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RF Controlled Robot to Travel on Uneven Surface for Space Applications

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ABSTRACT

Communication systems play a major role in maintaining communication between humans or organizations or institutions or radio broadcasting programs via wired or wireless communication systems. To overcome disadvantages of wired communications, advancement in technology has resulted in the development of most advanced wireless communication systems including wireless radio frequency technology, infrared technology, GSM technology, and so on.

NASA recently started an ambitious exploration program for Mars. Pathfinder is the first rover explorer in this program. Future rovers will need to travel several kilometers over periods of months and manipulate rock and soil samples. They will also need to be somewhat autonomous. Rocker-bogie based rovers are likely candidates for these missions.The physics of these rovers is quite complex. To design and control these, analytical models of how the rover interacts with its environment are essential. Models are also needed for rover action planning. Simple mobility analysis of rocker-bogie vehicles has been developed and used for design evaluation. In the available published works, the rocker-bogie configuration is modeled as a planar system. MATLAB is used for programming.

Mankind has long sought improved methods of land transport. In recent years, practical mobile robots have been successfully used in environments such as factories, offices, and hospitals as well as outdoors on prepared surfaces and terrain with minor irregularities. However, reliable mobility on extremely uneven terrain remains an elusive goal for man-made devices.

Keyword: *RF module, All-Terrain Vehicle, RF controlled the robot, Rocker-bogie, Wheeled Mobile Robot.*

1. LITERATURE SURVEY

'Design and Implementation of an RF Controlled Robotic Environmental Survey Assistant System' by Md. Shamsul Alam, Insan Arafat Jamil, Khizir Mahmud and Najmul Islam published in 2014, focused on the use of RF robots for the environmental survey which involved data collection and logging and sensors to sense the hazardous compounds in the vicinity[1].
'Low-Cost Radio frequency Controlled Robot for Environmental Cleaning' by M.Muthiah, Rk. Sathiendran, K.Nirmal published in the year 2015, used RF controlled robot for the cleaning in hazardous areas like Chemical Labs, Radiation Factories, etc. and even in home applications[2].

'Robust Stabilization of Wheeled Mobile Robots Moving on Uncertain Uneven Surface' by Xiaocai Zhu, Guohua Dong and Dewen Hu and Zixing Cai published in 2006, focuses on the stability of wheeled mobile robots (WMRs) which is more than legged robots. The control design is carried out for the dynamic model of unicycle, the most common and simplest among WMRs. The need of such WMRs has been the necessity of the age; they can be used in field operations such as for rescue and search applications. By this, we can be sure that less human harm is done in rescue operations [3].

'Analysis and simulation of rocker-bogie exploration rover' by Hervé Hacot1, Steven Dubowsky1, Philippe Bidaud2, focus on the stability of wheeled robot. Rovers will continue to play an important role in planetary exploration. Methods for solving the inverse kinematics of the system and quasi-static force analysis are described [4].

2. LITERATURE SUMMARY

From the literature survey, we conclude that problems related to uneven surfaces are many and it is important to reduce the problems related to human and how the quality of work is achieved with the better efficiency. The range of RF module is sufficient for low key applications; these applications can depend on the various fields they are to be used. The use of RF control can be helpful in the long range of activity and can be used efficiently.
The disadvantages for the above papers are that stability turns out to be the main problem due to obstacles in the traveling path.
Limitations of Existing Technology:

The technologies used in the systems are based on individual application purposes. All the systems have only 4 wheel drive systems and single applications such as cleaning, surveying or exploratory missions. Developing a 6 wheel drive for rocker bogie and transforming it into a multi-specialty robot is the need of the time

3. BLOCK DIAGRAM

The prototype of the rocker-bogie mechanism using RF communication system has been developed for supporting multiple applications which can be used in various terrains.

As shown in following block diagram we propose a system to provide direction to the robot through MATLAB, and the commands are transmitted to the robot using RF Trans-receiver.

