Inspection and Reconnaissance Micro-Rover for Use in Extraterrestrial Environments

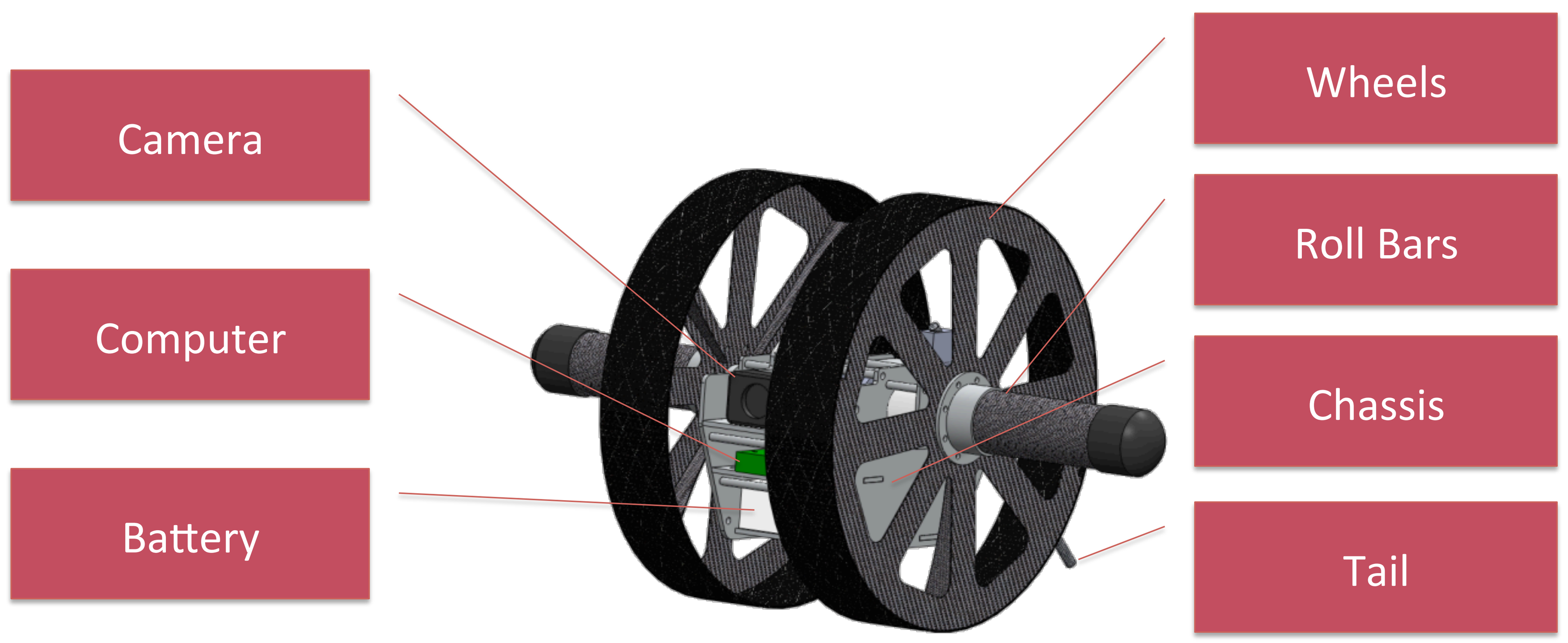
AUTHORS: Andrew Cunningham, Quan Peng, Cody Shultz, Jivesh Tolani

ADVISOR: Taşkin Padir **CO-ADVISORS:** Michael Gennert, Bradley Miller, Kenneth Stafford, Velin Dimitrov

ABSTRACT

The goal of this project is to design and implement a micro-rover capable of supporting a primary rover to complete mission specific tasks and objectives. This rover is designed with the intent of interfacing with many different robotic systems due to the ease of integration with Robot Operating System (ROS) and its small size. The project demonstrates the possibilities for smaller and lighter robotic rovers by exhibiting a small tele-operated, two-wheel, self-righting micro-rover with semi-autonomous features and a HD video stream for use in space applications. The Micro-rover project proves the capabilities of creating a small inexpensive secondary rover to play a key supportive role, allowing the pair to complete mission objectives faster and more efficiently.

