IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

DESIGN AND ANALYSIS OF METAL DETECTING ROVER VEHICLE USING ROCKER BOGIE SUSPENSION SYSTEM

[1]Prof. Roheshkumar Lavate, [2]Saurabh Shekhar, [3]Ashish Singh Panwar, [4]Rishabh Pandey,
[1]Assistant Professor, [2, 3,4]Research Scholar,
Department of Mechanical Engineering,
Bharati Vidyapeeth (Deemed to be university), College of Engineering, Pune, India

Abstract- This research paper gives the method to find the landmines in various conditions. These mines have undefined life and may cause huge damage to the Gross domestic product (GDP) and cause horrific injuries after the war is over. Therefore, many countries need reliable mines inspection systems. This project produced prototype landmine detection and marking robot that used GPS localization, autonomous navigation, and a prototype metal detection system and novel landmine marking system. Army needs better border security and security form naxalite which involves less risk of life of soldiers. This could be provided by providing the automatic mines detector and by providing the live footage. Our Rover vehicle have been Installed with this system with the rocker bogie suspension mechanism.

***Index Terms* - 360^0 Camera, GPS Tracker, Metal Detecting Rover, Rocker Bogie Suspensi**

I. INTRODUCTION

Removing land mines is an important agenda for many countries as the situations like natural calamities or land development can cause the situation compounded. Therefore, it is an urgent concern to detect and remove landmines safely from the ground. This landmines removal process begins with the detection of the landmines in ground using non- touched based detection methods. Non- touched based detection methods are used as they use signals for the detection. Several techniques have been designed and developed for the detection of the different buried landmines as each landmine have different mines case, explosive materials and the soil. These all involves high risk of life which needs to be eradicated.[1][2]

II. LITERATURE SURVEY

Rocker Bogie Suspension system have various applications which provides superior vehicle stability and vehicle mobility. This suspension system has the great obstacle climbing capability. This system contains more than one independent rocker arrangements and joins such a number of independent rocker into a single bogie.[2]The main advantage is that every wheel on this device is independent in rotation when compared to axle drive. Any wheel can move alone up a steep or down without affecting other wheels. Currently NASA Mars rover curiosity has this technology. It can further be used in some robotic arms etc.

Rocker bogie suspension system comprises of bogie having six wheels. All six wheels have an independent mechanism for the movement. The two front and two rear wheels have a separate steering system having zero turning ratio which provides turning of the wheels in place. So in order to climb the obstacle, the front wheels are forced by the rear and centre wheels. These wheels provide maximum required torque for the rotation of the front wheels. This lifts the front end of the vehicle and the obstacle is overtaken by the front wheels. Wheels at the centre are pushed by the rear wheels simultaneously the front wheels are lifted up and over. Finally the rear wheels are pulled over the barrier by the front and centre wheels by using the maximum torque generated by them. This slow movement of the wheels maintains the centre of gravity of the rover vehicle.[3]

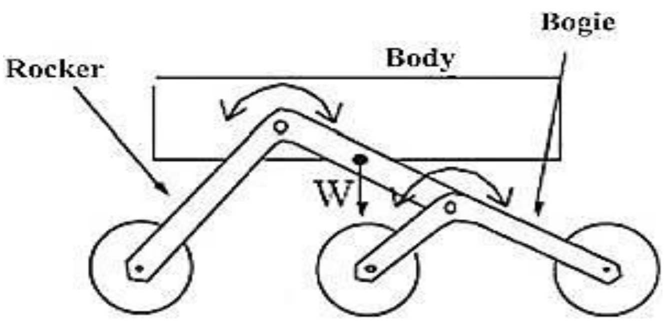

Fig.1. Rover Vehicle [4]

III. METHODOLOGY

This project is intended to use an unmanned ground vehicle as the platform of the project rather than an aerial vehicle. They tend to be more stable, have longer operating times and provide more space for attaching components. There were many options for selecting a ground vehicle particularly within the robotics department. To choose an appropriate base that would best suit our requirements we began the selection process. The rover had to remain operational in terrain where a minefield might be located. This means that the rover needed to be capable of traversing moderately rough terrain easily such as hills, deserts and grasslands.[5] Operation time was a big requirement as it directly impacted the ability to detect and mark landmines.

Several options were investigated for our landmine detections sensor. Various factors were considered in our selection of a landmine-detecting sensor. The detector must be low cost and require minimal computing power to operate, to meet our goal of keeping the rover low cost. Metal detectors are reliable throughout varying weather conditions, and can be made at a low cost. The majority of common landmines contain high enough metal contents to be detected by a metal detector.

