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DESIGN AND DEVELOPMENT OF TRI-STAR WHEEL ROVER

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Abstract: This project is a Prototype model of "TRI - STAR WHEEL ROVER". This project describes the mechanical design and development of Tri-Star wheel system for surveillance mobile robot. The robot will be used to enter potentially dangerous disaster site in search of human survivor and to collect some related information for rescue team. Surveillance mobile robot need to be able to overcome natural and virtual obstacles such as stairs which are the most known obstacles in the collapse buildings. The vehicle has four set of wheels arrangement to support its weight when it moves over the flat terrain. Each wheel frame consists of three sub-wheels attached with the sun wheel through three idle gears.

Keywords: Tri Star wheel., transporter, flat terrain etc.

1. INTRODUCTION

It is undeniably challenging for the typical robot to move higher up or at high statures as they are in absence of equilibrium they might tumble down without any problem. To beat this issue, here we planned and fostered a Tri Star wheel Rover which can adjust to any surface and will move in that manner with no interference. This machine animates movement of a robot so we call it as Tri Star wheel meandered.

A Tri Star wheel comprises of a three spoked wheel, with 3 leaf wheels on the finish of each spoke, all fuelled. This implies that very still, each Tri-Star wheel is probably going to have two leaf wheels in touch with the ground. On level landscape, the leaf wheels will just turn, and give basic, and moderately proficient footing. The entire gathering, leaf haggles is alluded to as a "meta-wheel".

1.1. DEFINITION OF PROJECT

Prototype consists of a camera module, voltage regulator circuitry with L293D motor driver and Arduino UNO. The real time video is displayed on the display which can be viewed from anywhere in the world using internet or within the Wi-Fi range and one can control it using the control provided.

- Setting up the Arduino UNO and installation of required packages.
- Write the controlling of the robot code based on the L293D IC logic.
- Connect the Wi-Fi dongle to connect Arduino UNO with Wi-Fi router.
- When it is connected with the WIFI router IP address can be found.
- Once we got the IP address, we can use it for the controlling purpose.
- Now build the robotic unit we can use DC motor based simple robot.to control the motors

L293D is needed.

- Connection of power supply. Arduino UNO gets turn on as soon as power is supplied.

1.2 DESIGN PRINCIPLE

An epicyclic stuff train comprises of two cog wheels mounted so the Centre of one stuff spins around the Centre of the other. A transporter associates the focuses of the two cog wheels and turns to convey one stuff, called the planet gear, around the other, called the sun gear. The planet and sun gears network so their pitch circles roll without slip. A point on the pitch circle of the planet gear follows an epicycloids bend. In this improved-on case, the sun gear is fixed and the planetary stuff's roll around the sun gear.

An epicyclic stuff train can be amassed so the planet gear rolls within the pitch circle of a fixed, external stuff ring, which is called an annular stuff. For this situation, the bend followed by an on the pitch circle of the planet is a hypocycloid.

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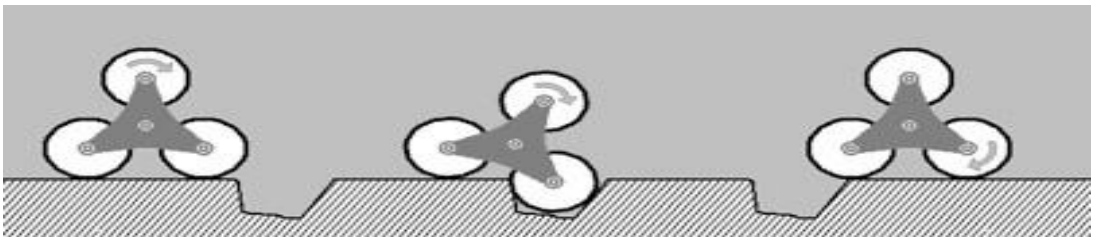

Fig 1: Tri-Star Wheel in Motion (From Internet)

1.3 PROBLEM STATEMENT

Today in this contemporary existence where innovative upsets particularly in guard space licenses nations to show its extent of force. These days the conflict is not being battled on front line yet interest subtleties of our adjoining nations assume a huge part to keep up with sound outer issues.

