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Design of All Terrain Reconfigurable Wheel Model

Rishi Kant[1], Saurav Kumar[2], Rashid Ali[3]

[1]Department of Mechanical Engineering , Siddaganga Institute of Technology ,Tumkur
[2] Department of Mechanical Engineering , Siddaganga Institute of Technology ,Tumkur
[3] Department of Mechanical Engineering , Siddaganga Institute of Technology ,Tumkur

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Abstract - An "All-TERRAIN RECONFIGURABLE WHEELS" or ATRW can make any vehicle capable enough to travel in almost any type of terrain. It ends the need of all-terrain vehicle (ATV). Moreover, ATRW is far cheaper compared to an ATV. The main objective of present work is to design and fabricate a good prototype of ATRW which will have wide range of application in defence, mining and agriculture sectors. The model proposed to make will help to give a better understanding about the challenges and design difficulties that will faced during fabrication of an actual ATRW ready to be used in a vehicle. It will also help to improve the design by minimalizing yet strengthening the complete structure of the wheel so that there is minimum or no chance of failure.

Key Words: All-terrain Vehicle, Wheel Orientation, Laser Cutting Process, Configurable Tracks

1.INTRODUCTION

The development of nation depends upon the achievements in the science and technology, which can strengthen the prosperity and security of the citizens. ATRW can be a great asset for our defence. It has capability of changing any normal vehicle into all-terrain vehicle. All-terrain vehicles (ATV): All-Terrain Vehicle or in short called as an ATV is basically a Land based automobile capable of reaching remote areas where normal cars/bikes cannot reach. Main focus of an ATV is to provide comfort and safety in uneven terrains. They function in environments like Riverbanks, mountains, snow, Forests etc. Pretty much anywhere taking your everyday cars/bike isn't practical.All-terrain vehicles have found various uses in: 1. Rescue operations in inhabitable land, 2. Military Combat Vehicles, 3. Adventure sports, 4. Mining and Exploration missions, 5. Agriculture, etc.

General Wheel Design:

Fig 1. In general wheels are of two types, the first one being the conventional wheels as shown in fig 1.1 that we see every day and the other is called tracks that we see in military tanks, JCB's, snowmobiles, etc as shown in fig 2 and 1 . The former is used in hard surfaces like roadways, mountainous terrains, etc. while the latter is used in soft surfaces like sand, mud, snow, swampy terrain. Now the efficiency of these vehicles is reduced by great extent due to 8 the tracks they use, the tracks reduce the mobility of vehicles as it decreases its speed on hard surfaces like road.

2. Background

2.1: 3-D PRINTING:

3D printing or three-dimension printing refers to the process in which the desired three-dimensional objects are created layer by layer deposition of material. The process of layer formation is controlled by a computer system. There are many different 3D modelling processes.

Some are listed below:

1)Material jetting

2) Vat photo polymerization

3) Material extrusion

4) Sheet lamination

5) Binder jetting

In our fabrication process, we are using the technique called material extrusion technique. This is the most commonly used technique in 3D printing Material extrusion technique: 9 Material extrusion technique is

also known as fused deposition modelling (FDM).It works on an "additive" principle by laying down material in layers. A plastic filament or metal wire is unwound from a coil and supplies material to produce a part. Thus, FDM is known as a solid based AM technology. It is referred to as "plastic jet printing" (PJP).Fig 1.3(a) and (b) shows the various parts of a 3-D printer.

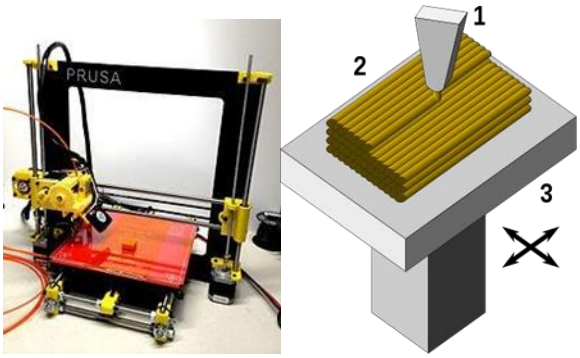


Fig : 3 (a) and (b)

