LRMSE: A Framework on Lunar Rover for Moon Surface Exploration

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Abstract - The purpose of this project is to create a prototype of a lunar rover which should efficiently travel on the lunar surfaces such as mounts, hills, rocky surface and also to collect the composition of regolith, and to compare the evaluation of chances of creating a lunar base for further space exploration. This rover is intended to do all these functions with the respective cameras and sensors attached. This project mainly concentrates on rover movement, image processing and innovative designing. This rover has a robotic arm to collect the sample of surface and a pan/tilt camera which transmits the images back for further image process. The rover can be remotely controlled or autonomously navigated. It also needs to be suitably and innovative designed.

Key Words: Lunar rover, sensors, image processing, edge detection.

1. INTRODUCTION

1.1. Moon Overview

Moon has a radius of 1738km; it has gravitational influences on earth's tidal movement. It is the 5th largest natural satellite in the solar system. Its gravitational force is 1/6th that of earth though its surface is grey, it appears bright because of the reflection of the sun's light. Moon has fascinated the human kind from the long time. The start of the space age from 1957 with the launch of Russian satellite sputnik has led the mankind within decades, an extraordinary advancement of having launched more than 1000 artificial satellites. In 1969, Man stepped his foot on moon for the first time. It's evident that our natural satellite should be explored further.

1.2. Rover Overview

Fig-1: View of Earth from Moon

In 1969, Neil Armstrong and Edwin, Aldrin buzz first stepped on moon.in the next years thus were more manned moon missions, In Apollo 15,16,17 the last of the Apollo series manned lunar rover were used.

In 1970, Russia launched a spacecraft named luna17. Under the LUNAKHOD program which landed the lunar rover LUNAKHOD-I on moon surface. It was the first Remote Controlled rover to land on moon. [2]

LUNAKHOD-II was the second remote controlled lunar rover to land on the moon in 1973.

LUNAKHOD-III was supposed to be initiated in 1977 but was cancelled.

The Chinese also launched a lunar rover by the name YUTU on December 1st 2013, which landed on the moon on 14th of December 2013.

India as already launched chandrayana-I in 2008, its first successful mission to moon which was a moon orbiter in the coming year 2019.ISRO has planned to launch chandrayanaII with their lunar orbiter and a lunar lander which carries rover along with it. Considering the above facts and the details about the lunar surface condition such as temperature, gravity and navigational issues obtained by multiple references and we tried to create the prototype of this same.

2. EFFECT OF LUNAR ENVIRONMENT ON SPACE VEHICLE SURFACE.

The lunar surface is very uneven and filled with Regolith, which consists of dust and sharp stone particles which is approximately 1meter thick and uniformly spread over the whole lunar surface.

The temperature in the lit side of the surface may rise up to 135 degree Celsius considering this Factor the materials used to construct over as to be carefully selected.

As the moon does not have atmosphere there is abundant radiation of UV and X-rays which easily charge the dust particles which tend to accumulate on the rover and especially on the parts of the rover such as sensors, batteries, wires and the wheels which create friction and thereby accumulates static charges which attracts the opposite charged dust particle. The highly temperature affect the battery performance and alter the sensor output due care has to be taken in this regard. Regolith it is made up of

calcium aluminum Silicon iron magnesium Oxygen and silicates and oxides.

3. SYSTEM MODEL

Lunar terrain is non-uniform with stones, boulders, mounds, hills and craters. The whole moon surface is covered with

Fig-2: Lunar surface

approximate 1m stick regolith. Regolith is made up of dust, minute particles, small hard and sharp particles created by the impact of asteroid on the moon surface. Regolith is comparable to sand on earth, but very fine sand and also the gravity of the moon is $1/6^{th}$ of that of the earth.so it provides very difficult to a vehicle on such a surface. There are high chances of wheels getting stuck in the regolith.so the wheels have to be designed accordingly. The wheels have to be light. But we cannot use normal wheels or tyre as we use here on earth. First of all, the temperature on moon surface varies very much that is from 135ºc to -230ºc in dark areas. The materials used should neither expand nor contract in size due to the temperature variations. We cannot use inflated tyre as they may explode due to lock of outside pressure

Fig-3: Design of Lunar Rover

Wheels should be wide and light so that they won't get sink in the regolith. They should be big enough to roll over small obstacles. They should be static charge resistant. [3]