ROVER DESIGN

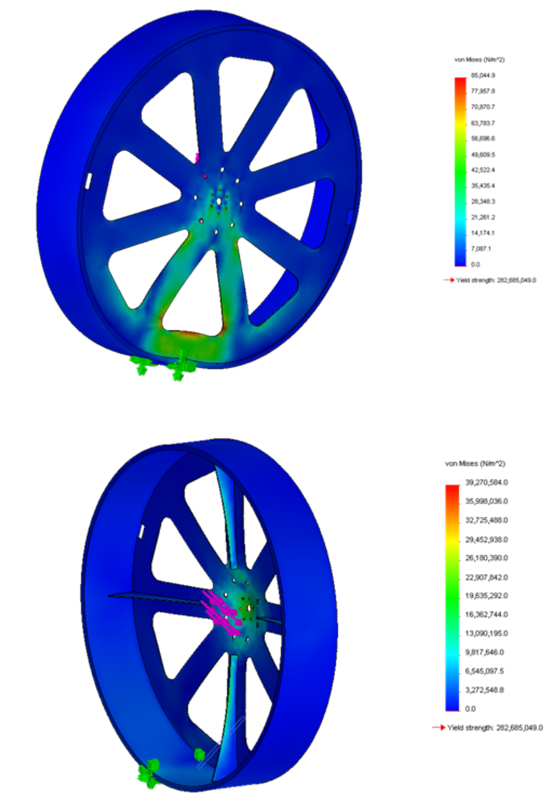


CAD model of micro-rover

Technical Specifications	
Dimension (LxWxH)	42x32x29 cm
Mass	2.7 kg
Maximum Speed	1 m/s
Communications	WiFi 802.11b/g
Video	640x480 pixels at 8 fps
Communication Range	150 m (line of sight)
Drop height	0.25 m at 9.82 m/s^2
Battery	12.8 V 3.3 Ah $LiFePO_4$

DRIVE SYSTEM

- Customized carbon fiber wheels for high strength low weight
- Roll bars to provide ability to self right from any orientation
- Compact flat EC motor/planetary gearbox combination
- Gearbox shaft can withstand up to 140N dynamic radial load, allowing rover to withstand 0.25 m drops
- Intuitive tele-operated controls using directional pad and joystick of a Xbox controller



A simulation of stresses encountered by the wheel during .25m drops at 0° and 45°.

Photograph of fully assembled micro-rover

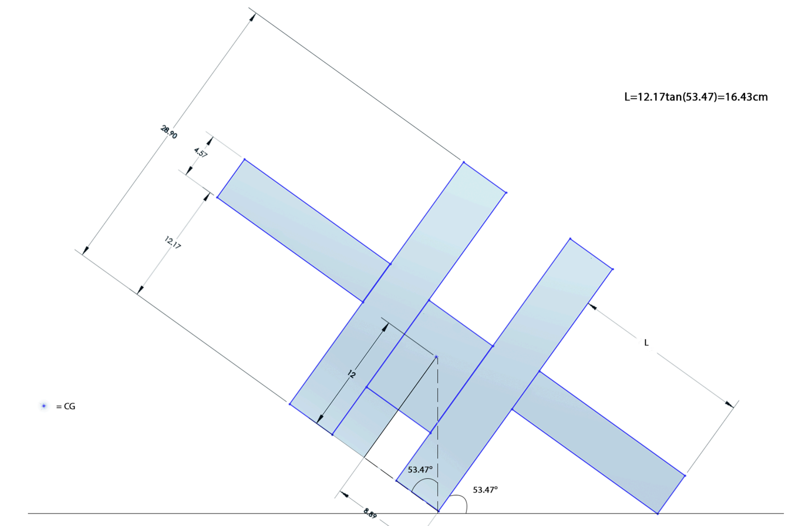
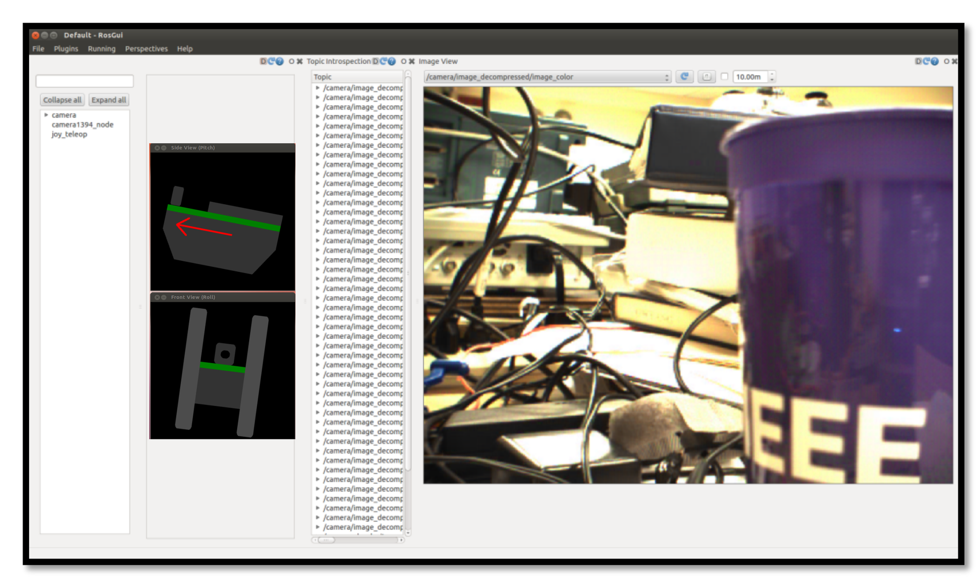


