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Rocker Bogie System using RF Communication

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Abstract

The rocker-bogie system is a robot that can travel in rough terrain. Its mechanism helps in maintaining stability. It is a multispecialty robot that can be used for various applications. The use of Rocker-Bogie mechanism helps in maintaining the balance of the robot which is used to travel on an uneven surface, usually called as an All-Terrain Vehicular Robot. The conditions preferably needed for the robot to work are in rough conditions, surfaces such as obstacles and surfaces with uneven travel conditions. The robot consists of an RF module of 2.4 GHz frequency to communicate between the user and the robot, a mobile camera acts as a video transmission device to the user during long-distance operations. The multi-specialty system of an all-terrain vehicle is a prototype which can be implemented easily at a low cost, making it efficient to implement. The major challenge in the working of the robot is its stabilization and balance. The rocker-bogie mechanism makes the robot an All-Terrain Vehicle and a multispecialty robot which can be used for various applications. A camera is also installed on it for video surveillance. This helps the user to visualize the surroundings and operate easily from anywhere.

Keywords: *Actuator, frequency, robot, Rocker bogie, RF module*

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INTRODUCTION

There is an increasing need for mobile robots which are able to operate in unstructured environments with highly uneven terrain. These robots are mainly used for tasks which humans cannot do and which are not safe. In order to achieve these tasks, any mobile robot needs to have a suitable mobile system according to each situation. The rocker-bogie suspension is a mechanism that enables a six-wheeled vehicle to passively keep all six wheels in contact with a surface even when driving on severely uneven terrain. There are two key advantages to this feature. The first advantage is that the pressure of the wheel on the ground will be equilibrated. This is extremely important in soft terrain where excessive ground pressure can result in the vehicle sinking into the driving surface. The second advantage is that while climbing over hard uneven terrain, all six wheels will nominally remain in contact with the surface and under load, helping to propel the vehicle over the terrain. Exploration rovers take advantage of this configuration by integrating each wheel with a drive actuator, maximizing the vehicle`s motive force capability. One of the major shortcomings of current rocker-bogie rovers is that they are slow. In order to be able to overcome significantly rough terrain without significant risk of flipping the vehicle or damaging the suspension, these robots move slowly and climb over the obstacles by having wheels lift each piece of the suspension over the obstacle one portion at a time. While performance on rough terrain obstacles is important, it should be also considered situations where the surface is flat or it has almost imperceptible obstacles, where the rover should increase its speed to arrive faster. The rocker-bogie suspension system can be sent for reconnaissance purpose which is exploring the surrounding to give visualization to a person or operator sitting somewhere for carrying the operation, by the help of a video camera. Hence, due to this feature of the rocker-bogie suspension system, this can be used in the military for visualizing the scenario at the region where the bomb is planted. Not only this, the rocker-bogie suspension system can be developed into a wheelchair to take patients

from one place to another climbing the stairs on its own. It can also be used for material delivery purposes.

LITERATURE SURVEY

The initiation of a rocker bogie suspension system can be traced to the development of planetary rover which is mobile robots, specially designed to move on a planet surface. Early rovers were teleoperated like the Lunokhod I while recent ones are fully autonomous, such as FIDO, discovery and recently developed curiosity mars exploration rover. The rovers needed to be very robust and reliable as it has to withstand dust, strong winds, corrosion and large temperature changes under mysterious conditions. Maximum rovers remain powered by batteries which are recharged by solar panels during the day installed over there surface. The locomotion system of the rovers remains crucial to enable it to reach objective sites, conduct research, and collect data and to position itself according to the demand. There are three main types of rover locomotion developed so far i.e. wheeled, legged and caterpillar locomotion. The main difference between the miscellaneous designs of planetary robots lies in the type of locomotion system [1-5].

Even after developing many-legged and hybrid robots, most researchers still focus on wheeled locomotion for rovers because of its locomotive ease and advantages and among wheeled locomotion design, the rocker-bogie suspension system based design remain most favored. The ancient FIDO rover and the Sojourner contain 6 steered and driven wheels suspended from a rocker-bogie mechanism for maximum suspension system just differ in front wheels [6]. The nano rover and nomad rovers have four steered wheels suspended from two bogies and CRAB rover utilizes two parallel bogie mechanisms on each side to overcome obstacles and large holes [7, 8]. As far as the initial research is concerned, the software optimization seeks for an optimum in the constrained solution space given an initial solution.

