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Design and Development of Mountain Climbing Robotic Vehicle

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Abstract: *India has no plans to lag in the race of equipping nations armed forces with up-to-date artificial intelligence and robots. The Centre for Artificial Intelligence and Robotics is a laboratory of Defense Research and Development Organization, leading research in artificial intelligence for India. The organization has already developed myriad of robots with varying applications. The Centre for Artificial Intelligence and Robotics has been working on a project to develop a Multi Agent Robotics Framework for more than eight months now. The Multi Agent Robotics Framework will equip India's armed forces with an array of robots that can function as a team, in a fashion similar to what our soldiers do. The Artificial Intelligence-powered multi-layered architecture is capable of providing multitude of military applications, and will enable collaboration amongst a team of various robots. Indian Army has already built — Wheeled Robot with Passive Suspension, Snake Robot, Legged Robot, Wall-Climbing Robot, and Robot Sentry, among others. The Centre for Artificial Intelligence and Robotics has also begun working on a project entailing the development of dependable intelligent mobile robots. This will assist in equipping Indian armed forces with self-reliant, adaptable, and fault-tolerant systems; besides improving robot's' ability to execute tasks autonomously. These robots have been designed to undertake operations in various conditions, both environmental and terrain. Unmanned systems targeted for military operations could only be enabled by intelligence and mobility. Moreover, India has several types of terrain – mountainous, desert, rural, urban, outdoor, and indoor; each presenting its own locomotion challenge to any robotic platform. This impediment could only be tackled by undertaking extensive research in locomotion technologies.*

Keywords: *RF 2.4GHz Multi-Channel Remote, Rhino Robot Controller, Motor Driver, Gear Motor, PVC Pipes, PVC Joints, Battery, Robotic Wheels*

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I. Introduction

Robotics is usually the branch of technology that deals with the design, construction, operation and application of robots. These technologies are used to develop machines that can substitute for humans and replicate human actions.

We have developed an adaptable all-terrain vehicle that can climb over obstacles. This is a robot for extreme terrain. The mechanism used in the vehicle allows the vehicle to move its hinged legs separately, allowing the vehicle to remain balanced and move on uneven surfaces. This is a lightweight, sturdy prototype model of mountain climbing vehicle with the primary objective of its mobility in uneven mountain areas as well as other surfaces like desert, rural, outdoor and indoor with stability along with being capable of operating upside down as well.

In section-2 we have described how our project can be useful. The motor driver used in our project utilizes H-bridge orientation, which is described in section-3. In section-4, we have described the Rhino Robot Controller, which houses all the necessary circuitry for the operation of the vehicle, along with its sub-components. These sections are followed by Result, Conclusion, Future Work, Acknowledgement and References with their respective sections.

II. Implementation of Mountain Climbing Robotic Vehicle

In today's time, where mankind is exploring space, there are places on our own earth where we cannot venture for various factors. Un-manned robots are the solution here. These tiny versatile vehicles can be operated remotely and safely from a distance and are sophisticated enough for performing the given task at hand.

A very similar need arises in the defense sector as well, where it isn't safe for an individual to do a lot of tasks, such as performing a recon of an area, infiltration, defusing bombs etc. whereas those tasks can be

performed using unmanned robots or robotic vehicles. Our 'Mountain Climbing Robotic Vehicle' is based upon the latter idea of providing a means of such to the defense sector. The vehicle is built such that it can easily trek on various surfaces and terrains.

III. Motor Driver

This driver utilizes the bridge orientation known as H-bridge orientation. An H bridge is an electronic circuit that enables a voltage to be applied across a load in opposite direction. These circuits are often used in robotics and other applications to allow DC motors to run forwards or backwards. Most DC-to-AC converters (power inverters), most AC/AC converters, the DC-to-DC push–pull converter, most motor controllers, and many other kinds of power electronics use H bridges. In particular, a bipolar stepper motor is almost invariably driven by a motor controller containing two H bridges, just like in our case.

