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Rajarshi Shahu College of Engineering, Pune.

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[ME3106]: Engineering Design & Innovations –II

Report on

All Terrain Vehicle with Individual link Mechanism.

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Abstract

The vehicle that is designed and developed is capable of stabilizing the vehicle and passing over all obstacles. The unique gear mechanism used for transmission enables proper transmission of excessive force. The two front links provide a firm support to the vehicle. The additional links help in increasing the climbing capacity of the vehicle. the low rpm motors help in producing higher torque which is suitable in such applications.

The placement of additional links plays a crucial role in design procedure. Their shape and design also affect the climbing capability of the vehicle.

The SMPS is used to provide stable connection to the motors and proves to be more affective than battery operated Arduino where speed reduction is observed

Introduction

All-Terrain Vehicle (ATV) has become a necessity for the sectors like Military, Aerospace, destructive testing and inspection, etc. Specially in sectors like defence and aerospace remotely operated all terrain vehicle has become an integral part of their research and development because stabilizing the ATVs is big challenge today because of the Terrain.
ATVs are remotely operated vehicle having the capability of passing over all sorts of terrains irrespective of the gradient and ground quality.

Now a days most of the remotely operated ATVs operate on a conveyor belt drive, which provide sufficient stability, but face some difficulty while crossing on rocky terrains. The reason behind that is, balance of the vehicle over a individual beam on single side is difficult to stabilize.
Hence to overcome this issue conventional wheel drive assembly can be employed. Now considering the challenges in producing the minor parts for a small suspension system a simple yet robust system is designed that can overcome the problem up to certain extent.

This project is completely based on the development of a mechanism which is capable of overcoming the above-mentioned problems with the help of individual link mechanism.
The individual link mechanism is fixed with a bevel gear mechanism that is used to neutralize the excessive force developed while the vehicle passes over an obstacle.
The mechanism helps in stabilizing the vehicle and the helps it cross bigger obstacle.

Problem Statement

Now a days most of the remotely operated ATVs operate on a conveyor belt drive, which provide sufficient stability, but face some difficulty while crossing on rocky terrains. The reason behind that is, balance of the vehicle over a individual beam on single side is difficult to stabilize.

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Objectives

The objective this project is to develop a mechanism for the all-terrain vehicle which is capable of stabilizing it and enhance its ability to cross bigger obstacles.

The mechanism that will be developed should be robust enough to cross multiple obstacles of varying size and also maintain the stability of the vehicle.

At the same time, it should also cross its obstacle effectively.

The gears used for the transmission of the force should successfully accomplish their task.

Literature Review

- Zain Murtaza stated in their report that an unmanned ground Vehicle can be used for operations like GPS, GUI, XBEE etc if the apt sensors are mounted on it. Moreover, the vehicle can be used for mine detection by the defence foreces etc. The low-cost remote operated ground vehicle which demonstrated the potential application for this type of vehicle.

- Richard A. McKinney et. al. states that ATV technology allows for conversion to an autonomous robot. In fact, recently released models of Honda ATVs have power assist steering utilizing an electric motor to facilitate this conversion. Currently the steering time response of the ATV has a large overshoot and steady state error. Proportional Integral Derivative (PID) controllers are able to improve these time response characteristics as well as possibly alleviate wear and tear on the internal components of motors.

- M. Yacoub et al have concluded thatIn order to implement the conversion of a conventional vehicle into a UGV, four control mechanisms needed to be electrically actuated; the accelerator mechanism, the steering mechanism, the braking mechanism and the shifting mechanism. Two main design constraints were imposed to the proposed solution. The first is to keep the outer shape and dimensions of the original vehicle unaltered. The second is to maintain the deactivation and reactivation of the UGV mode as simple as possible to facilitate the normal operation of the vehicle.