The objective behind evolution of rocker-bogie suspension system is to develop a system which minimizes the energy consumption, the vertical displacement of the rover`s center o mass and its pitch angle. In this research, our endeavor is to transfer these major advantages embedded with the rocker-bogie system into conventional vehicles in order to remove discomfort and complexities present in conventional suspension system in general and suspension system of heavy vehicles in particular principle. The rocker-bogie design consisting of no springs and stub axles. In each wheel which allows the chassis to climb over any obstacles, such as rocks, ditches, sand, etc that are up to double the wheel size while keeping all the wheels on ground maximum time. As compared to any suspension system, the tilt stability is limited by the height of the center of gravity and the proposed system has the same. Systems employing springs tend to top more easily as the loaded side yields during the obstacle course. Dependent upon the center of overall weight, any vehicle developed in the basis of rocker-bogie suspension can withstand a tilt of at least 50 degrees in any direction without overturning which is the biggest advantage for any heavy loading vehicle. The system is designed to be implemented in low-speed working [9, 10].

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 ivideon server. This mobile will be with the user who is operating the rocker-bogie. 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.

DESIGN AND METHODOLOGY

The rocker-bogie mechanism has six wheels which are being connected to the 60 rpm dc motors. The bogie part is connected to the rocker through the link. In the bogie part, the angle between the links is at 90°. The power supply to the wheels is provided by the batteries through the motor driver. The Arduino board is dumped with the code that is used to provide commands to the motor driver accordingly. The Arduino is also given a power supply of 5V. The rocker-bogie is at the receiver side and the transmitter will be held by the user.

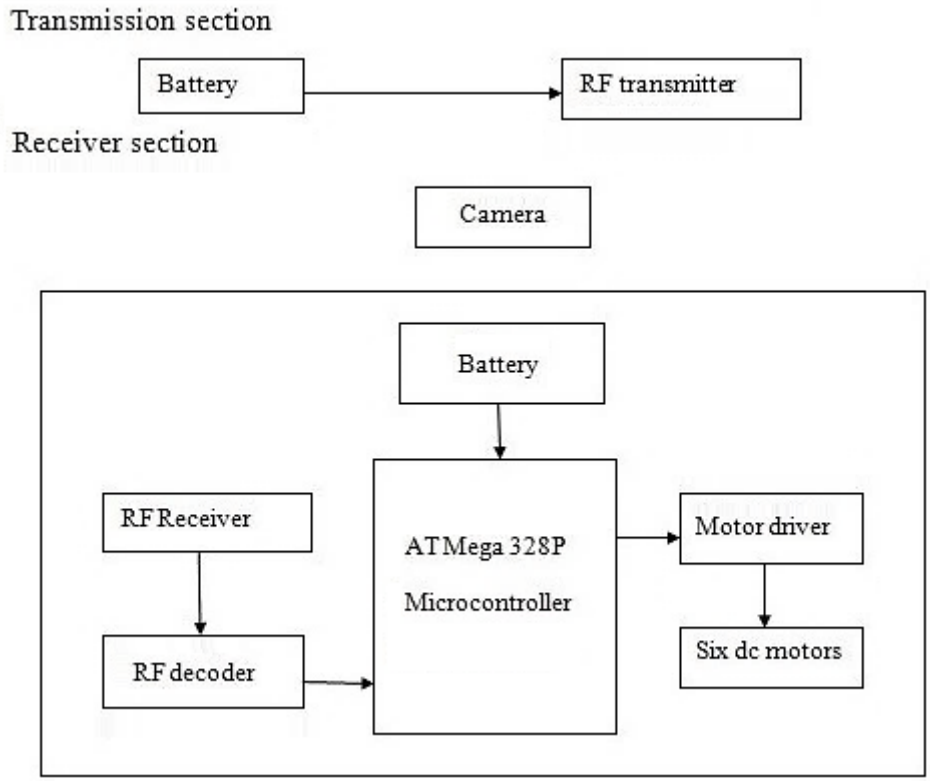


Fig. 1: *Block Diagram.*

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 Arduino board is connected to the RF receiver module and the L298n motor driver. The receiver acts as input to the Arduino and the output is the motor driver (Figure 1).

