LAND MINE DETECTION USING ROCKER BOGIE SYSTEM

Mahesh Kusuma¹, K Arun Kumar², G Vijay Goud³ and A Harika Reddy⁴
¹Sreyas Institute of Technology and Science, Hyderabad, TS, India,
²CVR College of Engineering, Hyderabad, TS, India,
E-mail: maheshkusuma@sreyas.ac.in

Abstract. The rover is a space device designed to move across the surface of celestial bodies. The rocker bogie is a robot that can travel in any kind of surfaces and is very popular suspension system. Its mechanism is to maintain stability. The main use of rocker bogie is that it can travel in rough terrains which can maintain balance and stability. This paper presents ESP 32 based prototype that can be implemented at low cost and with more efficiency. The main challenge in working of this robot is its stabilization and balance. This rocker bogie mechanism makes the robot an All-Terrain vehicle and a versatile robot that can be used for many applications. The metal detector that is mounted on the rocker bogie is used to find landmines. The signal which received from metal detector directly sends to GPS. The GPS modem thus navigate latitude and longitudinal coordinates and send the location of landmine as a pop to the mobile phone by using a blink application. The experimental results give how the landmine is detected using metal detector and location is sent to the user.

1. INTRODUCTION

Mobile robots are very important. Nowadays, they are used to operate on uneven surfaces. These mechanisms are mainly used in any place where humans cannot work. To travel the robots on an uneven surface these mobile robots are very useful. The rocker bogie mechanism enables a six wheeled vehicle to keep all six wheels in contact with a surface even when driving on severely uneven environments. There are two advantages to this rocker bogie. The first one is that the wheels pressure on the ground will be balanced. The second one is that while travelling over uneven surfaces, all six wheels will remain in contact with the surface. So, that the vehicle can overcome the uneven surfaces [1].

The major disadvantage of present rocker bogie rovers is that they are slow. In rough terrain areas there are many obstacles. By considering to the situation of obstacles we have developed rocker with 6 wheels so that it maintains the balance. The rocker bogie can be operated by the person sitting somewhere. The rocker bogie is mainly sent to travel in uneven surfaces and can detect the metal. It can be operated with the help of other android application by operating the person from another place. These rocker bogies not only used to detect metals but can also be used for many purposes. These can be used in military for detecting the bombs [2].

Metal detector is mainly used to detect metals that are inside the objects or metal objects which are under the ground. Metal detectors are used in security purpose at jails, airports, court houses to detect the metal weapons in person’s body. Land mines are devices which are found under or above the surfaces. These are used to destroy enemies. Landmines are made up of metals. Since these devices are buried
under the ground it is difficult to find them out. [4] Many soldiers and bomb squads lost their lives due to misfire of the land mine.

In proposed method, a metal detector is used which helps in finding out the landmine in more accurate and efficient way. Rocker bogie will help an individual to find the landmines which are imparted on uneven grounds and hill terrains. A perfect synchronization between the metal detector and the rocker bogie gives use the efficient and efficient results.

2. LITERATURE SURVEY

The rocker bogie mechanism has been first developed by NASA over many years [3]; NASA has sent some robot mechanisms called rovers. The first mars pathfinder mission is Sojourner. It has been landed on mars in July 1999. It is the first wheeled robot to the Red Planet. The second and third mars exploration rover missions are Spirit and Opportunity. They have landed on January 2004 to find the water on mars. The fourth is mars science laboratory mission name as Curiosity landed on August 29, 2012 it has been sent to find out if mars had all life needs as water and chemical ingredients to sustain. The next one which has been sent in 2020 is Perseverance going to land on at February 2021. It has been checking the percentage of human survival on mars.

This rocker bogie does not have spring and axels. The rocker bogie system is mounted with a mobile camera installed with IP webcam application. This is used for video surveillance. The video that is being captured by this mobile phone is visualized in the other android phone installed with video server. This mobile will be with the user who is operating the rocker bogie.[5][7] This a special feature that is being added to this system as advancement. Installation of mobile video surveillance adds a huge advantage to the rocker bogie mechanism.

3. DESIGN AND METHODOLOGY

The rocker bogie mechanism has six wheels which are being connected to the 150 rpm 6 DC motors. The bogie part is connected to the rocker through the link. In the bogie part the angle between the links are at $90^\circ$. The power supply to the wheels is provided by the batteries through the motor driver. The ESP32 board is dumped with the code that is used to provide commands to the motor driver accordingly. The ESP is also given a power supply of 12V. The rocker bogie is at the receiver side and the transmitter will be held by the user. The block diagram of proposed method is shown in figure 1 [3][6].

The rocker bogie motion is being controlled by the communication between transmitter and receiver through radio frequency waves. At the transmitter the module has four different control switches
i.e., left right forward and backward. The ESP32 board is connected to Regulated power supply and the L298N motor driver. The receiver acts as input to the ESP and the output is the motor driver.

