

DESIGN AND FABRICATION OF 360 DEGREE SOUND WAVE FIRE EXTINGUISHER

Submitted in partial fulfilment of the requirements for the award of Bachelor of
Engineering Degree in Mechatronics Engineering

by

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SCHOOL OF MECHANICAL ENGINEERING**

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

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BONA FIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of Aathishankaran.K.S (38090001) and Shaik Vali Abdul Haq (38090701) who carried out the project entitled **"DESIGN AND FABRICATION OF 360 DEGREE SOUND WAVE FIRE EXTINGUISHER"** under our supervision from December 2021 to April 2022.

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We Aathishankaran K.S (38090001) and Shaik Vali Abdul Haq (38090701) hereby declare that the Project Report entitled “**DESIGN AND FABRICATION OF 360 DEGREE SOUND WAVE FIRE EXTINGUISHER**” done by us under the guidance of **Dr.S.SIVASARAVANAN, MBA.,M.E.,Ph.D** is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering Degree in Mechatronics Engineering.



SIGNATURE OF THE CANDIDATE`S

DATE : 10.05.2022

PLACE: CHENNAI

ACKNOWLEDGEMENT

I am pleased to acknowledge my sincere thanks to the Board of Management of **SATHYABAMA** for their kind encouragement in doing this project and for completing it successfully. I am grateful to them.

I convey my thanks to **Dr.S.PRAKASH, M.E., Ph.D.**, Dean and Head of the Department School of Mechanical Engineering and **Dr.S.SIVASARAVANAN, MBA., M.E.,Ph.D** Associate Professor Department of Mechatronics engineering for providing me the necessary support and details at the right time during the progressive reviews.

We would like to express my sincere and deep sense of gratitude to my Project Guide **Dr.S.SIVASARAVANAN, MBA., M.E.,Ph.D** for his valuable guidance, suggestions and constant encouragement paved way for the successful completion of my project work.

I wish to express my thanks to all Teaching and Non-teaching staff members of the Department of Mechatronics Engineering who were helpful in many ways for the completion of the project.

ABSTRACT

A unique fire extinguisher technique is the subject of the project designing of Fire Extinguisher Based on Sound Waves. With a short response time, deals with firefighting operations. The goal of a sound wave extinguisher is to determine the frequency range within which a fire can be put out. It aids fire fighters in putting out fires at an early stage. Between 40Hz and 60Hz, fire can be quenched, and the sound wave can extinguish all forms of flames. The fire must be put out while it is still in its early stages, when the heat and flame created by the fire are at their lowest levels. The project's goal is to put out the fire as soon as possible in order to improve human safety and protection.

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CHAPTER I

INTRODUCTION

1.1 STEERING MECHANISM

The collection of components, connections, and other systems that allow ships (ships, boats) or vehicles (cars, motorbikes, and bicycles) to follow a predefined course is referred to as steering.

“The most typical steering arrangement is to use a hand–operated steering wheel in front of the driver to turn the front wheels. through the steering column, That contains universal joints(Which is the part of the collapsible steering column design) which allows it to wander from the straight course. Other systems such as tiller or rear wheel steering are rarely found on different types of vehicles. The differential steering is used in tracked vehicles such as bulldozers and tanks to change the direction. The tracks are constructed to move at the separate rates or even in the opposite directions, using clutches and brakes” [5]

Steering system with rack and pinion and recirculating ball:

The steering wheel drives the rack, which consists of a longitudinal a pinion gear which meshes with a gear and transforms linear motion along the circumference of the circumference of the circumference of the circum car's transverse axis. To apply steering the swivel pin ball joints that were replaced were subjected to a lot of force the previously employed kingpins of the steered wheels' stub axle, tie rods and the steering arm, which is a small lever arm are now used.

The rack and pinion steering mechanism gives you a lot of control and a direct steering sensation. Because it is not adjustable, the only option when it wears out and develops lash is to replace it.

The design of the worm and sector, as well as the nut and screw design, are both used in older designs. The recirculating ball system, which is still used on trucks and utility vehicles, was used to improve both types by reducing friction. The steering column rotates a big screw that recirculates balls to mesh with the nut. As the screw is cranked, the nut moves a gear sector, causing it to revolve about its axis; The Pitman arm is moved by an arm linked to the sector's axis, which is linked to the steering wheel linkage and therefore directs the wheels. The recirculating ball

version of this setup lowers friction by sandwiching big ball bearings between the screw and the nut; the balls emerge between the two halves and into a tube within the box that links one end to the other.

“Because the recirculating ball system has a far bigger mechanical advantage, it was previously restricted to larger, heavier cars, whereas the rack and pinion was restricted to smaller, lighter vehicles; however, due to the nearly universal adoption of power steering, this is no longer an important advantage, resulting in the increasing use of rack and pinion on newer cars” [11] adjustable through “a screw on the end of the steering box to account for wear, but it cannot be completely removed because it will create excessive internal forces in other positions, causing the mechanism to wear out quickly. This style is still used in trucks and other heavy vehicles where durability, maintainability, and mechanical advantage are more important than steering speed and direct sensation” [5]

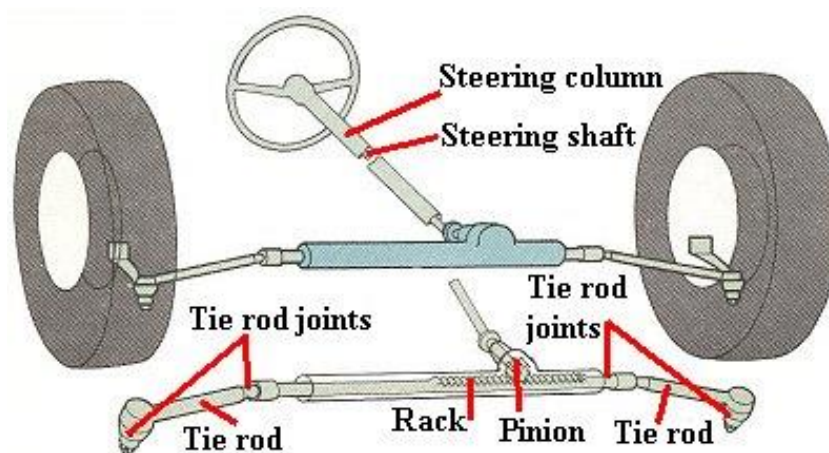


Fig: 1.1 : Steering System

1.1.1 Longitudinal Wave

“Longitudinal Wave- also known as compression wave which provides compression and rarefaction when moving in the same direction or opposite. The displacement of the medium can be vice- versa” [4]

1.1.2 Transverse Wave

“Transverse Wave- known as moving wave and has number of oscillations occurring perpendicular from the energy where it is transferred. One of the best reasons is light. Medium of displacement is perpendicular to the wave propagation of direction” [4]

1.2 FIRE

“Fire is a self-sustaining gaseous mixtures reaction that produces light and heat in variable degrees. The flame is the visible element of the fire. When a flammable and/or combustible material is exposed to a source of heat in combination with a good amount of oxidising agent, such as oxygen gas, a fire is ignited or temperature conditions above the fuel/oxidizer mix's flash point and can tolerate a high rate of oxidation, resulting in a chain reaction oxygen, chemical, fuel, and heat chain reaction are the four ingredients that make up fire. This forms referred to as a fire tetrahedron. Fire cannot exist unless all of these components are present and in the proper quantities.

Based on the types of fires they can put out, sprinkler systems are divided into four categories. Any fire extinguisher is given a number rating which specifies how so much fire it could put out. The greater the number the greater the firefighting capacity. The trying to follow is a simple guide to assist you in selecting the appropriate fire extinguisher for your needs. Also see how to buy a fire extinguisher. Class A fires are those that occur in conventional combustibles including such woods, rubbish, cloth, paper, garbage, and polymers. Class B fires are those that start with combustible liquids like petroleum oil, gasoline & paints” [1].

Flammable gases like propane and butane are also listed. Cooking oil and grease fires are not classified as Class B fires. Class-C fires are those that involve electrified electrical-systems which including motor, generators, transformer, and appliances. When the power is removed, Type C fires are reclassified like some of the other fire categories. “Combustible metal fires, potassium, sodium, aluminium, and magnesium are only a few examples. classified as Class D.”



