Rocket City Space Pioneers
X Prize Test Bed

Team Lead

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Abstract

The Rocket City Space Pioneers is a team of companies formed with the goal of sending a robotic lander to the moon and deploying a rover to traverse the lunar surface to compete for the Google Lunar X Prize. We have designed an X Prize Test Bed to test the technologies used on the lunar lander design and verify the integration of the subsystems. The modular test bed provides long-duration flight in a lunar gravity-simulated environment with three degrees of freedom while introducing minimal external force. The primary subsystems to be tested include propulsion, GNC, and structures, as well as subsystem integration.

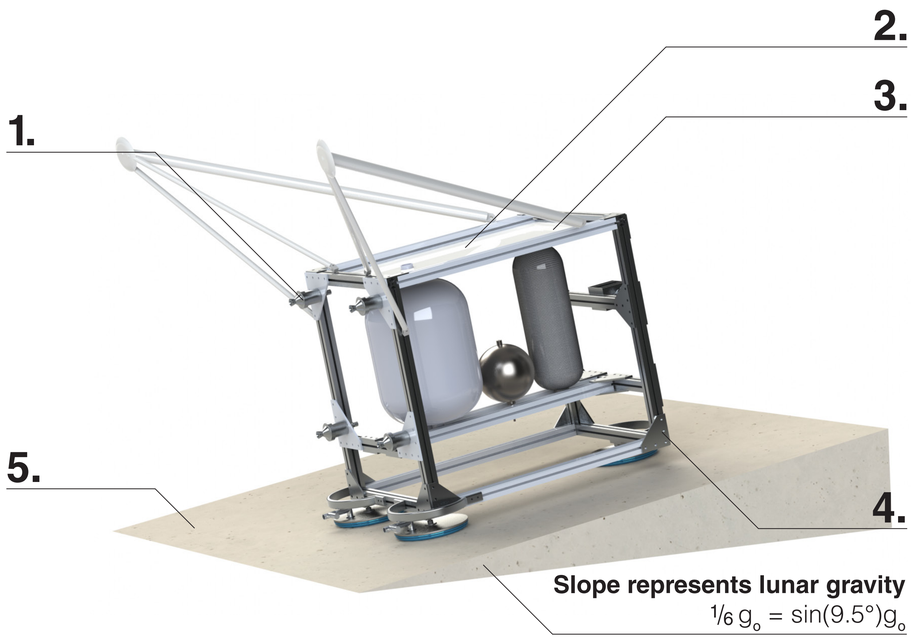


Figure 1: X Prize Test Bed concept with primary sub-systems

Requirements

Medium-fidelity test bed to test subsystems integration in simulated lunar gravity
Provide long-duration testing
Be able to test propulsion system
Be able to test landing gear
Be able to test GNC algorithms and obstacle avoidance

1. Propulsion

Peroxide/kerosene bi-prop system with the capability of running as a peroxide mono-prop.

Main thrusters:	4x 110lbf hydrogen peroxide/kerosene
Under development by Dynetics	
ACS thrusters:	2x 10lbf hydrogen peroxide
Flight time:	60 seconds
Total dV:	1470 ft/s

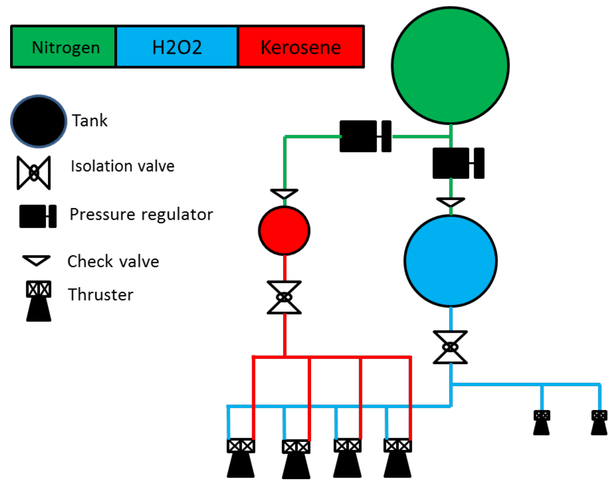


Figure 2: Simplified Propulsion Sub-System Schematic

2. Electronics

Computer: FPGA + Processor Core executes GNC algorithms, communication and power distribution
Valve Controller: Array of solid state relays and ports for solenoid valves, controlled by data line from Flight Computer
Comm: Wi-Fi connection for telemetry and command
Power supply: Rechargeable Li-Ion, 24 V Bus

3. Guidance, Navigation, & Control

3 x Laser Distance Sensor: 2 altitude, 1 cross-range
1 Digital Camera: vision-based navigation for landing
IMU: acceleration and attitude sensing
Algorithms: Developed by Draper Laboratory for autonomous robotic lunar landers

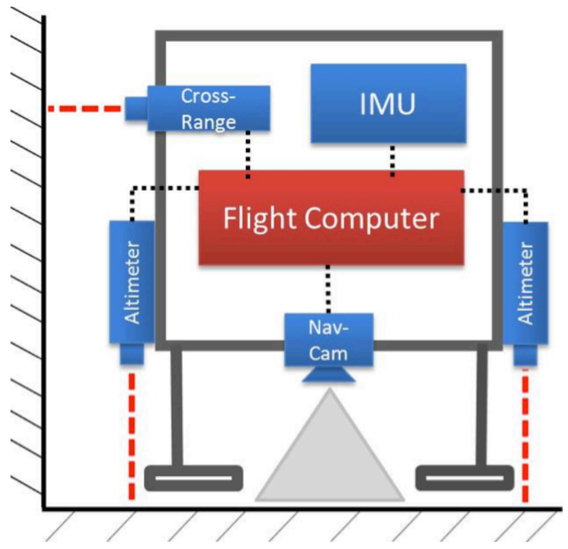


Figure 3: Component Overview of Guidance, Navigation, and Control Sub-System

4. Vehicle

3x air bearings, providing negligible friction with plane
Air bladder bearings allow for floor imperfections
135 seconds of support with on-board pressurized air
Frame of extruded 6063-T4 aluminum
Modular components, easy to reconfigure, almost entirely COTS parts
Electronics mounted on PVC sheets

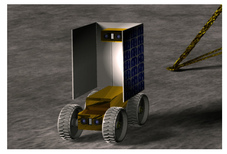
5. Plane

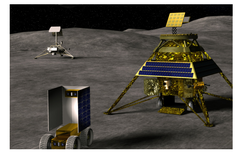
10m in simulated altitude, 5m in simulated cross-range
Wedge slab of regular concrete
Surfaced with high-strength, temperature-resistant concrete
Smooth to 0.25cm over 9 square meters
Vehicle lands on simulated lunar surface

Conclusions & Results

The platform provides sufficient capability to test GNC algorithms, propulsion subsystem performance, structures effectiveness, and subsystem integration in a simulated lunar gravity environment.

Total vehicle mass:	210 kg (wet), 180 kg (dry)
Total vehicle power:	345 watts
Total system cost:	$150,000
Target completion date:	February 2012





Dynetics

Research Advisor — Andy Crocker — Dynetics, Inc.