Diagram used to calculate necessary length of the roll bars to ensure the robot can always self-right

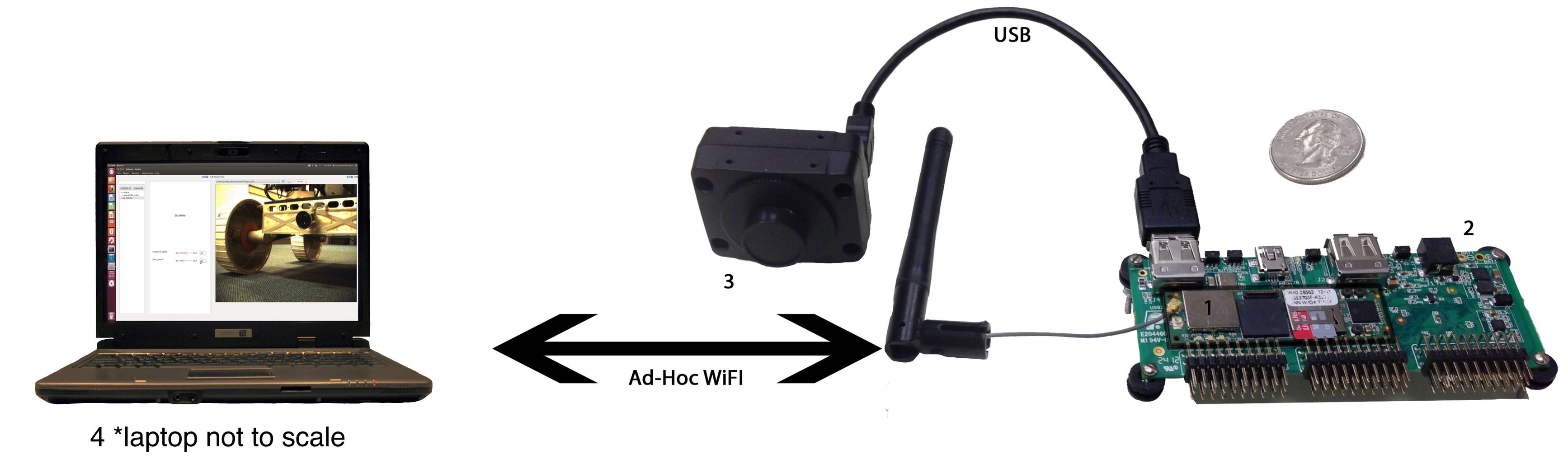
SITUATIONAL AWARENESS

- Vision
- Slope detection
- Speedometer
- Hall sensor based dead reckoning
- Temperature monitor



Control GUI including dynamic parameter configuration, slope detection, status monitor and camera feed.

VISION SYSTEM



- Used for navigation, scouting and inspection
- Overo Compresses raw image from camera for Wi-Fi transmission
- Laptop decompresses and processes the raw image
- Dynamically reconfigurable video resolution and frame rate for bandwidth optimization

Components of vision system:
1 - Gumstix Inc. Overo FE COM
Linaro OS + ROS Groovy
2 - Gumstix Inc. RoboVero
3 - Point Grey Firefly MV camera
1328x1048 at 23 FPS
4 – Laptop
Ubuntu PrecisePangolin + ROS Groovy

FIELD TESTING RESULTS

- Able to drive over 6 cm obstacles
- Drives down and up a hill with a slope of 30 degrees
- Able to self-right after rolling down a hill
- Can operate with video feedback up to 155m away
- If signal strength is low, reducing video quality increase system reliability and responsiveness

Self-righting after falling over

National Institute of Aerospace · NASA · maxon PRECISION MOTORS · ASTROBOTIC · MathWorks® · iCe Innovative Composite Engineering · HYDRO-CUTTER Precision Waterjet Cutting www.Hydro-Cutter.com