Fig: 1.2 : Classification of Fuel

1.3 SOUND WAVES

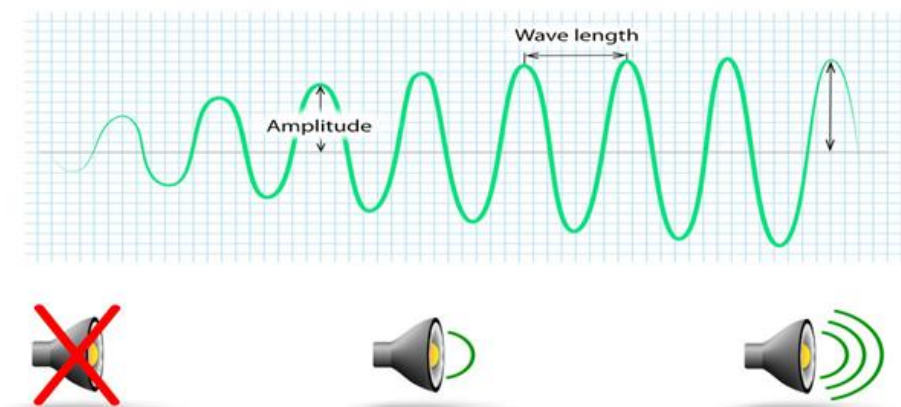


Fig: 1.3 : Sound Waves

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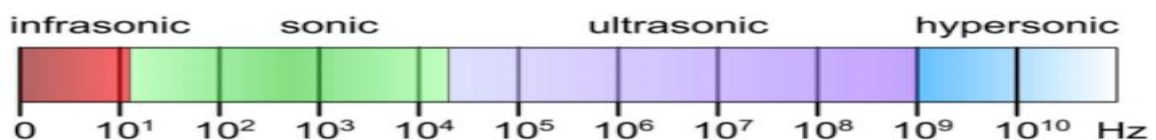


Fig: 1.4 : Various kind of Frequencies

1.3.1 Frequency range of sound wave

The sound wave does not travel across the medium; The waves are transferred by the vibrations of particles in a liquid or gas, however the mean position of the particles is not does not alter over time. During propagation, vibrations could be reflected, refracted, or attenuated by that of the substance. Sound never transfer in a suction, hence the medium is whatever carries a sound.

“Longitudinal waves are used to transfer sound across gases, plasma, and liquids. Longitudinal sound waves are waves with alternating pressure deviations from

equilibrium, creating local compression and rarefaction, whereas transverse waves (in solids) are waves with alternating shear stress at right angles to the propagation direction. Sound waves can also be observed using parabolic mirrors and sound-producing items” [7]

Sound waves are frequently described in terms of sinusoidal plane waves, which have the following characteristics: Sound pressure, sound strength, sound speed, and sound direction are all terms used to describe the frequency, length of the wave, wave period, and amplitude of sound are all factors to consider. “Sounds having frequencies in the range from 20 Hz to 20,000 Hz can be heard by humans”. Sound waves in air have wavelengths ranging from 17 m to 17 mm at normal temperature and pressure.

We hear a wide range of noises in real life, including screams, shouts, & laughter, and this isn't restricted to humans. Animals produce noises as well, but not in the same way that humans do. To help us understand this, we'll look at a number of fundamental characteristics in terms of sound waves Whenever sound waves get visualised, as a wave shape, we can see some basic features right once. The waveform depicts the fluctuation in air pressure that causes sound to travel. High-pressure zones alternate with low-pressure areas in these waves. Because of the waveform, sound waves now mimic light and other electromagnetic radiation.

Vibrations in a medium, usually air, produce sound. When a disturbance at the source is communicated to nearby molecules and propagated in the form of a wave, sound travels.

A waveform is a name given to the resulting pattern of oscillating pressure. A waveform is a name given to the resulting pattern of oscillating pressure.

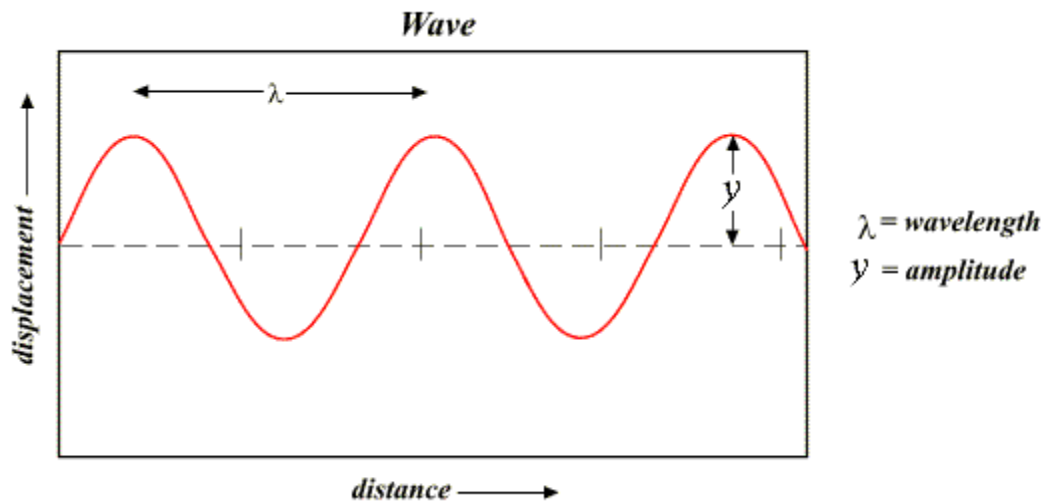


Fig: 1.5 : Distance Vs Displacement Graph

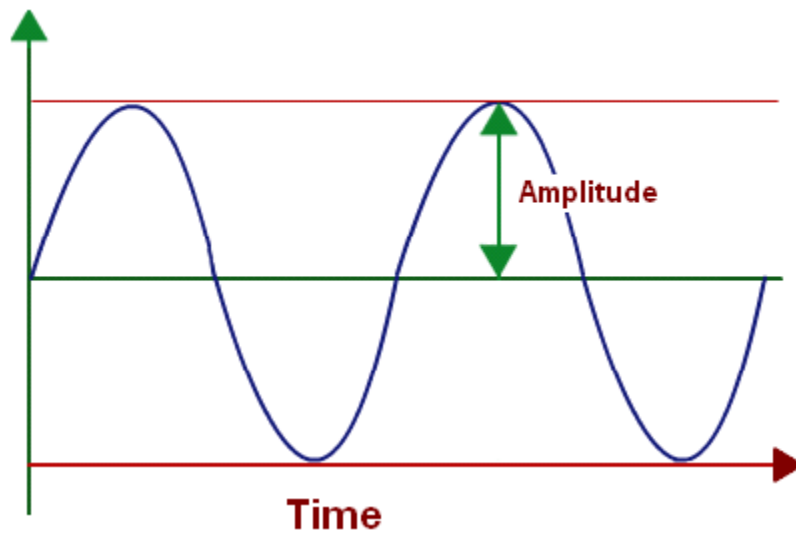


Fig: 1.6 : Amplitude of sound

Amplitude of sound: The amplitude of sound, also known as sound amplitude, is the amount of air particles that are displaced, and that is perceived as the loudness of sound.

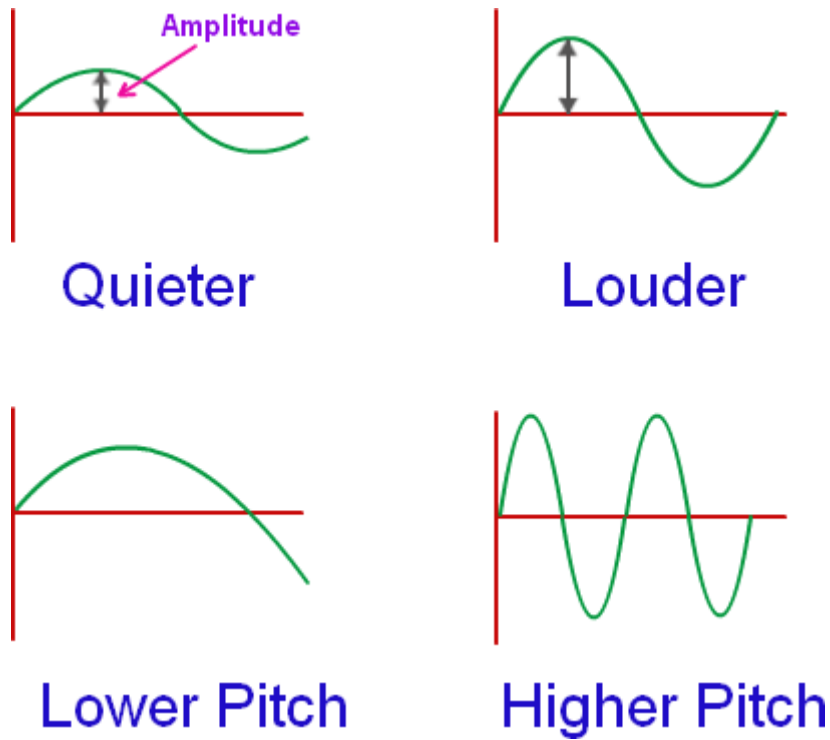


Fig: 1.7 : Types of Pitches

To understand more about sound, look at the graphs below. “In a sound wave from a drum is displayed in the first graph, while a sound wave from a whistle is displayed in the second graph is portrayed” [2].

The variations in the noises are obviously obvious, but have a look at the frequencies.



Fig: 1.8 : Variation in Pitches

“Shows the difference between high and low frequency sound waves, as well as their associated pitches” [1]

- Hertz (Hz) or cycles per second are the units of measurement.

- Humans can hear frequencies between 20 Hz and 20 kHz, and frequency is perceived as pitch.

Amplitude

- Determines how far an air pressure wave has deviated from its mean. $\text{dB} = 20 \log_{10}(A/B)$ ○ Measured in decibels
- Loudness Vs Amplitude
- The duration of a sound is the amount of time it lasts.

