ORYX 2.0: A PLANETARY EXPLORATION MOBILITY PLATFORM

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ABSTRACT

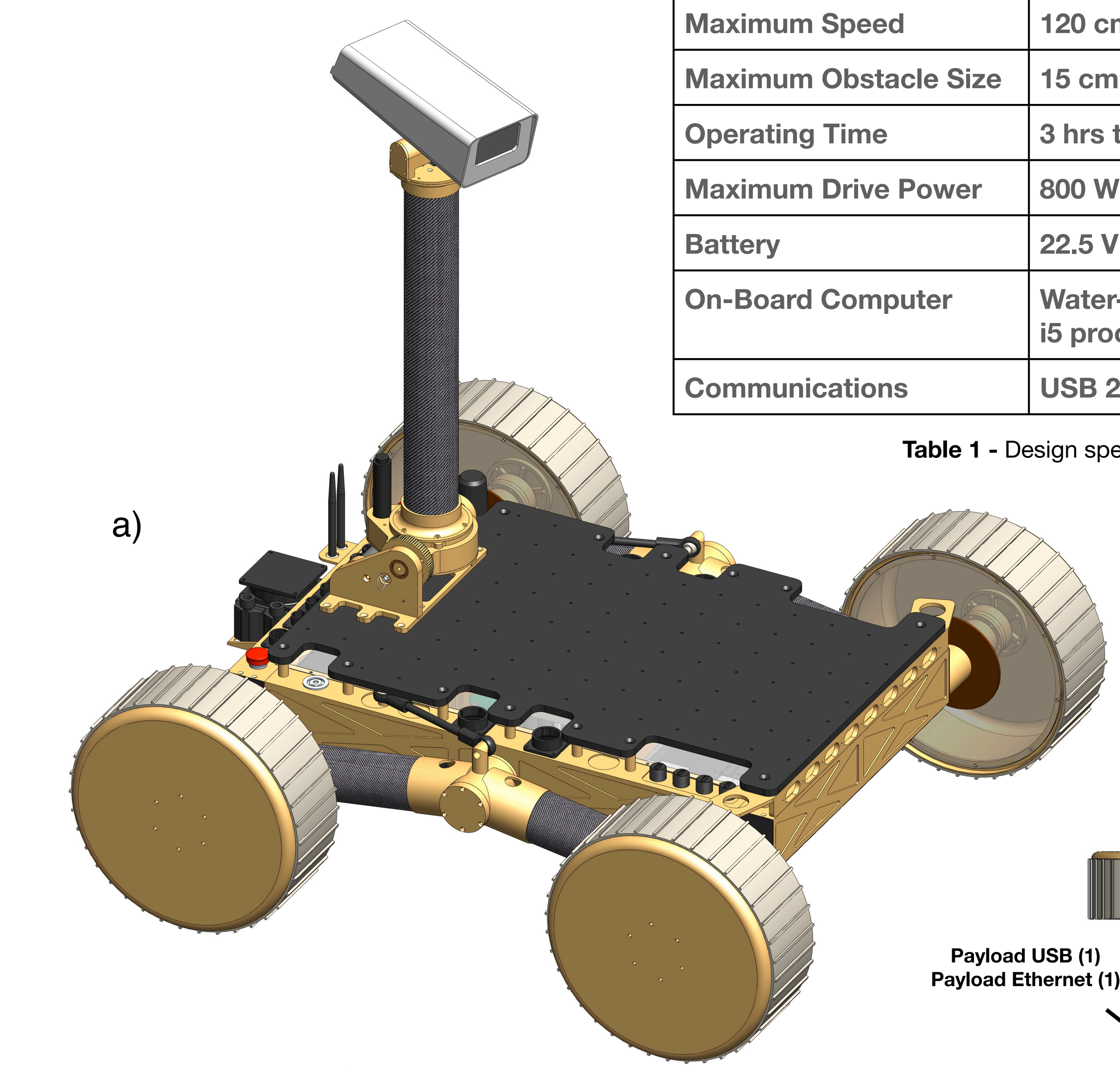
This project involves the design and realization of ORYX 2.0, a planetary exploration mobility platform. ORYX 2.0 is designed for operation on rough terrain to facilitate space related research and Earth exploration missions. Currently rovers are inaccessible to academic or industry researchers because of their high cost, making it difficult to conduct research related to surface exploration. ORYX 2.0 fills this gap by serving as a ruggedized highly mobile research platform with many features aimed at simplifying payload integration. Multiple teleoperated field testing trials on a variety of terrains validated the rover's ruggedness and ability to operate soundly. Lastly, a deployable pan-tilt camera was designed, built, and tested, to demonstrate the rover's modularity.

