Photocell Radiometry and Iron Deposit Experimentation

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Introduction

In order for interplanetary colonization to be viable, robotic missions must forge a path for human colonists by performing experiments and collecting data that will allow mission planners to fine-tune the colonization missions. Accurate information is crucial for both scientific and colonization missions, and inaccurate information can cause catastrophes and result in the loss of the craft and any passengers. The PRIDE (Photocell Radiometry and Iron Deposit Experiment) rover performs two critical experiments that will not only allow TerraBlair colonization mission planners to have accurate surface images, but will search TerraBlair for ferrous metals that will be crucial for the construction and expansion of the colony settlement. To this end, the PRIDE rover carries a magnetic field sensor and a photocell experiment that will be used to ground truth radiometry data collected by earlier orbiters such as the X-9000.

The magnetic field sensor will allow the rover to identify iron deposits on or just below the surface, and thus easy to mine. This information will save colonists from having to prospect for iron, and will allow mission planners to situate a colony near one or more of these deposits. Easy access to steel for structural beams will allow the colony to construct additional houses and other buildings to support an expanding population. The metals can also be used to construct everything from tools to sewer pipes that will allow the colony to remain self-sufficient while maintaining an adequate quality of life for its residents.

The ground truthing of the radiometry data also will have an impact on the study and colonization of TerraBlair. “Real” data collected by the rover can be compared to data collected over a much wider area by an orbiter, allowing scientists to determine the accuracy of the orbiter data and allow them to extrapolate the ground truthing dataset onto the larger orbiter images to make them more accurate. Accurate radiometry data will be crucial for colonies as it will give mission planners more information about potential landing sites. Also, iron deposits may also be associated with a particular terrain type, allowing orbiters to find similar terrains that may also have iron deposits. Thus, the data collected by the PRIDE rover will enhance our understanding of and further colonization prospects on TerraBlair.

The heart of the PRIDE mission is the rover (see figure 1), which resembles a small tank and is about one square foot in size. An onboard battery, contained within the rover's computer, powers the science experiments as well as the two electric motors that drive the treads. Treads allow the rover to conquer rough terrain, and they have lots of traction on a variety of terrains, allowing the robot to move freely on all or most parts of TerraBlair. The magnetic field sensor, photocell, and light (for control) are attached to a center crossbeam at the bottom of the rover, just beneath the motors. The chassis of the rover was designed with many rugged braces to support the weight of the various rover components, and to prevent parts from slipping out of place. The result is a rover that will be able to handle any terrain that it will encounter over the course of its mission.

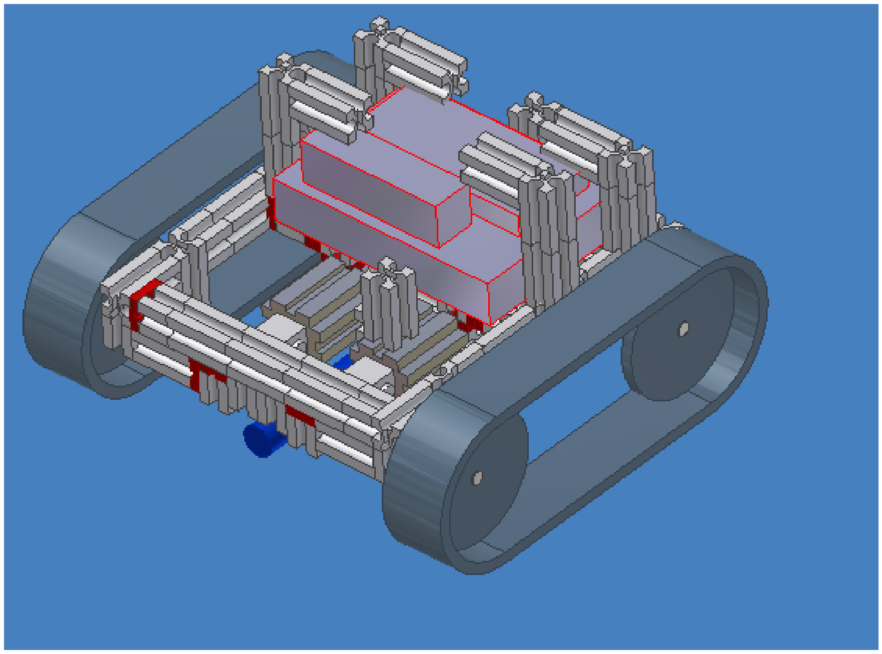

Figure 1: PRIDE rover

Along with other landers, rovers, and orbiters, the PRIDE rover will forge a path for the first human visitors and eventually, the first colonists of TerraBlair. The experiments preformed by the rover will benefit all who will come to TerraBlair, and all who wish to study this unusual planet, which will forever be known as the first interplanetary human colony in history.