1.3.2 Characteristics of sound waves:

“Sound cannot travel in a vacuum. This is the polar opposite of light's characteristic. Sound waves are generally longitudinal, whereas light waves are transverse, which is a distinction that is outside the scope of the syllabus. But they're not that distinct. Consider the characteristics of sound as it travels through the air” [2]

1.3.3 Reflection of sound waves:

“The phenomenon of Echo is caused by this sound characteristic. The repeated reflections from the sky and land surfaces also contribute to the thunder's rolling. Sound waves are reflected in the same way as light waves are reflected. The angle of incidence and reflection are the same. The reflecting surface, like a cloud, should have a big surface area for a noticeable reflection. The term "reflection" is used in a variety of contexts SONAR is a sound-wave-based technology primarily underwater, to navigate and communicate the identification of items on or beneath the water's surface is done using sound waves reflected from objects” [2]

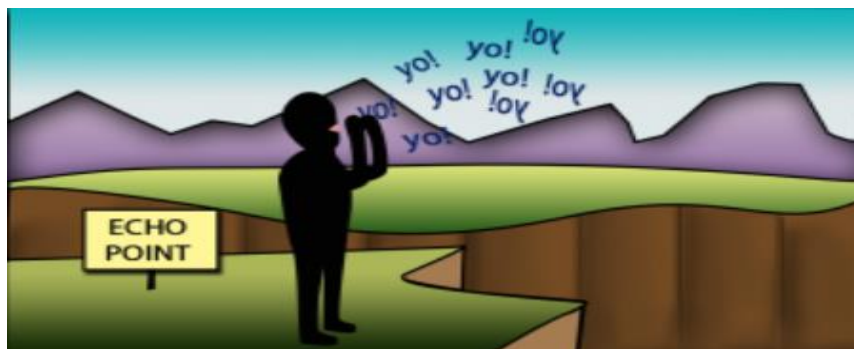


Fig: 1.9 : Reflection of Sound Waves

1.3.4 Refraction of sound waves:

When the density of the material through which light travels varies, refraction occurs. When the density of the atmosphere changes, sound refracts through which it is Changes in movement. The volume of a gas drops inversely proportionate to the increase in temperature. It resembles light waves so much that it experiences Total Internal Reflection (TIR) is a term that refers.

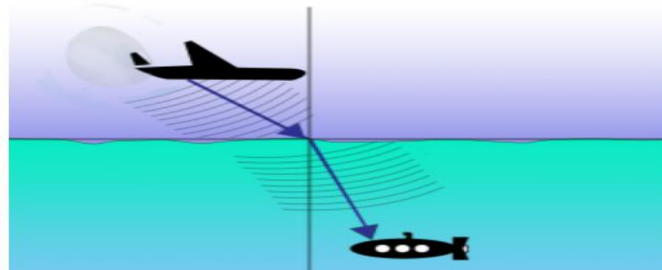


Fig: 1.10 : Refraction of Sound waves

1.3.5 Diffraction of sound waves:

“Consider this for a moment. He can still hear you if you close the door and yell for your friend outside your room. Sound waves can bend around and around obstructions. If the door has a little hole in it, the small opening will operate as a localized source of the sound. Sound waves diffraction is a vital element of our perception of the world around us. Close lightning strikes sound like a sharp crack, whereas far away strikes sound like deep rumbling thunder. This is because sound waves with deeper tones can bend around obstructions easier than sharp noises, so you only hear the deep rumbling” [2]

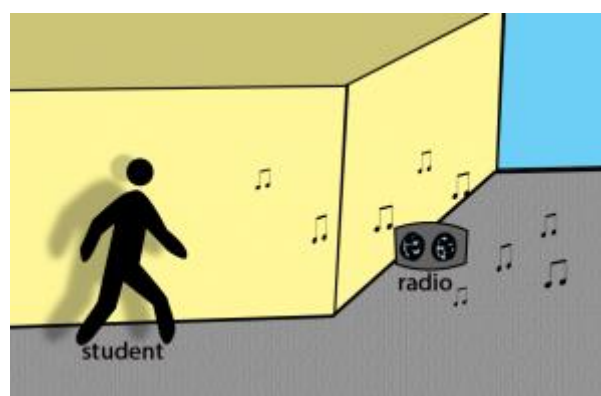


Fig: 1.11 : Diffraction of Sound Waves

CHAPTER 2

LITERATURE SURVEY AND SCOPE OF THE PROJECT

2.1 LITERATURE SURVEY

Baker Abdalhaq et al (2015), classical prediction fire schemes do not match the real fire propagation, basically, because of the complexity of the physical models involved, the need for a great amount of computation and the difficulties of providing accurate input parameters. We describe an enhanced prediction scheme, which uses recent fire history and optimization techniques to predict near future propagation. The proposed method takes advantage of the computational power offered by distributed systems to accelerate the optimization process at real time.

Bong-young Kim et al (2019), existing extinguish methods, which rely solely on chemical reactions of fire extinguishing agents, are limited in overcoming the rapidly changing fire fighting environment. A Sound Fire Extinguisher that supplies sound energy to the flame can be an alternative. The Sound Fire Extinguisher, first released by DARPA, is too heavy and bulky to be suitable for fire fighting environments. In this study, we proposed the application of pseudo sinusoidal wave using switching power to achieve high power, compact and lightweight of Sound Fire Extinguisher. As a result of the experiment in chapter 5, when a general sinusoidal oscillator and amplifier are used, a weight of 0.5 Kg is output at 100 watts, and a heat sink of more than 0.5 Kg is required. On the other hand, in case of pseudo sinusoidal wave using switching power, the weight of amplifier required to output 150 watts was only 0.2 Kg. Experimental results show that the Sound Fire Extinguisher is compact and lightweight with high output by applying pseudo sinusoidal wave method using switching power.

Caiyi Xiong et al (2020), Dripping of molten fuels is a widely observed phenomenon in the wire fire and façade fire, which promotes the fire spread and increases the fire hazard. The flame attachment to drip is a necessary condition for dripping ignition, so that extinguishing the dripping flame can effectively reduce the dripping fire hazard. In this work, we investigated the use of acoustic wave to extinguish the fast-moving dripping flame. Continuous drips, with a mass of 6.2 mg and a diameter of 2.6 mm, were produced from a burning polyethylene tube, and two fall heights, 0.3 m and 0.7 m with velocities of about 2 m/s and 3 m/s, were selected as

the targets. The sound source varied in pressure from 80 to 114 dB and frequency from 90 to 110 Hz. Results showed that the effectiveness of flame extinction by acoustic wave decreases as the dripping velocity increases, so the acoustic wave is more effective to extinguish the dripping flame in the early stage. An extinction criterion was formulated based on a characterized Damköhler number to describe the underlying mechanism. This work provides important information on the acoustic effect on a moving flame and helps mitigate the fire hazard of dripping phenomena.

Chi Yuan et al (2015), because of their rapid maneuverability, extended operational range, and improved personnel safety, unmanned aerial vehicles (UAVs) with vision-based systems have great potential for monitoring, detecting, and fighting forest fires. Over the last decade, UAV-based forest fire fighting technology has shown increasing promise. This paper presents a systematic overview of current progress in this field. First, a brief review of the development and system architecture of UAV systems for forest fire monitoring, detection, and fighting is provided. Next, technologies related to UAV forest fire monitoring, detection, and fighting are briefly reviewed, including those associated with fire detection, diagnosis, and prognosis, image vibration elimination, and cooperative control of UAVs. The final section outlines existing challenges and potential solutions in the application of UAVs to forest firefighting.

Gore.S.R et al (2018), the need for innovation and modernization in fire extinguishing techniques is extremely necessary. Accidents caused due to fire are disastrous and can lead to irreversible losses. With the rising amount of dangers to the environment in various aspects, it is essential to avoid as much damage as possible. The existing techniques have been created considering only their efficiency in extinguishing fires and not considering the harms they can cause to the environment. Another area of concern is the disasters caused by fire accidents in space. The use of traditional chemical extinguishers in space is necessary to be avoided as much as possible. Study shows that sound waves could be one of the potential alternatives for extinguishing fires. Research is necessary in the development of a similar practical method of fire extinguishing and analyzing which frequency of sound waves gives optimum results. A possible reason for the flame extinguishment due to sound waves can be that the continuously altering high and low pressure waves when coupled with high air flow velocity cause disruptions in the air-fuel ratio at the flame boundary which leads to diminishing of the boundary.