TABLE 3.1 Parts used and their specifications

Parts	Use	Specifications
Rover Vehicle	Rover vehicle works on the rocker bogie suspension systems which have better stability in comparison to others. It works as the central body of the system.	UPVC Schedule 40 Outer Diameter (OD) = 33.4mm; Inner Diameter (ID) = 25.4mm; Wall Thickness= (OD)-(ID) = 8mm
Arduino Uno	Arduino is heart of the rover vehicle which is connected with various other devices including metal detector, global Wi-Fi, power source (battery) and camera. This controls the motion of the rover vehicle. It has been programmed according to the requirement of the Army.	Microcontroller : ATmega328 Operating Voltage 5V
Metal Detector	Metal detector detects the mines stubbed inside the ground. It is connected with the arduino uno which gives the stops the rover vehicle to prevent the damage. Arduino uno gives the live location of the rover vehicle which thereby gives the location of the mines.	VCC 9V 2cm
Battery	Constant power source is required for the smooth functioning of the rover vehicle. This is provided by connecting the battery of 12V. Battery is connected with almost every system available on the rover vehicle	12V 1.3 Ah/ 20HR Amptek Lead Battery
Camera	It provides 360 degree live footage from the live ground which could even store in the SD cards. Camera continuously needs power input which is provided through the battery.	Mi 360˚ Camera Input Power 5V—1A Camera Angle 110˚
GPS Tracker Module	GPS tracker module is connected to the battery which gives the live location of the rover vehicle in the application. It gives the GPS location in terms of the latitude and longitude.	Support: 850/900/1800/1900 MHz Location Accuracy: 10m
Global Wi-Fi	Global Wi-Fi device helps to provide the live footage for even the far distance and providing the GPS location of the device.	NODEMCUWiFi
Motor:	The torque output is controlled by motor. Here the motor used is decided by the maximum velocity of the rover.	Speed: 100RPM DC 12V
Wheels	Rubber wheels have been connected to the motor. Hexagonal brass coupling connects both. Wheels have high rubber quality as the steering system have zero turning ratio which leads to skidding of the wheels.	*Wheels:* Weight: 160g Diameter: 130mm Wide: 60mm Material: Rubber

Hex Brass Coupling:
Diameter 6mm

IV. DESIGN CONSIDERATIONS

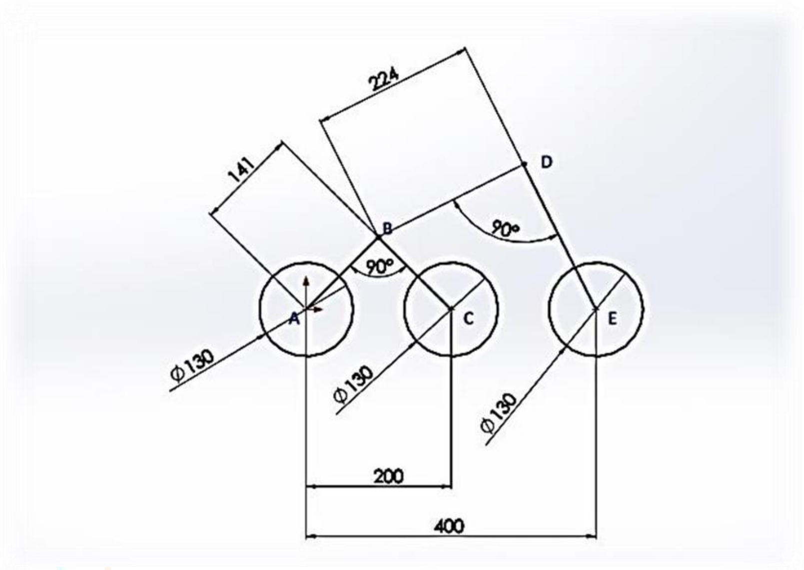

Fig.2 - 2D Drawing of Rocker Bogie Mechanism

Above fig. shows the schematic diagram of the rover vehicle in which the linkages length are fixed for getting the stability. The objective of the calculation is to climb the object, which could be of certain dimensions. The dimensions of the linkages should be perfect for achieving the proper climbing of the rover vehicle. Calculations have been done using Pythagoras theorem. For climbing with stability, it is mandatory that the one pair should be at the rising position. [6]

