Design and Development of the Telescope-deployment High-vacuum teleOperated Rover (THOR) in an Airless Body Environment

C. Womack, M. Crist, L. Kruger, K. DeGeorge, K. Tuan, J. Burns

University of Colorado Boulder

LUNAR — LUNAR UNIVERSITY NETWORK for ASTROPHYSICS RESEARCH

Introduction

LUNAR (Lunar University Network for Astrophysics Research) proposes to telerobotically deploy a lunar farside radio telescope array to study the formation of the early universe. The LABS (Lunar and Airless Bodies Simulator) team designed, fabricated, and assembled THOR (Telescope-deployment High-vacuum teleOperated Rover) to investigate deployment strategies, electronic survivability of COTS parts, and rover system survivability over an abbreviated lunar year (24 hour day/night cycles). THOR's development has also provided an opportunity for student training, offering a chance for hands on-training, as well as experience in design for space applications.

Design and Development

LABS rover development began for deployment testing of the polyimide (Kapton) antenna array. The previous rover iteration lacked realism due to hard-wired power, the inability to tread through regolith, and insufficient thermal survivability. These shortcomings have been rectified to include:

- On-board power
- Wireless control
- Passive deployment operations
- Regolith trekking
- Thermal protection

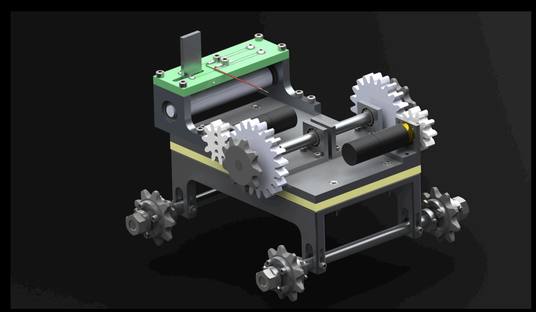

Fig.1 THOR Solidworks Model

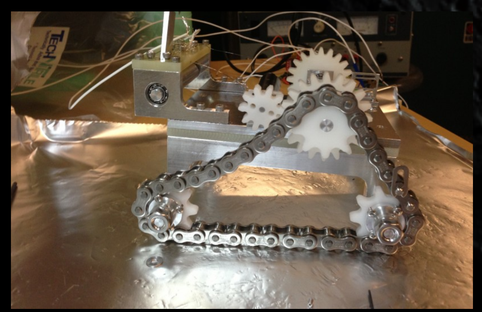

Fig.2 THOR Mobility System

Mobility

The LABS team designed THOR to be able to tread through lunar regolith, without causing dust migration that could potentially interfere with the vacuum chamber's pumps. Highly geared motors drive a stainless steel chain, acting as a track system to move the rover with all wheel drive. Due to the compaction of dust in the chain links and lack of tread surface area, we implemented a concave wheel system. The larger wheelbase allows drive chain to clear the regolith.

Electronics

As a low-cost and readily available option, we used an Arduino with an H-bridge motor driver circuit to provide the control system. The system was protected from the thermal and vacuum environment by placing the electronics in a G-10 box filled with heat transfer epoxy resin.

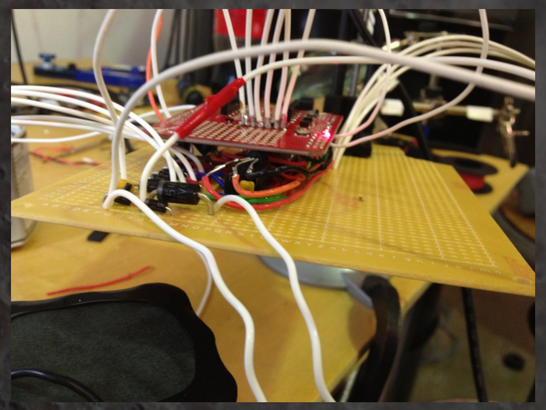

Fig. 3 Arduino H-Bridge Driver Circuit

Fig. 4 Insulated power system (Li-Ion)

Deployment

Passive deployment was chosen to reduce the complexity of the system, ensuring the reliability of the deployment. When current passes through shape memory alloy wire, a hinged brake foot lifts, allowing the Kapton antennae to deploy.

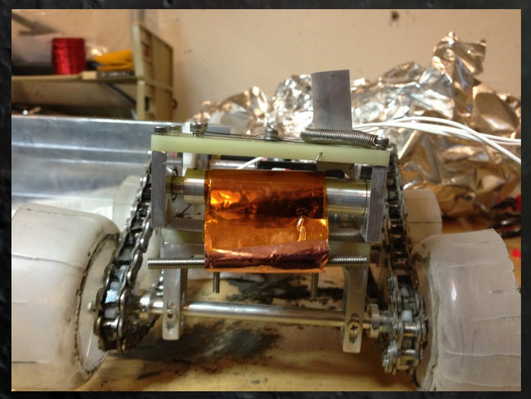

Fig. 5 Kapton Deployer

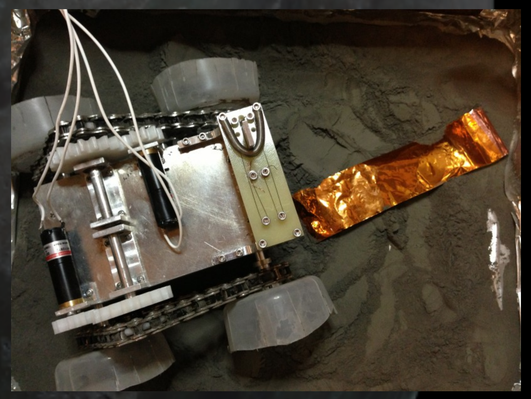

Fig. 6 Simulated deployment of Kapton antennae arm

Conclusion and Future Iterations

Survivability testing is currently underway inside one of LUNAR's vacuum chambers, simulating the degrading conditions on the Moon. Results from this test will aid in building the technology base needed to fabricate telescope components and electronics that will be able to withstand the harsh lunar environment. The data collected will also dictate what modifications will be made to the next generation rover. These experiments the ISS telerobotics tests described in the poster by Kruger et. al.

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