Jose.A.J.Berni et al (2009), two critical limitations for using current satellite sensors in real-time crop management are the lack of imagery with optimum spatial and spectral resolutions and an unfavorable revisit time for most crop stress-detection applications. Alternatives based on manned airborne platforms are lacking due to their high operational costs. A fundamental requirement for providing useful remote sensing products in agriculture is the capacity to combine high spatial resolution and quick turnaround times. Remote sensing sensors placed on unmanned aerial vehicles (UAVs) could fill this gap, providing low-cost approaches to meet the critical requirements of spatial, spectral, and temporal resolutions. This paper demonstrates the ability to generate quantitative remote sensing products by means of a helicopter-based UAV equipped with inexpensive thermal and narrowband multispectral imaging sensors. During summer of 2007, the platform was flown over agricultural fields, obtaining thermal imagery in the 7.5–13- μ m region (40-cm resolution) and narrowband multispectral imagery in the 400–800-nm spectral region (20-cm resolution). Surface reflectance and temperature imagery were obtained, after atmospheric corrections with MODTRAN. Biophysical parameters were estimated using vegetation indices, namely, normalized difference vegetation index, transformed chlorophyll absorption in reflectance index/optimized soil-adjusted vegetation index, and photochemical reflectance index (PRI), coupled with SAILH and FLIGHT models. As a result, the image products of leaf area index, chlorophyll content (Cab), and water stress detection from PRI index and canopy temperature were produced and successfully validated. This paper demonstrates that results obtained with a low-cost UAV system for agricultural applications yielded comparable estimations, if not better, than those obtained by traditional manned airborne sensors.

Lexter.J.Resullar et al (2020), artificial intelligent systems applied to robots have been a part of our work environment but it is not only limited to industrial automation. Recently, fire fighting robots are developed to mitigate disaster during fire accidents. In this work, fire fighting robotic system equipped with sensitive flame sensors, avoidance mechanism, alarm and SMS capability is developed, designed and fabricated. Circuit design integrates several components to a microcontroller to successfully carry out its programmed task. The structural design of the chassis is to accommodate all components for optimum performance. The codes were adjusted to see what was most efficient and fit the task at hand. The Fire Fighting Robot with Alarm System has its featured components such as Flame Sensor, Smoke Sensor,

Ultrasonic Sensor, Piezo Speaker, LED, and Global System for Mobile Module and Mini Water Pump. Experimental results revealed that successful operation of the fabricated fire fighting robotic system take place. The optimal response time of the move stop was found to be 400 ms this suggests that the robotic system will start extinguishing the fire and automatically stop the pumping of water upon complete extinguishing of fire. Furthermore, the installed ultrasonic sensor successfully sent signal to the microcontroller to perform the avoidance mechanism of the robotic system from the obstacle. Likewise, the fire and smoke alarm detection as well as the SMS messaging capability was successfully activated upon the detection of fire and smoke. This successful fabrication of fire fighting robotic system will be a potential mechanism to fighting fire disaster.

Luis Merino et al (2012), the paper presents an Unmanned Aircraft System (UAS), consisting of several aerial vehicles and a central station, for forest fire monitoring. Fire monitoring is defined as the computation in real-time of the evolution of the fire front shape and potentially other parameters related to the fire propagation, and is very important for forest fire fighting. The paper shows how an UAS can automatically obtain this information by means of on-board infrared or visual cameras. Moreover, it is shown how multiple aerial vehicles can collaborate in this application, allowing to cover bigger areas or to obtain complementary views of a fire. The paper presents results obtained in experiments considering actual controlled forest fires in quasi-operational conditions, involving a fleet of three vehicles, two autonomous helicopters and one blimp.

Mohd Aliff et al (2019), fire incident is a disaster that can potentially cause the loss of life, property damage and permanent disability to the affected victim. They can also suffer from prolonged psychological and trauma. Fire fighters are primarily tasked to handle fire incidents, but they are often exposed to higher risks when extinguishing fire, especially in hazardous environments such as in nuclear power plant, petroleum refineries and gas tanks. They are also faced with other difficulties, particularly if fire occurs in narrow and restricted places, as it is necessary to explore the ruins of buildings and obstacles to extinguish the fire and save the victim. With high barriers and risks in fire extinguishment operations, technological innovations can be utilized to assist firefighting. Therefore, this paper presents the development of a firefighting robot dubbed QRob that can extinguish fire without the need for fire fighters to be exposed to unnecessary danger. QRob is designed to be compact in

size than other conventional fire-fighting robot in order to ease small location entry for deeper reach of extinguishing fire in narrow space. QRob is also equipped with an ultrasonic sensor to avoid it from hitting any obstacle and surrounding objects, while a flame sensor is attached for fire detection. This resulted in QRob demonstrating capabilities of identifying fire locations automatically and ability to extinguish fire remotely at particular distance. QRob is programmed to find the fire location and stop at maximum distance of 40 cm from the fire. A human operator can monitor the robot by using camera which connects to a smartphone or remote devices.

Ritik Yadav et al (2020), the project titled Designing of Fire Extinguisher Based on Sound Waves is associated with new technique of fire extinguisher. Deals with the fire fighting operations with a quick response time. The purpose of sound wave extinguisher is to find out the range of frequency within which fire can be extinguished. It helps the fire fighter to fight the fire at early stage. Fire can be extinguished between 40Hz to 60Hz and the sound wave can extinguish the fire of all types of flames. The fire suppression needs to be done at the incipient stage where the heat and flame produced by the fire is at the minimum point. The expected outcome of the project will be, to counter the fire at its initial stage for better human safety and protection.

Sezgin Kilic et al (2019), forests have crucial importance for the sustainability of Earth and humanity and one of the biggest threats to the existence of forests are the fires. This paper proposes a conceptual model for mitigating forest fire risk by use of self-adaptive and autonomous unmanned aerial vehicles (UAVs). Memory less property of exponential distribution is also reflected and considered in the calculations of forest fire probabilities. Stochastic and dynamic properties of the situation and the mathematical complexity of the routing problem entailed and justified a simulation study. The effectiveness of the proposed dispatching approach for routing UAVs and the validity of the proposed model are tested on a small sized realistic scenario. Experimental results encourage the development of complex models. Integrating the proposed model with advanced information technologies may lead to the development of a digital twin system.

Yi-E-Y et al (2018), sound fire extinguisher is developed based on principle of quenching fire by lowering its temperature with contacting vibration energy from low

frequency sound under 100 Hz to fire and then, blocking inflow of oxygen with a sound wind. The one researched by American students are at very basic level to be commercialized. It concentrates a sound beam through special sound winds and increases sound energy performance 10 times more to put out the fire. This is because it utilizes basic theory of making sound and as sound has a tendency of dispersing, big sound and energy have to be created to extinguish fire. That is even if 100 W is produced, it just makes a big noise but only 1/10 of it can be used for putting out fire. This special sound wind has convex shape which concentrates all the sound into one place to increase effectiveness by more than 10 times. Even 1~2 m away, initial control can be done. As a result, size of battery as well as amplifier can be made small to have minimized size and weight, making it more practical.

2.2 AIM AND SCOPE OF THE PRESENT INVESTIGATION

2.2.1 Aim

- To determine the frequency range that was employed to extinguish the flame.
- Identifying the most appropriate frequency range.
- To determine the frequency range capable of suppressing an open flame.
- To determine the best frequency range for achieving the least amount of sound energy when extinguishing a fire.
- Investigating the mechanics of sound-flame interactions

2.2.2 Sound-flame interactions & using sound wave as flame extinguisher

One of the options for developing new flame extinguishing systems is to equipment was discovered to be sound waves. Combustion of Several aspects process can be influenced by sound waves. By altering the velocity of its medium, a sound wave can influence the At the boundary, that is at the end of the flame, the Air-Fuel Ratio lightest point of fuel burning (air). Variations in air velocity can also affect the fuel flow rate surrounding the as well as a source of heat increase the heat source's convective heat transfer and reduce the flame's temperature on average These characteristics are similar to flame blow-off effects.

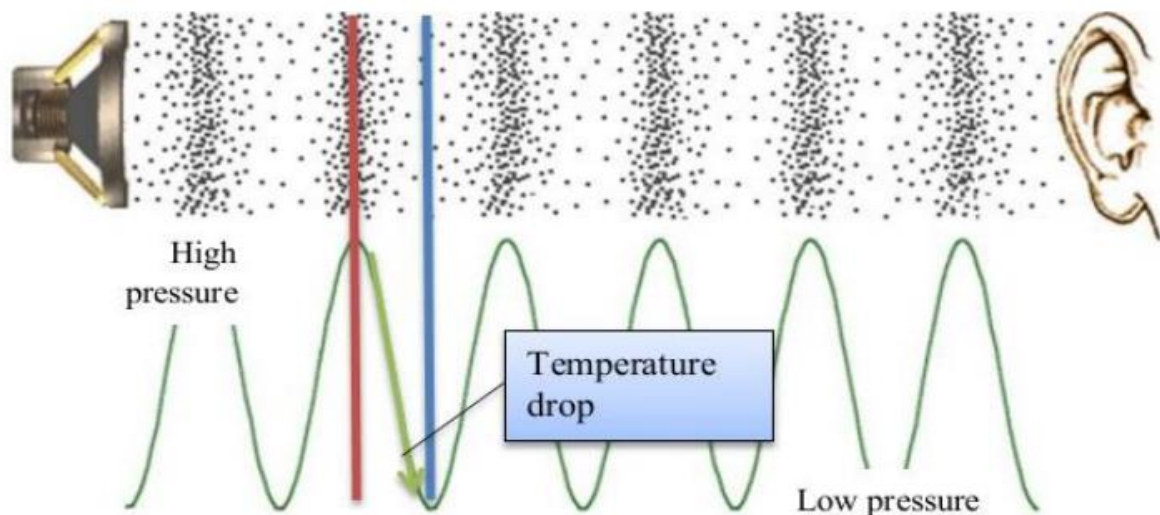


Fig: 2.1 : Sound Wave Influence

Figure shows the main stream analysis for the sound wave influence on the flame. As a result of pressure variations produced by sound wave transmission, the temperature profile around the flame will fluctuate dramatically. A shift in pressure from high to low generates an instantaneous change in temperature, as per the

initial rule of thermodynamics. The combined acts taken by modifying the flame's temp, pressure, and air-to-fuel ratio in a controlled sound wave environment will change the flame behaviour. A pressure perturbation has been found to impact the material's burning rate and produce combustion instability can result in flame extinction.