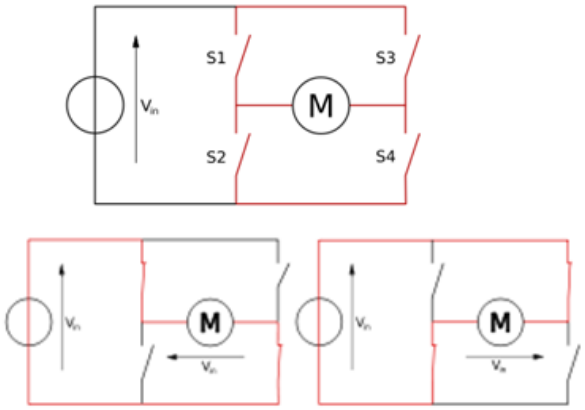

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Figure 1: Four Switches of H Bridge

An H bridge is built with four switches (solid-state or mechanical). When the switches S1 and S4 are closed and S2 and S3 are open a positive voltage will be applied across the motor. By opening S1 and S4 switches and closing S2 and S3 switches, this voltage is reversed, allowing reverse operation of the motor. Shown in adjacent figure is how the motor driver operates based on the various states of the four switches.

Table 1: Table summarizes the operation with S1-S4 corresponding to the diagram above

S1	S2	S3	S4	Result
1	0	0	1	Motor moves right
0	1	1	0	Motor moves left
0	0	0	0	Motor coasts
1	0	0	0	Motor coasts
0	1	0	0	Motor coasts
0	0	1	0	Motor coasts
0	0	0	1	Motor coasts
0	1	0	1	Motor brakes
1	0	1	0	Motor brakes
1	1	0	0	Short circuit
0	0	1	1	Short circuit
0	1	1	1	Short circuit
1	0	1	1	Short circuit
1	1	0	1	Short circuit
1	1	1	0	Short circuit
1	1	1	1	Short circuit

IV. Rhino Robot Controller

The Arduino UNO R3 based 20A Rhino Robot Control Board is a versatile motor controller for driving dual DC motor rated up to 20A each. Key features include multi-functionality incorporation of ATmega328P-AU microcontroller (Arduino Uno R3 based) and 20A motor driver into a single control board designed for robotics applications. It can drive 2 robot driving motors (connected three motors in parallel for six wheeled robot) in skid steer control with analog speed control. Also it can control up to eight servo motors connected at servo port and motor connector-3.

Most important feature about the board that it includes is that it can be programmed by Arduino IDE with the use of USB slot provided on the board. It can be controlled by UART communication, Play Station-2 or IR remote control.

4.1 Sub components

The Arduino UNO R3 based Rhino Robot Controller Board has a number of components incorporated in its circuit, which are discussed below.

4.1.1 8-Bit Microcontroller

The ATmega328P is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega328P achieves throughputs approaching 1 MIPS per MHz allowing the system designed to optimize power consumption versus processing speed.

4.1.2 Bridge Controller

The PL-2303HX bridge controller operates as a bridge between one USB port and one standard RS232 Serial port. The two large on-chip buffers accommodate data flow from two different buses. The USB bulk-type data is adopted for maximum data transfer. Automatic handshake is supported at the Serial port. With these, a much higher baud rate can be achieved compared to the legacy UART controller.

4.1.3 Step Down Switching Regulator

The LM2596 series of regulators are monolithic integrated circuits that provide all the active functions for a step-down (buck) switching regulator, capable of driving a 3-A load with excellent line and load regulation. These devices are available in fixed output voltages of 3.3 V, 5 V, 12 V, and an adjustable output version.

4.1.4 Dual 4-Line to 1-Line Data Selectors/Multiplexers

Each of these data selectors/multiplexers contains inverters and drivers to supply full binary decoding data selection to the AND-OR gates. Separate strobe (G) inputs are provided for each of the two 4-line sections.

4.1.5 P-Channel MOSFET

This P-Channel MOSFET has been produced using Fairchild Semiconductor's proprietary Power Trench technology to deliver low Rds on and optimized Bvdss capability to offer superior performance benefit in the applications. Here, this MOSFET is being used as an Inverter, to invert the polarity of the flow of current.

4.1.6 Power MOSFET

This HEXFET Power MOSFET acts as a high frequency isolated DC-DC converter with synchronous rectification for Telecom and Industrial use. This chip can provide 20A continuous current when incorporated with a proper heat sink. Here, we are using this component to drive the motors.

V. Working Principle

Following is the block diagram of the project, the various blocks of which are described accordingly.

5.1 RF Transmitter

The RF Transmitter is basically a wireless Play Station-2 gaming controller. The user provides the necessary physical commands on the controller using the motion wheel or the four-direction buttons which are then converted to radio waves and transmitted. A unique signal is sent for each of the physical command available. The frequency of the signal transmitted is 2.4GHz.