1.4 PROBLEM SOLUTION

As we as a whole realize that robots are supplanting people and to acquire high versatility on testing landscapes, a portable put together robot working with respect to Tri-Star wheel instrument administered via Planetary Gear course of action has been proposed.

The Robot is planned such that it can scale the deterrent with the assistance of its wheels by having both rotatory and progressive movement and furthermore hold its importance in Surveillance purposes. It is manageable to continue on run of the mill landscape regions.

It has been made viable with Bluetooth module framework subsequently making it wireless. And intensifying it with our camera makes it entitled for observation purposes.

1.5. SOLUTION APPROACH

The investigation of different exploration papers containing utilizations of the Tri – star wheel system. Their testing has been done to climb a particular tallness of the snag by the tri star system. Plan and creation of the meandered have been finished with the assistance of Solid works and 3D displaying innovation, individually.

2. FINAL 4DESIGN

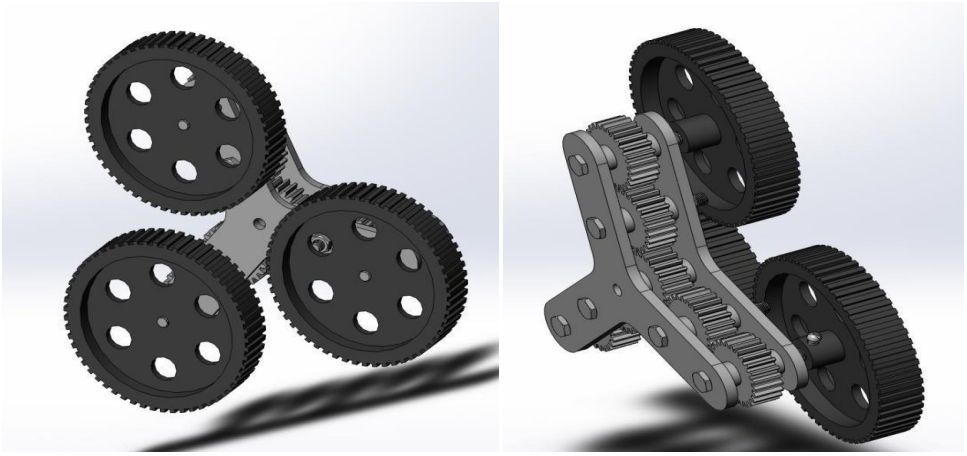

Fig 2: Design of Tri-Star Model (CAD Model)

2.1 SPECIFICATION OF MODEL:

Weight: ~ 1.5 kg

Size: 53 x 46 x 22 cm^3

Chassis Material: Wood

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2.2 DESIGN CALCULATIONS:

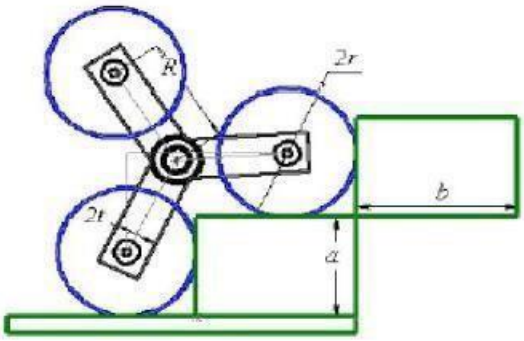


Fig 3: Tri-Star wheel on hurdle

were,
R = the distance between the centre of Tri-Star wheel and the centre of its wheel a = the height of the stairs b =width of stairs r = radius of regular wheel
t = the thickness of holders that fix the wheel on its place on Tri-Star wheel