The chemical kinetics of processes have been found to be affected by ultrasonic frequency (Ultrasound in Organic Chemistry). The chemical process is reliant for the bonding that has been harmed each chemical component at a set of frequencies, and high-frequency stimulation of a process can increase combustion while delaying and perturbing it. However, because the ideal frequency for a flame suppressor was found to be 60 Hz in a previous experiment, ultrasonic use for flame suppressor has not been investigated.

CHAPTER 3

MATERIALS AND METHODS

3.1 METHODOLOGY

- Studying various journals papers
- Selected successful model
- Studying Problem statement for selected model
- Overcoming the Problem
- Redesigning the model
- Finalizing Dimensions
- Sketching the model
- Selecting the material work efficiently and cost effective
- Fabrication
- Testing

3.2 MATERIALS

3.2.1 Subwoofer:

“A woofer, or a full loudspeaker, is referred to as a subwoofer (or sub), designed to reproduce pitched audio frequencies known as bass. A subwoofer's normal frequency range is around Consumer goods have a frequency range of 20–60 Hz, professional live sound has a frequency range of below 100 Hz, and professional live sound has a frequency range of below 80 Hz for THX-certified systems. Subwoofers are designed to supplement loudspeakers' low frequency range while also covering higher frequency bands. (Figure 3.7) One or more woofers are installed in a loudspeaker enclosure to make subwoofers capable of withstanding air pressure and resisting deformation, which is frequently built of wood. Reaction to the bass (in the enclosure with a port or passive radiator), Designs include infinite baffle, horn-loaded, and band pass” [1] are among the many subwoofer enclosure designs available, each having its own set of compromises in terms of efficiency, bandwidth, size, and cost. Passive subwoofers are powered by an external amplifier and have a subwoofer driver and enclosure. A built-in amplifier is included in active subwoofers.



Fig: 3.1 : Sub woofer

3.2.2 Vortex cannon:

“An air vortex cannon essentially operates by rapidly and efficiently delivering force to air molecules trapped in a semi-enclosed environment. When the cannon's stretchy balloon surface snaps forward, it collides directly with air molecules, driving them towards the cannon's opening and setting off a chain reaction of high-speed collisions with other air molecules and the barrel's sides. All of these clashing high-speed air molecules can only get out of the barrel through the aperture at the end. The fast escape of air molecules creates a stream, or jet, of air that emerges from the cannon. A stable donut-shaped gaseous projectile is formed when a jet of air escapes the entrance of an air vortex cannon into the still air outside. A toroidal vortex or vortex ring is what this flying gas donut is called, hence the name air vortex cannon. The friction between the jet of air and the edges of the cannon's opening, as well as the slow moving air outside the air cannon, creates a toroidal vortex. Figure 3.8 The margins of the fast-moving jet of air slow down and coil back away from the centre of the jet when it brushes against the hard circular opening of the cannon and the slow-moving air outside, generating a donut shape, also known as a torus” [1-6]

3.2.3. Air vortex

“The calm air around the vortex has a relatively high pressure, which helps the ring maintain its form as it moves ahead. Fill the barrel with a little fog from a fog generator or CO₂ gas collected from dry ice resting in room-temperature water to view the toroidal vortex formed by your cannon” [6]

Vortex rings can form almost everywhere whether the fluids are gases or liquids, when a jet of fluid is launched into a mass of still fluid. Vortices, such as those created by your air cannon, can be formed by a number of things, like helicopter blades or mosses that distribute their spores by blasting them outward. Dropping food dye into a glass of cold water straight down allows you to see vortex rings in a liquid. Underwater, whales, and dolphins even blow disseminate their spores by blasting them outward. Dropping food dye straight down into a glass of cold water allows you to see vortex rings in a liquid. Underwater, whales, and dolphins even blow bubble vortices.

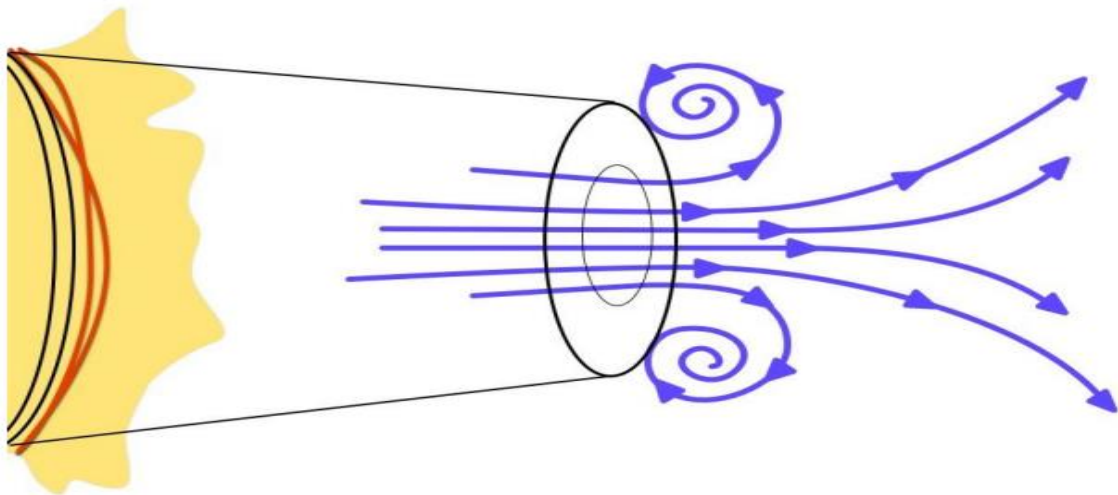


Fig: 3.2 : Air vortex



Fig: 3.2 : Portable fire extinguisher

3.2.4 Working Model

It consists of a mobile phone. The sine signal is generated by the mobile's function. The subwoofer receives these generated sine signals. The amplifier is connected to the subwoofer. The subwoofer's output is directed through the optimized vortex cannon.

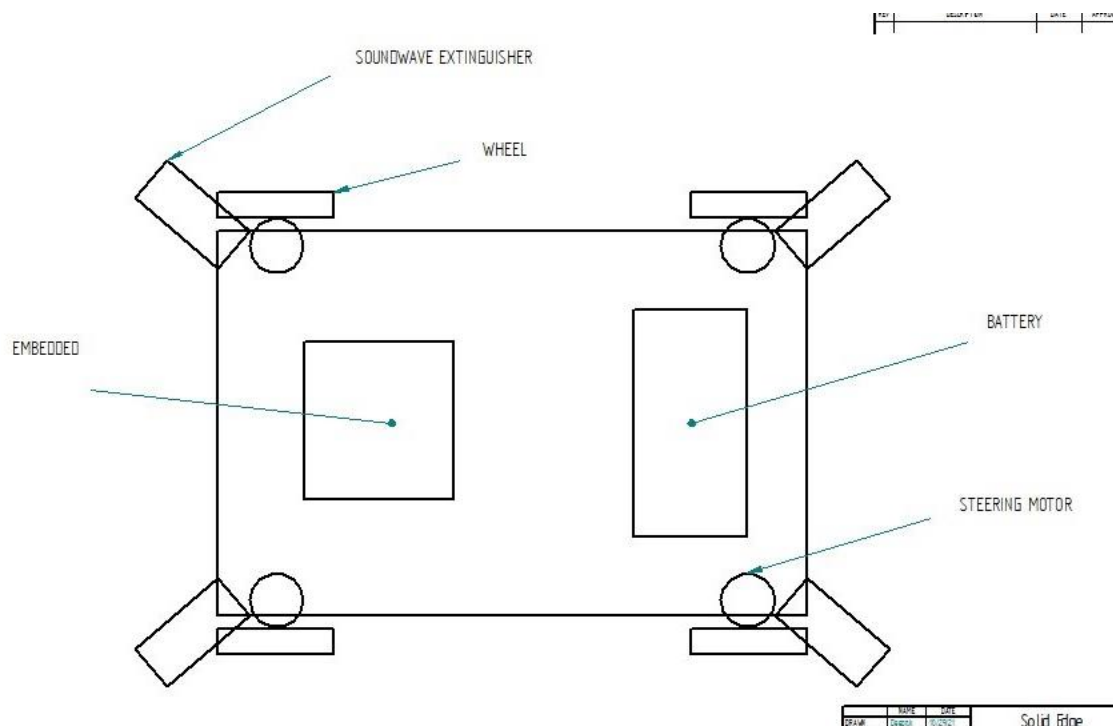


Fig: 3.3 : Working Model

Our project's goal is to combine all four steering mechanisms into a single-vehicle. In the case of zero-degree radius turning, this can be accomplished by changing the typical steering system and employing a customized differential gearbox. In this

case, the vehicle revolves around its axis. The principle we followed for this project was to alter the steering system. The modifications are listed below.