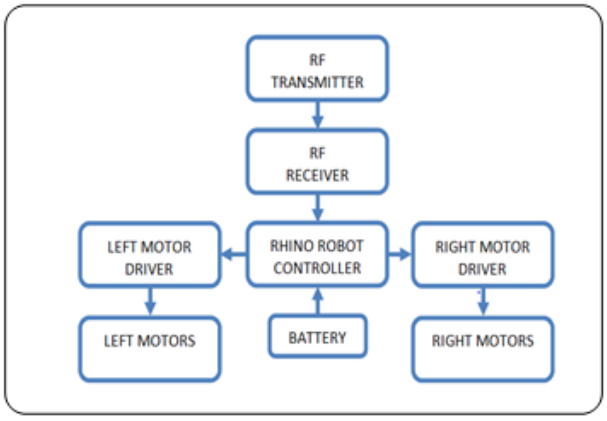

Figure 2: Block Diagram Representation of the Model

5.2 RF Receiver

The RF Receiver receives the radio frequencies radiated from the controller. This receiver, after receiving the signals, converts them to analog signals which are then fed to the Rhino Robot Controller. A unique signal is fed for each of the unique signal received, which is further translated by the controller circuit.

5.3 Battery

This 12-volt DC battery provides uninterrupted regulated DC power to the Rhino Robot Controller, necessary for all the functions on the controller circuit along with driving the motors.

5.4 Rhino Robot Controller

The Arduino UNO R3 based 20A Rhino Robot Control Board is a versatile motor controller for driving dual DC motor rated upto 20A each. This controller circuit converts the analog input from the RF receiver to a digital signal which is then used to drive the motors accordingly. Along with a number of other components within (described before), the controller circuit contains motor drivers and inverters. The drivers drive the motors with the appropriate voltage and the inverters invert the flow of current when the necessity arises.

5.5 Motors

There are a total of six motors used in this model, three on the right and three on the left. These 12 voltDC gear motors are driven using the 12V battery and are adjusted using the motor drivers and the inverters. The motors rotate either clockwise or anti-clockwise depending upon the direction of flow of current, which is manipulated using the motor drivers and the inverters.

The motors are driven either rotate forwards or backwards depending upon the mechanical input provided from the controller-

a. Move Forward- All six motors rotate forwards.
b. Move Backward- All six motors rotate backwards.
c. Rotate Right- Three motors on the right rotate backwards and three motors on the left rotate forwards.
d. Rotate Left- Three motors on the right rotate forwards and three motors on the left rotate backwards.

VI. Result

Finally, we have assembled all the parts, to fully complete the structure of our Robotic Vehicle. The model "Mountain Climbing Robotic Vehicle" after completion can now be operated in various terrains comfortably and remotely from an approximate distance of around 25-30 meters. It will have a standalone battery life of about 1 hour on a continuous usage.

VII. Conclusion

Thus, after creating the basic design of the prototype model on AutoDesk Fusion 360, the desired components are purchased and connected to each other. Finally, we have the complete structure of the vehicle which can be controlled by the PlayStation 2 controller.

VIII. Future Work

Having a visual feedback could exponentially increase the usability of the vehicle. We can also work on the aspect of increasing the range of operation in the future. More complex functions can be programmed and

mapped on the vehicle with added parts, such as feedback camera, better shock absorbers, better wheels, better transmitters and receivers, that will increase the usability of the device.

Acknowledgement

This "Mountain Climbing Robotic Vehicle" is not only the product of our sincere efforts but is also possible because of the guidance and moral support provided by our faculties from the Department of Electronics & Communication Engineering, ADTU.

References

[1]. R. Zhang, 2014, Design and Implementation of an Autonomous Climbing Vehicle, A dissertation submitted to the Department of Computer Science and the Committee on Graduate Studies of Stanford University in partial fulfillment of the requirements for the Degree of Doctor of Philosophy, Stanford University, Stanford
[2]. R.K. Das, A. Upadhyay and R.K. Garg, , 2017, An Unmanned Tracked Vehicle for Snow Research Applications, Defence Science Journal, Vol. 67, No. 1, January 2017, pp.74-79, DOI: 10.14429/dsj.67.8952, DESIDOC
[3]. https://rac.gov.in/druse/index/themesdescription
[4]. https://www.networkworld.com/article/2234308/nasa-fashions-mountain-climbing-robot.html
[5]. https://www.intorobotics.com/18-extreme-all-terrain-robots/
[6]. https://analyticsindiamag.com/ai-robotics-revolutionizing-defence-sector-indian-army-takes-credence/
[7]. http://defencelover.in/exposition-robotics-unmanned-systems-announced-drdo-younengineersg-/
[8]. https://youtu.be/3Zx7tGtwF5g

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