



# AUTONOMOUS FIRE EXTINGUISHING ROBOT USING SOUND WAVES

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## Abstract

Fire accidents are catastrophic in nature, leads to unrecoverable loss. The current fire extinguishing techniques comes with several drawbacks and is not eco-friendly. Extinguishing fire in an enclosed region has always been a problem, other than the accessibility for the fire fighter to get entry to the place, gaining access to the water, carbon dioxide (CO<sub>2</sub>) or different fire extinguisher to the closed space is a primary challenge. A compact, unbiased and reliable fire extinguisher is required in order to overcome this problem. Space station and submarine are the principal examples of the utility that highly require new fire extinguisher technology that will be able to be used in the confined and very limited space.

Current method of fire fighting technology has shortcome such as toxic to humans and leaves residues (for dry chemical based fire extinguisher ) while water based fire extinguishing technique freezes in cold climates and conduct electricity. Sound wave could be one of the potential alternatives as fire extinguisher. The present project aims to develop the portable autonomous fire extinguishing robot using sound waves.

**Key Words:** Enclosed region, compact, unbiased, catastrophic, eco-friendly, primary challenge, residues, toxic, extinguisher.

## I. INTRODUCTION

Fire is a self-sustaining, chemical chain reaction with varying degrees of light and heat. Flame is the observable portion of the fire. Fire starts when a flammable and/or a combustible material, in combination with an adequate quantity of an oxidizer for instance, oxygen gas is exposed to a source of heat or ambient temperature above the flash stage for the fuel/oxidizer mix, and is able to withstand a rate

of rapid oxidation that produces a chain reaction. Fire is made up of four components: Fuel, Oxygen Heat and Chemical Chain Reaction. This is normally called the fire tetrahedron. Fire cannot exist if deprived of all of these elements in place and in the right proportions.

There are four major methods for putting off fire. The most common way used to extinguishing fire is to cool down the burning material. For fire involving solid materials water is commonly used as cooling agent.

When water comes in contact with fire it gets vaporized thus cutting down the oxygen supply. Care should be taken that water should not be put on to hot cooking oil or fat as it causes the fire to spread. Second way is to exclude oxygen from the fire this can be done by the use of Asphyxiating agents.

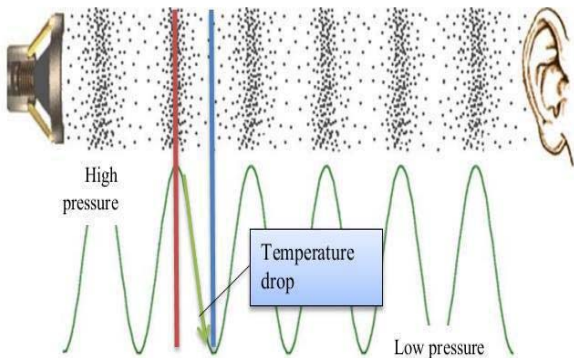
Foam containing fire extinguisher help in isolating the fuel surface from the air and cool down resulting in reducing combustion and being able to resist wind. Foam is an electrical conductor therefore it should not be used in electrical fire.

The current fire extinguishing technologies has several drawbacks. Sound waves are found to be one of the alternatives to extinguish the fire.

This project utilizes the scientific principle of physics and the engineering aspects of electronics. Acoustic wave patterns are referred to as longitudinal pressure waves, in which they are able to agitate air molecules away from the fuel of the flame. The ideal gas law has an effect on suppressing a flame. When the pressure waves are being directed at the source of a flame, it will decrease the pressure at the source which will in turn decrease the average temperature of the flame.

**2.EXPERIMENTS AND DISCUSSIONS**

In the search of new extinguishing techniques sound waves is found to be ideal and efficient. There are some aspects of the combustion which is affected by sound waves. The flame air-fuel ratio at the boundaries can be affected by sound waves by changing the velocity of its medium (air) and the changes in air velocity affect the flow of fuel around the heat source as well as increasing the heat transfer of the heat source and reducing the average temperature of the flame these effects are same as normal flame blow off characteristics.



Fig(b). Traverse nature of sound waves

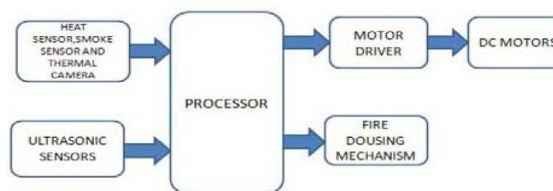
The main stream analysis for the sound wave effect on the flame is depicted in Figure(b). The pressure fluctuations due to the sound wave propagation will cause a significant change in temperature profile near the flame. High pressure to low pressure and vice versa will cause immediate change on the temperature according to the first law of thermodynamic. The combine actions of fluctuating temperature, pressure and air-fuel ratio to the flame will affect the flame behavior under the regulated sound wave environment. A pressure perturbation is known to have influence on the burning rate of a material and cause combustion instabilities, which could eventually lead to flame extinction.