1. There are two steering columns, one for front-wheel steering and the other for rear-wheel steering (Rack and Pinion).
2. Knuckle joints and pins are utilised to link the front and rear steering columns with an additional steering shaft.
3. Modifying the differential gear box so that one side of the wheel can rotate clockwise while the other can rotate counterclockwise during a zero-degree turning radius.
4. By altering the location of the steering column's tie rods on guide plates, the vehicle's steering modes can be adjusted.

3.3 LIST OF COMPONENTS

- Arduino Nano
- Sound amplifier
- Speaker 250watt
- Bluetooth Module
- Battery 12v 4.5ah

3.3.1 Arduino Nano

The Arduino Nano is utilized in this project. Using a constant voltage source, it is used to create a clock with a precise frequency. Arduino mini is different from other Arduinos in that it is very compact, making it ideal for little projects, and it supports breadboards, allowing it to be connected to additional components on a single breadboard. There is one drawback to utilizing Arduino Nano: it lacks a DC power connector, which means you can't use a battery to provide external power. The Arduino Nano is the board of choice for many projects that call for a compact, easy-to-use microcontroller. This will allow you to create larger programmes (it has 50% more program memory) and with a lot more variables than the Arduino Uno (the RAM is 200 percent bigger).



Fig: 3.4 : Arduino Nano

“The Arduino Nano can connect with a pc, another Arduino, or any other MC's. The ATmega328 supports UART TTL (5V) serial communication on digital pins 0 (RX) and 1 (TX) (TX). An FTDI FT232RL on the PCB channels serial communication over USB” [3]

The FTDI drivers (included with the Arduino software) offer a virtual com port to applications on the computer. A serial monitor is included in the Arduino software, allowing simple textual data to be transferred to and from the Arduino board. The RX and TX LEDs on the board will blink when data is transferred via the FTDI chip and USB connection to the PC (but not for serial communication on pins 0 and 1). A Software Serial library may be used to communicate serially on any of the Nano's digital pins. The ATmega328 also supports I2C (TWI) and SPI communication. The Wire library included with the Arduino software makes utilising the I2C bus a snap. Please refer to the ATmega328 datasheet for information on how to use SPI communication. “The Arduino Nano may be programmed using the Arduino software (download). Select Board from the Tools > Board menu "Arduino Duemilanove or Nano w/ ATmega328" (according to the microcontroller on your board)” [3]

The bootloader on the ATmega328 on the Arduino Nano comes preburned, allowing you to upload new code to it without the use of an external hardware programmer. It uses the original STK500 protocol to communicate. You can also use Arduino ISP or equivalent to bypass the bootloader and programme the microcontroller directly through the ICSP (In-Circuit Serial Programming) connector.

The Arduino Nano is constructed in such a way that it may be reset by software running on a connected the decrease of DTR may be well synchronized with the start of the upload, the bootloader can have a shorter timeout. This setup has some other implications.

“Every time a software connection is established to the Nano while it is attached to a Mac OS X or Linux computer, it resets (via USB). For the following half second or so, the Nano's bootloader is active. It is set up to reject incorrect data (anything other than a fresh code upload), but it will intercept the first few bytes of data sent to the board once a connection is established. If a sketch on the board receives one-time configuration or other data when it first starts, make sure the programme it communicates with waits a second after initiating the connection and before transmitting this data” [3]

Instead than needing a physical press of the reset button before an upload, the

computer. One of the FT232RL's hardware flow control lines (DTR) is connected to the ATmega328's reset line via a 100 nano farad capacitor. When this line is asserted, the reset line drops long enough to reset the chip (taken low). "The Arduino software makes advantage of this feature to enable you to upload code by hitting the upload button in the Arduino environment" [3]

3.3.2 Speaker



Fig:3.5: Speaker

Speakers make sound by moving a quantity a flow of air in such a way that is heard. In most situations, speakers transform electrical impulses into sound. Speakers are classified into two parts: passive and powered. Passive speakers make up a vast majority of commercially available speakers. Passive speakers don't even have an amplifier built in and must be linked to one via normal speaker wire. Active speakers or self-powered loudspeakers are other terms for powered loudspeaker. They have built-in high and/or low frequencies amplifier. Overwhelming power often require huge shells, restricting their portability and use in contrast to passive speakers. "Because they feature built-in electronic components that require external power sources, they can be less dependable" [18]

3.3.3 Types of speakers

a) Dynamic:

These speakers are the most popular speakers and they are passive speakers. To create lower frequency sound like base, They include 1 or more speakers



Fig : 3.6 : Dynamic

b) Subwoofer:

Dynamic loudspeakers with only one woofer driver are known as subwoofers. To boost low-frequency performance, a bassport is frequently added in the speaker's enclosure. These speakers transmit low-frequency or bass sound.



Fig: 3.7 : Subwoofer

c) Horn:



Fig: 3.8 : Horn

Horn amplifiers, like dynamic speaker systems, employ drivers that are placed at the very edge of a cone-shaped structure. The sensitivity of this speaker is great, and it can efficiently transfer sound over a large area.

d) *Electrostatic:*



Fig: 3.9 : Electrostatic

Flat-panel loudspeakers, often known as diaphragm speakers, are electrostatic speakers. Over two conductive, stationary panels, they have one motor and a thin membrane. Electrostatic speakers are usually powered from the outside and hooked into an electrical socket. Because the tiny membrane moves so little, it receives an alternating current from an amplifier, which generates sound.

e) *Planar magnetic*



Fig: 3.10 : Planar - Magnetic

Instead of the large diaphragms found in electrostatic speakers, these speakers have a tall, thin, and narrow metal ribbon. This sort of speaker does not require an electrical connection to function.

3.3.4 Bluetooth Module

As individuals discover the ease of a wireless and portable speaker, Bluetooth speakers are becoming more popular [1]. However, for individuals who require more powerful and affordable Bluetooth speakers for larger applications, such as theatrical and dance rehearsals, the market is deficient. Boom box style speakers are available from large firms such as Bose and JBL, however they cost more than \$300 [2][3]. We built a portable amp with Bluetooth capacity that can turn regular household speakers into Bluetooth speakers, as speakers have become more widespread in households in recent decades. Users can purchase our equipment to use with their own speakers rather than being locked onto a speaker and amplifier that is offered by other firms since they can reuse their speakers. This provides the consumer with more freedom at a reduced cost. The device is expected to be built for less than

\$100 provides the consumer with more freedom at a reduced cost. The device is expected to be built for less than \$100.

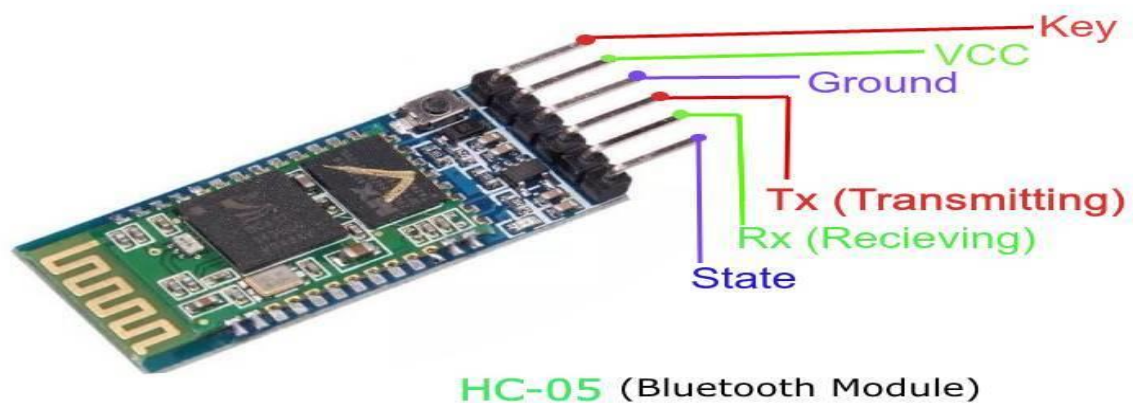


Fig: 3.11 : Bluetooth Module

Battery 12v 4.5ah :

A battery is a group of electrolytic cell linked in series that may be used as a direct current source.

Only one anode and cathode are present in a cell.

Anodes and cathodes are found in the battery.



Fig: 3.12 : Battery

Cell : Contains only one anode and cathode

Battery: Contains several anodes and cathodes

Requirements of a battery

The following criteria should be met by a good battery:

1. It must be light and compact in order to be easily transported.
2. It should have a lengthy life span, both when in use and when not in use.