ROVER DESIGN

SPECIFICATION	
Dimensions (LxWxH)	96 x 89 x 31 cm
Mass	35 kg
Rated Payload	15 kg
Maximum Speed	120 cm/sec
Maximum Obstacle Size	15 cm
Operating Time	3 hrs typical
Maximum Drive Power	800 W
Battery	22.5 V 36 Ah, Lithium Ion w/ BMS
On-Board Computer	Water-cooled Mini-ITX w/ Intel Quad-core i5 processor
Communications	USB 2.0, Ethernet, Wireless-N, 4G LTE

Table 1 - Design specifications for ORYX 2.0

a)



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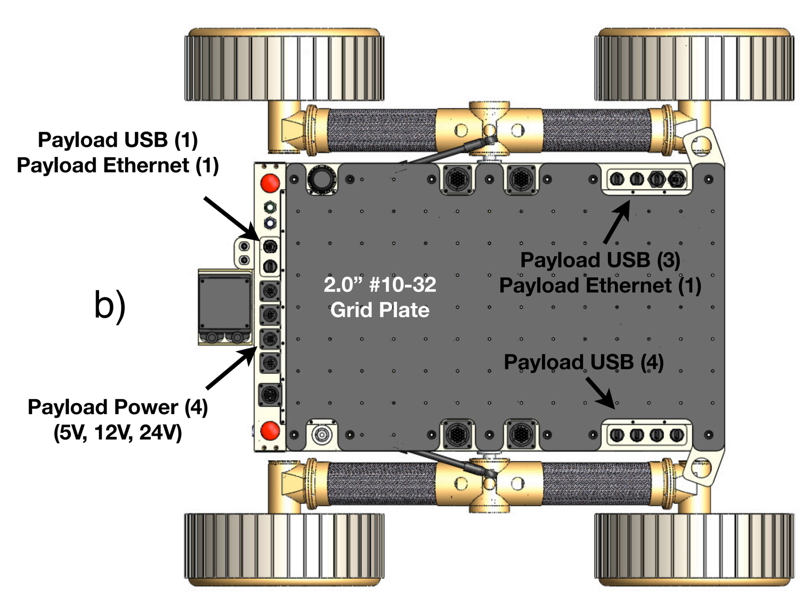

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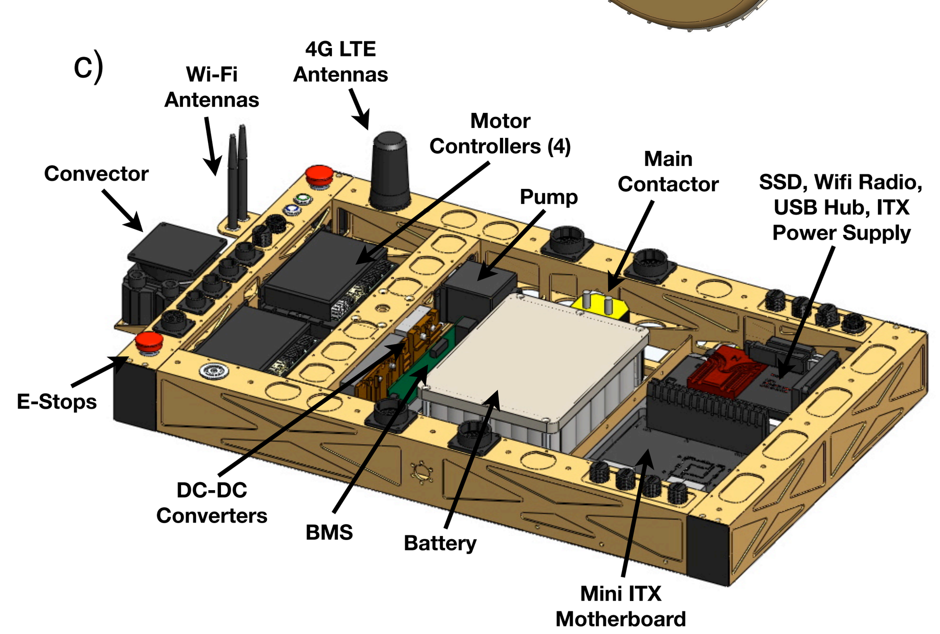
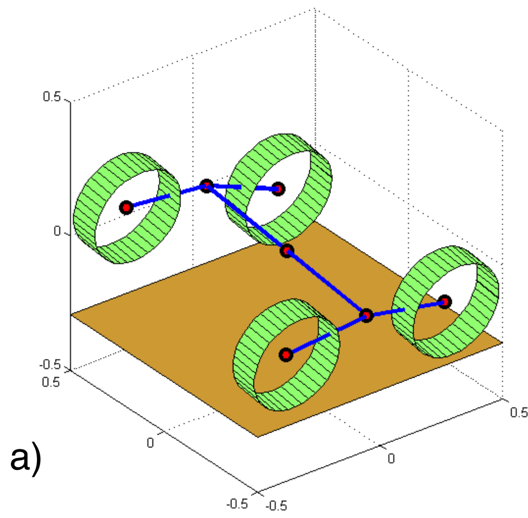