The Block Diagram of the developed prototype is as follows:

Transmitter

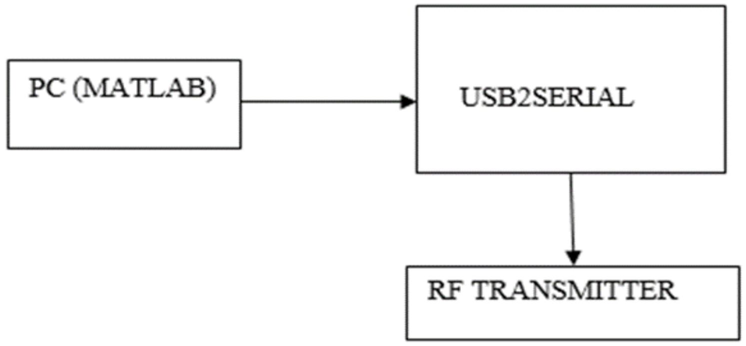


Fig -1: Block Diagram-Transmitter

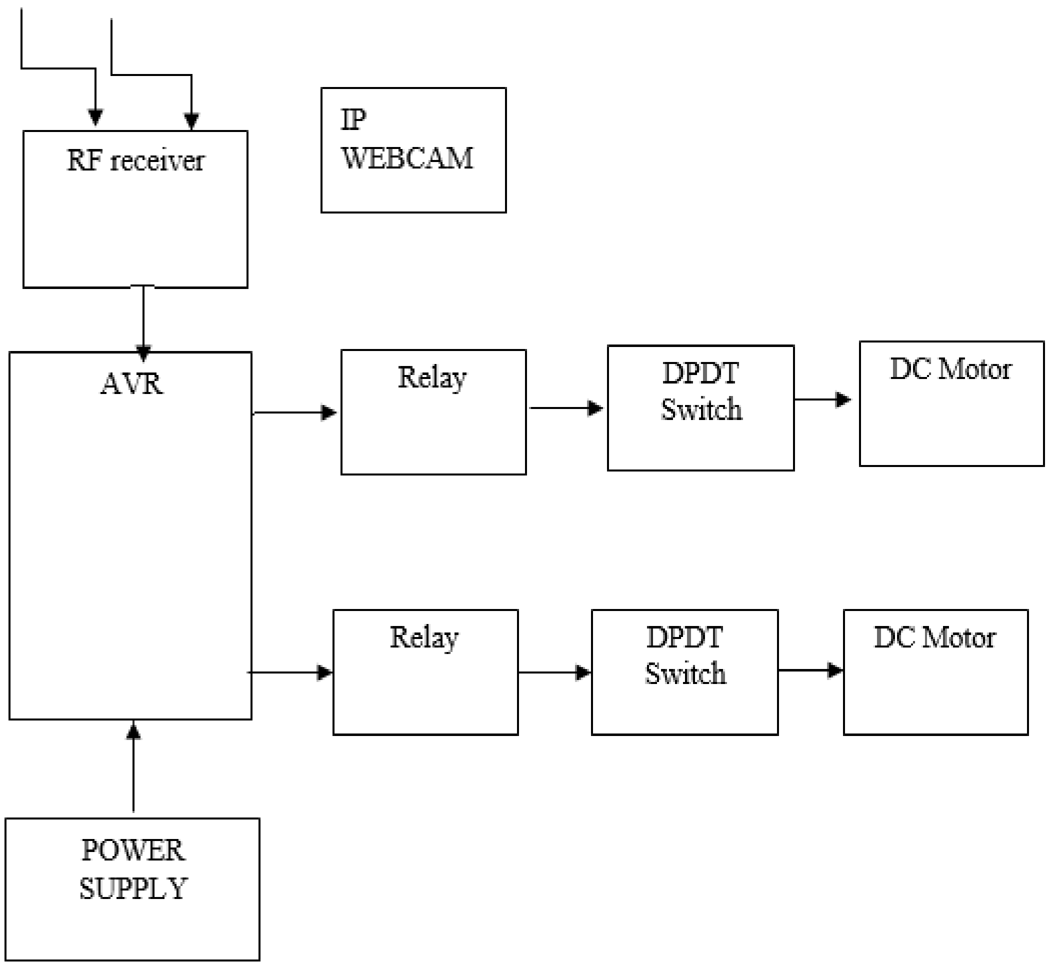


Fig -2: Block Diagram-Receiver

Description

Communication between PC and microcontroller is be carried out by RF module. Based on the controlling of vehicle commands will be sent from pc to microcontroller using RF Module. The microcontroller will then move the vehicle forward, backward, left, stop or right. USB2Serial is used to send command PC through RF transmitter module this command receive RF receiver. The RF module used in this prototype is a well-established circuit. It is based on 3 wire digital serial interface and an entire Phase-Locked Loop (PLL) for precise local oscillator generation .so the frequency could be set. It can be used in UART / NRZ / Manchester encoding/decoding. It is a high performance and low-cost module. The relays are used to drive the motors and give the vehicle motion according to the tabs used in Matlab. 6 wheels and motors have been used which are operated by the relay switching functions. The Microcontroller is used to control the switching of relays and the display data on the 16*2 LCD. The LCD displays the operation being carried out. An IP web-based camera is used as a base function to operate on an uneven surface. A mobile phone is mounted on the top of the vehicle and the video is transmitted and streamed on the laptop. The Wi-Fi hotspot is used to transmit the data. The mobile camera mounted over the top of the robot ensures proper vision while the activities of the robot are in progress.

