

Mission Report 3: LUNAR Rover Design

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Abstract:

The main purpose of this rover is to observe the area of the lunar surface in traces of any rust around the moon with the help of the previous VIPER discovery. This rover will run over the moon’s hematite and take samples of the phenomenon that causes the rust on the moon. Since the previous rover is going to investigate the moon’s water and ice, this rover will use similar methods of research to investigate the mysterious rust happening on the moon. If such water exists on the moon, with the help of VIPER’s information, this rover will help discover the mystery of the possible rust occurrence on the moon. Since the moon “does not have a magnetic field to shield the hydrogen,” it is a mystery if the moon has rust occurring (Good, Andrew, NASA JPL). This is because, for iron to rust, it needs a catalyst like oxygen or moisture for it to rust. Then this catalyst will cause an oxidation reaction. The iron reacts with water and oxygen to form hydrated iron oxide or rust. Both water and oxygen are necessary for it to create a rusting effect. This rover will investigate the possible traces of rust on the moon using the technology of taking samples of both the weather and the hematite/surface of the moon at locations where there is water. It will go to locations near the water to see if there are any traces of rust forming nearby with its mobility and technology to get data back to base for further investigation.

The first objective is for the rover must have great mobility, extreme temperature changes, and roam over the area of possible water to see if there is any rust nearby by checking the precipitation and humidity. This can be possible by creating a simple rover with great mobility on the wheels and materials to withstand the temperature of the rover. Another is to use a similar technology of the Spectrometer System by Ames Research Center (NASA) to determine the nearby water or areas that are likely to inhibit a rust effect. This technology will use a device to find oxidation of the elements water and oxygen that makes up the rusting on the moon.

The second objective is to take the samples of the weather (air or atmosphere) and land (hematite) from the moon near locations of water to detect if there are any traces of rust. This can be possible by using a similar technology of “Mars Oxygen In-Situ Resource Utilization Experiment (MOXIE),” by NASA Jet Propulsion Laboratory to grab samples of the air or atmosphere of the moon and observe the elements within the sample. This sample will be in a tube or container that is sealed tight, and non-pressure sensitive (pressure does not affect the evidence). If the sample has traces of a rust effect, this evidence is kept and can be detected by using a corrosion device for the surface and inner moon samples or the tools in objective three for the air or weather samples. Another way is to use a similar technology to the “Regolith and Ice Drill,” by Honeybee Robotics using the previous rover exploration to take samples outside and inside of the moon’s surface with a drill. This technology is prevalent in the VIPER rover but this time it is using a slightly different technology by finding samples of hematite or the moon’s surface elements that are affected by the water around it, oxygen, and hydrogen to detect rust.

Lastly, the third objective is to analyze the samples live with the technology inside of the rover and either report back the data to the base or take the rover back to contain the evidence for further investigation. This will be possible by using a corrosion detector device that uses the probes against the samples of the hematite (IMS, Olympus). For the air or weather samples, another device must be made similar to the VIPER that detects the oxidation of the elements water and oxygen that is on the moon. This can be made by using the “Mars Oxygen In-Situ Resource Utilization Experiment (MOXIE),” by NASA Jet Propulsion Laboratory. The data will either be analyzed lived through another technology or sent back to base to investigate the samples at a laboratory by Kennedy Space Center (NASA) using the “Mass Spectrometer Observing Lunar Operations (MSolo).” All these samples can answer the questions about the rust effect on the moon with help of VIPER’s samples of the moon’s water.

