Georgia Tech Night Rover

Autonomous Solar Harvesting Planetary Rover

Cornell Cup USA presented by Intel

May 5th, 2012

Georgia Institute of Technology

Team Members

- David Esposito – Computer Science
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- Roberto Pereira – Computer Engineering
- Kevin Reilley – Aerospace Engineering
- John Richardson – Electrical Engineering

- Faculty Advisor
  - Dr. Jay Summet – College of Computing

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Design Competitions

- **Intel Cornell Cup**
  - **May 2012**

- NASA Night Rover Centennial Challenge
  - Spring 2013

NASA Centennial Challenge

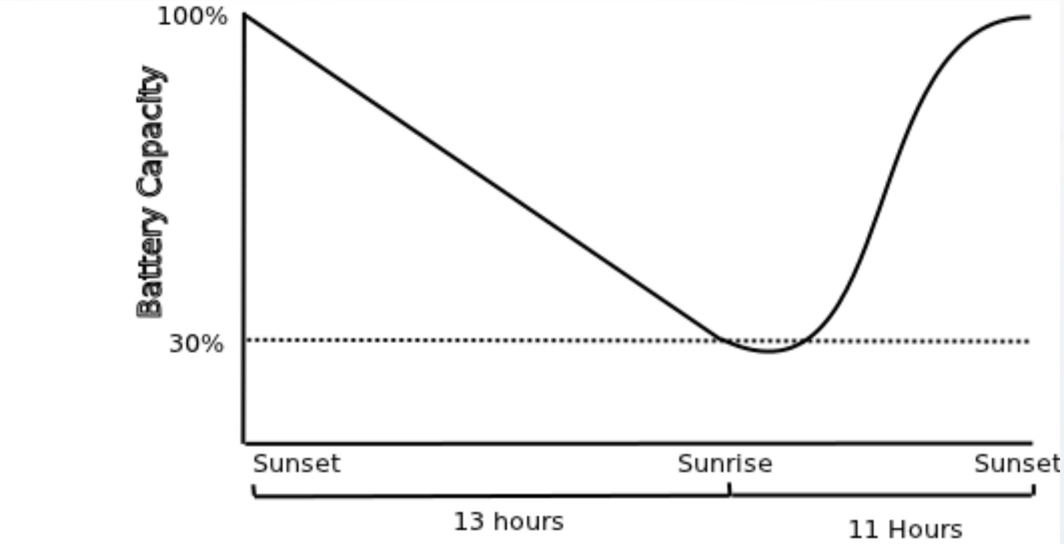
- Requirements
  - Maximum distance over 72 hour period
  - Autonomous traversal of rugged terrain
  - Conversion of solar energy to mechanical energy
- Goals
  - Continuous motion over 72 hour period
  - Harvested solar power meets or exceeds power consumed

Intel Cornell Cup

- Requirements
  - Design toward Centennial Challenge requirements and build functional prototype
  - Maximum distance over 24 hours in environment with smooth surfaces e.g. parking deck
- Goals
  - Accurate environment sensing with at least one level of redundancy
  - Minimize mass and power consumption
  - Integration of electrical and software sub-systems

