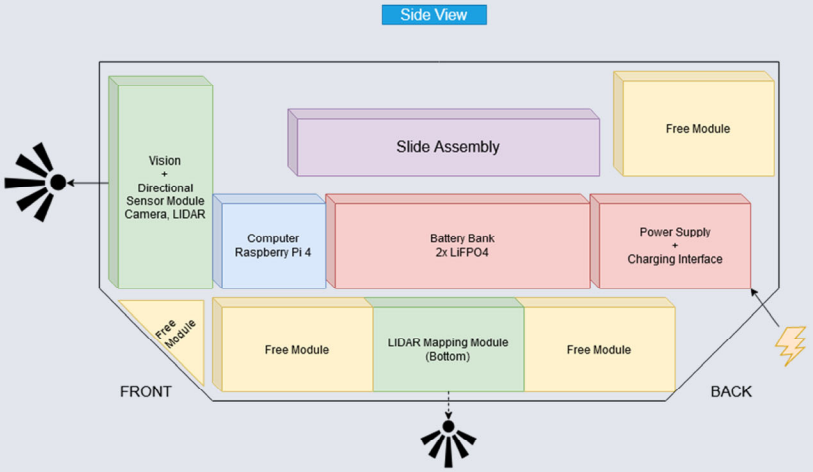
By the proposed design, we show that a four-wheeled rover gains exceptional all-terrain mobility with the introduction of two A-frame legs which give the rover the partial characteristics of a quadrupedal robot. The main rover body hangs from pivot points at the top of the A-frames, allowing for a low center of mass. The body of the rover is populated with interchangeable bays that can be equipped with sensor packages and storage space.

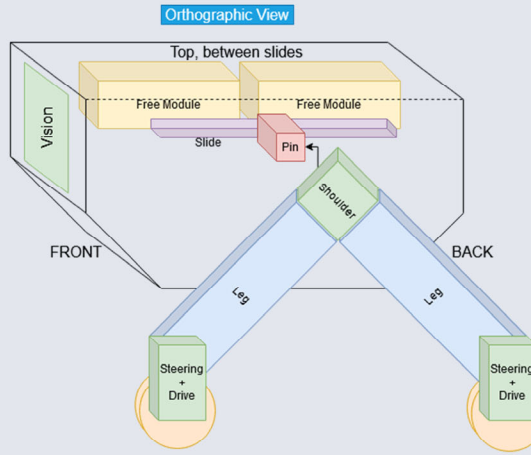


Main Body model showing sliding arm anchor plates.



Arm assembly model showing two of the arms joining at a shoulder.





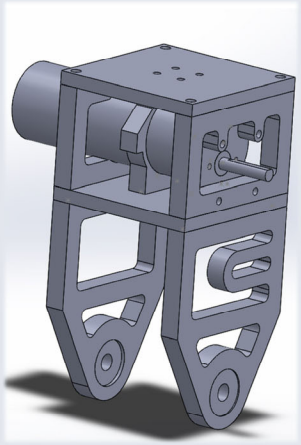
Methods

Mechanical Design – The chassis was developed using CAD modeling. The body and arms of the rover are made from t-slotted aluminum extrusion. The wheel modules, shoulder joints and slide mechanisms were designed in-house and custom fabricated from aluminum.

Electrical Design – The power supply system as well as the emergency back-up power module were designed and fabricated in-house using circuit simulation software and PCB milling.

Project Management – Managed our own workflow, goals, and resources to keep the project on-schedule, on budget, and well defined in documentation. Held weekly meetings to present progress and future development goals.

Staging the chassis components: rover body, one arm pair assembly, and temporary mountings for the control system.



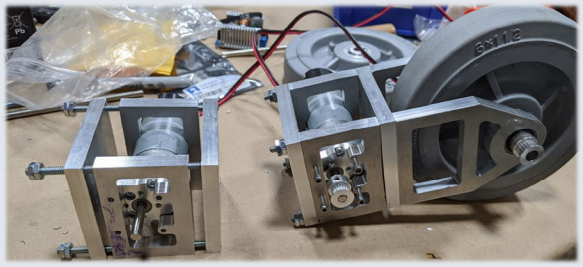
Model of drive module.

Technology

- Computing – Raspberry Pi 4 + Arduino UNO
- Mobility – Brushed DC motors
- Communication – Private LAN WIFI
- Mapping – LIDAR array + GPS
- Near Object Detection – Time of Flight sensor array
- Power – Lithium Iron Phosphate battery array
- Vision – Variable FOV camera + pitch and yaw control
- I/O – USB, GPIO, I2C
- Software – Python, Arduino C/C++

Future Development

The lunar rover project is on-going and there is much yet to be done. Currently we are at the cusp of having a mechanically complete prototype. Moving forward, we plan to utilize this summer quarter to continue development into the extensive electronic architecture and software.



Drive module assembly.