The transmitter module has the encoder in it to encrypt the data bits before transmitting to the receiver. The receiver module has the decoder to decode the data that it receives from the transmitter. Whenever we press any button on the transmitter side, it sends a particular code to the receiver module then the receiver module will decode the message and send it to the ESP module. In the ESP32, it takes the input and gives corresponding data code to the L298D motor driver. The driver is used to drive the motors by providing the power supply and commands. It acts like an amplifier. It takes the current generated from the ESP32 and amplifies it since this amount of current is alone not enough to drive the motors. Hence the motor driver amplifies the current and drives the motors. So, through the motor driver the motors will rotate, and the body moves.

Landmine detection using rocker bogie has been constructed using the main mechanism named rocker bogie system which helps the vehicle to move in uneven surfaces like sand, snow, rough and in the stones. The objective of this mechanism is to detect the landmines which are under the ground and to save the lives of people. The mine consists of metals and minerals. This mechanism is mainly controlled by blink application in android. The main component which functions this rocker bogie is ESP32 module.

Metal detectors work on the principle of “Faraday’s law of electromagnetic induction”. This law states that a current will be induced in a conductor which is exposed to a changing magnetic field. This induced current will generate the elf which helps us to detect the metal. A metal detector comes with a buzzer when a metal detector detects the metal it gives a beep sound.

Whenever a metal detector detects the metal the GPS module which is integrated with the metal detector and ESP module will send a popup which contains latitude and longitude coordinates of the land mine.[8] A good synchronization between the speed of the rocker bogie and metal detector will help and individual to detect the land mine more efficiently.

ESP32 is a progression of ease, low-power framework on a chip microcontroller with incorporated Wi-Fi and double mode Bluetooth. The ESP32 arrangement utilizes a TensilicaXtensa LX6 microchip in both double center and single-center varieties and remembers worked for receiving intensifier, channels, and force the board modules. ESP#@ is made and created by Espressif Systems, a Shanghai- based Chinese organization, and is made by TSMC utilizing their 40 nm process. It is a replacement to the ESP8266 microcontroller, and it is operated in 2.4 GHz [10].

3.1. Design Calculations

Aim of this paper to introduce a robot that can travel on irregular surfaces. To make it all-terrain vehicle and overcome on rough terrain, dimensions of the linkage should be proper. The four wheels will be at a different position at an instance. this will help us to find the dimensions of the rocker-bogie linkage, there are totally six wheels since the two wheels which are present in the middle are considered to the free wheels hence whenever rocker bogie wants to move upward or on the rough terrains it will apply complete force on the back wheels and moves forward.[9]

Now, need to obtain the distance between the first and second wheel. Considering the right-angled triangle ABC,

Using Pythagoras theorem to ΔABC

Let the length of the limbs AB = BC = 15 cm

\[ AC^2 = AB^2 + BC^2 \]  
\[ AC = \sqrt{(15)^2 + (15)^2} \]
\[ AC = 21.21 \cong 21 \text{ cm} \]

The angle between the joints i.e., the rocker and bogie are 90°. The angle at B and D is 90°.

![Diagram of Rocker-Bogie Linkage distance finding]

**Figure 2.** Rocker-Bogie Linkage distance finding

### 3.2. Velocity

The velocity of the rocker bogie can be calculated using the rpm of the wheels.

Diameter of the wheel is 10 cm.

The rpm of the wheel = 32

Velocity of the wheel = 16.75 cm/sec

### 4. SOFTWARE IMPLEMENTATION

#### 4.1 Arduino Software

Arduino is open-source software on which we can perform many projects using different hardware products. Arduino is an IDE (Integrated Development Environment) using we can develop, deploy and create code. This code is dumped into the circuit boards and thus can also be saved to the computer.

The key features are:

- An Arduino consist of analog and digital pins with the help of these pins we can perform various operations on the board it may be an analog operation or a digital operation. And it all depends on the peripherals that are connected to the Arduino board.

- We can perform different functionalities on the board by sending set of instructions to the board by using micro controller.

- Unlike other programmable circuit boards Arduino doesn’t require any hardware to dump the code on to the board. We can use a Universal Serial Bus cable to dump the code.

- Additionally, this integrated development environment uses a simplified version of C++, to make the user feel free and comfortable while using the software.

- Arduino has a standard form factor that will divide the functionality of the controller into a more accessible product.
4.2 Blynk Application:

1. Download blynk application: Blynk application for iOS and android is found on the respective play store and app store. Blynk is the easiest and user friendly application that works with the hardware of user’s choice.

2. Install blynk library: In order to run the projects with the help of the application we need some library which helps in commination of data between hardware project and the code that is dumped on the hardware.