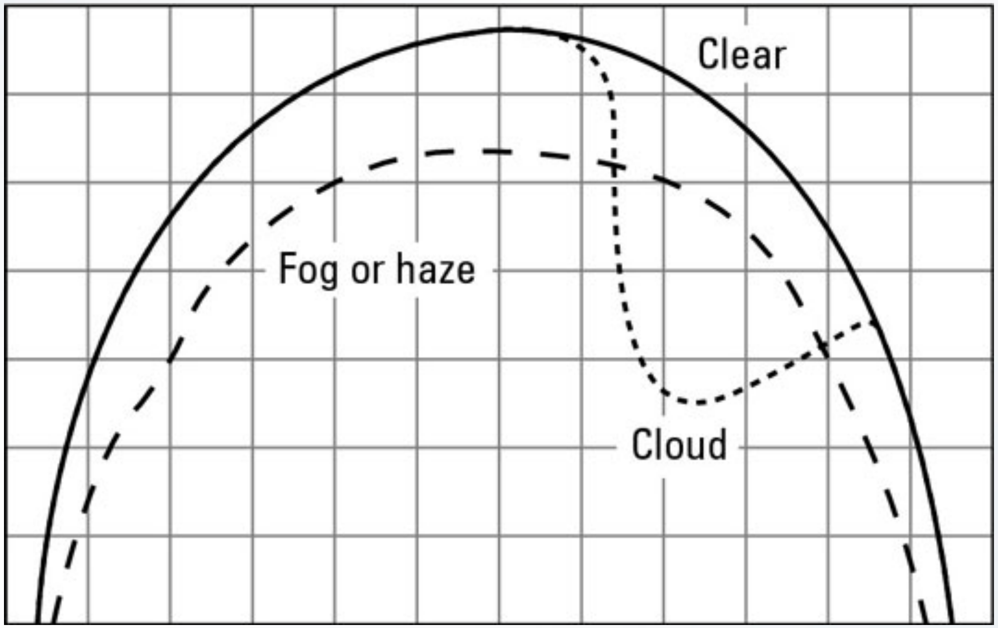
Continuous Motion and Power Requirements

- Batteries start fully charged at sunset
- Discharge and fully recharge over 24 hours
- Based on theoretical and experimental power budget, 5.6 Ah required at 12.8V



