ANALYSIS ON ASSOCIATION OF FUNDAMENTALS ON 360° ROTATING AND SOUND WAVE FIREFIGHTING ROBOT

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Abstract
The Endeavour The creation of a sound wave-powered, 360-degree rotating firefighting robot is related to a novel fire extinguisher approach. The least amount of time is spent on the firefighting operations. A sound wave fire extinguishers primary function is to extinguish flames by employing sound waves that fall inside a certain frequency range. The ability to tackle fires at an early stage aids firefighters. All forms of fires can be put out by sound waves between the frequencies of 45 and 55 Hz. The fire must be put out as soon as possible, and more effort is not necessary to accomplish so. Our project's anticipated outcome is to put out the fire earlier, which will ensure worker's safety. Zero turn steering gives much better maneuverability and control on the car. We have developed a new idea for our four-wheel driving vehicle which will help us to turn the vehicle about its vertical axis. Zero degree turning capability is achieved by turning the front adjacent wheels in opposite direction and by steering the rear adjacent wheels opposite to the front wheels which signifying reduces the turning radius of the vehicle to almost zero.
Keywords: Sound wave Fire extinguisher, 360° rotation, zero degree turning, four wheel steering, vortex tube.

1. Introduction

Automobiles are now a need for both passenger and cargo transportation in the modern world. The first four-wheeled vehicle was unveiled in 1893 by Benz. The Spijker Brothers in the Netherlands created the four-wheel steering system in 1902; it was intended to make turning the vehicle simpler by practically reducing the turning wheel base. This made the steering mechanism considerably more effective. Because steering adjustments are small at high speeds, the rear wheels turn in the same direction as the front wheels at low speeds but in the opposite way at high speeds. By changing the direction of the rear wheels there is reduction in turning radius of the vehicle which is efficient in parking, low speed cornering and high-speed lane change. In many or all vehicles are steered by turning the front wheels in desired direction, while rear wheels following there are several problems of parking at public places, parking at home, parking at multiplexes and traffic jam etc. So, to overcome these problems main aim is to developing the system having minimum turning radius or required minimum turning space.so we have chosen zero turn vehicle as it indicates that the vehicle can turn without leaving the gravitational axis and subsequent radius would be almost zero. The existing fire extinguishers have many flaws. The present existing techniques are not eco-friendly, here comes the need for a new way or technology to extinguish the fire which will not ham anything except the fire. Sound waves are the potential technology to achieve such a task by propagating low frequency waves using speakers and are concentrated using vortex tube.

2. Review of Literature

Caiyi Xiong et al., (2021) explored acoustic-driven flame extinction via different experimental techniques, but the interpretation of results and the underlying mechanism are still unclear. In this work, a candle flame (20 W) is tested in two kinds of sound fields, one developing freely and the other guided by a cylindrical tube.

Dr. S.N Kini et al., (2015) designed a robot for detecting fire and extinguishing it. Fire Fighter is a robot designed to use in Industries, Manufacturing, etc. It can be operated and controlled by remote user and has the ability to extinguish fire after locating the source of fire.Ritik Yadav et al., (2020) designed a fire extinguisher which deals with the firefighting operations with a quick response time. They found fire can be extinguished between 40Hz to 60Hz and the sound wave can extinguish the fire of all types of flames.

Sonali Jain et al., (2020) introduced a type of fire extinguisher that eradicates the use of both water as well as chemicals by using sound/acoustic waves, thus saving resources as well as preventing equipment and health damage caused by chemicals.

Anurag Ranjan et al., (2020) designed a 360^{o} degree rotating vehicle which is suitable for operation in narrow paths and sharp corners. In this system, each of the 4 wheels has given drive with stepper motors, so it can rotate 360 degrees.

3. Methodology

The flow chart of the implementation and execution of the project work is as shown in figure1.