Minimum radius of regular wheel (r_{min}) to prevent the collision of the holders to the stairs is derived as follows:

$$r_{min} = \frac{6Rt + a(3b - \sqrt{3}a)}{(3 - \sqrt{3})a + (3 + \sqrt{3})b} \quad \text{----------(3)}$$

Now putting the respective values in Equation 3;

R=7.8 cm, t=1.2 cm
a=8 cm b=15 cm

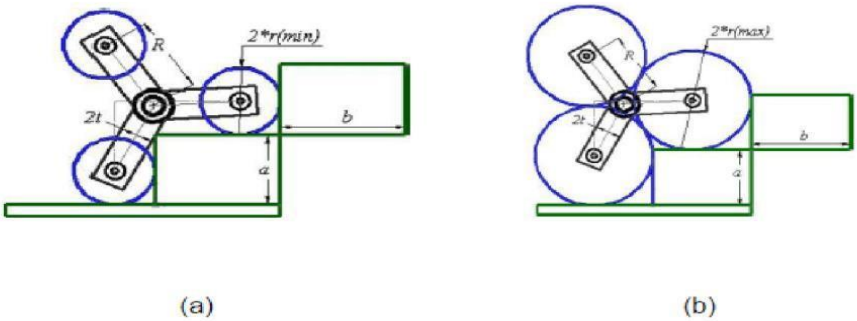
$$Rmin = \frac{6 \times 7.8 \times 1.2 + 8 \times (3 \times 15 - \sqrt{3} \times 8)}{(3 - \sqrt{3}) \times 8 + (3 + \sqrt{3}) \times 15}$$

The value of R_{min} obtained is 3.8cm.
Maximum radius of regular wheel (R_{max}) to prevent the collision of the wheels together refer to Figure (2):

$$R_{max} = \frac{\sqrt{(a^2 + b^2)}}{2} \quad (4)$$

$$Rmax = \frac{\sqrt{289}}{2}$$

Also, putting values of and b in Equation 4 to calculate the value of R_{max}
The value of R_{max} obtained is 8.5cm.



(a) (b)

Fig 4: Minimum and Maximum Radius Wheel

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2.3. GEAR SELECTION:

The specifications of gears are obtained According to the centre-to-centre distance at holder (R) the pitch diameter of gear have chosen to be 40 mm refer to figure 3, all planetary gears have same dimension that we need to transmission same power to all wheels.

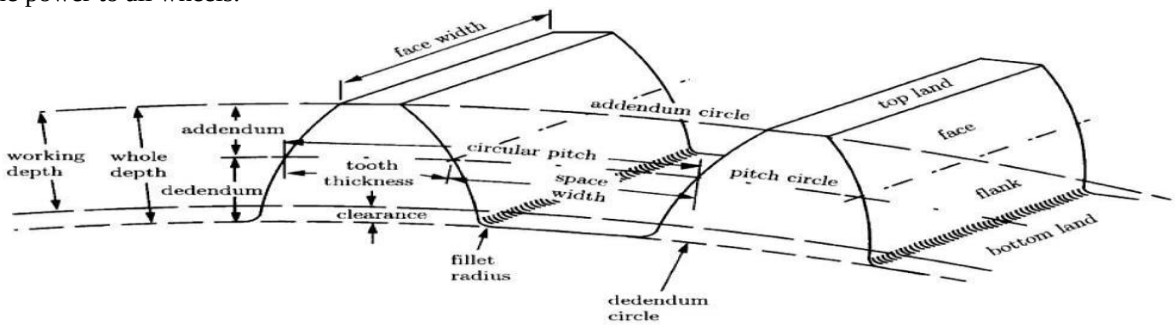

Fig.5: Gear Terminologies (From Internet)

- **Module:**

It is the ratio of the pitch circle diameter in millimetres to the number of teeth. It is usually denoted by (m) according to the size requirements of the triangle star wheel and in order to decrease the installation accuracy. m=DT m=4025=1.6mm.

