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Design and Implementation of Rover for Mars Communication: Review and Idea

Mr. Anilkumar Patil[1], Rohan Jayadev[2], Ashita Shah[3]

[1]*Mr. Anilkumar Patil, Assistant Professor, Dept of ENTC Engineering, DYPIEMR-PUNE, Maharashtra, India*
[2]*Rohan Jayadev, Student(BE ENTC), DYPIEMR-PUNE, Maharashtra, India*
[3]*Ashita Shah, Student(BE ENTC), DYPIEMR-PUNE, Maharashtra, India*

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Abstract – *It shows how the mars rover communicates back to the earth. It includes a virtual Mars station and a virtual Earth station. The Mars rover captures an image and sends it to the virtual Mars station. Now the image is converted into a suitable signal so that it is transmitted to an orbiting satellite. This satellite sends the signal to the virtual earth station. It is converted to the original image on the virtual earth station. This signal is sent to another orbiting satellite if in case the communication with the first satellite fails.*

***Key Words Used*: Virtual Mars station, Virtual Earth station, Rover, Orbiting satellite**

1. INTRODUCTION

In Mars Mission (1971), orbiters/landers failed because of the contact lost between the Mars and the Earth Station. Thus the main focus is on how the rover on the mars would communicate successfully to the earth station without the failure of the orbiting satellite which would lead to the loss of information. Hence this paper focuses on how the rover would successfully transmit information to the earth from the Mars without information lost. Also it proposes an alternative for the probability of loss of information.

2. BLOCK DIAGRAM OF COMMUNICATION IN MARS ROVER

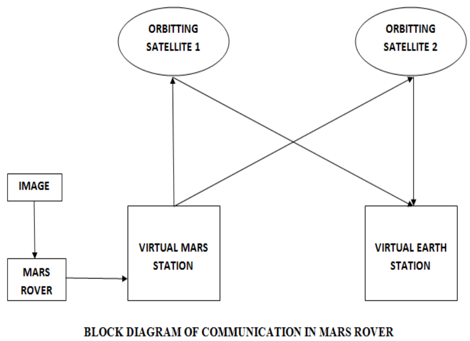

Fig 1-: Block Diagram of communication in Mars Rover

2.1 Problem Statement

- Deciding the distance between the two virtual servers so that they don't communicate directly between them.
- This would be decided by using link margin calculation

2.2 Basic Working

- Capturing an image:
  1. Stepper Motor would rotate the raspberry pi camera for 10 degrees/second thus rotating 36 times.
  2. The images would arranged in a sequence to generate a panaromic image.
- This image would be transmitted using compression techniques like DCT, DWT, etc. to the transceiver IC CC1120 at the virtual mars station.
- It would then be converted to a suitable signal using BPSK Modulation technique
- Through the dipole antenna it would be given to the two orbiting satellites through free bands available of 144-148 VHF and 435-438 VHF.
- If any one of the orbiting satellite fails then the signal would be transmitted through the other satellite thus avoiding the loss of information.
- It would then be received through a dipole antenna at the virtual earth station and would be converted to the original format using BPSK Demodulation technique.

Transmission of signal to both the satellites so that even if one satellite would fail the other would transmit the signal effectively.

3. PARTS AND DESIGN OF THE ROVER

3.1 Parts of the Rover

Table -1: Parts of the rover

PARTS	QUANTITY	DESCRIPTION
STEERING WHEELS	6	For mobility purpose
SOLAR POWER CELLS	1	For power source (12 volts, 7 amperes battery)

DC MOTORS STEPPER MOTORS	2 2	To achieve 2.1 degrees/sec of rotation. One motor to drive the wheels and one to turn the wheels. One stepper motor to rotate the rover, another to rotate the camera module. DC motor driver IC L293D would be used.
RASPBERRY PI MODULE	1	One motor gives 10 degrees rotation hence rotating for 36 times and arranging in sequence which would be done using digital image processing.
PI CAMERA	1	30 frames/second.
DIPOLE ANTENNA	2	One at the virtual mars station and the other at the virtual earth station.
TRANSCEIVER IC CC1120	2	For full duplex communication at the transmitting and the reception side.