- Debesh Pradhan et al states that The front links not only connects the two motor wheel pair (i.e., the front and the middle wheels) but also gets attached to the main chassis by means of front pivot. Hence, this link can rotate about the front pivot and rear links can rotate about rear pivot. To restrain the motion of the rear links, they are connected to the chassis via spring of suitable spring constant. Use of the additional spring in Rover 2 can be justified as the spring gets compressed when the front wheels encounter an obstacle, which helps to increase the normal reaction hence reduces slip. The rear springs connect the rear link with chassis allowing some flexibility which would be absent if instead rigid links was used. As the front wheel gets raised the spring gets compressed however the middle wheel remains in ground since the link joining front and middle wheels is pivoted in the middle and free to

rotate as per compression of front springs. This clearly explains use of front spring and link between middle and front wheels. Further, if the latter was a rigid joint and not pivoted in the middle the middle wheel would be found floating in air without any use during movement in staircase and other step obstacle overcoming.

Methodology

Initially a cad model was designed with rough dimensions and was fabricated.

The gears used for the model were purchased from the local steel vendor.

Before using, pilot holes were drilled inside the gears to make arrangement for the shafts with the hep og column drill.

While fabricating the model, initially the base plate was cut using the gas cutter.

Then according to the dimensions specified in the design the supports and shafts were cut using gas cutting. Then the links were made using the gas cutter and grinder after which the holes were drilled using the column drill.

Then a rough assembly was made out of all the components and then each component was either welded or fastened into its respective place. The entire assembly oriented on the meshing of gears as it was important to have proper meshing of gears to accomplish the objective. Now that all the components were assembly the entire model was cleaned to removed sharp edges and weld spots with the help of an angle grinder.

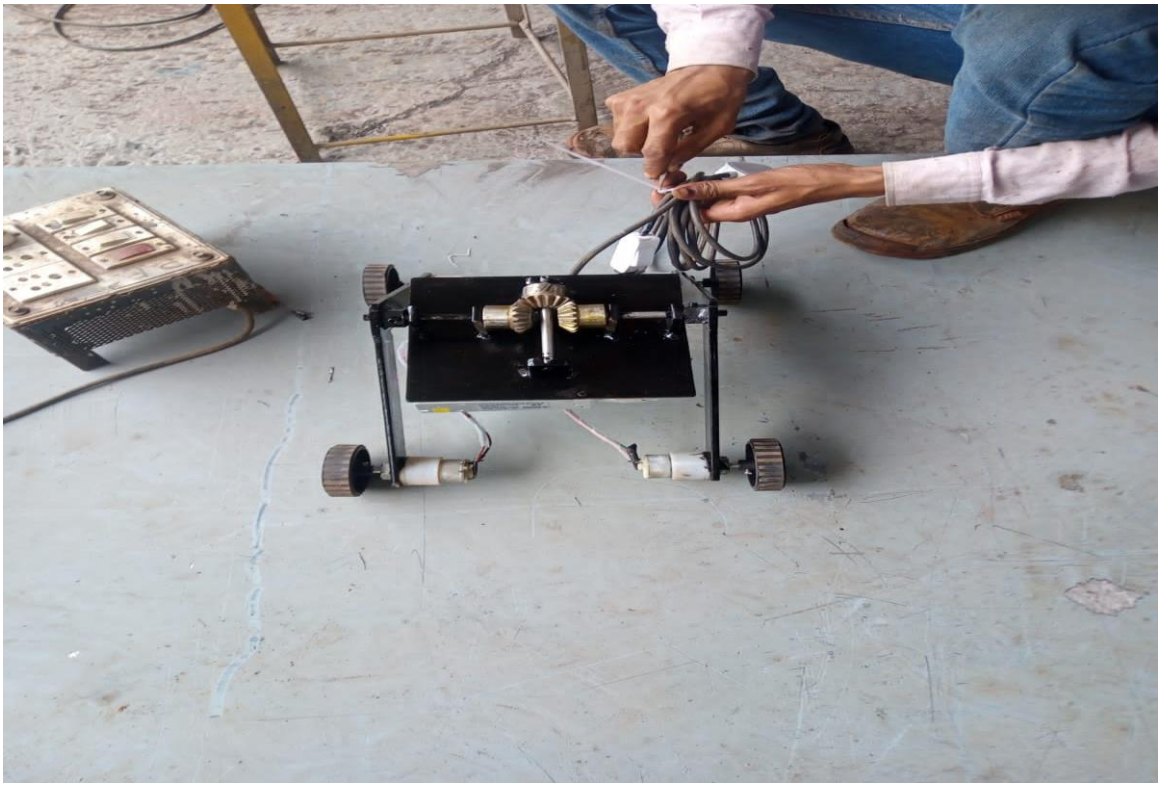
Finally, the entire structure was painted to prevent corrosion. After the structure was ready, the SMPS and motors were attached to the assembly and then the electrical connections were done. After all the components were assembled and the connections were soldered properly the model was tested.