2.2: LASER CUTTING

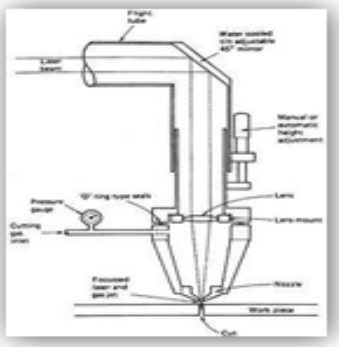


Fig 4 : Laser Cutting Mechanism

- Laser cutting is a technology that uses a laser to cut materials and is typically used for industrial manufacturing applications. Laser cutting works by directing the output of a high-power laser obtained through optics. The laser optics and CNC (computer numerical control) are used to direct the the laser beam generated. A typical commercial laser for cutting materials involved a motion control system to follow a CNC or G-code of the pattern to be cut onto the material. The focused laser beam is directed at the material, which then either melts, burns, vaporizes away, or is blown away by a jet of gas, leaving an edge with a high-quality surface finish. Industrial laser cutters are used to cut flat-sheet material as well as structural and piping materials.

Fig 5 : Laser Cutting Process

2.3: PROBLEM DESCRIPTION AND OBJECTIVES

1) Need for a better alternative: -

- The military combat vehicles and artillery guns have to be air lifted to the battlegrounds due to their incapability of mobility in tough terrains like the mountain ranges, snow, swamps, desert, etc.
- In mining ground it's extremely difficult and unsafe for mining dump trucks to travel via uneven plain using ordinary wheels due to the risk of slipping.
- Vehicles used for search and rescue operation are only specialized for mobility in a particular terrain and that makes them inefficient during a search and rescue operation as there is a requirement of the vehicle to move in diverse terrains.
- Every terrain requires a different type of wheel for smooth and stable motion.
- Normal wheels are not efficient and stable in soft and swampy terrains (like mud, snow, swamps, desert, etc.). Wheels which can have slipping motions with the ground are preferable for these areas.
- For hard and tough terrains wheels with rolling motion are preferred.

Fig 6: Triangular wheel Tracks

2) Objectives:

Usual wheels used in automobiles cannot be used in rough terrain in some important application it is required that the vehicle needs to be moved in very rough terrain wherein the usual wheels are of no use. To overcome this problem, it is required to use specially

designed wheels which can move in rough terrain without any problem.

a) Taking this in consideration the main objective of present work is to develop a model of wheel which can be used in all terrain.

b) The other objectives are to fabricate the components required using 3-D printer and laser machining.

3. Design And its Components

3.1: Proposed Solutions

Fig 3.1 Different wheel orientations

The ALL TERRAIN RECONFIGURABLE WHEELS have both rolling and slipping motion depending upon the surface in contact. For smooth and swampy terrains, the triangular track like orientation of wheel provides slipping motion and conventional circular orientation of the wheel is used for hard and tough terrains. The wheel can be reconfigured into any of the two orientations as per need.

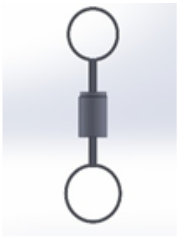
In order to overcome this major issue in these vehicles and convert them into an all-terrain vehicle we need to redesign the wheels into a reconfigurable one that can change into tracks as per requirement. This will be of great help in the military as the military vehicles need to travel in almost all types of terrains within a short period of time. These wheels can also be used in vehicles which are used to commute in deserts and snowy regions.

3.2: Background of Design

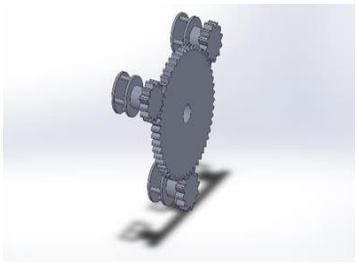
The idea for design and fabrication of an all-terrain reconfigurable wheel is a very new one and is still in a conceptual phase. Organizations like DARPA has developed versions of this wheel are highly classified and are not accessible to other countries. Such wheels can play a major role from military point of view for transport of heavy vehicles through rough terrains like mountain areas, swamps, deserts, snow, etc.

The application of these wheels in military creates the need to develop these all terrain reconfigurable wheels in India, as our country has its international borders in very tough terrains which deprive us to give quick land support in war fronts. Heavy vehicles have to be air lifted due to their incapability of mobility in such tough terrains. These reconfigurable wheels provide us with a solution for all our military needs w.r.t. mobility. There is no research going on in our country on this topic and hence the present work is to address this issue.

3.3 : Components and Working Process:



1)Hydraulic Systems -A hydraulics system functions and performs by using fluids that is pressurised. In a hydraulics system pressure applied to a contained fluid at any point is transmitted undiminished. That pressurised fluid acts upon every part of the section of a containing vessel and creates force or power. Due to the use of these force and depending on how is applied operators can lift heavy loads.