Figure 1 - a) CAD model of entire rover, b) CAD model of payload integration features, c) CAD model of electronics layout

AVERAGING SUSPENSION

- Passive averaging suspension to achieve ground compliance
- Creates higher stability and better weight distribution
- Averages the pitch and roll of the rover's chassis
- Reduces power requirements and increases the ability to overcome obstacles
- Can use proprioceptive sensor information and MATLAB kinematic model to estimate terrain profiles

a)



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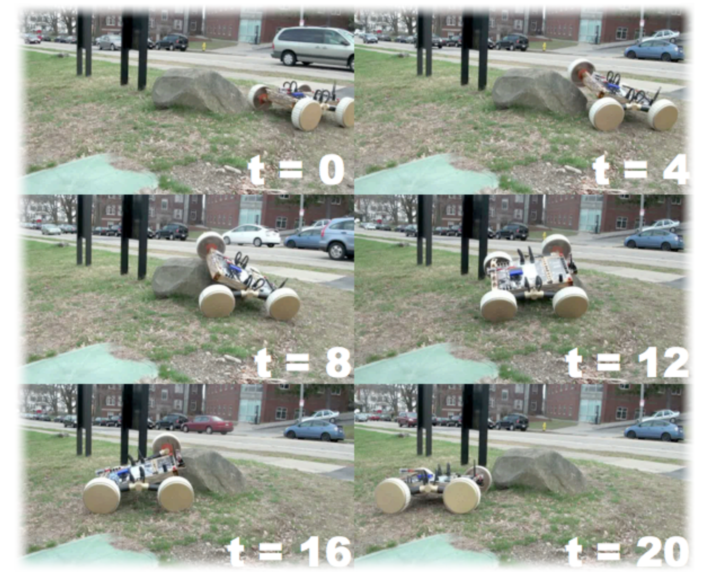

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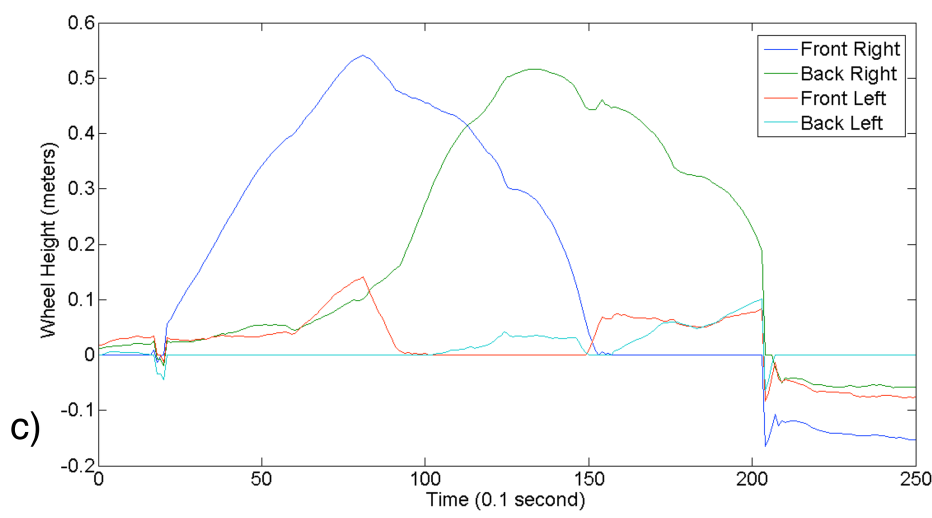

Figure 2 - a) Visualization of MATLAB kinematic model, b) Timelapse photographs of ORYX 2.0 traversing a 50 cm rock, c) Estimated terrain profile from ORYX 2.0 traversing the 50 cm rock