- **Pitch diameter (D):**

It is the diameter of the pitch circle (an imaginary circle which by pure rolling action would give the same motion as the actual gear).
Here, D=40mm

- **Pressure angle or angle of obliquity:**

It is the angle between the common normal to two gear teeth at the point of contact and the common tangent at the pitch point. It is usually denoted by φ. The standard pressure angles are 14 ° and 20°.

- **Total depth (h_t):**

It is the radial distance between the addendum and the duodenum circles of a gear. h_t=2.25×m h_t=2.25×1.6=3.6 mm.

- **Tooth thickness:**

It is the width of the tooth measured along the pitch circle Tooth thickness=1.57×m
1.57×1.6=2.51 mm.

3. WORKING OF THE PROJECT

- The regulator presses the switches for the development of the Rover.
- The signals are communicated from the versatile to the Bluetooth module on the meandered utilizing Arduino the single is changed over and ship off the engine driver.
- The DC Motors controls the sun stuff of the relative multitude of 4 wheels.
- The sun gear sends rotational movement to the planetary stuff joined around its pivot.
- The planet gears fixed to the wheels, drive the wheels on the ground or landscape.
- As soon as the wheels interact with a snag, the wheel stop because of which the movement of the planet gears are ruined.

Due to which the force accessible at the sun gear is communicated to the transporter arm and transporter arm pivots about its hub.

3.1 DESIGN SPECIFICATIONS:

3 Length of Rover – 53 cm 2. Width of Rover – 46cm 3. Height of Rover – 22 cm 4. Wheel Diameter – 11cm 5. Gear Diameter – 4cm 6. DC motor – 30 rpm

7. Battery Capacity – 2200 mAh 8. Camera Resolution (Web Server type) – 2MP

9. Ground Clearance – 10 cm 10. Base width – 30 cm.

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3.2 FINAL IMAGES OF TRI-STAR WHEEL ROVER:

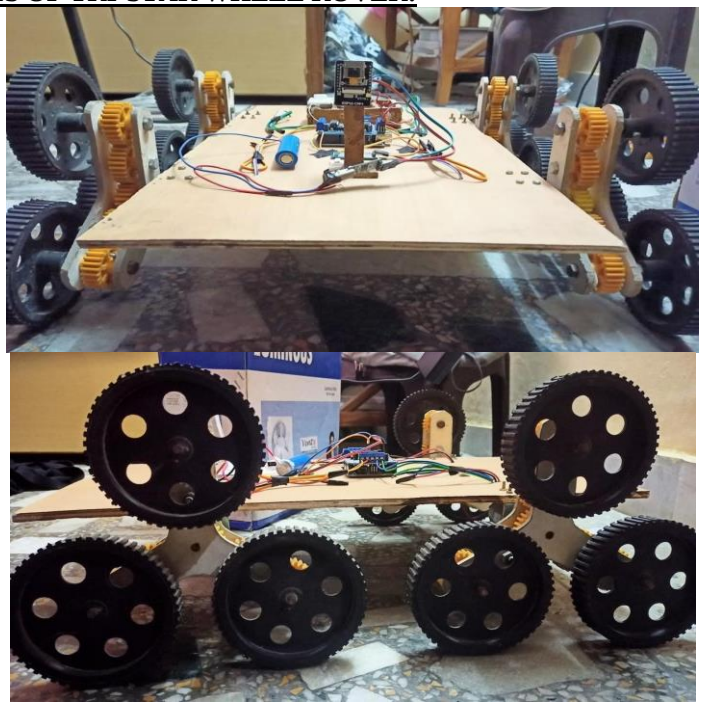

Fig.6: Final Image of Tri Star Wheel Rover (Assembly Design)

4. RESULT ANALYSIS AND DISCUSSION

4.1 CALCULATION:

To select a proper motor to drive this system we have to determine the following specifications.