Key Words

- Viable
    - Workable, useful for a colony
    - Determined by:
        - Size of the iron deposit
        - Terrain iron deposit is located on
        - Proximity of the iron deposit to expected colony sites
- Iron deposits
    - Iron deposits exist if the magnet field sensor returns a higher value in one area than its surrounding areas
- Radiometry
    - How much light is reflected off a surface
    - Helps determine terrain
- Incidental light
    - Light reflected by a terrain
- Ambient light
    - General background light
- Magnetic field
    - The area of space where electrical charges experience an influence
- Handyboard
    - Used to obtain measurements, but more portable than the CBL
- CBL

    - Used to obtain measurements
- Empirical equation
    - Used to convert handyboard measurements to CBL measurements
    - Determined by taking data on shades of gray from both the photocell and the CBL and graphing the data

Background

The Alpha Particle X-Ray Spectrometer (APXS) is a tool designed to study the alpha particles and x-rays emitted by rocks and soils to determine their elemental chemistry. Alpha particles are emitted through radioactive decay and x-rays through electromagnetic radiation. The elemental chemistry describes the elements that form the minerals. It also provides information about the formation and climate of a planet's crust. The APXS is a small instrument and most of its electronics are located in the body of the rover. The measurements the APXS takes will mostly be at night and will require at least 10 hours of accumulation time.

When trying to settle on a planet, it is extremely useful and cost effective if materials used to settle on the planet can be taken from the planet itself. The soil of Mars is composed of approximately 5 to 14 percent iron oxide, and by using a practice employed by the Romans. Using water to convert carbon dioxide to methane produces carbon monoxide, which reacts with rust to produce iron and carbon dioxide. Normally, iron would corrode too easily and be too heavy to be practical in use. However, because of Mars' lower gravity and lower amount of oxygen in the atmosphere, the iron would be very useful on Mars. The iron can be used to make wires and other parts that are necessary when settling on a planet.

The NASA Mars Rover Spirit uncovered much interesting information when it did its first soil analysis. In this analysis, two spectrometers were used: the Moessbauer spectrometer and an alpha particle X-ray spectrometer. Interesting data gained from the Moessbauer spectrometer include that the soil of Mars is not easily disturbed and that olivine, a mineral that does not survive well under weathering conditions, can be found in Mars' soil. The X-ray revealed that the minerals that compose Martian soil include silicon, iron, chlorine, and sulfur. Scientists are guessing that it is the chlorides and sulfates that are keeping the soil together.

Many instruments are used aboard the Mars Rovers, such as spectrometers which help to gather data about the elements that compose the soils and rocks. One such spectrometer, the Moessbauer spectrometer, is used to acquire information about iron-bearing soils and rocks. To get this information, the spectrometer emits cobalt-57 gamma particles at the soils and rocks of interest. These gamma particles interact with the nuclei of the material and the radiation that is "backscattered" can be used to determine information about the types and amount of iron in the soils and rocks.

Procedures

Data Collection

Start the rover at the beginning of its assigned path. Initialize the radiometry and magnetic field arrays using the equipped control, then discard control. Next, obtain a control value for radiometry by using the photocell to measure the radiometry on a known shade of gray and obtain a control value for iron by using the magnetic field sensor to measure the magnetic field on a known iron deposit. Move forward by running both motors, leaving behind the calibration material. Then, use the photocell to measure radiometry on the new area and use the magnetic field sensor to measure the magnetic field on the new area. Move forward and take radiometry and magnetic field data. Keep moving and taking data until the rover has completed its path. The rover is then turned off. Now, the empirical equation can be applied to the photocell data in order to ground truth the radiometry. Also, by comparing the magnetic field data with the control, it can be determined which areas contain iron based on their magnetic fields.

Data Analysis Techniques

To analyze the data, the magnetic field measurements will be examined to find irregularities, which in comparison to the control magnetic field value of iron, will determine where iron is located. Next we will analyze radiometry. Each radiometry denotes a change in elevation or terrain of Terrablair. Through the radiometry measurements, we can determine radiometry's correlation to terrain, and the type of terrain iron is found on. The terrain will be used as a factor in viability.