3. The battery's voltage should not change significantly during use.

3.3.5 TYPES OF BATTERY

1. *Primary Battery (or) Primary cells:*

External electrical energy cannot be used to reverse the electrode and electrode responses in these cells. Because the reactions only take place once and then die, they are not charged. Dry cell, for example mercury cell

2. *Secondary Battery (or) Secondary cells:*

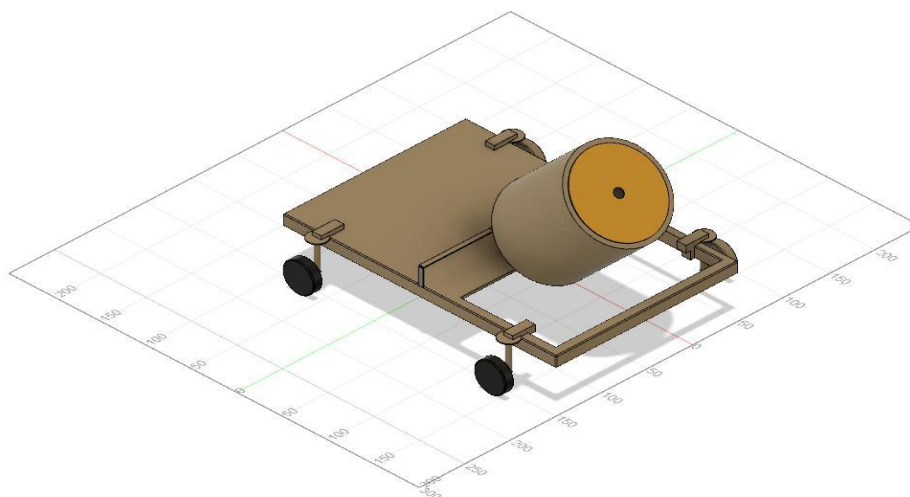
By delivering external electrical energy via these cells, the electrode reactions can be reversed. As a result, they may be recharged and reused by passing electric current. These are also known as Accumulators or Storage Cells. Storage cells made of lead, nickel, and cadmium, for example.

3. *Flow battery (or) Fuel cell*

Reactants, products, and electrolytes all flow through these cells on a constant basis. Chemical energy is turned into electrical energy in this process.

3.4 3D Modelling

3.4.1 CAD Designing:



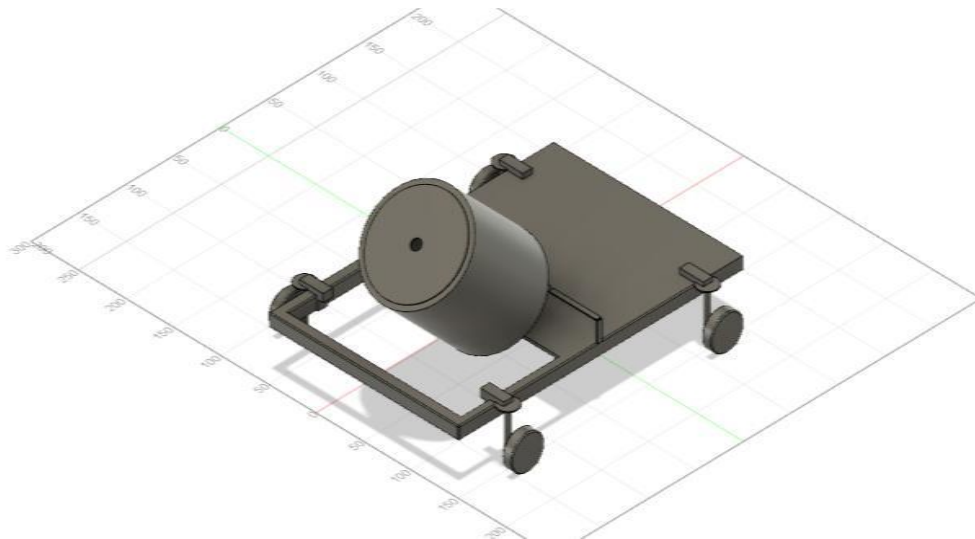


Fig: 3.13 : CAD Design

3.5 CIRCUIT DESIGN

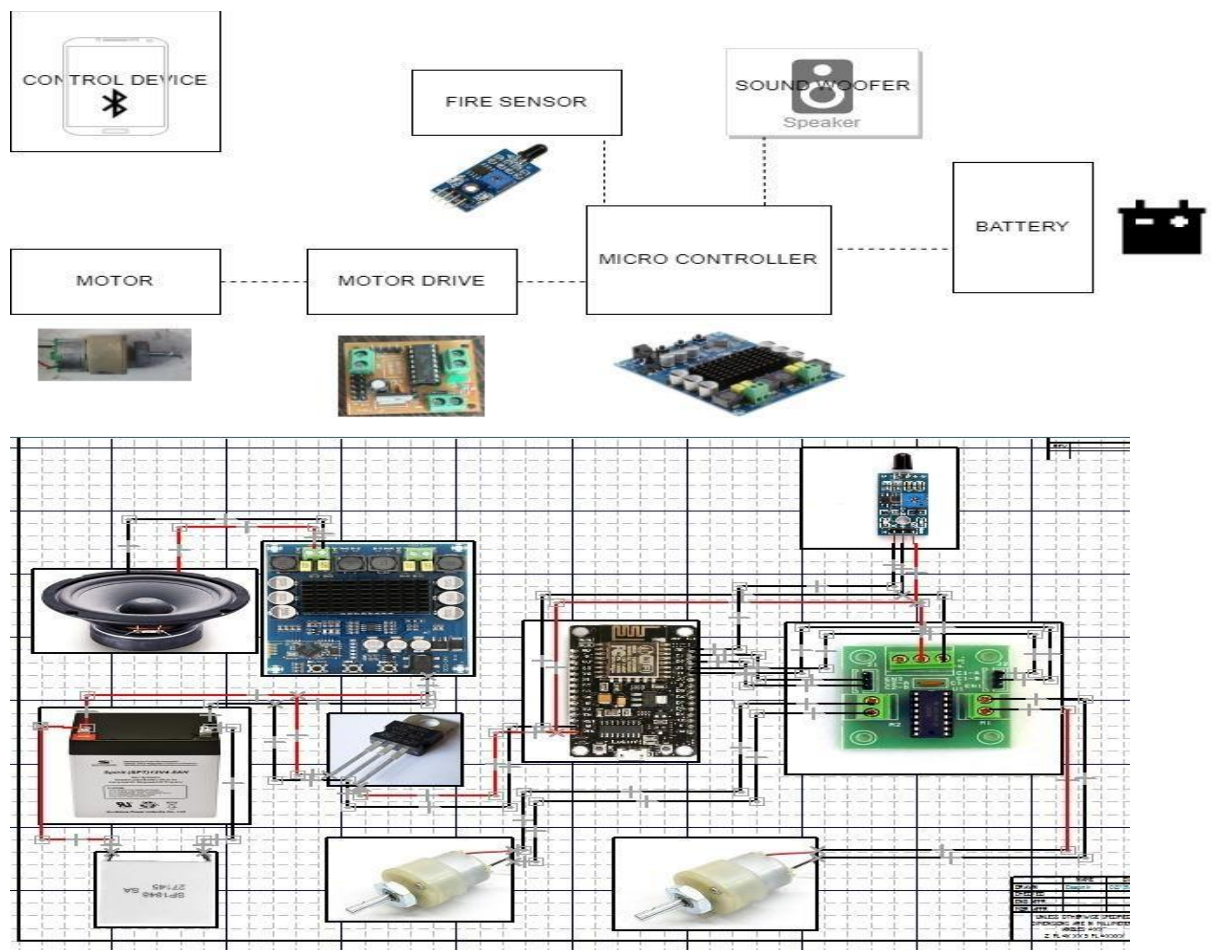


Fig: 3.14 : Circuit Diagram of 360 Degree Robot

3.6 ASSEMBLING PROCESS

In this level we are going to assemble the parts to make it ready. Here are some pictures that you can find below. In the below figure it is showing that the designation of the frame work and subwoofer.



Fig: 3.15 : Assembling Process



Fig: 3.16 : Sound Wave Fire Extinguishing Robot

CHAPTER 4

RESULT AND DISCUSSION, PERFORMANCE ANALYSIS

4.1 RESULT

The result of this project is simple that our code is runs successfully and able to operate the robot model and can operate it easily using mobile phone via Bluetooth. Also this project is working fine can able to extinguish the fire around itself by keeping extinguish 3600. Here is the screenshot of simulating the code using Arduino software showing the result of that code and simulating easily.

