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Design and Fabrication of Remote operated Defence vehicle.

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ABSTRACT: The Project is an electrically powered remote operated vehicle primarily designed used to collect the information and handle the dangerous and risky situations by the use of various sensors and cameras.Current mobility design are complex, using many wheel or leg. They are open to mechanical failure caused by the harsh surface at several places. So we use rocket bogie suspension system, a six-wheeled ROV capable of traversing rough terrain using an efficient high degree of mobility suspension system. The ROV has to operate on rough and harsh environments for which it was designed but several factors restrict its operational capabilities, so the focus of our research is to get over restrictions or to minimize it within an acceptable range for smooth performance of system.Vehicle can climb stairs and negotiates steep slopes.Can tow suspected platforms and operate continuously for 2 hours once fully recharged. Using SOLIDWORKS software the design of the ROV has been fine- tuned and by experimenting with prototypes improvements and feature were included into the ROV.The result of the project was the implementation of independent directional control utilizing minimum drive modules which increases the efficiency of the battery and increases the operating time of the ROV.

I. INTRODUCTION:

In today's world there are limited number of defence ROV's which has limited capability and mobility so to increase the mobility we use the 'Rocker-bogie suspension system'. Recently, NASA sent a Mars rover known as 'Curiosity' which also uses rocker-bogie suspension design & it has become a proven mobility application known for its superior vehicle stability and obstacle--climbing capability. The term "Bogie" mentions the links that have a driving wheel at each end. Bogies recently were used as load wheels in the tracks of army tanks as loungers assigning the load over the terrain. Bogies were also generally used on the trailers of semi-trailer trucks. Both applications now uses trailing arm suspensions system over others.The Rocker Bogie system don't have any springs, stub axles or any other damping device for each wheel, allowing the rover to get over the obstacles, such as rocks, that are up to fourth the wheel's radius in size while keeping all six wheels on the ground. As with any suspension system, the tilt stability is limited by the height of the center of gravity of the system. To perform any other task like pick and place or cutting etc. There is a robotic arm, installed on the top of the vehicle which can work around in 360°according to our need. The robot also has wireless cameras mounted on top of the platform and arm to keep an eye on what is coming in front and give a proper visibility to the operator.

II. CALCULATIONS:

2.1 Calculation of length of link:

The main aim of the work is stair climbing. To achieve proper stair climbing abilityand the dimensions of the linkages should be proper. Assuming the stair height and length 200 mm and 485 mm respectively. To climb stairs with higher stability, it is required that only one pair of wheel should rise at a time. Since to find the dimension of bogie links, front wheels should be placed at horizontal position means at the end of the rising as shown in. And rear wheels should be placed just before the start of rising. There should be some gape between vertical face of stair and rear wheel to striking of wheel. Now, need to obtain the distance between first and second wheel through CAD software (200 mm). Considering the right angled triangle ABC,
Using Pythagoras in AABC assume lengths AB and BC is x

$$AC^2 = AB^2 + BC^2$$
$$200^2 = x^2 + x^2$$
$$200^2 = 2x^2$$

x =141.42mm

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Hence, AB=BC=141.42mm

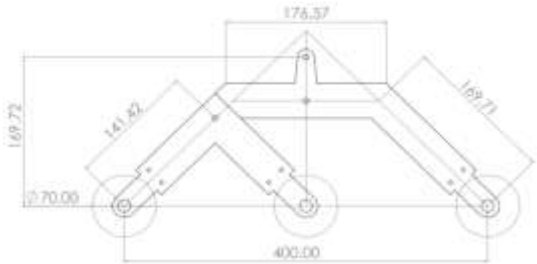

Fig.1

2.2 Calculation for wheel:

Design of wheel is required at velocity up to 10 cm/s. Assume speed is 20- 50 rpm motor Using velocity relation velocity is calculated for assumed speed. Using calculated velocity value need to find out diameter of wheel is 63.66mm. Hence we select the wheel of 70 mm diameter. Selection of neoprene rubber band for the wheel makes it light weight and durable, provides excellent traction, friction between ground and wheel. Thepvc wheels which we are going to use are low cost solution that is durable enough for a combat robot yet still light enough to be practical. For robot used six wheels.