Solar Power Requirements

- Batteries fully recharged at end of 24 hours period i.e sunset

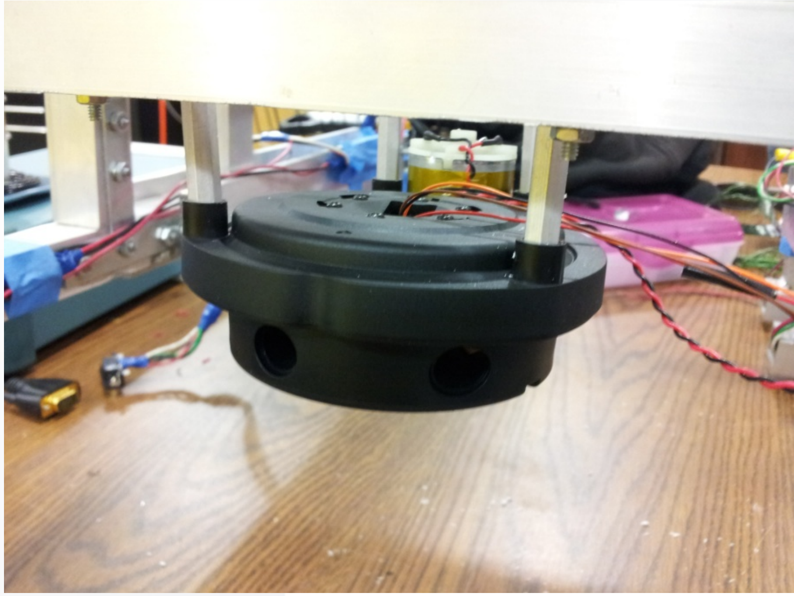


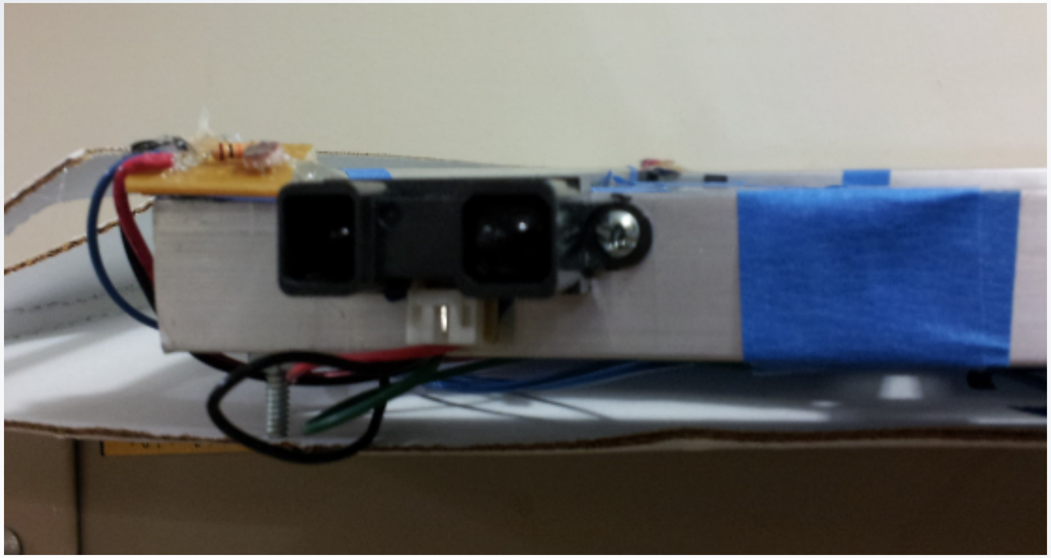
- 25W panel required for adjusted power requirements

- 18V @ 3.4A panel charges batteries and supplies power to remaining electrical system

Distance Sensing

- LIDAR module provides 360 degree distance information for the environment
- IR sensors provides real time collision detection





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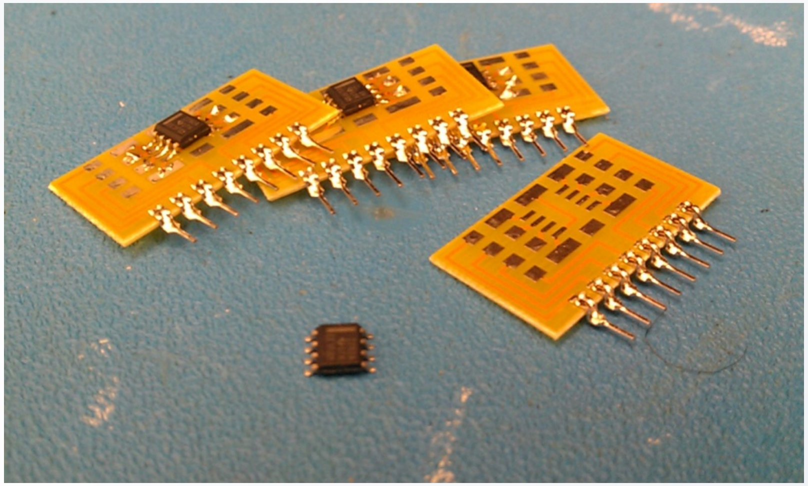
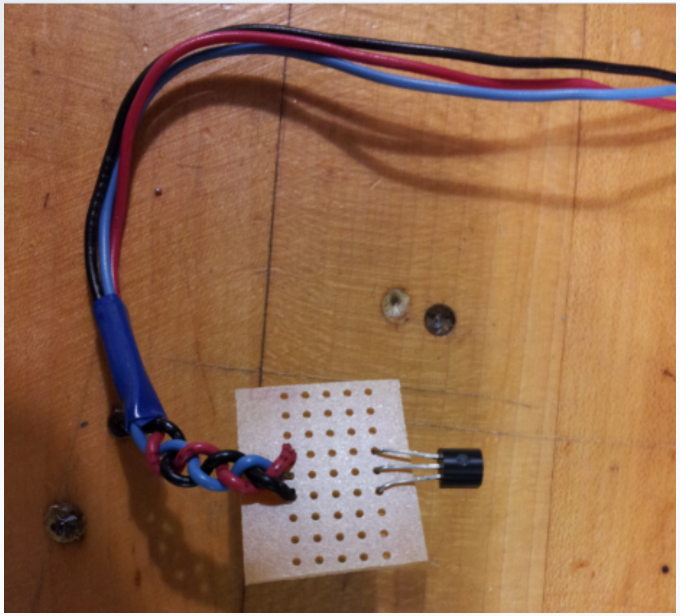
Sun Seeking Path Planning