The SMPS (Switching Mode Power Supply) was used to instead of Arduino to reduce the cost and the complexity of the circuit. Moreover, SMPS provides more stable connection and has least chances of fusing in case of overload or short circuiting. The SMPS consist majorly of bridge rectifier circuit which converts AC into DC.

The motors operate on a 12V DC supply at 30rpm. The motor speed can be varied with motor controller circuit if necessary.

The testing phase consisted of on ground experimentation of the vehicle on various obstacles and determining the areas where work was required.
The motors on one side of the vehicle were connected together in series with one another and that on the other side were also connected in the same way. This was purposely done to simplify the circuit.

While assembling the gears initially the gears were meshed together and the shafts were inserted inside them. These shafts were then inserted into their respective supports and when the meshing was proper, all the components were welded tot the base plate.




shot on moto g⁶⁰

Design And Operation.

Operation/Working.

When one side of the vehicle passes over an obstacle, upthrust is generated on the side of the vehicle. Now this excessive force needs to be neutralized in order to stabilize the vehicle. So, for that, links are attached to the wheels who move according to the force that is created. The links are connected to one of the shafts of the bevel gear mechanism that can transmit this force to other side.

The 3 bevel gears are meshed with each other and so the two gears which are connected to the links rotate in exactly opposite direction. Thus, when the gears rotate and the gear on the other side transfers the motion to link, the link moves in the exact opposite manner to that of the first link, to maintain the stability of the vehicle. In the is way the opposite action results in application of the resultant force which stabilizes the vehicle. The gears help to transfer the extra force and the links help in taking the required action. In this way the vehicle shock is absorbed.

If such system is not used that is the two links are connected to each other directly with the help of shafts the vehicle may experience a fall of accident which crossing a steep and sloppy obstacle for a longer time.

Thus, such systems are essential in these vehicles for their safety

The effect of the obstacle depends on its hight and also the diameter of the wheel. Larger wheels help in overcoming larger obstacles.

The additional links provided at the rear end help the front wheel to over come a larger obstacle with a shorter wheel diameter. They help in applying more force while climbing. If installed in the front, they can help climb over much larger obstacles. The location of the links plays a significant role in this. If the additional are not designed correctly they may face n issue while crossing the obstacle.

The placement of the additional links plays an import role in the design of the vehicle. If the links are attached slightly above the centre of gravity of the vehicle is disturbed making it unbalanced. To accomplish such design the dimensions of the

front link need to be altered. Currently the additional links are placed at the same level as the wheels of front link to minimize the design complexity. But to enhance the design their placement can be changed.

When the vehicle is passing over a steep obstacle, the additional links help in providing extra force to overcome it. The also help in supporting the vehicle while it climbing obstacles link steps or wall.

Advantages

- This robust system is cheaper than other suspension systems.
- Due to less moving parts the losses are less and hence the efficiency is more

Disadvantages.

- The link design may fail sometimes if the additional link entangles with some external body.
- The system is applicable only for remotely operated vehicles.

Applications:

- Remotely operated military vehicles for special operations
- Remotely operated vehicle for mine detection
- Space rovers

Design Considerations and CAD Drawing.

Dimensions of the components are mentioned below.