Specifications of the System

Table -1: Specification of the system

1.	Dimensions	50*25*45
2.	Speed of vehicle	5 km/hrs.
3.	Voltage	12v
4.	Task	Vision

4. HARDWARE DESIGN

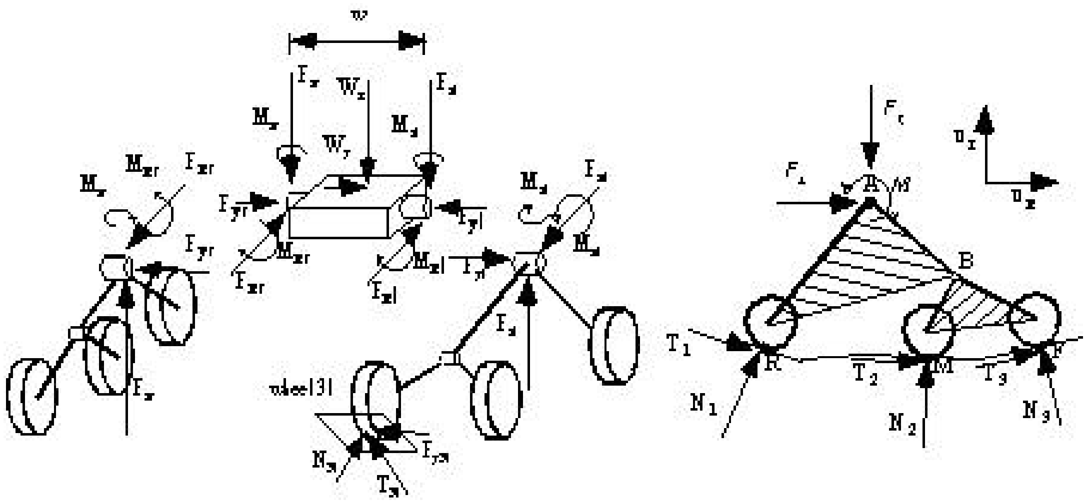


Fig-3: Mechanism of Rocker-Bogie

The Rocker–bogie mechanism provides better stability during the travel path of the robot. All the minor obstacles are overcome by this mechanism.

The normal and the tangential forces between the i^{th} wheel and ground are N_i and T_i respectively, see Fig.

Assuming that the vehicle roll angle is small, the transverse forces acting at the wheel contact point (F_{y1} to F_{y6}) will be relatively small. Further, by assuming that each of these forces has the same magnitude, M_{xl}, M_{xr}, M_{zl}, and M_{zr} can be computed (the width of each of the rocker-bogie assembly is small as compared to the width and height of the vehicle, hence M_{xl}, M_{xr}, M_{zl}, and M_{zr} are the only function of F_{yi}). The resulting equations of static equilibrium for the body are:

$$F_{xr} + F_{xl} = 0$$
$$(F_{xr} - F_{xl})\, w/2 + M_{zr} + M_{zl} = 0$$
$$F_{zr} + F_{zl} - W_z = 0$$
$$(F_{zl} - F_{zr})\, w/2 + M_{xr} + M_{xl} = 0$$

The system of equations permits the values F_x, F_z, M_y that is applied from the body to each rocker to be calculated. These forces and moments are then considered inputs to the planar problem shown in Fig. 3. The equations of equilibrium in the planar case are:

$$\sum \mathbf{F} \cdot \mathbf{u_x} = \sum_{i=3}^{i=1} (\mathbf{T_i} + \mathbf{N_i}) \cdot \mathbf{u_x} + F_x = 0)$$

$$\sum \mathbf{F} \cdot \mathbf{u}_z = \sum_{i=3}^{i=1} (\mathbf{T_i} + \mathbf{N_i}) \cdot \mathbf{u}_z - F_z = 0$$