Wheel Diameter: 70 mm
Wheel Width: 20 mm
Shaft Diameter: 6mm
$V= \pi DN/60$
Assumed speed to be 10 cm/sec
therefore,
$10= \pi DN/60$
DN = 190.986
For N= 30rpm, D= 7cm

2.3 Calculation for wheel base:

ϴ= tan-1(y/x)
ϴ=tan-1 (200/420)
Therefore,
ϴ=22.45 degree
Now, width of the stairs is 485mm so the maximum length of the rover can be 485mm
To deduce the wheel base,
Total length - (dia. of front wheel + dia. of rear wheel)/2
= 485-(35+35) =415 mm.

2.4 Calculation of Height:

Height of rocker bogie-
H2 =x2 – y2
H = (168.8142 -118.92)1/2 =118.85mm
height = 118.85 + 35
= 153.85mm

Total height = height of rocker bogie + arm length + distance between them
= 153.85+ 400+50 ~ 650

III. DESIGN:

3.1 Design Methodology:

As per the study it has been found that the rocker bogie mechanism decreasethe motion of the vehicle by half in relative to other suspension systems because each of the bogie's six wheels has an independent drive for motion and in which the front and rear wheels have individual control systems which allow the vehicle to turn in place as zero degree turning radius. Every wheel also has thick bands which provides the proper grip for climbing and scrambling over rocks with ease. In order to get over the vertical obstacle faces, the front wheels are bounded against the obstacle by the mid and rear wheels which generate maximum required torque. The rotation of the front wheel then lifts the front of the ROV up and over the obstacle. Those wheels which remain in the center, is then supressed against the obstacle by the rear wheels and pulled against the obstacle by the front till the time it is lifted up and overit. At the end, the rear wheels are pulled over the obstacle by the front two wheels due to the application of pull force. During each wheel's motion over the obstacle, forward running of the vehicle is slowed or completely stated which finally maintain vehicle's COG. The above mechanism is practically proved by using as it has been used on eightwheel drive ATV system in order to get maximum benifited by rocker bogie system.

3.2 Material selection:

Material for the links and other parts of frame for rocker bogie suspension system robotic arm chosen is Rigid PVC.The vehicle need to move in rough terrains and has to withstand higher temperature, humid environment so a material which is rigid, water resistant, heat resistant has to be chosen. Material should also be light in weight and economical to cost.Rigid PVC contains all these properties and is less expensive so best fitted for manufacturing.
Material properties of Rigid PVC-

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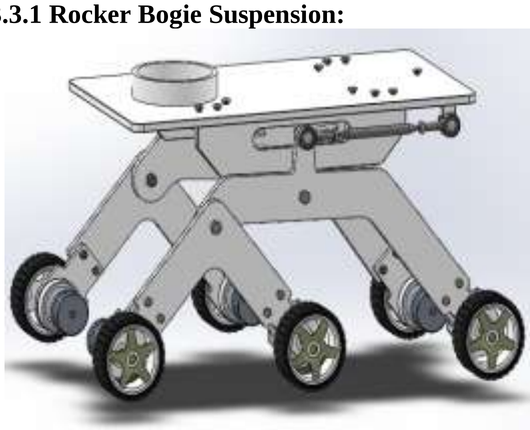
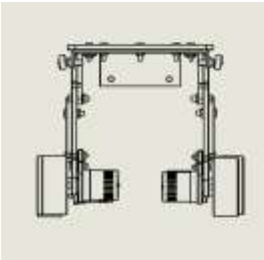
Property	Value	Unit
Elastic Modulus	2410000000	N/m^2
Poission's ratio	.3825	N/A
Shear modulus	866700000	N/m^2
Mass density	1300	Kg/m^3
Tensile strength	40700000	N/m^2
Compressive strength		N/m^2
Yield strength		N/m^2
Thermal expansion coeficient		/K
Thermal conductivity	.147	W/(m-K)
Specific heat	1355	J/(Kg-K)
Material damping ratio		N/A