Base Plate: 190mm SQ, 2mm thickness

Link: 248X40X4mm

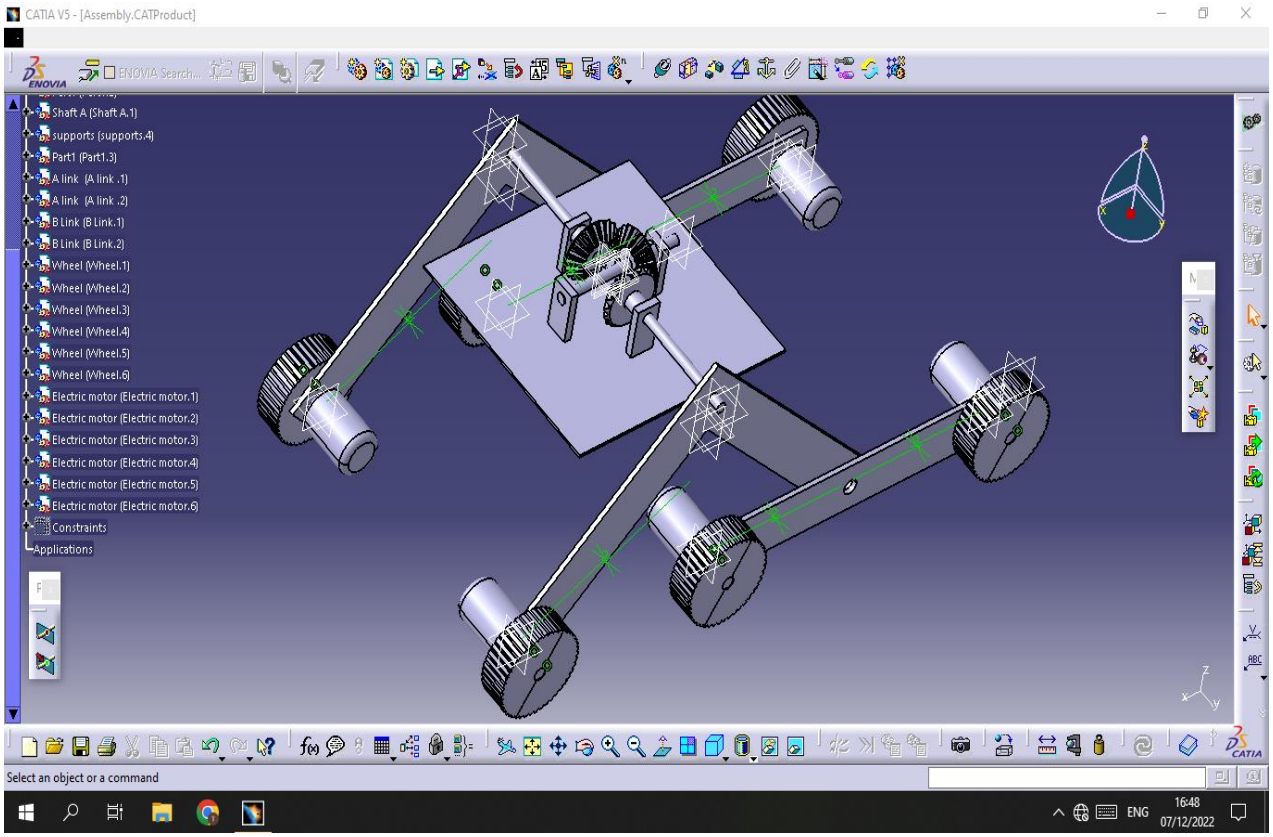
Additional link :300X40X4mm