MANUFACTURING AND ASSEMBLY

- Lightweight rigid aluminum and carbon fiber structure
- Chromate conversion and anodization for corrosion resistant non-porous coating
- $19,000 budget, 135 machined parts, 7 weldments, ~500 crimped pins, ~300 solder joints

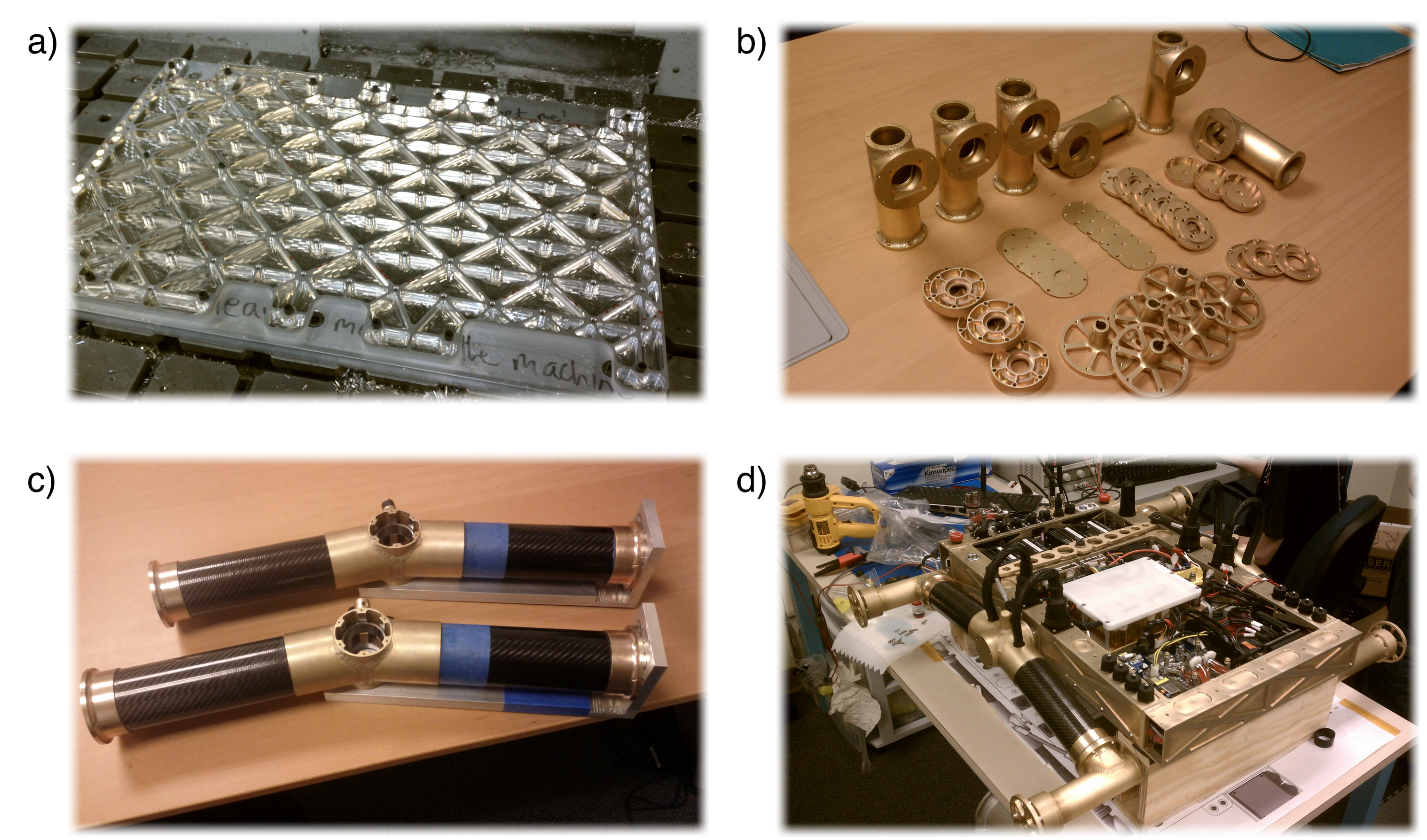

Figure 3 - a) Machining top plate, b) Drive module parts after chromate conversion, c) Suspension arms on carbon fiber bonding fixture, d) Rover during wiring and assembly

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PROPRIOCEPTION

- Inertial orientation sensor for yaw, pitch, and roll feedback to provided situational awareness
- Absolute encoder (12-bit) for feedback on position of averaging suspension
- Temperature sensors (22) to monitor system health
- Individual and combined battery cell voltages
- Position, velocity, current, and status feedback on all motors
- Sensor data combined to warn users of potential problems and disable systems operating at dangerous levels