4.2 POWER CALCULATIONS:

Input voltage through 18560 LI-ION CELLS= (3.7×2=7.4) volts.

Input current= 4400mA Using the formulae; $\boldsymbol{P}=\boldsymbol{V}\times\boldsymbol{I}$

Power comes out to be 32.56 Watt.

4.3 TORQUE CALCULATIONS:

$\boldsymbol{P}=\boldsymbol{T}\times\boldsymbol{w}$ $\boldsymbol{w}=\boldsymbol{2\pi N60}$

$\boldsymbol{T}=\boldsymbol{P}\times\boldsymbol{60}\div(\boldsymbol{2\pi N})$ Where N= RPM of motor

- For N=30RPM

$T=32.56\times60\div(2\times\pi\times30)$ Torque=10.36 N-m

- For N=45RPM

$T=32.56\times60\div(2\times\pi\times45)$ Torque=6.9129 N-m

- For N=60RPM

$T=32.56\times60\div(2\times\pi\times60)$ Torque=5.1820 N-m

4.4 HEIGHT CALCULATIONS:

The goal is to determine a configuration which optimizes the Tri- wheel such that the centroid of the Top wheel is collinear with the vertical edge of the step when the step rise is maximized.

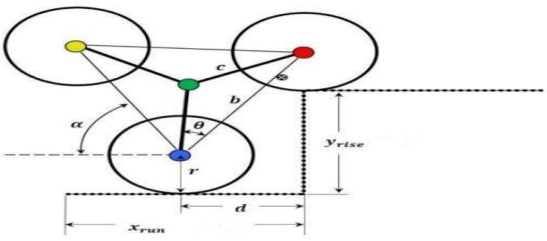

Fig 7: Maximum Height Calculation

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As per the following notations from the figure3:
Now taking value of c= 7.1cm
Putting the value in Eqn 1 we will get d=9.339 cm
Now taking value of b=12.8 cm
Putting the value in Eqn 2 we get
Y_{rise} or H_{max} = 8.75 cm
But Practically H_{max} Obtained Is 8 cm %Error = $(\mathbf{8.75}-\mathbf{8})/\mathbf{8}.75\times100=8.5\%$

5. CONCLUSION

All in all, the Tri-Star Wheel system has been effectively evolved from a hypothetical portability answer for a completely useful evidence of idea and working model. The commitment of this work is to give a clever motion system that empowers a robot to surpass current straight velocities for robots, climb obstructions and navigate impediments, and do as such keeping cost, space imperatives, and heartiness as a top priority. This plan has been improved particularly to viably climb an assortment of standard hindrances or obstacle measurements and gives usefulness that is presently viewed as absent among other normal headway ideas in the wake of evaluating their capacities. It is cheerful that innovation can be carried out in different applications like hazardous law removal and maybe even extra earthbound investigation.

In this venture we have created Tri-Star wheel meandered for offering the support to supplant the human in many fields like military undertakings, security frameworks and perilous climate. The created model has finished the job effectively

During the trial of this venture, it was understood that it would equip for furnishing live film with powerful quality and speed which could be utilized for observation in crisis circumstance, on the off chance that it would go into genuine creation at an optimal scale. However, the underlying expense of the venture appeared to be higher yet more exact assembling would abbreviate this.

The last Tri-Star Wheel idea either meets or surpasses every one of these exploration destinations, as approved by the testing and establishment measure. It is cheerful that this plan will eventually add to the general security of the fearless people on call who assist with protecting our networks. In the more extensive feeling of science, the Tri-Star Wheel adds its tire tracks to the current rundown of velocity ideas, giving new usefulness and potential inside this field of examination.

However, there is opportunity to get better and future development, this examination has approved execution of the Tri-Wheel through fundamental testing and has consequently certified the investigation prompting the end result—all while showing its planner a considerable amount route.

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