2) Epicyclic Gear train- It consists of two gears mounted so that the centre of one gear revolves around the centre of the other. A carrier connects these centres of the two gears and rotates to carry one gear called the planet gear around the other called the sun gear.

3)Drive Shafts – It is a mechanical component used for transmitting torque and rotation.

4)Wheel Tracks – It is a system of vehicle propulsion in which a continuous band of treads or track plates is driven by two more wheels.

5)Wheel Hub – It is a mechanical part the holds the skeleton of the wheel together and is connected to the drive shaft.

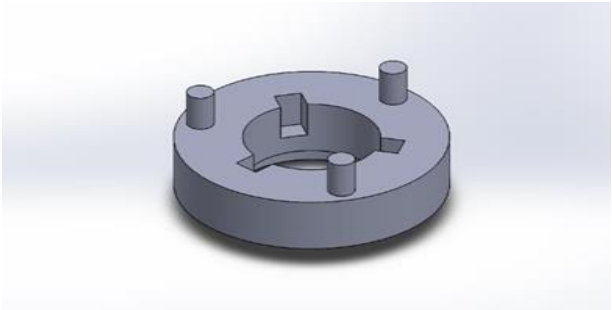


Fig : Wheel Hub

4. Working of Prototype

Drive shaft is connected to the power transmission through a differential. The end of the drive shaft is a hydraulic system that is mounted with a gear in it which at first is mounted with a gear which first make the drive shaft rotate which in turn rotate sprocket and thus the wheel rotates, which is in circular orientation.

The motion taking place in this orientation is rolling in nature and wheel behaves like any other ordinary wheel

Now in order to change the configuration of the wheel the hydraulic drive shaft is actuated which shifts the gear in epicyclic gear system. The epicyclic gear systems also called sun and planet gear system has one central gear (sun gears having both internal and external teeth). The gear mounted on the shaft transmits power to the central gears which is turn rotates the planet gears.

The three hydraulics cylinders at the center of the circular wheel attached simultaneously shifting the planet gear to form the triangular orientation of the tracks. In this way the wheel reconfigures its shape from circular wheel to triangular tracks. In the triangular orientation planet gear along with rollers moves the tracks to provide a slipping motion with respect to the surface.

5. Fabrication of Prototype (steps)

1) Ideation-

The idea- "A wheel which can change its shape depending upon the type of terrain it is travelling through. It has capability to convert any vehicle into ATVs.

2) Literature survey – Studied the working of ATVs and the technology incorporated in these vehicles.

3) Planning- Designed the wheel to achieve the desired mechanism for transition from one orientation to other.

4) Analysis- Using Ansys software and finite element method the stress-strain distribution acting on different components of the system is analysed.

5) CAD design- Designed each and every components of the machine according to the plan using SolidWorks.

6) 3-D printing- Fed the CAD design into Netfab software to repair and then to Repetier to get 3-D printed parts required.

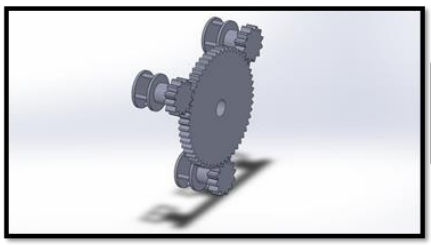
7) Laser cutting- Parts like gears, pinion and skeleton of the wheel are cut from acrylic sheets using laser cutting device.

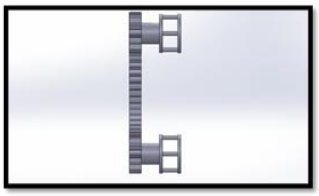
8) Assembly- All the 3-D printed and laser cut parts are assembled together to obtain the model of ATRW.