3. Account creation on blynk application: Once application is installed; we have to create an Account. This creation of account helps us to access the project from anywhere just by logging into the application.

4. Create new project: Click on new project and select the hardware on which you want to perform the project. If we cannot find the hardware that we are using on the list, we can select a generic hardware board. This application also comes up with dark or light UI interface.

5. Connect hardware: Once you download the app on your mobile and login using your Gmail accounts it generates auto token for your device. Check your inbox for email from blink with the auth token. Using this auth token you can create a project of your own by connecting hardware to the application.

5. RESULTS

Integrating software along with the hardware and mechanical parts makes up the rocker bogie system. Figure 3 shows the prototype of proposed Rocker-Bogie system using ESP 32.

![Prototype of Rocker-Bogie System](image_url)

**Figure 3.** Prototype of Rocker-Bogie System

Rocker bogie system is controlled using Blynk application. Initially Blynk application is connected to kit over the Wi-Fi module. There will be some delay during this process and the screen of mobile phone looks something like shown in below figure 4.
In this app., 2 buttons are there to move rocker bogie in forward/backward direction. The first button is used to move the rocker bogie in forward direction. The figure 5 shows blynk application to move rocker bogie in forward direction.

Figure 4. Rocker-Bogie Initialization

Figure 5. Rocker-Bogie Forward Direction
The second button is used to move the rocker bogie in backward direction. The below figure 6 shows blynk application to move rocker bogie in backward direction.

![Figure 6. Rocker-Bogie Backward Direction](image)

Below figure 7 shows Blynk application when rocker bogie detects the land mine using metal detector and location is sent to the mobile phone as popup. And using GSM module, the longitude and latitude are identified.

![Figure 7. Rocker-Bogie metal detection and its location identified](image)
6. CONCLUSION AND FUTURE SCOPE

This paper proposed a method will be helpful in the fields of military to locate the enemies, geographical research to inspect the soil and other materials, and in space research. By using a metal detector, the landmine is detected with more accurate and efficient way. Rocker-Bogie helps a person to find landmines on uneven plain and hilly terrain. With the advancements in technology the rocker bogie mechanism finds its major application in surveillance purpose with the camera installed on it and operator or used is located far away from system. By developing a bigger model its importance increases for hospitalized people to climb stairs and uneven surfaces. With most efficient algorithms of artificial intelligence one can built an artificial arm which in turn takes the commands an dismantles the bomb. By using last technology, we can incident laser light for the confirmation weather its truly a landmine or some random substance.

REFERENCES

[1]. P. Panigrahi, A. Barik, Rajneesh R. & R. K. Sahu, “Introduction of Mechanical Gear Type Steering Mechanism to Rocker Bogie”, Imperial Journal of Interdisciplinary Research (IJIR) Vol-2, Issue-5, ISSN: 2454-1362,2016.

[2]. Jaradat M A, Bani Salim M N and Awad F H (2012), “Autonomous Navigation Robot for Landmine Detection Applications”, 8th International Symposium on Mechatronics and its Applications (ISMA), April, pp. 1-5.

[3]. Muhammad Zubai,Mohammad Ahmad Choudhry,"Land mine detecting robot capable of path planning",IEEE journal,22 february 2011.Brian D. Harrington and Chris Voorhees, “The Challenges of Designing the Rocker-Bogie Suspension for the Mars Exploration Rover”, Proceedings of the 3fh Aerospace Mechanisms Symposium, Johnson Space Center, May 19-21, 2004.

[4]. R.Siegle,"Land mine detection” IEEE instrumentation and measurement magazine,vol.5,issue.4,jan 2020.

[5]. D. S. Chinchkar, S. S. Gajghate,"Design of rocker bogie mechanism", IARJSET, vol.4,pp 46-49 Jan 2017.

[6]. H. Aoyama, K. Ishikawa, J. Seki, M. Okamura,S. Ishimura, Y. Satsumi, “Development ofMine Detection Robot System”, International Journal of Advanced Robotic Systems, ISSN:1729-8806, 2008.

[7]. Nitin Yadav, BalRam Bhardwaj, Suresh Bhardwaj,"Design analysis of rocker bogie suspension system and access the possibility to implement on front loading vehicles”, ISOR journals , vol. 12, no. 3,pp 64-67,June 2015.

[8]. E. Abbott, D. Powell, “Land-Vehicle Navigation Using GPS,” Proceedings of IEEE, Vol.87, No.1, 1999.

[9]. E. Colon, P. Hong, J-C. Habumuremyi, l.Doroftei, Y. Baudoin, H. Shali, D. Milojevicand J. Weemaels “An integrated robotic system für antipersonnel mines detection,” ControlEngineering Practice, Volume 10, Issue 11,November 2002, Pages 1283-1291.

[10]. https://www.espressif.com/sites/default/files/documentation/esp32_datasheet_en.pdf