**3.MECHANISM OF FIRE EXTINGUISHER**

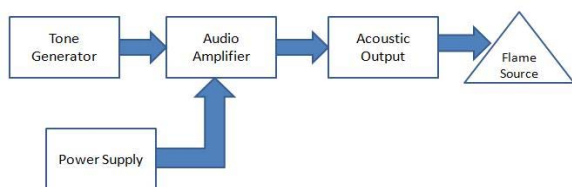
The acoustic wave impacts kinetic energy to the reactants of the flame causing the net velocity of reactants to be greater than the flame propagation velocity. Flame oscillates about the fuel under acoustic excitation.



**4. WORKING**



Fig(c). Block Diagram



Fig(d). Fire dousing mechanism

The room is divided into a number of quadrants, for each quadrant a heat and smoke sensor is placed at top of the roof. These sensor locations are fixed. If there is fire detected, then the heat and the smoke sensors send signals to the NRF which in turn sends it to the processor. Based on which sensor is triggered the location of the fire is found.

The map of the room is loaded in the robot's memory. Therefore the robot will go to the location of the fire based on the NRF signals. NRF module is a trans-receiver which is used to send the signals from the sensors to the robot. It is used for wireless transmission of signals. Using the strength of the NRF signals the robot makes sure it's going towards the fire.

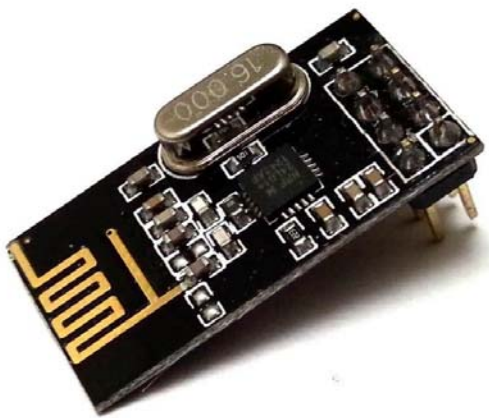
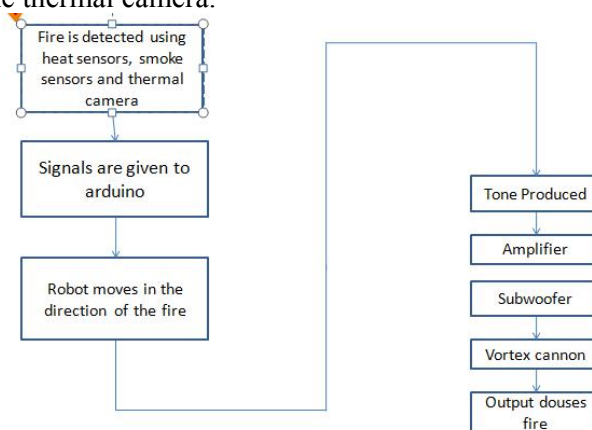


Fig. NRF Module

Once it reaches the fire, arduino gives signals for tone generation. The tone generated is amplified by an amplifier and then given to the sub woofer. A sub woofer is dedicated to the pre production of pitched audio frequencies known as bass. The output of the subwoofer is given to the vortex cannon. A air vortex cannon primarily works by applying force quickly and efficiently to air molecules. When the stretchy balloon surface at the back of the cannon snaps forward, it collides directly over the air molecules, accelerating them towards the opening of the cannon and setting of high speed collisions with other air molecules

and the sides of the cannon's barrel. The only way for all of these colliding high speed air molecules to escape out is through the opening at the end of the barrel. The rapid escape of the air molecules forms a stream, or jet, of air that flows straight out of the cannon. The output of the vortex cannon douses the fire.

Thermal Camera is placed on the robot. Once the robot reaches the fire location the thermal camera gives the accurate fire location. It also gives the area of the fire. The thermal imaging camera renders infrared radiations as visible light, such cameras allow seeing areas of heat through smoke, darkness or heat permeable barriers. The robot is programmed such that it moves towards the direction of heat sensed by the thermal camera.



Fig(e). Flowchart

## 5.CHARACTERISTICS OF PORTBLE FIRE EXTINGUISHER

- No residue compared to chemical fire extinguisher.
- Lighter material weight.
- Less damage to surroundings.
- Non toxic.
- No expiration date.
- No refilling date.
- Can be used in confined places.

## 6. APPLICATION

It can be used in-

- Record maintaining rooms where fire can cause loss of valuable data.
- Server rooms for immediate action in case of fire.
- Extinguishing fire where probability of explosion is high.
- Energy working environment requiring permanent operations attention.
  - At power plant control rooms
  - At flight control centers

## 7. CONCLUSION

The idea of extinguishing fire with sound is a novel one. A small fire which is left untreated leads to a bigger one. The proposed system will indeed be useful in fighting fire in multilevel information conveyance capabilities so that a bigger disaster can be avoided.

## 8. FUTURE SCOPE

The robot can be used to navigate from room to another. It can be built for altering environment and bigger fire as in the case of forest fire. It can be extended for swarm robotics.

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