3.3 CAD Model:
3.3.1 Rocker Bogie Suspension:

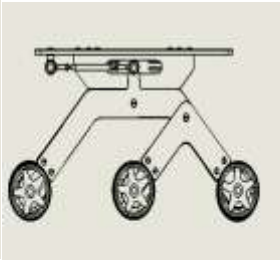


Mass Properties-
Mass = 2972.95 grams

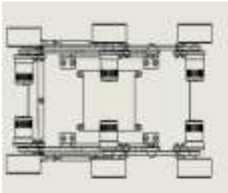
Volume = 1880513.81 cubic millimeters
Surface area = 759907.81 square millimeters
Center of mass: (millimeters)
X = 180.59
Y = 132.77
Z = 91.85



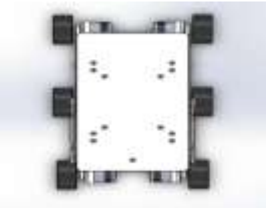
Front view



Side view



Bottom view



Top view

Bill Of Material-

Sr.no	Item number/name	Quantity
1	Battery Box	1
2	Platform	1
3	Central Arm	1
4	2.5mm Screw	13
5	2.5mm Nut	13
6	Bogie	2
7	Platform Base	2
8	Rocker	2
9	Motor	6
10	Motor Mounting Bracket	6
11	Motor Shaft	6
12	1.25mm Screw - Copy	18
13	2mm Screw	12
14	2mm Nut	12
15	Wheel	6
16	Tie Rod	2
17	Rod End	4
18	Cavity	4
19	Ball End	4
20	Tie Rod Nut	4
21	IS 1336 - M3 x 12 - - 12N	4
22	IS 1364-4 - M3-N	4

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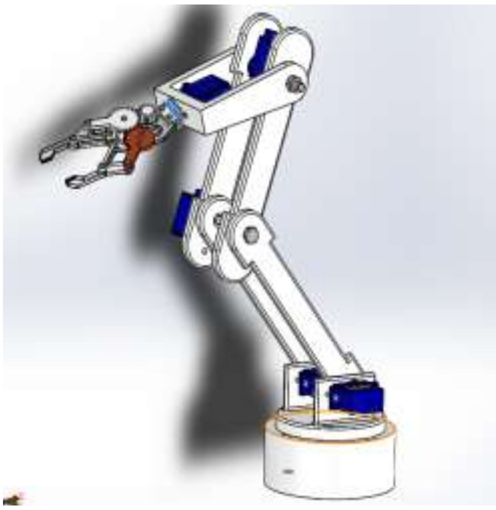
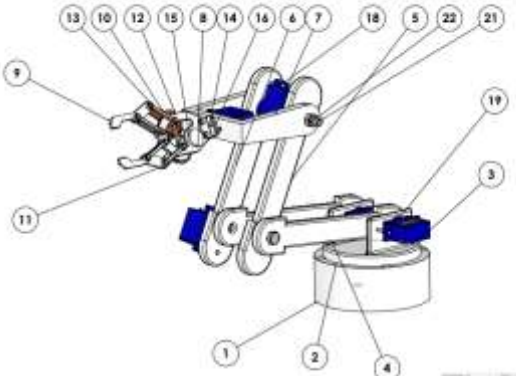
3.3.2 Robotic arm:



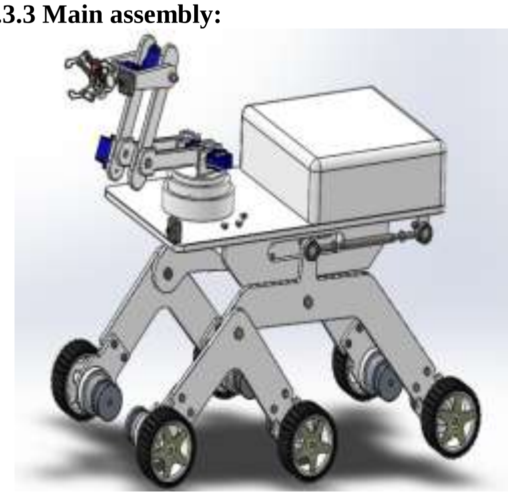
Mass Properties-
Mass = 312.63 grams
Volume = 239373.34 cubic millimeters
Surface area = 124588.66 square millimeters
Center of mass: (millimeters)
X = -7.56
Y = 54.26
Z = 6.86