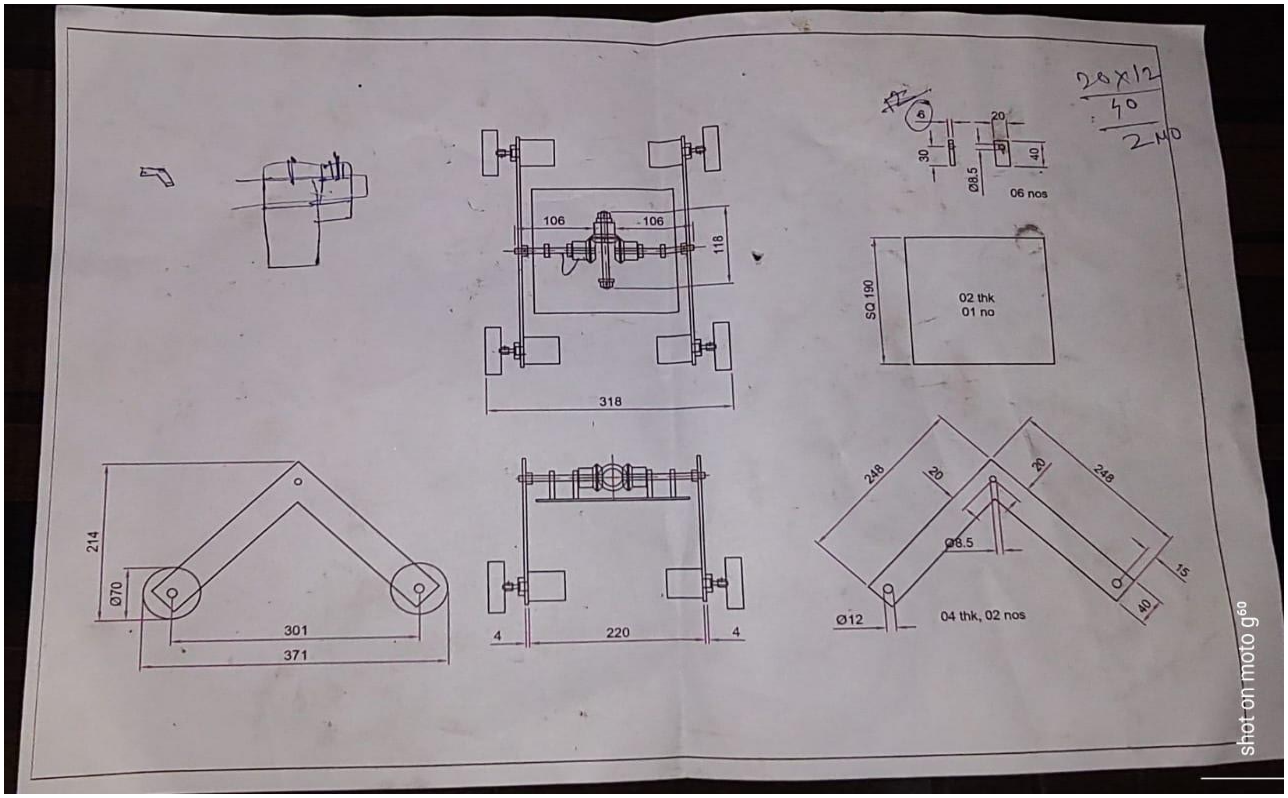
Gear: 16H2. (Gear number)

Wheel: 70mm dia.

Motor:12V DC 30rpm

Shafts: 12mm.