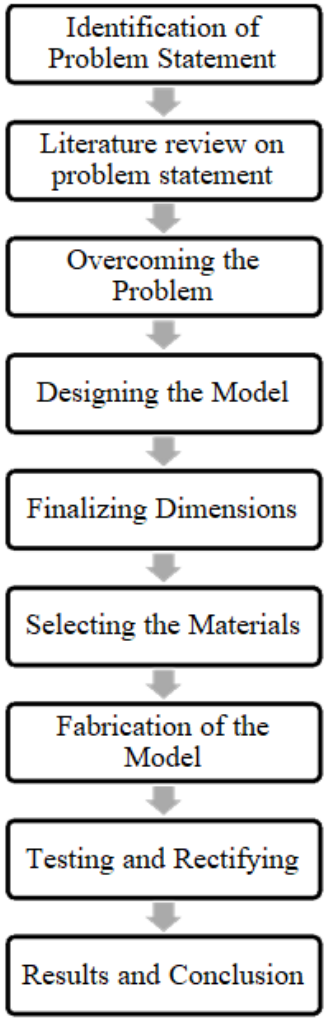

Fig 1. Flow chart of Execution of project

4. Chassis Design

The chassis of the proposed model is of a rectangular configuration with sufficient accommodations made for fasteners, motors, and wiring. The main constituent material of the chassis is mild steel. As shown in figure 2, the chassis is modelled in CATIA V5 and is subjected to inertial measurement which has yielded a total mass of **1.142 Kg**. The dimensions of the chassis have been considered based on the dimensions of the miscellaneous components on the frame. It has enough space to manoeuvre through the irregular terrain.

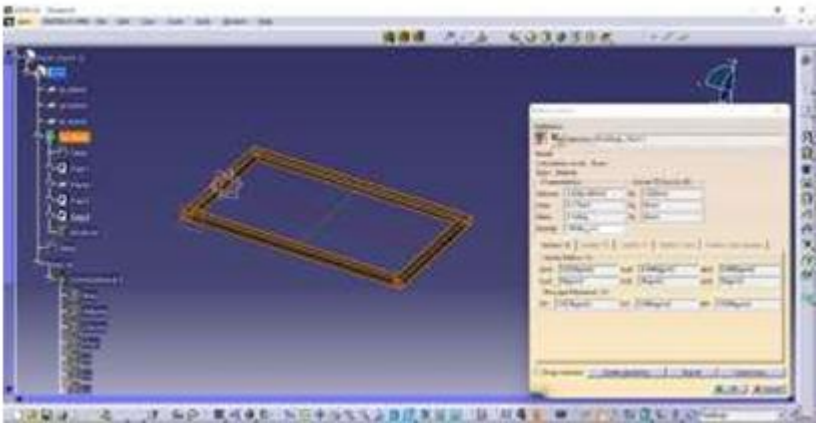

Fig 2. Chassis design in CATIA V5

5. Results and Discussion

The result analysis involves the calculation of total effort which includes the computation of rolling resistance, grade resistance, acceleration force and motor trque.

Calculation of Total effort (TTE):

This is the total force of traction exerted by the on the surface of the ground, parallel to the direction of its motion.

TTE = (RR+ GR+ Fa) …… (1)

Calculation of rolling resistance (RR):

Rolling resistance (RR) = W*Crr …… (2)

Where:

W = Weight of the Model in N

Crr = Coefficient of rolling resistance

The following Table 1 shows the relative coefficients of rolling resistance between rubber and a few surfaces.

Table No.1: Coefficient of rolling resistance on different surfaces

Terrain of contact	Crr (Coeff of rolling resistance)
Asphalt	0.9
Concrete	0.015(average)
Mud	0.090(Medium grade)
Grass (firm / limp)	0.055/ 0.075
Sand	0.150(soft sand)
Snow (2-4 inches)	0.010– 0.020

Calculation of grade resistance (GR):

(GR) = W*sin θ…… (3)

Where:

W = Weight of the Model in N

□= Angle of inclination

Calculation of Acceleration force (Fa):

(Fa) = (m*V²) /r…… (4)

Where:

M = Mass of the Model (kg)

V = desired velocity of the Model (m/s).

R = radius of wheel (m).

Calculation of motor torque at each wheel (τ):

τ = TTE*r …… (5) Where:

τ = Torque generated (Nm).

TTE = Total Tractive Effort (N).

r = wheel radius (m).

Conclusion

The unique concept of putting out a fire using sound has a lot of potential uses in the modern world. Different ratios of pressure and frequency can be used to create a particular air velocity. This kind of suppression necessitates an understanding of the acoustic cavity's shape in order to accomplish appropriate speaker placement and excitation at the right resonant frequencies for the space. To enable the vehicle to revolve along its own vertical axis, each of its four wheels may independently turn.

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