Hence this would involve deciding the charging and discharging time taken by the solar power cells to achieve the required ratings. Also deciding the format of the image would be transmitted and compression techniques which would be used to transmit the image. Taking care of the time constraints involved in sequencing of the image captured to form a panaromic view. For steering purpose, Ackerman steering principle would be used.

3.2 Mobility System

- Six 25 cm diameter wheels.
- Rover body has 30 cm ground clearance
- Solar panels
- Wheel baseline- 1 m side by side, 1.25 m front to back.
- Straight line driving speed is 3.75 cm/sec
- Rover can turn in place at roughly 2.1 degrees/sec.
- Rover is statistically stable at a tilt of 45 degrees.
- Driving on more than 30 degrees slope is not recommended
- Rocks taller than a wheel are considered as mobility hazards.

Position of the rover is estimated by how much the wheels have turned. Orientation is measured by inertial measurement unit that has 3 axis accelerometer and 3 axis angular rate sensors.

3.3 Design of the Rover

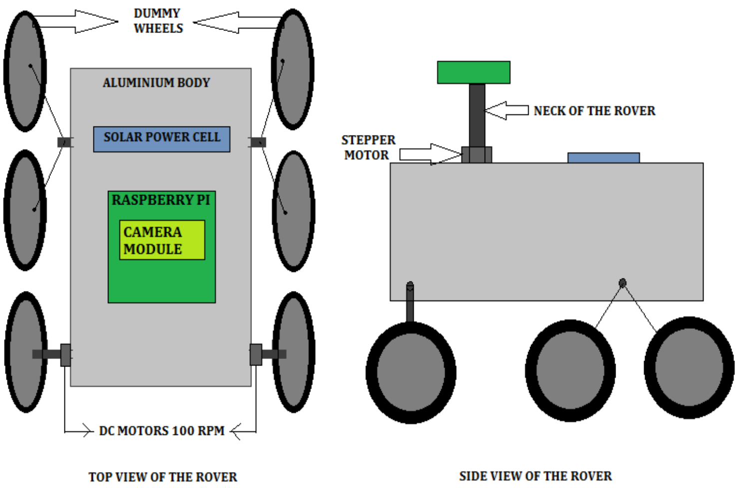

Fig 2:- Top View and Side View of the Rover

4. COMPONENTS USED

4.1 Raspberry Pi Module

- Operating system is of Raspbian.
- BCM2837 (BROADCOM) is the system on chip used.
- CPU is 1.2 GHz (64 or 32) bit quad core ARM Cortex.
- It has an operating frequency 900 MHz.
- Has micro SD slot for storage purpose.
- 4 watts power.

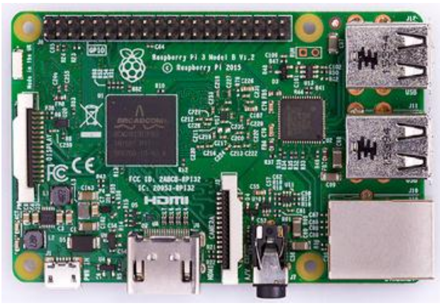

Fig -3: Raspberry Pi 3 B

4.2 Raspberry Pi Camera

Camera module is a 5 megapixel custom designed add-on for Raspberry pi, featuring a fixed focus lens. It is capable of 2592x1944 pixel static images, and also supports 1080pixel 30 frames per second, 720pixel 60 frames per second. Camera is supported in Raspberry pi.