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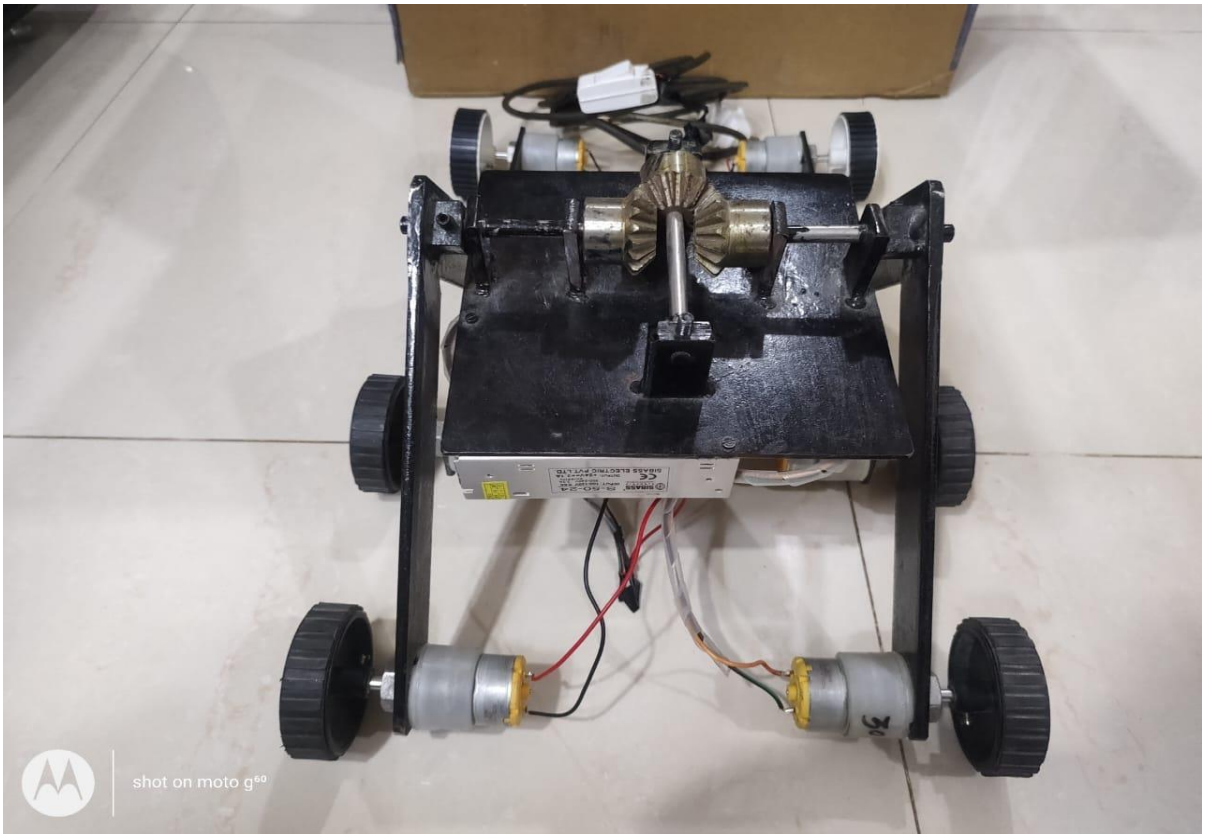
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Component specification

Bevel Gear

Bevel gears are most often used to transmit power at a 90° right angle. The axes of the two bevel gear shafts intersect and the tooth-bearing faces of the gears themselves are conically shaped. Bevel gears are most often mounted on shafts that are 90 degrees apart.

Material: Alloy Steel

No. of teeth:22

Module:3mm

Outer Diameter: 66mm

Type: Straight Bevel Gear.

Quantity:03.

Size: 25x25x25 mm

Other Details:

- Bevel Gears, Polyacetal Resin, Ratio 1:1 - 5:1
- Bevel Gears, Polyketone Resin, Ratio 1:1 - 5:1
- Angular Drive with Polyacetal Bevel Gears, Ratio 1:1
- Angular Drive with polyketone Bevel Gears, Ratio 1:1
- Bevel Gears Made of Brass, Ratio 1:1 - 4:1
- Bevel Gears, Steel, Straight Tooth System, ratio 1:1 - 4:1

Motor

Single phase

Operating voltage: 12VDC.

Speed 30rpm.

Weight: 150gms

Torque: 3 to 15 kgcm

SMPS

A switched-mode power supply (switching-mode power supply, switch-mode power supply, switched power supply, SMPS, or switcher) is an electronic power supply that incorporates a switching regulator to convert electrical power efficiently.

Like other power supplies, an SMPS transfers power from a DC or AC source (often mains power, see AC adapter) to DC loads, such as a personal computer, while converting voltage and current characteristics.

Input Voltage: 215-264V AC.

Output Voltage: 24V DC.

