

## FUNDAMENTALS OF 360° ROTATING AND SOUND WAVE FIREFIGHTING ROBOT

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### Abstract

The project Design and fabrication of 360° rotating and Soundwave Firefighting Robot is associated with new technique of fire extinguisher. It deals with the firefighting operations with least amount of time spent. The main purpose of sound wave fire extinguisher is to put out the flames using sound waves with a specific range of frequency. It helps the fire fighter to fight the fire at early stage. The sound waves can extinguish all types of flames between the frequencies of 45 Hz to 55 Hz. The extinction of the fire must be done at an earliest stage and the flame does not need extra effort to be put out. The expected result from our project is to extinguish the fire in an earlier stage 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:** Soundwave Fire extinguisher, 360° rotation, zero degree turning, four wheel steering, vortex tube.

### Introduction

In present world, automobile has become essential for transportation of goods and passengers. By Benz in the year 1893, the first four-wheel automobile was introduced. The four-wheel steering mechanism was invented in 1902 by the Spijker Brothers in the Netherlands, it was used so that it would be much easier to turn the vehicle as it would reduce the turning wheel base virtually thus it was a much more efficient steering mechanism. At low-speed the rear wheels turn in opposite direction to that of the front wheel but at high speeds the rear wheels turn in the same direction as the front wheels because the steering adjustments are minimal. 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.

### 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° 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.

### **Methodology**

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

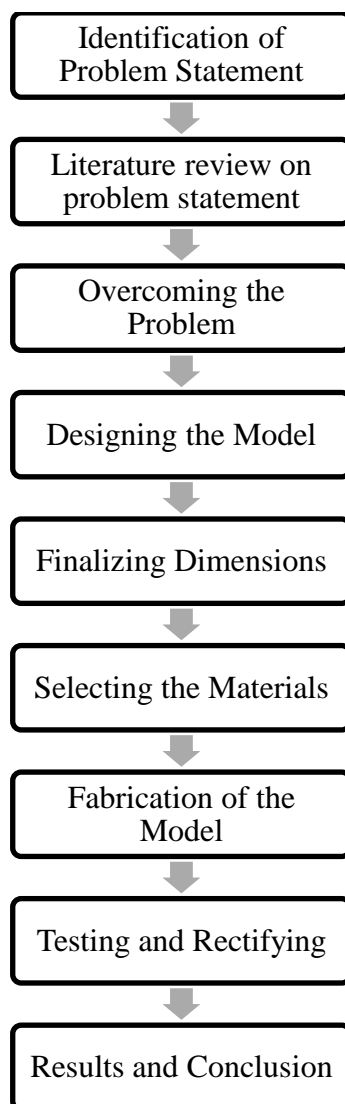


Fig 1. Flow chart of Execution of project

### **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.

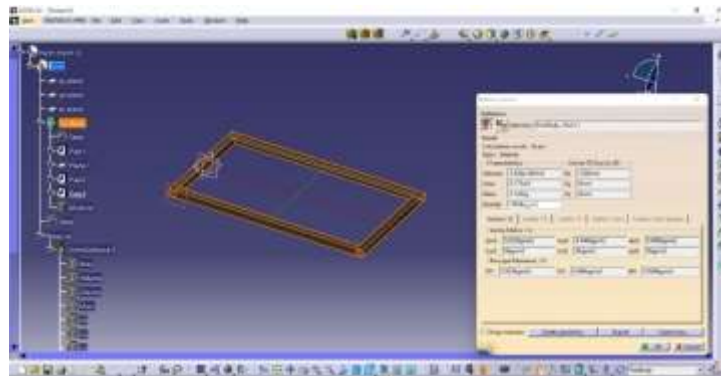


Fig 2. Chassis design in CATIA V5

**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 torque.

**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.

$$TTE = (RR+ GR+ Fa) \dots\dots\dots (1)$$

**Calculation of rolling resistance (RR):**

$$Rolling\ resistance\ (RR) = W * Crr \dots\dots\dots (2)$$

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):**

$$(GR) = W * \sin \theta \dots\dots\dots (3)$$

Where:

W = Weight of the Model in N

θ = Angle of inclination

**Calculation of Acceleration force (Fa):**

$$(Fa) = (m * V^2) / r \dots\dots\dots (4)$$

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 ( $\tau$ ):

$$\tau = TTE * r \dots\dots\dots (5)$$

Where:

$\tau$  = Torque generated (Nm).

TTE = Total Tractive Effort (N).

r = wheel radius (m).

### Conclusion

The idea of extinguishing fire with sound is an innovative one, and has many possible applications in today's world. One can generate a specific air velocity using various combinations of pressure and frequency. This technique of suppression would require knowledge of the geometry of the acoustic cavity, so that the optimum placement of the speaker(s) can be achieved, as well as excitation with optimal the resonant frequencies for the room. The 4 wheels of the vehicle turn independently to allow the vehicle to rotate in its own vertical axis.

### References

- [1] Caiyi Xiong., Zilong Wang. (2021), Acoustic flame extinction by the sound wave or speaker-induced wind, "Fire Safety Journal", 126(103479).
- [2] Dr S.N. Kini., Shweta Khatade.(2015), Survey on Fire Fighting Robot Controlled Using Android Application, "International Journal of Innovative research in science, Engineering and technology", 4 (11).
- [3] Ritik Yadav., Ramiz Shirazi.(2020), Designing of Fire extinguisher based on Sound Waves, "International Journal of Engineering and advanced technology", 9(4).
- [4] Sonali Jain., Manan Luthra., Sonic Fire Fighting System, "Interntional conference on computer communication and informatics".
- [5] Anurag Ranjan., Sarvind Kumar. (2020), 360 Degree wheel rotation vehicles, "International Journal of Creative Research thoughts", 8(6)
- [6] Hood, C., &Frendi, A. (2005), On the Interaction of a Premixed Flame with an Acoustic Disturbance. 41<sup>st</sup> AIAA/ASME/SAE/ASEE Joint Propulsion Conference & Exhibit (pp. 1-10).
- [7] Wnęk W., Kubica P., Basiak M.(2012), pro Standards designing sprinkler extinguishing systems- A comparison of the main parameters, "Safety Fire & Protection and technology" 27 (83).
- [8] Rakowska J., Ślosorz Z. (2011), Corrosion gas installations and fittings fire, "Safety State and Tech Fire ", 24 (113).
- [9] Radwan K., Rakowska J.(2011), Analysis of effectiveness Components use of the aqueous solutions of mixtures of foaming concentrates to extinguish residue fires of flammable liquids, "Chemical Industry",90 (2118).