- Current sensors are used to keep track of the amount of power available



- Photocells tell the state of the solar panel with respect to light intensity

Electrical Subsystem Monitoring



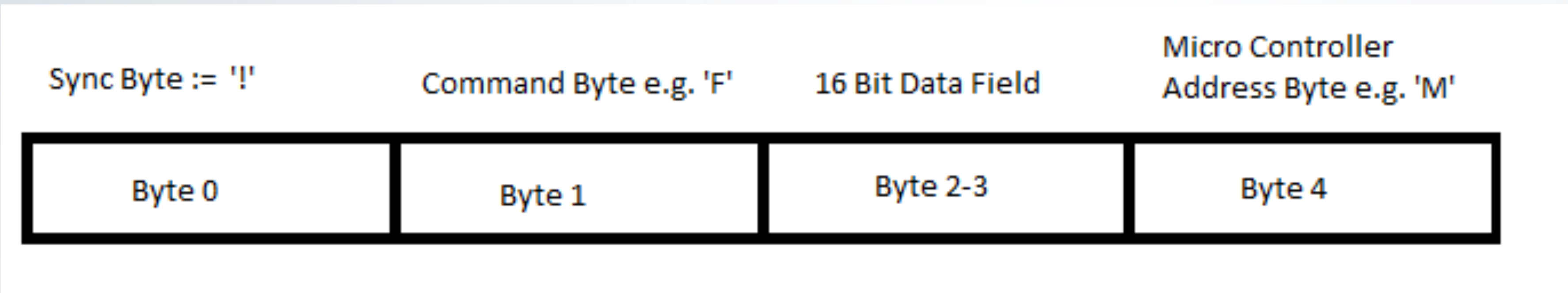
- Temperature and current sensors are used to prevent failure of the batteries and Atom board
- Monitoring battery voltage and input/output current provides the battery state of charge

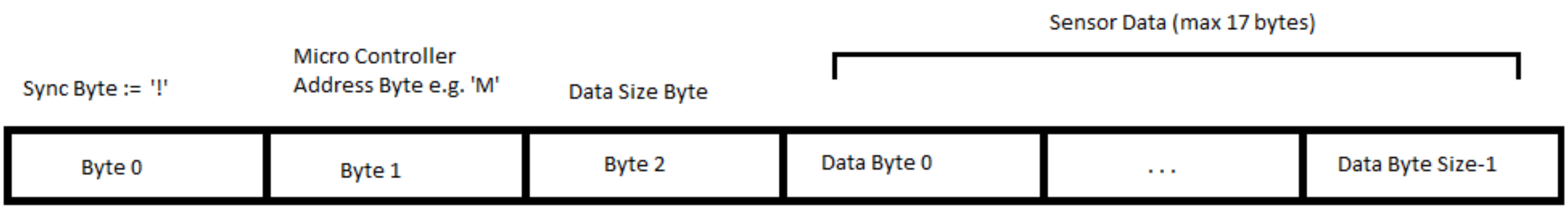
Software Purpose

- Primary Functionality
  - Build a 2D representation of the environment from LIDAR data
  - Generate weighted paths through the environment
  - Generate and transmit atomic instructions to Arduino motor controller
- Additional functionality
  - Live data monitoring
  - Data logging for further algorithm analysis and future simulations