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 any button is pushed on the transmitter side, it sends a particular code to the receiver module. The receiver module will decode the message and send it to the Arduino. In the Arduino, it takes the input and gives corresponding data code to the motor driver. The motor driver is used to drive the motors by providing the power supply and commands. It acts as an amplifier. It takes the current generated from the Arduino and amplifies it since this amount of current is alone not sufficient to drive the motors. Hence the motor driver amplifies the current and drives the motors. So, through the motor drive the motors will rotate and the body moves. For the video surveillance, an IP webcam is fixed on the rocker-bogie. To watch the video an android phone is used by the user in which ivideon cloud is installed. The ivideon cloud application is used to monitor the video continuously which is being recorded by the IP webcam. These both devices are to be connected to the internet source to watch the video. In this way, we can use the rocker-bogie for video surveillance also which has many applications in the military field and also for agriculture purposes.

Methodology

As per the research, it is found that the rocker-bogie system reduces the motion by half compared to other suspension systems because of each of the bogie's six wheels which allow the vehicle to turn in place as 0-degree turning ratio. Every wheel also has thick cleats which provide grip for climbing in soft sand and scrambling over rocks with ease. In order to overcome vertical obstacle faces, the front wheels are forced against the obstacle by the centre and rear wheels which generate maximum required torque. The rotation of the

front wheel then lifts the front of the vehicle up and over the obstacle and obstacle overtaken. Those wheels which remain in the middle is then pressed against the obstacle by the rear wheels and pulled against the obstacle by the front till the time it is lifted up and over. At last, the rear wheel is pulled over the obstacle by the front two wheels due to applying pull force. During each wheel's traversal of the obstacle, forward progress of the vehicle is slowed or completely halted which finally maintain vehicles centre of gravity.

Design Calculations

The main objective of this project is to design a robot which can travel on irregular surfaces. To make it all-terrain vehicle and overcome on rough terrain, dimensions of the linkage should be proper. The pair of wheels should be at a different position at a time. Hence to find the dimensions of the bogie linkage, the first pair of wheels should be placed at the horizontal position and the second pair should be placed just before the start of rising.

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 is 90°. The angle at B and D is 90° which are shown in Figure 2.

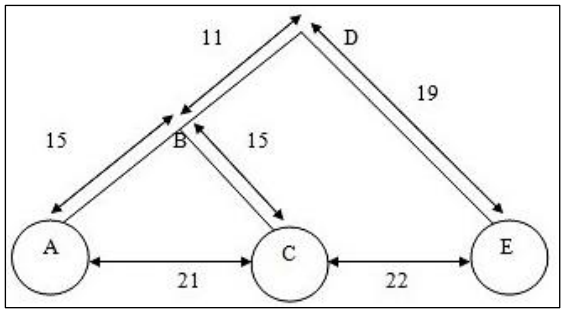


Fig. 2: *Design of Rocker Bogie.*

Velocity

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

The diameter of the wheel is 10 cm.
The rpm of the wheel = 32
Velocity of the wheel = 16.75 cm/sec

HARDWARE IMPLEMENTATION

Arduino UNO

The Arduino UNO is generally used for hardware and software interface. It stores the data in the form of commands and performs the actions according to the code dumped onto it. In the rocker-bogie project, the motor driver L298N and the receiver module is connected to the Arduino. The Arduino takes input from the RF receiver module and gives output through the motor driver. The motor driver drives the dc motors and thus the directions are changed accordingly.

The digital pins 8, 9, 10, 11 are connected to the motor driver which are used to drive the left and right motors of the rocker-bogie. The 8, 9, 10, 11 digital pins of Arduino are connected to the receiver module. When a key is pressed on the transmitter module the corresponding code is generated and is encoded by the encoder that is present on it. This code is being transmitted to the receiver module. The receiver module will decode the message and send it to the Arduino. The Arduino will run the code that is dumped on it and perform the necessary actions. The output is sent to the motor driver and the motors are being in motion accordingly. The Arduino board is provided with power supply through the motor driver.