Required specifications:

Chassis: The dimensions are, length, width, and height. The size of the main base of the box is 5 x 4 x 1 ft and aluminum. The size of the small box below it for the axle is 4 x 3 x 0.4 ft and aluminum or stainless steel for durability. The total height of the cameras and light attached to the rod and connected is 2 ft and the metal should be able to handle the extreme temperatures of the cold without being affected like either aluminum or stainless steel. The light and width are 1.3 x 1.25 ft for the whole piece together and the camera is brazed stainless steel or aluminum. The axle rod is stainless steel and 5 x 1 x 1 ft, and the wheels are 1 x 1 x 1 ft with a metallic or grooved footing for the surface of the moon. The drill device is the blue polygon at the very bottom after the axle base which is 1 x 1 x 1 ft and is 0.1 ft sticking out. The purple rod at the top is a thin cylinder to represents an antenna that connects to the control panel inside for all the devices and instruments. It has a dimension 0.1 x 0.1 x 1 ft. The two shapes the green triangle, and the half cylinder is light blue repents the other instruments inside the rover, but I placed them on top to show it. Both have a dimension of 1 x 1 x 1 ft. Overall, the total length, width, and height of the entire rover are 5 x 6 x 4 ft. It does not exceed the maximum length, width, and height which is 8 x 6 x 4 ft of the requirements. To see the rover, see the image below. It is built using the program Tinker CAD. The link is attached to the citations at the end and as well as the images below.

Diagram

Description automatically generated

Lee, Victoria A

Diagram

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Mobility Design: The rover will move on the lunar similar to the VIPER. This is because it needs to be flexible for it to turn around and move. The rover should have both back and front wheels to steer and provide acceleration for ease of moment and agility. The rover should also be able to handle the rough surfaces of the moon with the grooved wheels that handle all terrains on the moon such as impact craters, highlands, riles, and ice surfaces. By doing so I have added a grooved terrain wheel that is aluminum to handle all types of terrains on the moon and a sturdy axle. The materials I would mostly use for the parts are any material without a metal that can rust and last long such as aluminum. This is because if the rover has a defect, it will cause data error and samples for analysis due to the instruments detecting the rust on the vehicle instead of the moon’s surface and air. And so, I have added that the materials used are aluminum or stainless steel for durability. Since the temperature of the moon is from “-193°C at night to 111°C in the day” it also needs materials that can handle the temperature and are compatible with the devices that can all be attached to the rover (NASA). The rover is also designed to move easily over the Moon's regolith and ice. Overall, this can be done through the wheel’s flexibility and smooth mobility.

Instrument Package and Robotic Component:

The first instrument used is a similar device of a “Neutron Spectrometer System (NSS)” provided by Ames Research Center (NASA) to detect water surfaces from a distance to help the drill or scrapper to pick up evidence. Specifically, this instrument specializes in locating surface water, hydrogen, or oxygen compounds from a distance. When the device finally detects the location of the rust, it will give the information back to the second device. The second device is a drill so that it will start getting samples. This device also measures the energy reaction of the oxidation of water (H2O), hydrogen, and oxygen atoms when struck by neutrons or electrons and within each other. I describe it as within each other since iron rusts through a catalyst that causes an oxidation reaction. The device will need to be tweaked to detect a catalyst reaction and oxidation. The “Resource Prospector” is the first rover to use this instrument. The second rover to use the device is the VIPER for the water mission (Chen, Rick, Culler, Jessica, and DC Agle). This device should also be similar to the lunar rover I am describing and built to detect the traces of rust on the moon. Overall, this device will help my rover coast over the moon’s surface and find traces of water where the rust should lie nearby and complete objective one.

The second instrument is the “Regolith and Ice Drill (TRIDENT),” provided by Honeybee Robotics which was used in the VIPER rover and modified again for this Rust detecting lunar rover (Chen, Rick). As described, it will “deploy its 3.28-foot (1-meter) drill, dig up the soil of three feet below the lunar surface” (Chen, Rick). TRIDENT is a drill that spins multiple blades to cut through the ground while collecting fragments of hard surface materials. At the bottom of the rill is “the tip with a long carbide cutting teeth pattern” for the drill (Chen Rick). According to NASA, this material is “harder than steel to maintain their sharpness” and “carries a temperature sensor to take readings below the surface and flutes” (Chen, Rick). NASA describes that this device will “spin the flutes” transporting the evidence cut upwards so that it can be kept in storage inside where the other instruments are (Chen, Rick). Then, the rover could either analyze it or take it back to base for a laboratory to examine it. Overall, this device will help gain samples of the possible rusting occurrences in the rocks or surface to help complete objective two.

