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Design and Development of Fire Safety Robot

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Abstract: There are many risks when a fire starts in an industry or in any remote area. For example, in cotton mills, garment factories, fuel storages, etc; electric short circuits, gas leakages, also sometimes improper handling of inflammable materials can lead to fire accidents whose effects can be devastating. Also, in a worst-case scenario, causing heavy losses not only financially but also destroying areas surrounding it. Robotics is the emerging solution to protect human lives, wealth and surroundings. The aim here is to design a 'Fire Fighting Robot' using an embedded system. A robot capable of fighting a simulated household fire will be designed and built. It must be able to autonomously navigate through a modeled floor plan while actively scanning for a flame. The robot can even act as a path guider in normal cases and as a fire extinguisher in an emergency. Robots designed to find a fire, before it rages out of control, can one day work with fire-fighters greatly reducing the risk of injury to victims. The project will help generate interests as well as innovations in the fields of robotics while working towards a practical and obtainable solution to save lives and mitigate the risk of property damage.

***Index Terms*–Design, Development, Fire Safety, Robot.**

1. Introduction

Fire is the result of a chemical reaction, called combustion. At a certain point in the combustion reaction, called the ignition point, flames are produced. Flames consist primarily of carbon dioxide, water vapor, oxygen and nitrogen. Fire emits heat and light. Flame temperatures of common items include a candle at 1,400 °C (2,600 °F), a blow torch – at around 1,600 °C (2,900 °F) a propane torch at 1,995 °C (3,620 °F), or a much hotter oxy acetylene combustion at 3,000 °C (5,400 °F).

Fig. 1: Image of Fire

This is commonly called the fire tetrahedron. Fire cannot exist without all these elements in place and in the right proportions. For example, a flammable liquid will start burning only if the fuel and oxygen are in the right proportions. Some fuel-oxygen mixes may require a catalyst, a substance that is not consumed, when added, in any chemical reaction during combustion, but which enables the reactants to combust more readily.

2. Robot

A robot is an artificial agent, meaning it acts as a substitute for a person, doing things it is designed for. Robots are usually machines controlled by a computer program and electronic circuitry. They are designed to carry out a series of complex actions automatically. It is an automated machine which can sense its surrounding environment, make decisions, and perform actions by carrying out computations in the real world. We have robots that do surgery inside our body. We have robots that can land on mars. While some

can walk on two, four, six or more legs. Due to its diversity in size, design, capabilities the term 'Robot' means different things to different people.

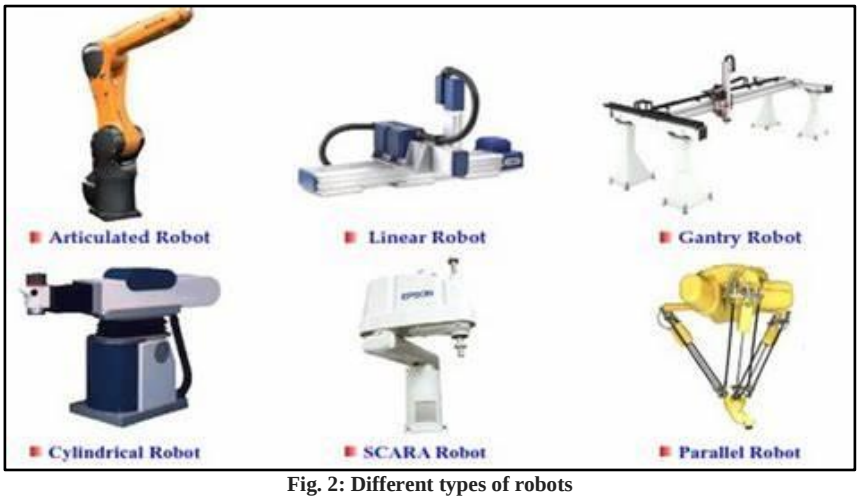


Fig. 2: Different types of robots

It is a machine designed to replace human beings in performing a variety of tasks, either on command or by being programmed in advance. Most robots today are used to do repetitive actions or jobs considered too dangerous for humans. Like, a robot is ideal for going into a building that has a possible bomb. Robots are also used in factories to build things like cars, candy bars, and electronics. As a word, robot is a relative newcomer to the English language. It was the brainchild of a brilliant Czech playwright, novelist and journalist named Karel Čapek (1880-1938) who introduced it in his 1920 hit play, R.U.R., or Rossum's Universal Robots.
The first digital and programmable robot was invented by George Devol in 1954 and was named the Unimate. It was sold to General Motors in 1961 where it was used to lift pieces of hot metal from die casting machines at the Inland Fisher Guide Plant in the West Trenton section of Ewing Township, New Jersey.

3. Classification of Robot

- Arm geometry
- Degrees of freedom
- Power sources
- Type of motion
- Path control
- Intelligence level

4. Literature Review

Teh Nam Khoon, Patrick Sebastian, Abu Bakar Sayuti Saman et al.**[1]** In this integrating all the hardware such as flame sensors, motor driver circuitry, LDR sensors, the expected patrolling and fire extinguishing tasks are possible to be carried out and executed with minimum level of error. By deploying the AFFMP to monitor for hazardous sites via patrolling process, it aids to share out the burden of fire-fighters in firefighting tasks as the fire-fighters can safely delegate the firefighting tasks to AFFMP. For future enhancements to the current project, additional features can be integrated onto the system, namely the wireless communication module, so that it can communicate between the operator and the victims within the fire site; image processing technique to analyze for fire source instead of using the flame sensors; utilisation of renewable source of energy such as solar power to drive the main circuitry on the AFFMP's platform; ability to navigate on uneven surfaces; and ability to climb staircases.