The L298N motor driver is used to drive the dc motors. It provides control to the motors. Since the current generated from the Arduino is very low and is not sufficient to drive the dc motors motor driver is being used. The motor driver will amplify the current and provides a sufficient amount to drive the motors.

The control pins of the motor driver are connected to the 8, 9, 10, 11 digital pins of the Arduino board i.e. the logic pins are directly connected to these digital pins through jumpers. The motor driver is the output device that is connected to the Arduino through which the motors are being controlled in that respective action or command given by the user. The left side of the motors are connected to the motor A

and right side of the motors are connected to the motor B. Power supply is given through batteries. The 12 v supply is directly given from the rechargeable battery and 5v supply is given to the Arduino from the motor driver.

RF MODULE

The rf transmitter and receiver module are used to transmit the data between two devices. The range of rf module is around 60 meters. It is operated at a frequency of 433Mhz. the receiver module is connected to the 4, 5, 6, 7 digital pins of the Arduino. When any key is pressed on the transmitter module the associated code bits are encoded using the encoder which encrypts the data and sends it to the receiver module. The receiver module will decode the message sent by the transmitter and gives the information to the Arduino since the receiver module is the input for the Arduino. The decoded message is in the form of bits that are assigned to the respective action. The RF receiver module is supplied with an 8v battery and transmitter module is supplied with 9v battery.

The dc motors are connected to the tires through couplings. When the command is passed by the user through the RF transmitter module the necessary actions are being done by the Arduino and the power is provided through the motor driver. Since the power that is generated in the Arduino is alone not sufficient to drive the motors, motor driver is used. It provides the necessary power to the motors to be driven.

SOFTWARE IMPLEMENTATION

Arduino is a prototype platform (open-source) based on easy-to-use hardware and software. It consists of a circuit board, which can be programmed (referred to as a microcontroller) and a ready-made software called Arduino IDE (Integrated Development Environment), which is used to write and upload the computer code to the physical board (Figure 3).

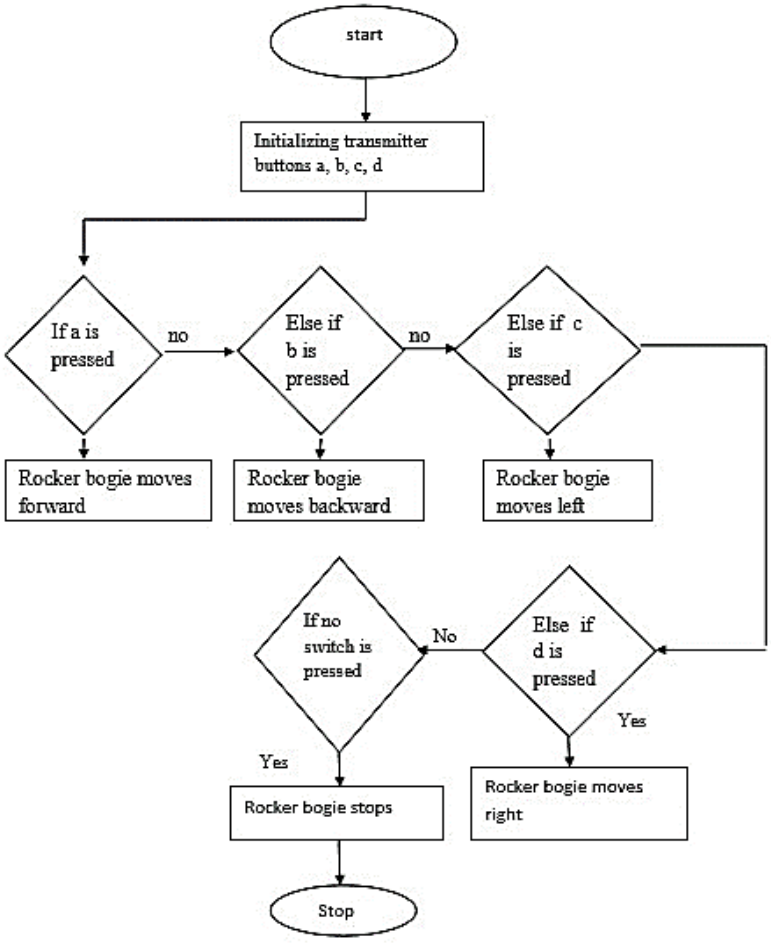


Fig. 3: *Flow Chart.*

The key features are:

- Arduino boards are able to read analog or digital input signals from different sensors and turn it into an output such as activating a motor, turning LED on/off, connect to the cloud and many other actions.
- You can control your board functions by sending a set of instructions to the microcontroller on the board via Arduino IDE (referred to as uploading software).
- Unlike most previous programmable circuit boards, Arduino does not need an extra piece of hardware (called a programmer) in order to load new code onto the board. You can simply use a USB cable.
- Additionally, the Arduino IDE uses a simplified version of C++, making it easier to learn to program.
- Finally, Arduino provides a standard form factor that breaks the functions of the micro-controller into a more accessible package.

IP WEBCAM

The IP webcam is an android application that is used for video surveillance. The IP webcam turns an android phone into a network camera with multiple viewing options. The video is recorded and can be viewed using ivideon cloud. It has features like night vision, motion detection and sound detection.

The mobile phone must be in the Wi-Fi zone in order to stream the video. The video clarity can be enhanced by changing the settings and also adjust the other attributes and features of the camera as per the visible requirements.

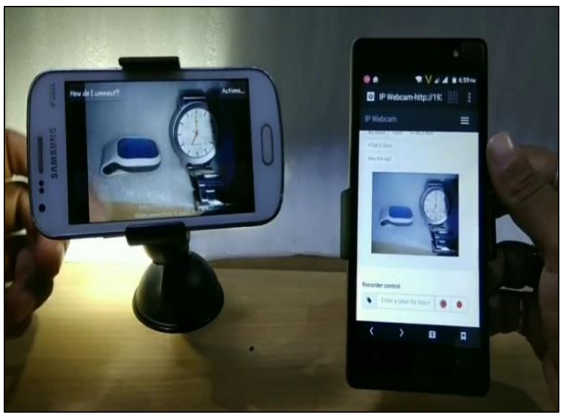
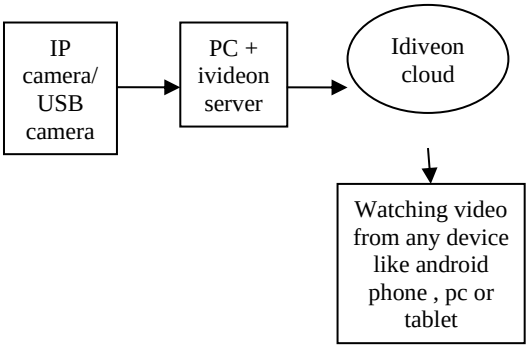


Fig. 4: *IP Webcam and ivideon Server.*

To watch this video live we have two options i.e., local broadcasting and cloud streaming. In local broadcasting, the IP address of the device is used to stream the video. Whereas, in cloud streaming, we can monitor by using ivideon cloud software (Figure 4). By login or create an account in it, we can acquire video surveillance.

IVIDEON CLOUD

Ivideon is video surveillance software designed to connect web and ip cameras to ivideon service. We can monitor the things and stream live through the internet connection (Wi-Fi). The IP webcam and the device in which the ivideon application is installed must be connected to the Wi-Fi or any internet source. We can ON and OFF the camera and change the video quality from the place where we are. After installing the application on the android mobile phone, we must log in with the same id as in the webcam application. It is like an interface between them. Using this we can watch the place where the rocker-bogie is going and get the information regarding it.