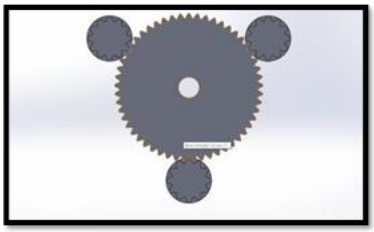
6. Advantages of ATRW

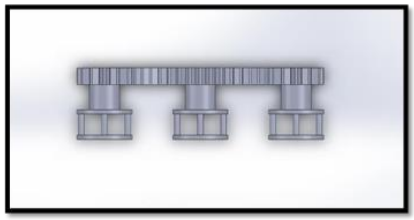
•The military combat vehicles and artillery guns equipped with these wheels can provide quick response in any type of terrain where the battleground lies thereby ensuring reliable support in war fronts.
•In mining ground it's extremely difficult and unsafe for mining dump trucks to travel via uneven plain. ATRW can provide sufficient grip and avoid slip in the narrow and difficult terrains in these fields avoiding any accident ensuring the safety of workers.
•In agriculture, the farmers can switch between these orientations of wheels when on cultivating fields or on road as per demand to increase the efficiency of vehicle.
•In search and rescue operation vehicles these wheels can have remarkable effects as the vehicle will not be restricted to carry out its operation in a particular terrain only thus saving numerous lives.
•Every terrain requires a different type of wheel for smooth and stable motion. ATRW will adjust the orientation of wheel depending upon the surface of contact.
•Normal wheels are not efficient and stable in soft and swampy terrains (like mud, snow, swamps, etc.). Wheels which can have slipping motions with the ground are not preferable for these areas. ATRW can be used conveniently in these areas.

7. SolidWORKS Models :

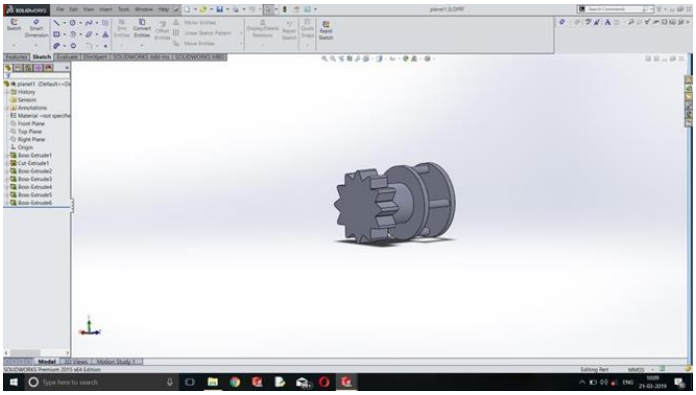

:ISOMETRIC VIEW

SIDE VIEW:


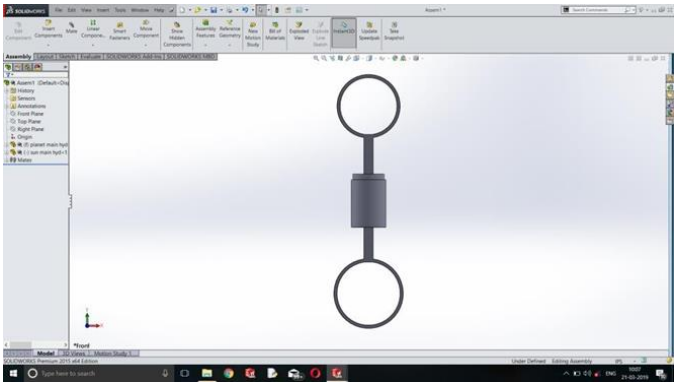

: FRONT VIEW



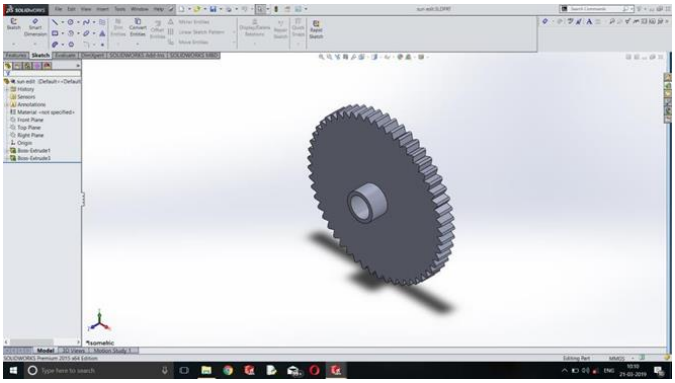
TOP VIEW:



PINION



HYDRAULIC



GEAR

8. CONCLUSIONS

The model of ATRW has been fabricated.

The model propose gave a better understanding about the challenges and processing difficulties that was to face during fabrication of an actual ATRW ready to be installed in a vehicle. It also helped us improve the design by minimizing yet strengthening the complete structure of the wheel so that there is minimum or no chances of failure.

With the help of ATRW it's possible to get a reliable performance on all types of terrains from any vehicle in which it is installed thereby serving its sole purpose. The orientation of the wheel has been changed as per required terrain with the help of a single lever. Its features add a lot ease for its customers in commute no matter which type of terrain they are travelling in.

The ATRW can find its application in various sectors like military, mining, search and rescue, agriculture, adventure, general off-road mobility, etc.

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