The obstacle assumed is of height and length 150 mm and 400mm respectively. So the wheel base should be of minimum 400mm. Now on applying the Pythagoras theorem on ΔABC;
Let AB= BC= x
$200^2 = x^2 + x^2$
$200^2 = 2x^2$
x = 141.42 mm
Similarly, all the linkages lengths are calculated .The results are shown on the fig itself.
We have assumed maximum velocity of the rover to be 0.5m/s as it should be able to provide the stability to the system.
Max. Velocity of rover: 0.5m/sec.
Total body weight = 9.511 Kg
Following are the given specifications of the Mabuchi 100 RPM RF-500TB-12560;

TABLE 4.1 Motor Specifications

Speed (RPM)	Torque (N-m)	Power Output(W)	Weight of Motor(Kg)
100	1.79	1.56	0.155

Material of Body: Schedule 40 UPVC pipe
Total Body Weight (W)= Body + Battery + Tyres + Motors + Metal Detector + GPS Tracker + Camera (Wireless) + Supporting Plates + Circuit Boards + Nuts & Bolts + Miscellaneous.
W = (3.783 + 0.948+ 0.930 + 235 + 1.5) Kg =9.511 Kg
Length of the shaft required for transmitting the torque to the Rover is calculated using the load and torque based.
Length of the Shaft (Calculated) = 15.67mm

V. DESIGNING ON SOLIDWORKS

Fig.3. Solid Works Model of Rover Vehicle

VI. ANALYSIS

Shear Stress on Shaft $= \frac{T\ x\ r}{J}$

$$= \frac{1.79\ x\ 16}{\pi\ x\ 0.006^3} = 42.2055\ \text{N}/mm^2$$

Weight on RHS $= \frac{1.133}{6}$ = 1.188 Kg× 9.81 = 11.66 N

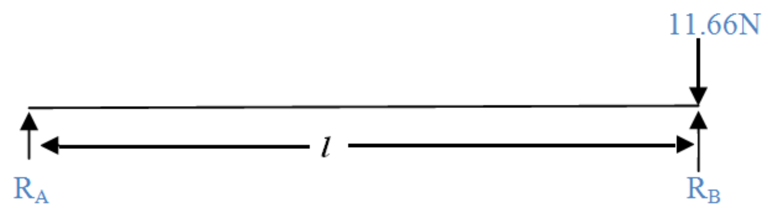

Fig. 4 Motor shaft force distribution

$R_A + R_B$ = 11.66N

Bending Moment at B (M) = 11.66 l

Equivalent Twisting Moment (T_{eq}) = $\sqrt{T^2 + M^2}$ = $\sqrt{1.790^2 + 11.66l^2}$

$T_{eq} = \frac{\pi \times (0.006)3 \times 42.2055 \times 10^6}{16}$ = 1.0358 Nm

Putting this value in the equivalent twisting moment equation,
We get,

l = 15.67 mm.

Length of Shaft (Calculated) = 15.67 mm

Now applying static load on shaft;

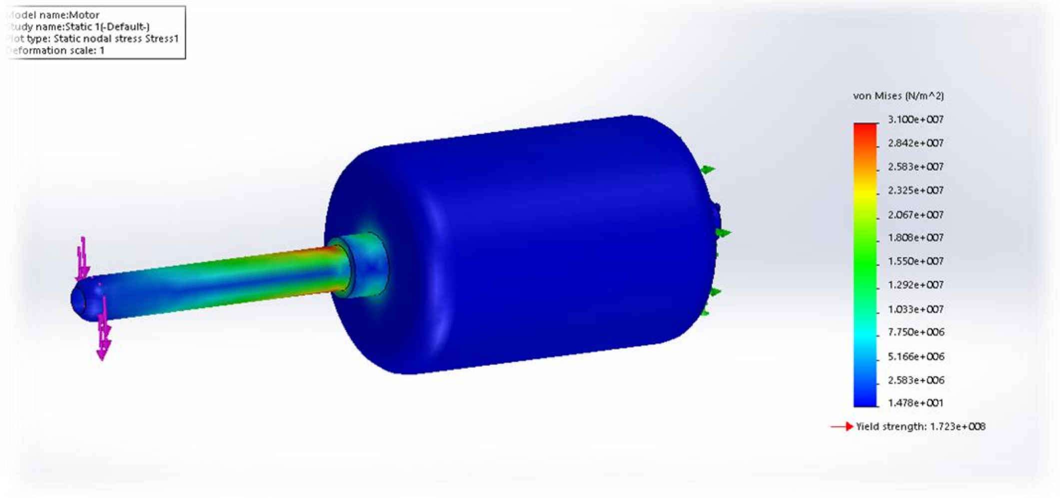

Fig.5. Analysis of Motor and its Shaft

VII. RESULTS

This research work shows the mechanism of rocker bogie suspension mechanism on various surfaces. The load applied by all the materials mounted on the rover vehicle is distributed through the linkages to the motors shaft. The static load applied on the motor's shaft is simulated. The results show that the yield strength applied on the shaft is within the safe limit.