The third instrument is called the “Mars Oxygen In-Situ Resource Utilization Experiment (MOXIE),” provided by the NASA Jet Propulsion Laboratory to analyze the reaction or oxidation (O, C, and H2O) of multiple elements that cause the rust effect. MOXIE is a device that collects CO2 from the atmosphere that "electrochemically splits the CO2 molecules and analyses it" (Hecht, Michael, Potter, Sean). The rover is modified to search for oxidation reactions between the two elements (CO2) in the atmosphere. MOXIE can analyze the mineral and composition of the samples taken for the oxidation of the rust rather than possible oxygen for humans. It does this by measuring “the mass-to-charge ratio of ions that elucidate the chemical elements" contained in the collected sample to see the causation of the rust (Hecht, Michael, Potter, Sean). Overall, this device will also help gain concrete evidence of the possible rusting occurrences in the atmosphere to help complete objective two.

Lastly, one of the robotic components used is the cameras and light attached to the rover at the front. The camera is attached to a bendable rod allowing it to rotate up and down to see the location from different perspectives. The light is next to the camera at the top to allow clarity to the camera's vision. The camera will also have thermal vision and night vision to help aid the motion ranges of the robot. The rotation of the rod is not necessary for left and right because the camera perspective will be a wider angle or similar to a peripheral vision of a person driving the car (180 degrees). Another component is a small device nearby that sends in eddy currents to help detect the rust occurrence from a collected solid sample available for this method. Corrosion occurs by a deteriorating metallic substance by chemical or oxidation. This device analyzes corrosion in the rock by sending an eddy current with a robotic probe to gather measurements. The quantitative measurements can detect if it is a uniform, pitting, exfoliation, or intergranular corrosion of the sample collected (IMS, Olympus). Overall, these devices contribute to the rover's mobility and analysis to complete objectives one and possibly two.

Center contributions:

The first contribution is the NASA's Jet Propulsion Laboratory in California. This center will help provide aid to modifications of MOXIE for the detection location of water and possible rust areas. Since it has designed and built the “moon mineralogy mapper instrument” that paved the way for the discovery of water on the moon, it was also the first center to publish an article concerning possible rust on the moon (Good, Andrew, NASA JPL, Culler, Jessica, and DC Agle). This concern not only explains how the inspiration and discovery of the begging of water but also the start of solving two mysteries: water and rust on the moon. Thus, this center will help contribute to achieving objectives two and one.

The second contribution is NASA's Johnson Space Center in Houston. This center will help provide aid to the hardware and model design of the rover. Since this rover has similar technology, the hardware will be made similar to VIPER (Magazine, Smithsonian). The similarities will be mostly in the instruments. The design I built so that it will cover the surface of the moon that is near those water areas that the VIPER mission discovered. Thus, this center will help contribute to achieving objective one for designing a rover to help make it possible to add in other instruments.

The third contribution is Ames Research Center (NASA) in Iowa. This center will help provide aid to the NSS and other spectrometer System instruments necessary to help detect rust. The machine and center will investigate the elements, molecules, or atoms to determine if the sample has a hint of rust in it. If there is, keep the sample and send it to the laboratory which is the Ames Kennedy Space Center. This modified instrument will help with the main goal and completing the objectives. Thus, this center will help contribute to achieving objective one.

Lastly, the fourth contribution is Ames Kennedy Space Center (NASA) and commercial partner Honeybee Robotics in Altadena, California which helps use the “Mass Spectrometer Observing Lunar Operations” for analyzing the elementary particles and oxidation causation. This center will contribute to analyzing the molecules or elements of rust in the samples collected. Another contribution is the creation of TRIDENT (drill) with collaboration with Honey Robotics that can help achieve the sample collecting objective. As stated above in an earlier paragraph it explains the purpose of the drill. Thus, the Ames Kennedy Space Center will help contribute to achieving objective three.

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