Atom to Arduino - USB Protocol

- Choose USB for simplicity and reliability
- Sync byte to ensure proper parsing





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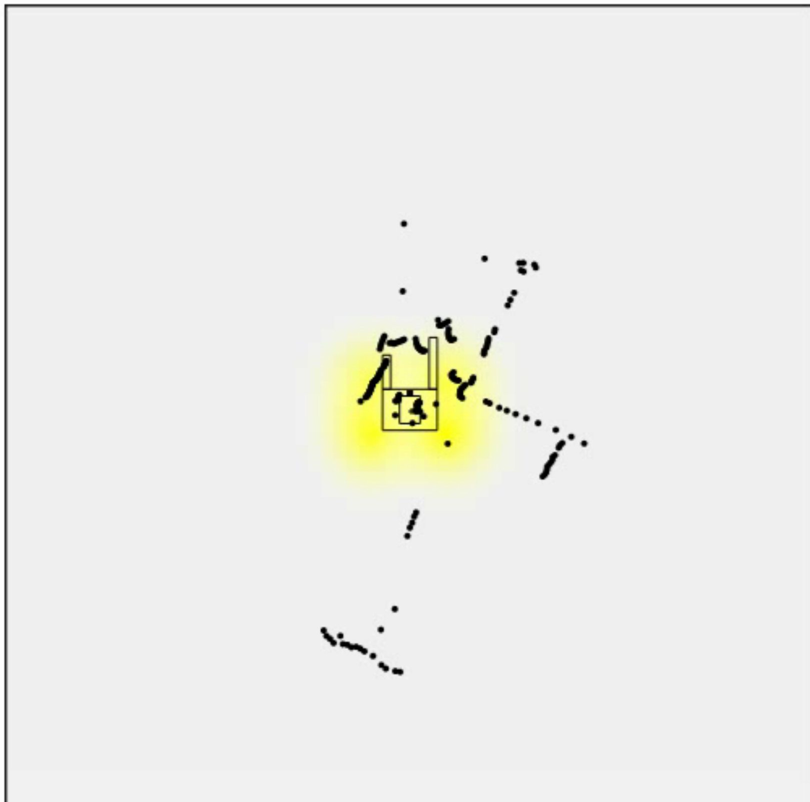
Live Data Monitoring

Live Data | About GT Night Rover | Help

Geogria Tech Night Rover

Autonomous Solar Harvesting Planetary Rover



```
Battery SOC           = 0.00%
Battery V             = 0.00 V
Solar Panel V         = 0.00 V
Battery Current       = 0.00 A
Solar Panel Current   = 0.00 A
Total Power           = 0.00 W
```

```
Cpu 1  = 26.95%
Cpu 2  = 28.44%
Memory = 46.66%
Program Alive Time = 28.00%
Program Sleep Time = 58.11%
IO Wait Time = 1.13%
```

Structural Design and Influences

- Requirements
  - Design toward NASA Centennial Challenge
  - Navigate smooth terrain (Cornell Cup)
  - Maximize distance traveled with minimum power consumption
  - Maintain structural integrity during possible collisions

- Influences
  - NASA Planetary Rovers
  - Experimental high speed navigation technique

Structure Overview

- Altered-rocker-bogie design
  - Fixed rocker joint and free bogie joint
  - More motors with smaller current draw

- Closed body design
  - Added structural integrity
  - Mass reduced using lexan enclosure

Obstacles Encountered

- Turning
  - Wide wheel base with soft rubber wheels
  - Solution: omni-directional wheels

- Gear box structural integrity
  - Increased wheel diameter and force on small risers and screws
  - Temporary Solution: solid axel using larger motor
  - Future Solution: custom gearbox to place structural loads on properly supported axels

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Project Status

- Electrical Sub-System
    - Confirmed power budget and power source ratings
    - Functional environmental sensing with built in redundancy
    - Functional motor speed and direction control
- Software Sub-System
    - Successful environment sensing and reconstruction
    - Solar seeking path planning
    - Live data monitoring for debugging
    - Reliable communication protocols
- Structural
    - Design toward NASA Night Rover Centennial Challenge

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