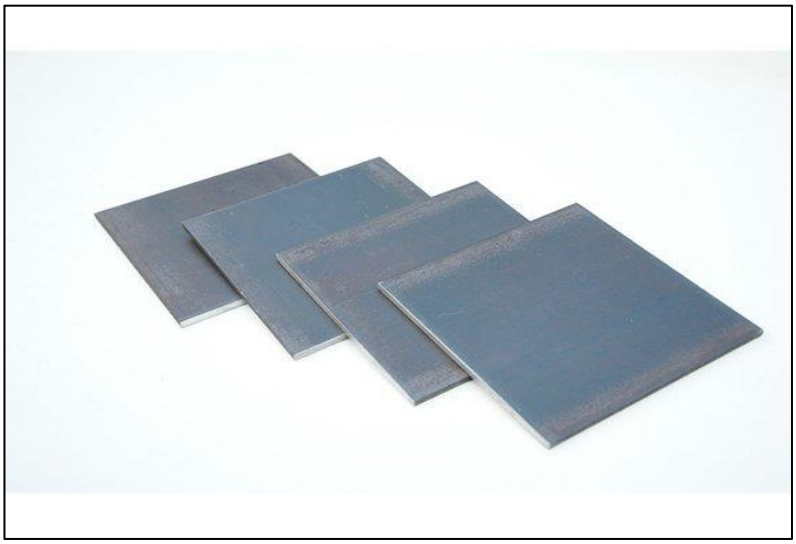
Output Current: 7Amp

Adjustable Voltage: 4.5V to 5V DC

Output Type: Single.

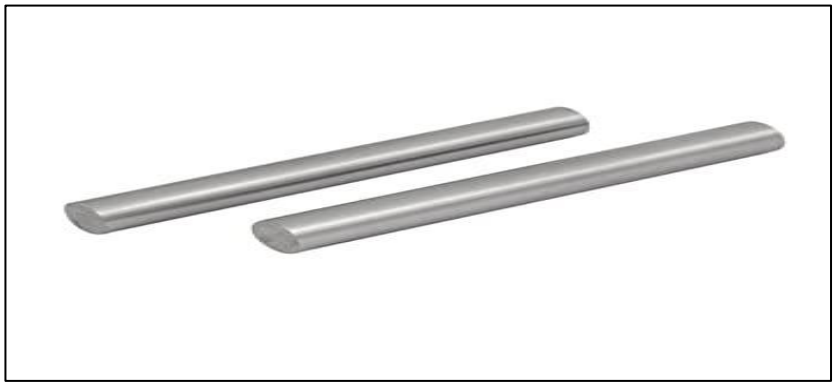
Phase: Single Phase

Base Plate, Link: Mild Steel



Mild steel material is selected to make the design more robust. Initially it was decided to make a 3Dprinted model but then understanding the material behaviour of the plastic fibres and their load carrying capacity, it was decided to use MS as the Base metal.

Shaft:



Material: Stainless Steel

Grade: (SS310)

Diameter: 12mm

Wheels

Diameter: 70mm

Width: 12mm

Material: Rubber.

Colour: White, Black

Costing

Sr. No	Component Name	Quantity	Rate	Amount
1	Motor	6	190	1140
2	Wheels	6	30	180
3	SMPS	1	650	650
4	Gears	3	400	1200
5	Miscellaneous	-	-	530
Total				3700

Conclusion.

The model that was developed was capable of passing over all sorts of obstacles. The vehicle can successfully transmit the upthrust from one side to another side and can also apply the resultant force. The result so produced was that the vehicle would experience a deflection of a few degrees which can be minimized by employing better machining techniques.

If the wheel diameter is increased the vehicle can cross larger obstacles

Future Scope

1. If the design of the link is changer from triangular to some other geometry it can help in crossing bigger obstacles.
2. If the shapes of the link and the additional link is changed from a rectangular section tto a C section it can result in better statistics.
3. Moreover a Arduino and a Bluetooth module can help in making it a wireless vehicle.
4. A freely moving link mechanism can help in giving a gyroscopic action the vehicle which can reduce its deflections.

Referances

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