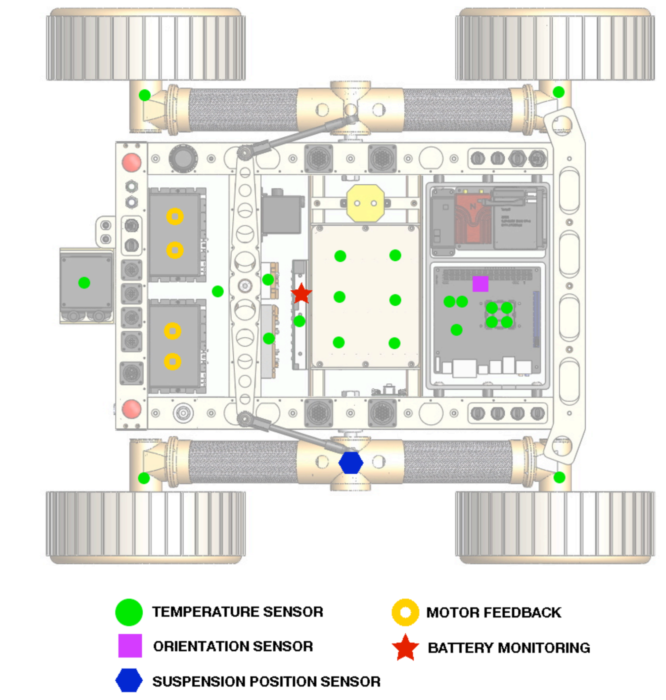

Figure 4 - Layout of rover sensors

SOFTWARE

- Use of Robot Operating System (ROS), a modular framework for research platforms
- Teleoperated joystick control with telemetry
- Developed ROS packages that will be contributed back to the ROS community

Figure 5 - Layout of user interface, telemetry (left), camera feed at night (right)

FIELD TESTING

- Teleoperated the rover in natural terrain over both 4G LTE and Wi-Fi
- Able to traverse obstacles up to 50 cm high
- Will be tested at NASA's JSC Rock Yard at the end of May and evaluated by NASA engineers
- Rover will be teleoperated from WPI campus for an analog sample return mission

Figure 6 - Overcoming a rock during field testing

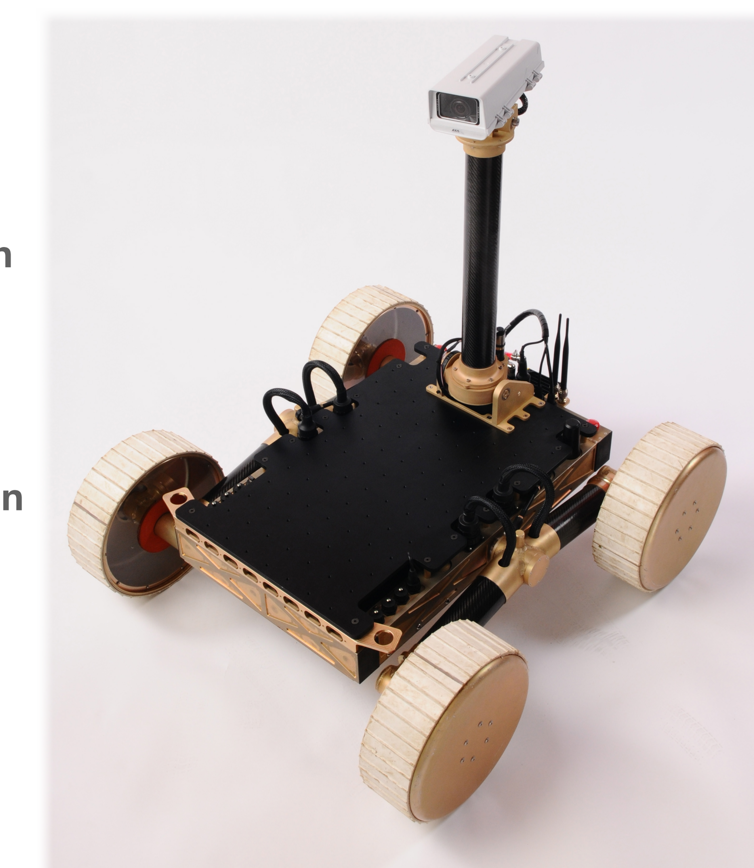

Figure 7 - Photograph of rover with camera payload

Presented at:
- Brown University MicroRover Workshop
- Boston Museum of Science
- IEEE TePRA Conference Poster (April 23rd)