4.2 SIMULATION IN MATLAB

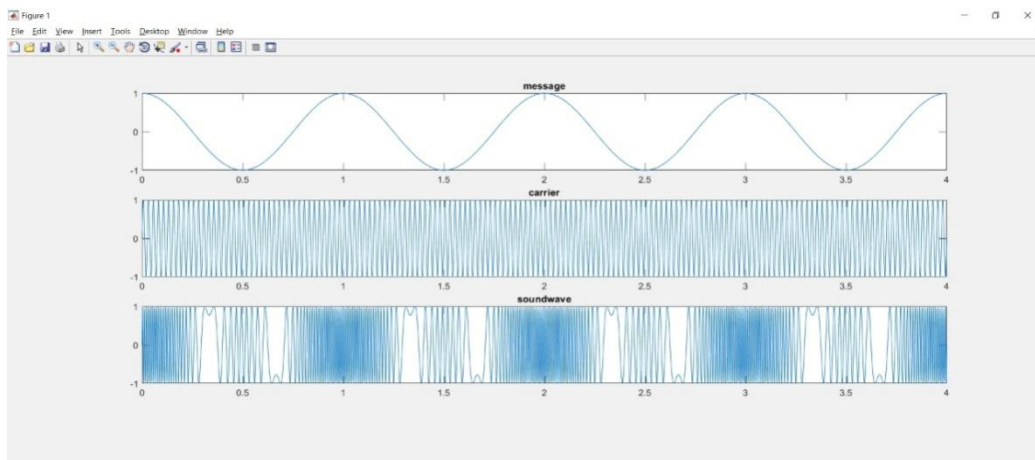


Fig: 4.1 : Simulation of 360 Degree Robot

The output sound waves from subwoofer (40 Hertz to 80 Hertz)

4.3 ARDUINO CODE

```
#define BLYNK_PRINT Serial
#include <WiFi.h>
#include <WiFiClient.h>
#include <BlynkSimpleEsp32.h>
#include <ESP32Servo.h>

BlynkTimer timer;

Servo backservo1;
Servo backservo2;
Servo frontservo1;
Servo frontservo2;

int servo1Pin = 15;
int servo2Pin = 4;
int servo3Pin = 18;
int servo4Pin = 19;

char auth[] = "5BL-Lc09Vt8tMQRoleFxAGSBiZrPt79e";
char ssid[] = "iot";
char pass[] = "12345678";

int in1 = 14;
int in2 = 27;
int in3 = 26;
int in4 = 25;

int fire_sensor = 23;
int fire_val;

BLYNK_WRITE(V1)
{
    int ang1 = param.asInt();
    backservo1.write(ang1);
}

BLYNK_WRITE(V2)
{
    int ang2 = param.asInt();
    backservo2.write(ang2);
}
```

```
BLYNK_WRITE(V3)

{

  int ang3 = param.asInt();
  frontservo1.write(ang3);

}
```

```
BLYNK_WRITE(V4)

{

  int ang4 = param.asInt();
  frontservo2.write(ang4);

}
```

```
BLYNK_WRITE(V5)

{

  int val1 = param.asInt();
  if(val1 == 1)

  {

    backservo1.write(0);
    backservo2.write(180);
    frontservo1.write(180);
    frontservo2.write(0);

  }

  else

  {

    normal();

  }

}
```

```
BLYNK_WRITE(V6)

{

  int val2 = param.asInt();
  if(val2 == 1)

  {
```

```

    backservo1.write(90);
    backservo2.write(90);
    frontservo1.write(0);
    frontservo2.write(0);

}

else

{

    normal();

}

}

BLYNK_WRITE(V7)

{

    int val3 = param.asInt();
    if(val3 == 1)

    {

        backservo1.write(90);
        backservo2.write(90);
        frontservo1.write(180);
        frontservo2.write(180);

    }

    else

    {

        normal();

    }

}

BLYNK_WRITE(V15)

{

    int zeromode = param.asInt();
    if(zeromode == 1)
    {

        zero_steer_fw();
    }
}

```

```

    }

    else

    {

        stp();

    }

}

BLYNK_WRITE(V16)

{

    int zeromode = param.asInt();
    if(zeromode == 1)

    {

        zero_steer_bw();

    }

    else

    {

        stp();

    }

}

BLYNK_WRITE(V9)

{

    int val5 = param.asInt();
    if(val5 == 1)

    {

        fw();

    }
    else

    {

        stp();

    }

}

```

```

    }

}

BLYNK_WRITE(V10)

{

    int val6 = param.asInt();
    if(val6 == 1)

    {

        bw();

    }

    else

    {

        stp();

    }

}

BLYNK_WRITE(V11)

{

    int ang11 = param.asInt();
    frontservo1.write(ang11);
    frontservo2.write(ang11);

}

void setup()

{

    Serial.begin(9600);
    pinMode(in1, OUTPUT);
    pinMode(in2, OUTPUT);
    pinMode(in3, OUTPUT);
    pinMode(in4, OUTPUT);
    pinMode(2, OUTPUT);
    pinMode(fire_sensor, INPUT);
    digitalWrite(2, LOW);

    backservo1.setPeriodHertz(50); // standard 50 hz servo
    backservo1.attach(servo1Pin, 1000, 2000);

```

```

    backservo2.setPeriodHertz(50); // standard 50 hz servo
    backservo2.attach(servo2Pin, 1000, 2000);

    frontservo1.setPeriodHertz(50); // standard 50 hz servo
    frontservo1.attach(servo3Pin, 1000, 2000);

    frontservo2.setPeriodHertz(50); // standard 50 hz servo
    frontservo2.attach(servo4Pin, 1000, 2000);

    //Blynk.begin(auth, ssid, pass);
    Blynk.begin(auth, ssid, pass, IPAddress(143,244,131,97), 8080);
    digitalWrite(2, HIGH);
    timer.setInterval(1000, fire);
}

void fire()
{
    fire_val = digitalRead(fire_sensor);
    if(fire_val == 0)
    {
        Blynk.virtualWrite(V20, "Fire Detected");
    }
    else
    {
        Blynk.virtualWrite(V20, "No Fire");
    }
}

void zero_steer_bw()
{
    digitalWrite(in1, LOW);
    digitalWrite(in2, HIGH);
    digitalWrite(in3, HIGH);
    digitalWrite(in4, LOW);
    Serial.println("zero mode");
}

void zero_steer_fw()

```

```

{
    digitalWrite(in1, HIGH);
    digitalWrite(in2, LOW);
    digitalWrite(in3, LOW);
    digitalWrite(in4, HIGH);
    Serial.println("zero mode");
}

void bw()
{
    digitalWrite(in1, HIGH);
    digitalWrite(in2, LOW);
    digitalWrite(in3, HIGH);
    digitalWrite(in4, LOW);
    Serial.println("backward");
}

void fw()
{
    digitalWrite(in1, LOW);
    digitalWrite(in2, HIGH);
    digitalWrite(in3, LOW);
    digitalWrite(in4, HIGH);
    Serial.println("forward");
}

void stp()
{
    digitalWrite(in1, LOW);
    digitalWrite(in2, LOW);
    digitalWrite(in3, LOW);
    digitalWrite(in4, LOW);
    Serial.println("stop");
}

```

```
void normal()

{

    backservo1.write(90);
    backservo2.write(90);
    frontservo1.write(90);
    frontservo2.write(90);

}

void loop()

{

    Blynk.run();
    timer.run();

}
```

CHAPTER 5

CONCLUSION

Overall, the sound wave extinguisher design and improvisation were successful. All of the tasks that extinguishers are supposed to undertake are performing appropriately. With these adjustments, the sound wave extinguisher In terms of safety, firefighting, and rescue operations, it will be a new success. It can be observed from the results of the experiment that sound waves can extinguish flames. In 4-wheel steering, there are four modes, each of which is implemented differently in most 4 wheel steering cars. Each has its own disadvantages. For example, using crab mode increases the turning radius, which makes it more difficult to manoeuvre the vehicle around sharp bends. Similarly, using rear steer mode reduces the turning radius to a greater extent, which increases the risk of the vehicle toppling at high speeds. To overcome these issues, both modes have been combined in a locomotive and their performance has been examined as demonstrated.

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OUTCOME OF THE PROJECT

- We had applied and attended a conference at Contemporary Innovations in Mechanical Engineering (CIME-2022).
- Submitted as Journal Paper to CIME'22

Journal Paper First Page:

360° ROTATING AND SOUNDWAVE FIRE EXTINGUISHER

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Abstract:

A unique fire extinguisher technique is the subject of the project Using Sound Waves to Design a Fire Extinguisher. With a short response time, deals with firefighting operations. A sound wave extinguisher's purpose is to figure out what frequency range a flame can be put out in. It aids fire fighters in putting out fires at an early stage. Between 40Hz and 60Hz, fire can be quenched, and the sound wave has the ability to extinguish all types of fires. The fire must be put out while it is still in its early stages, when the heat and flame created by the fire are at their lowest levels. The project's goal is to put out the fire as soon as possible in order to improve human safety and protection.

Keywords: *Modelling, Sound waves, Fire Extinguisher, 360 degree rotatable robot, Fire, Steering Mechanism.*

1. INTRODUCTION:

1.1 Steering Mechanism:

The collection of components, connections, and other systems that allow ships (ships, boats) or vehicles (cars, motorbikes, and bicycles) to follow a predefined course is referred to as steering.

"The most typical steering arrangement is to use a hand-operated steering wheel in front of the driver to turn the front wheels. through the steering column, That contains universal joints(Which is the part of the collapsible steering column design) which allows it to wander from the straight course. Other systems such

Conference Certificate:



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Dear authors,

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Authors : Sivasaravanan S, Aathishankaran K S and Abdul Haq Shaik Vali
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