4. OBJECT DETECTION

Image processing technique is an efficient obstacle detection technique. By processing the image, we can avoid obstacles and potential hazards. This can be done by relying on certain structural patterns. However, there may be a problem in unstructured unknown environment, where such patterns may not exist. For example, in some industrial process's computer vision is used to monitor the growth of vegetables. A more complex case related to automobile security is where you develop a system for dead angles. So, this involves specific hardware with software which uses person detection to detect whether an object, rocks or whatsoever is in a range which

Fig-4: Design of Wheel

is considered as too close to the vehicle. [5] Image processing is now routinely used by a wide range of individuals who have access to digital cameras and computers. With a minimum investment, one can readily enhance contrast, detect edges, quantify intensity, and apply a variety of mathematical operations to images. Although these techniques can be extremely powerful, the average user often digitally manipulates images with abandon, seldom understanding the most basic principles behind the simplest image-processing routines. Although this may be acceptable to some individuals, it often leads to an image that is significantly degraded and does not achieve the results that would be possible with some knowledge of the basic operation of an image processing system.

4.1.Edge Detection

The most rudimentary technique for picture recognition is something called edge detection. The essential idea is that pixels associated with a character item will be notably comparable, but pixels related to distinctive items will be extraordinarily distinctive. So, if we calculate the difference pixel-to-pixel then any time we see a large or dramatic distinction pixel to pixel, then we will draw an edge there. As soon as we've drawn all the edges in our photograph, we

have to have a reasonably properly concept of what scenes had been looking at.

4.2. Image Classification

Further developed picture acknowledgment calculations contain ideas of articles. A calculation searching for objects will have some idea of what a object is. It's general shape, size, and how to manage this data. These article mindful calculations can generally be ordered as Image Classification calculations.

The calculation can utilize this data to all the more likely recognize protests by coordinating diagrams and examples to a known arrangement of pictures. This likewise implies when a picture is distinguished, the calculation discovers moderately progressively about the scene around it. A ceased vehicle implies we should stop, a consolidation sign painted on our path implies we have to move over.

The real procedure of picture characterization is considerably more fluctuated and complex than edge location. Anyway, a genuinely basic usage is to utilize Neural Networks. We won't cover Neural Networks here, yet successfully they are layers of channels the PC will apply to information so as to figure out what it is taking a gander at. For instance, the PC may ask is there a huge red territory in the picture? And afterward: Is the red territory molded like an octagon, or some calculated perspective on an octagon? And after that: Does the red octagon state STOP, in which case, the calculation infers that it is presumably taking a gander at a stop sign. Every one of those inquiries would be displayed as a layer, or hub, in the neural system, and these systems can traverse thousands or a large number of hubs. All the more strangely, these and show signs of improvement the more they are utilized, similar to our cerebrums.

It is nothing unexpected then that as PCs and calculations develop, we are endeavoring to make them increasingly more like us, on the grounds that all things considered, we experienced no difficulty recognizing felines or street signs, so it bodes well to demonstrate PC vision after our own. [7]

5. AUTONOMOUS NAVIGATION

The navigation on the lunar surface is quite challenging task. The lunar terrain which is made up of regolith, a thick bed of fine dust, dust particles and small hard and sharp particles? This surface causes fraction difficulties, latitudinal and longitudinal wheel slip causing trajectory error.

The Autonomous Navigation is a combat vehicle upgrade used to convert manned vehicles to autonomous unmanned capability or to upgrade already unmanned vehicles to be autonomous. In autonomous navigation vehicles the vehicle is able to plan its path and execute the plan without any human intervention. [1] The information for planning the path is based on the inputs from the sensors which are mounted onto the vehicles. [4]

6. ADVANTAGES AND DISADVANTAGE OF LUNAR ROVER.

Advantages:

- Lunar rover helps in exploring the lunar rover surface at low cost

- No necessity of human physical pressure there by low risk.

Disadvantage:

1. In case of any physical damage to the rover happens, it cannot be repaired. [6]

6. CONCLUSION

A Sensor will be attached to the prototype of the lunar rover. The requirements are the images to produce terrain model, 10rpm dc motor for adjustable speed. To satisfy those requirements, the prototype of the lunar rover consists of the pan/tilt camera where it rotates 360º in all the direction. The captured image has been processed through image processing using edge detection technique by calculating the difference pixel-to pixel and drawing an edge fairly get an idea about the scene in the captured image.

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