This type of video surveillance is useful in many ways. It can be used as a security camera at homes, offices, shopping malls, banks and other public places. It can be used by the security guard to monitor the different areas by sitting at one place if the area is very large like industries and other factories. This technology can also be implemented in those where humans cannot go or in the places where the disasters occur, which can be harmful to humans. It can also be used in the military as a secret hidden camera to know the information regarding the enemies and the threats that may occur. This will be very much useful and can be easily implemented since it does not require much equipment. It can be easily operated by the user.

Certain settings like zoom, stream quality, exposure compensation, and misc. have to be done before. Advanced settings like night vision gain and exposure, video and photo resolution, orientation, mirror and flip, flash and focus mode, anti banding, white balance, color effect lock exposure, lock white balance has to be set before the video transmission according to the requirements and also by considering the state of surroundings where video has to be captured.

RESULT

Integrating software along with the hardware and mechanical parts makes up the rocker-bogie system.

Image of rocker-bogie and its climbing uneven surfaces are shown in Figure 5 and 6, respectively.

Fig. 5: *Image of rocker-bogie.*

Fig. 6: *Image of rocker-bogie climbing uneven surfaces.*

Figure 7 shows the red colored outline on the mobile.

Fig. 7: *Red-colored outline is displayed on the mobile.*

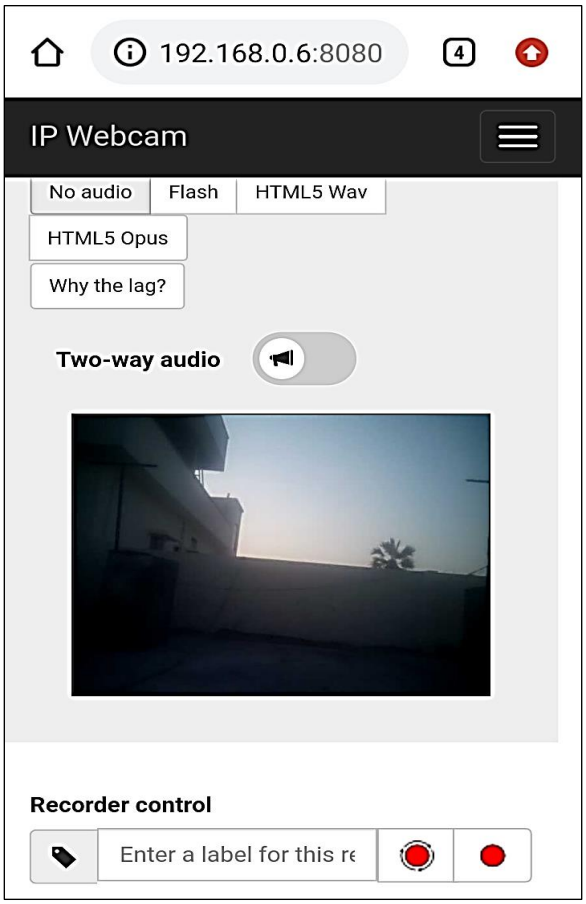


Fig. 8: *Video streaming on the user mobile.*

The video is seen in the other mobile phone by the user who is operating it from the far distance (Figure 8). We can also change the settings of the IP webcam which is mounted on the rocker-bogie such as zooming for clarity. The camera direction can also be changed from front to rare or rare to front direction. The level of sensitivity of the motion detection can be adjusted as per the requirements. Video resolution can be adjusted and few other settings are also available in the IP webcam application which makes the video transmission and visualization much efficient.

CONCLUSION AND FUTURE SCOPE

The final outcome of the rocker-bogie is innovative and motivational for future requirements. Here we conclude that this project will be helpful in the fields of the military to locate the enemies, geographical research to inspect the soil and other materials, and also in space research. It will be useful in many ways and can be utilized to the maximum of its advantages.

FUTURE SCOPE

- With the development in technology, the rocker-bogie can be used for reconnaissance purpose with the camera installed on it and minimizing the size.
- By the development of a bigger model, it can be used for transporting humans and material through rough terrain or obstacles.
- It can also be used for geological mapping of unknown terrains as it can even provide live video feed and images of the terrains being explored.
- With some developments like attaching an arm to the rocker-bogie, it can be made useful for the bomb diffusion squad such that it can be able to cut the wires for diffusing the bomb.

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