Bill of Material-

Sr. No.	Item name/number	Quantity
1	fixed base	1
2	moving base	1
3	Towerpro Micro Servo 9g	6
4	Link1	2
5	Link2	1
6	Link2.1	1
7	LINK3	1
8	13	1
9	11	2
10	12	6
11	14	1
12	15	1
13	16	10
14	17	2
15	18	1
16	GTLC1	1
17	GTLC3	6
18	Pin1	6
19	Pin2	4
20	Pin3	2
21	IS 1364 HHB(Grade A) - M5 x 25 x 25-N	2
22	IS 1364-3 - M5-W-N	2

3.3.3 Main assembly:



Mass Properties-
Mass = 4243.84 grams
Volume = 2856996.33 cubic millimeters
Surface area = 1038505.79 square millimeters
Center of mass: (millimeters)
X = 186.88
Y = 183.78
Z = 92.61

IV. OTHER COMPONENTS:

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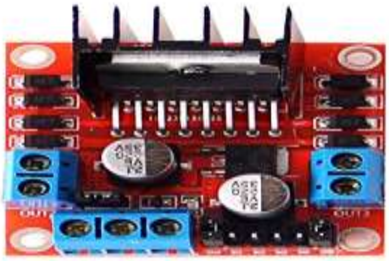
1) Arduino UNO R3
2) Wifi module ESP-01ESP8266

3) Motor driver module L298N 2A



4) GPS MODULE NEO 6M

5) Camera

6) BATTERY (LI-ION, 12 VOLT)

7) Wire
8) Glue
9) Tool box

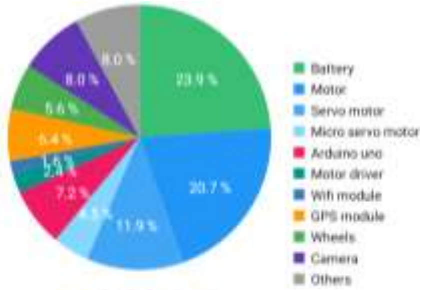
V. COST ANALYSIS:

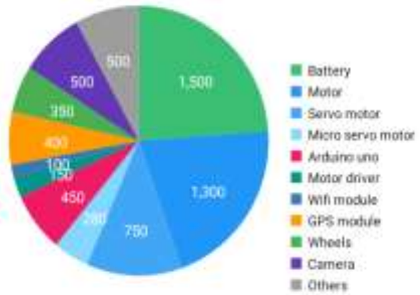
S. NO	Items	Qty.	Material	Amount (per piece)	Total
1	Links	31	PVC	N/A	500
2	Shaft	5	PCS	50	50
3	Battery	1	-	1400	1400
4	Wheel	6	Plastic	60	360
5	Motor	6	Alloy	150	900
6	SERVO MOTOR	6			1000
7	CAMERA	2		500	1000
				TOTAL	4410

SR.No	Items	Qty.	Amount	Total
1	ARDUINO UNO R3	2	250/pc	500
2	WIFI module	2	100	100
3	Motor controller module	1	140	140
4	PCB	2	25	50

5	Wire & cables		150	150
			Total	940

Total estimated cost= INR 6500





VI. CONCLUSION:

This is a broad field of study and is very less explored. So this gave us the idea for the development of this rocker bogie suspension system in a cost successful manner. Our aim during the development of the ROV will be to optimize the speed such that the ROV do not flip and may travel a little faster too and make it economical with maximum possible rigidity and strength. With the certain advancements the rocker bogie system can be used for defense related operations and also in towing trucks and other system for climbing stairs. According to the different weight acting on link determines the torque applied on it. By supposing exact stair dimensions, accurately sized rocker bogie can climb the stair with good stability. The designed and manufactured ROV can climb the angle up to 45˚. Also we tested for the camera with AV recording mounted on the platform of rocker bogie system and found satisfactory performance of its capability for providing image and video. It is possible to find the rover attitude and configuration, given its position and ground properties, and whether the rover will skid, tip or maintain its balance. The near to zero tilt system using the rovers power supply attached to the main frame of the rover to as a counter weight and self-balance itself reduces the chances of tilt or overturning. The mechanism of the rover has been developed, and the movement of the system results in the ability to affect the normal forces by applying specific wheel torques. This property has been checked practically and can be used for the design of an active traction control system.

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