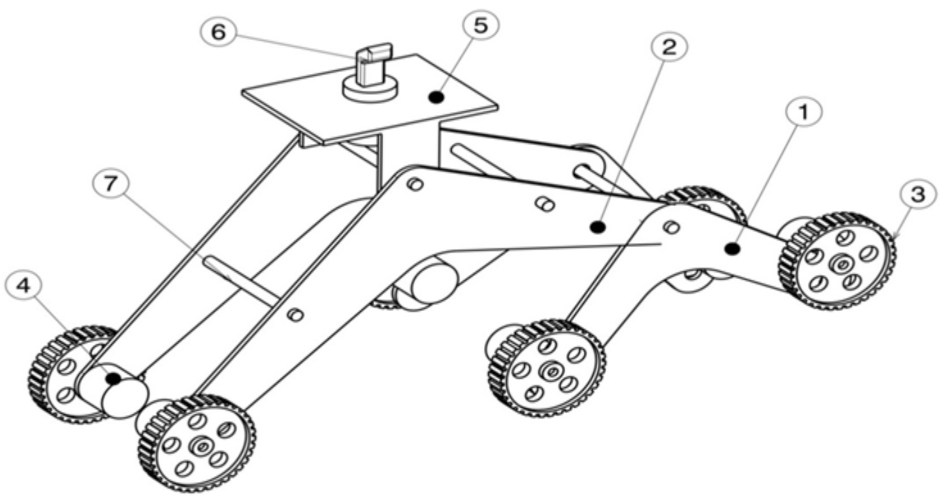
$$\sum \mathbf{M_y}, body = \mathbf{T}_1 \times \mathbf{RA} + \mathbf{N}_1 \times \mathbf{RA} + \mathbf{T}_2 \times \mathbf{MA} + \mathbf{N}_2 \times \mathbf{MA} + \mathbf{T}_3 \text{ x } \mathbf{FA} + \mathbf{N}_3 \times \mathbf{FA} + \mathbf{M}_y = \mathbf{0}$$

$$\sum \mathbf{M}_y, bogie = \mathbf{T}_2 \times \mathbf{MB} + \mathbf{N}_2 \times \mathbf{MB} + \mathbf{T}_3 \times \mathbf{FB} + \mathbf{N}_3 \times \mathbf{FB} = \mathbf{0}$$

These equations are solved with the following constraints on the wheel torques:

1) $\mathbf{T_i} \leq \mu \, \mathbf{N_i}$: no slip i^{th} wheel (or will just slip).
2) $N_i \geq 0$ insures i^{th} wheel ground contact.
3) $\tau_i \leq \tau$ max to insure the i_{th} wheel motor does not saturate.
, where t_i is the i^{th} wheel motor torque.
Note that t_i is related to the wheel tangential force T_i by the wheel radius. [4]
Hence the use of the rocker-bogie mechanism is more favorable.
The wheels of the rocker-bogie mechanism can overcome the minor obstacles by balancing on either of the wheels, even if one of the wheels does touch the ground due to an obstacle. The frame of the prototype is made up of acrylic sheet, which makes the system even lighter. The placement of wheels is in such a way that all the wheels will be in a synchronous movement. Due the lightweight of the robot, it can be operated hazel-free.