Fig -4: Raspberry Pi 5 MP Camera Board Module

4.3 Transceiver IC CC1120

- CC1120 is a high performance single chip Transceiver
- Configurable Data Rates 0 to 200 kbps (64 dB bandwidth at 12.5 kHz Offset)
- Good Receiver Sensitivity

Fig -5: Transceiver IC CC1120

4.4 PIC18F4550

PIC18F4550 is an 8-bit microcontroller and is based on 16 bit instruction set architecture. PIC18F4550 consists of 32 KB flash memory, 2 KB Static RAM and 256 Bytes EEPROM. This is a 40 pin microcontroller having 5 input output ports.

Fig -6: PIC18F4550

4.5 DC Motor

- To achieve precision rotation, DC motors would be used. 2.1 degrees/second rotation would be achieved.
- One motor would be used to drive the wheels.
- One motor would be used to turn the wheels.
- One would be mounted on raspberry pi through a rod to achieve 10 degrees of rotation.
- Hence it would rotate 36 times hence giving a rotation of 360 degrees.
- Driver IC L293D would be used to drive the motor.

Fig -7: DC Motor- 100 rpm

4.6 Solar Power Cells

- This would be used as a power source.
  The time needed for it to charge and discharge would be calculated to achieve 12 volts, 7 amperes current.

Fig -8: Solar Power Cell

4.7 Stepper Motor

- One motor is used to rotate the rover
- The other is used to rotate the camera.
- A stepper motor is used so as to achieve precise rotation.

Fig 9 -: Stepper Motor

4.8 Dipole Antenna

- It would be used at the transmitting and the receiving stations. Transmission of the signal and for reception of the signal so that the it would be converted to the original format again.

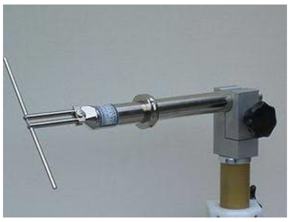

Fig -10: Dipole Antenna

5. SOFTWARE USED

5.1 Python Language

- Python is a widely used high-level, general-purpose, interpreted, dynamic programming language. Its design philosophy emphasizes code readability, and its syntax allows programmers to express concepts in fewer lines of code than would be possible in languages such as C++ or Java.

6. APPLICATIONS

- Communication between the rover and the earth station is achieved.
- The information from mars is obtained and analyzed on the earth station.

REFERENCES

[1] Jong Hoon Ahnn. The robot control using the wireless communication and the serial communication. Presented to the Engineering Division of the Graduate School of Cornell University. http://www.cs.cornell.edu/~ja275/nasa/nasa%20final%20report.pdf

[2] Rajeev K Piyare and Ravinesh Singh. Wireless Control of an Automated Guided Vehicle. http://www.iaeng.org/publication/IMECS2011/IMECS2011_pp828-833.pdf

[3] K.K. Belostotskaya and V.I. Gusevsky. The Antenna System of Mars Rover. Published in Microwaves, Radar and Wireless Communications 2000. MIKON- 2000. 13th International Conference on 22-24 May 2000. http://ieeexplore.ieee.org/document/913919/

[4] Jeffrey J. Biesiadecki and Mark W. Maimone. The Mars Exploration Rover Surface Mobility Flight Software: Driving Ambition. Published in 2006 IEEE Aerospace Conference Proceedings, March 2006, Big Sky, Montana, USA. https://www.robotics.jpl.nasa.gov/publications/Mark_Maimone/biesiadecki_maimone06.pdf

[5] Robert D Braun and Robert M Manning. Mars Exploration Entry, Descent and Landing Challenges. Published in Aerospace Conference, 2006 IEEE. http://www.ssdl.gatech.edu/papers/conferencePapers/IEEE-2006-0076.pdf

[6] Songze Li, David T.H. Kao, A. Salman Avestimehr. Rover-to-Orbiter Communication in Mars: Taking Advantage of the Varying Topology. Published in Information Theory (ISIT), 2015 IEEE International Symposium on 14-19 June 2015. http:// ieeexplore.ieee.org/document/7347383/