Different systems apply different forces on the linkages of the suspension system which results in different torques produced. After the specific dimensioned obstacles have been assumed, the accurately dimensioned rover vehicle climbs the barrier with greater stability. It could climb up to angle of 45 degree. The testing of the rover vehicle was carried along with the audio video recording using the camera mounted on the vehicle. The performance was found satisfactorily with the 360 degree rotation of the camera. During obstacle climbing test for length less than 400 mm system cannot climb the obstacle.

The GPS tracker module installed on the rover vehicle provides the live location on the application, which could be used for tracking the rover vehicle. When the metal detector detects the landmines, the vehicle stops and provides the live location of the landmine on the application, which could later be disabled. Simultaneously the camera gives the live overview of the area on the application itself.

VIII. CONCLUSION

This paper proposes the procedure to detect landmines in different burial conditions. This proposed method uses metal detectors and GPS trackers which will detect the mines as well as give the location of the mines which can further be removed. It also gives the 360 degrees survey of the area by using camera which also records the audio and videos. As it is an unmanned type of landmine detection system, there is no risk of life involved. So this is better than others available for the landmine detections. The materials we choose for fabricating the prototype are easily available in the market. The real model using the industrial material with higher grade can be more effective and have better life and withstanding power.

REFERENCES

[1] Wesley B. Williams and Eric J. Schaus University of North Carolina at Charlotte/Georgia Institute of Technology "Design and Implementation of a Rocker-Bogie Suspension for a Mining Robot", 2015 ASEE Southeast Section Conference.
[2] Vishnu V., Albin Sani, Alen Paul, Savio Mathew, Febin Devis, Rahul P. K, Nithin Ranjan, "Robotic Fire Extinguishing Vehicle with Rocker Bogie Suspension System", International Journal of Advance Research, Ideas and Innovations in Technology, Impact factor: 4.295 (Volume-3, Issue-3) ISSN: 2454-132X.
[3] S. V. Patil, S. Deshmukh, Y. L. Maske "Modelling and MBD simulation of stair climbing robot with rocker bogie Mechanism", International Journal of Innovative Research in Technology, 101743, (Volume 1 Issue 12), Page no. 267-273, ISSN: 2349-6002, 2015.
[4] Rocker Bogie Suspension Mechanism [Cited on 5.11.2018] Available on the website "www.google.com".
[5] Bal Ram Bhardwaj, Suresh Bhardwaj, Nitin Yadav, "Design analysis of Rocker Bogie Suspension System and Access the possibility to implement in Front Loading Vehicles" IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 12, Issue 3 Ver. III (May. - Jun. 2015), PP 64-67.
[6] D. S. Chinchkar, S. S. Gajghate, R. N. Panchal , R. M. Shetenawar , P. S. Mulik, "Design of Rocker Bogie Mechanism", IARJSET International Advanced Research Journal in Science, Engineering and Technology National Conference on Design, Manufacturing, Energy & Thermal Engineering (NCDMETE-2017), Vol. 4, Special Issue 1, January 2017, ISSN (Online) 2393-8021, ISSN (Print) 2394-1588.
[7] Chris Voorhees, Brian D. Harrington "The Challenges of Designing the Rocker-Bogie Suspension for the Mars Exploration Rover" Proceedings of the 3 f h Aerospace Mechanisms Symposium, Johnson Space Center, May 19-21, 2004.
[8] Kwang Hee Ko, Gyubin Jang, Kyungmi Park, Kangwook Kim "GPR-Based Landmine Detection and Identification Using Multiple Features" Hindawi Publishing Corporation International Journal of Antennas and Propagation Volume 2012, Article ID 826404, 7 pages doi:10.1155/2012/826404.
[9] H. Kasban, M. El-Kordy, F. E. Abd El-Samie, O. Zahran, Sayed M. Elaraby, "A Comparative Study of Landmine Detection Techniques", Sens Imaging (2010) 11:89–112 DOI 10.1007/s11220-010-0054-x.
[10] Kevalaji Mane, Ashok Ibitwar , Sadanand Sonwane, Dnyaneshwar Pitale , Prof. Ajay Ingle, "Rocker Bogie Suspension System", Vol-3 Issue-3 2017, IJARIIE-ISSN(O)-2395-4396.