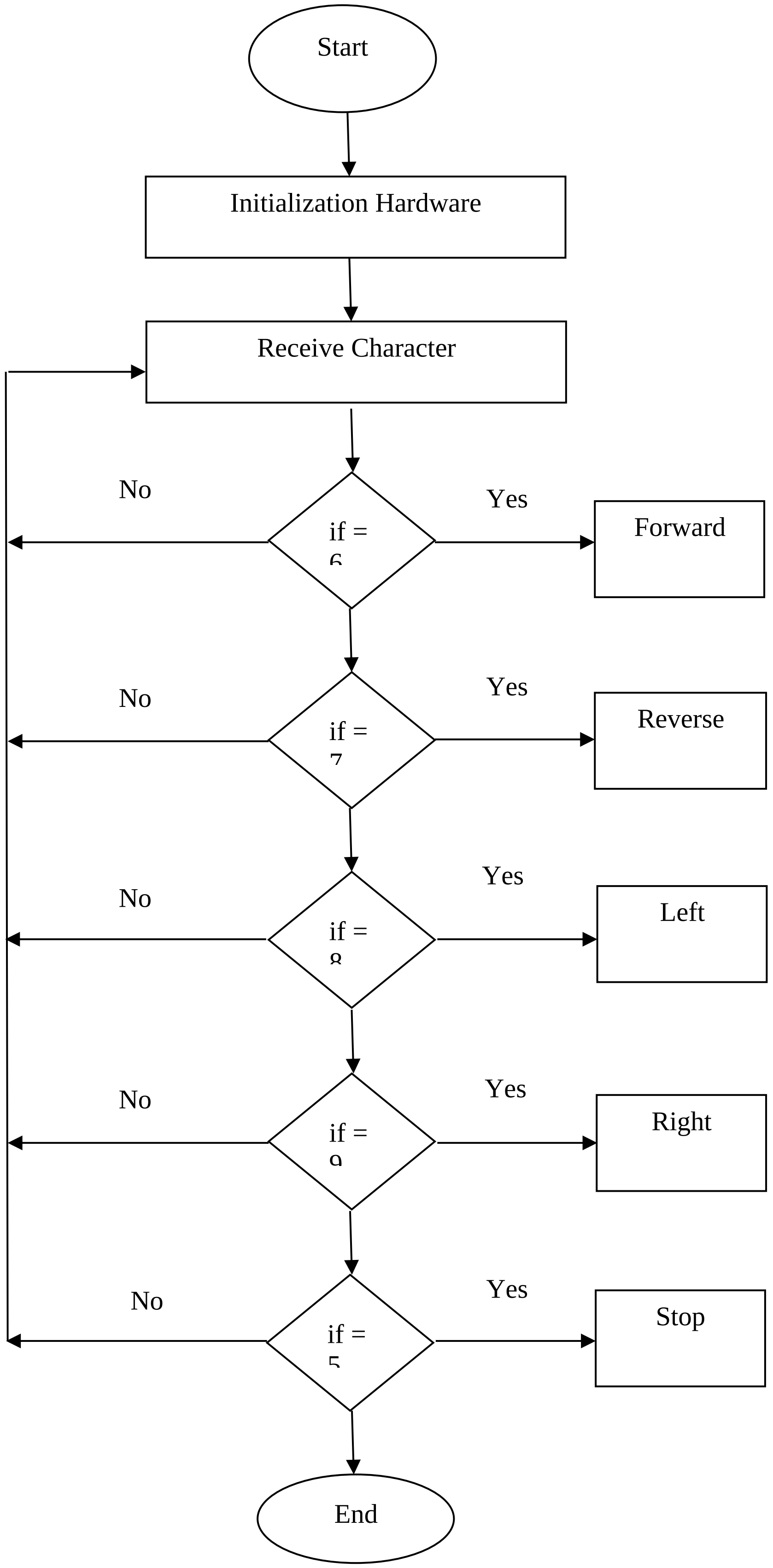
ALL DIMENSIONS ARE IN MM



Sr.No	Component Name	Quantity
1	Arm 1	2
2	Arm 2	2
3	wheel / Leg	6
4	Motor	6
5	Top Frame	1
6	Camera	1
7	Support Fixture	4

Fig-4: Structure of Rocker-Bogie

Flow Chart of MATLAB:



5. EXPERIMENTAL RESULT AND ITS ANALYSIS

Various tests based on the motion of the vehicle have been carried out. The vehicle successfully overcomes the obstacles in its path. For around 100 times the vehicle has been tested on various terrains of ground and the vehicle has passed for over 85% of times. The performance of the robot was satisfactory considering the motion of the robot. The RF module can transmit data to a range of 15 m. Wi-Fi hotspot has been used to connect the mobile camera, laptop and video stream the data. The smart phone used transmits the video over a distance of 12 meters. The transmission of video is clear and in sync until the distance of about 10 meters and it starts to lag from later onwards. The RF robot is controlled with the help of MATLAB GUI used for controlling the directions of the robot. The interface consists of the steering of the robot according to the path (left, right, straight, reverse). The relays are used to run the motors in the respective direction. On pressing the respective buttons (5, 6, 7, 8, 9) the robot will stop or move in forward, reverse, left and right. The RF (Radio Frequency) transmitter-receiver pair of sensors is used for the communication wirelessly with the MATLAB interface.

6. ACKNOWLEDGEMENT

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7. REFERENCES

[1] Insan Arafat Jamil, Shamsul Alam, Najmul Islam and Khizir Mahmud, "Design and Implementation of an RF Controlled Robotic Environmental Survey Assistant System".
[2] K.Nirmal, Rk.Sathiendran, M.Muthiah, "Low-Cost Radio frequency Controlled Robot for Environmental Cleaning", 2015 International Conference on Circuit, Power and Computing Technologies[ICCPCT*]*, 2015, 978-1-4799-7075-9/15.
[3] Xiaocai Zhu, Guohua Dong and Dewen Hu and Zixing Cai, "Robust Stabilization of Wheeled Mobile Robots Moving on Uncertain Uneven Surface", 2006.
[4] Hervé Hacot, Steven Dubowsky, Philippe Bidaud, "Analysis and Simulation of a Rocker-Bogie Exploration Rover".