Joga D. Setiawan*, Mochamad Subchan*, and Agus Budiyono et al. **[2]** This paper describes the viability of simulation and animation of Fire Fighting Robot in order to evaluate the performance of the robot design in meeting some of the contest rules such as navigating in a labyrinth arena without hitting walls, quickly extinguishing a flame in a room and return home. This work shows the benefit of a virtual reality tool that enables students to quickly evaluate and clearly visualize the dynamic and motion of a Firefighting Robot and the interaction between the robot and its environment before spending too much time in building the robot. The present model gives a reasonably accurate analytical representation of an example Fire Fighting Robot and its contest arena. In turn, students can become more familiar with the analytical models. This model can give the basis of a model that could be used by students.

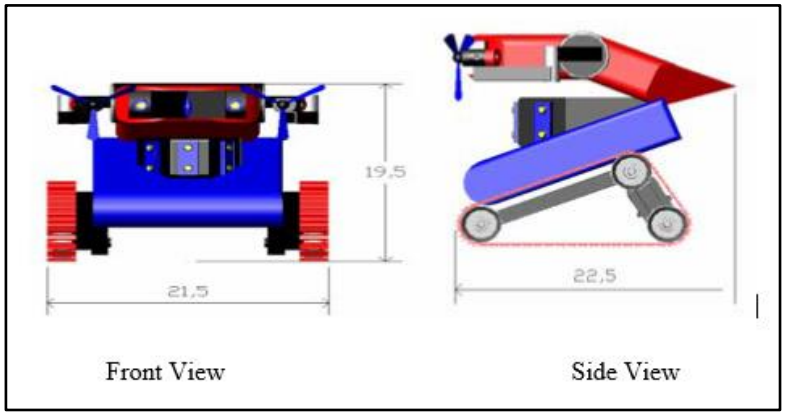


Fig 3: 2D View of robot design by Joga D Setiawan

David J. Ahlgren1et al.**[3]** The Technical Tuesday lectures taught fundamental concepts of electrical, mechanical, and computer engineering, and the workshops developed basic engineering skills including programming in C and the use of laboratory instruments and CAD packages. Several workshop assignments required students to apply newly-acquired electrical and mechanical construction skills. Through readings, seminar discussions, and guest lecturers, the course succeeded in presenting engineering design from philosophical, professional, and practical perspectives. Team-led discussions of readings encouraged development of communication skills. More than one-half of the students in the 2000 offering went on to take an engineering course in the first term of their second year. While lacking significant prior software development experience, several students found robot programming so interesting that they decided to major in Computer Science. Still, the course attracted many students to the Engineering major.

David J. Ahlgren, Igor M. Verner et al. **[4]** This paper introduces the Trinity College Fire- Fighting Home Robot Contest (TCFFHRC), evaluates the curricular impact of the contest at university and high school levels, and provides examples of student projects inspired by the contest. We evaluate the contest by analyzing participant survey data from the 2000, and 2001 contests, and we present our conclusions about the educational benefits of developing a robot for this competition.

Sahil S.Shah, Vaibhav K. Shah, Prithvish Mamtora, Mohit Hapani et al. **[5]** in this many possibilities a fire can start in an industry or in any remote area. For example, in cotton mills, garments, fuel storages, etc., electric leakages can lead to huge damage. Also it's a worst-case scenario, causing heavy losses not only financially but also destroying areas surrounding it. Robotics is the emerging solution to protect human lives and their wealth and surroundings. The aim here is to design a Fire Fighting Robot using an embedded system. A robot capable of fighting a simulated household fire will be designed and built. It must be able to autonomously navigate through a modeled floor plan while actively scanning for a flame. The robot can even act as a path guider in normal cases and as a fire extinguisher in an emergency. Robots designed to find a fire, before it rages out of control, can one day work with fire-fighters greatly reducing the risk of injury to victims. The project will help generate interests as well as innovations in the fields of robotics while working towards a practical and obtainable solution to

Igor M. Verner, David J. Ahlgren, Jacob E. Mendelssohn et al. **[6]** This paper presents a quantitative assessment of the Trinity College Fire-Fighting Home Robot Contest, the largest robot contest open to designers of any age, affiliation and experience Our assessment develops a profile of the participants, and it evaluates factors that motivate the participants, including interest in designing robots, interest in science and technology, career opportunities, and engagement of robotics as a hobby. The paper also evaluates participants' progress in eight key disciplines related to robot design, including electronics, teamwork, system design, and programming.

M.Nithiya & E.Muthamizh et al. **[7]** our goal is to develop an intelligent multi sensor based firefighting robot in our daily life. We design the fire detection system using four flame sensors in the firefighting robot, and program the fire detection and fighting procedure using sensor based methods. The firefighting robot is equipped with four thermistors/flame sensors that continuously monitor the temperature. If the temperature increases beyond the predetermined threshold value, buzzer sounds to intimate the occurrence of fire accident and a warning message will be sent to the respective personnel in the industry and to nearby fire station with the GSM module provided to it. A Fire Fighting Robot continuously monitors the temperature at four sensors and if a fire accident is true, the robot moves to the direction to which the temperature is recorded to be the relatively maximum among the four sensors and extinguishes the fire with a water pump provided to it. After extinguishing the fire it comes back to its initial position. It is more advantageous than a smoke detector as it can extinguish the fire at the inception rather than waiting for an object to burn and produce smoke. When a smoke detector detects fire it, sprays water all over the place, instead of that particular point of source. It voluntarily detects and extinguishes fire without human aid.

5. Designs about FFR (Fire Fighting Robot)

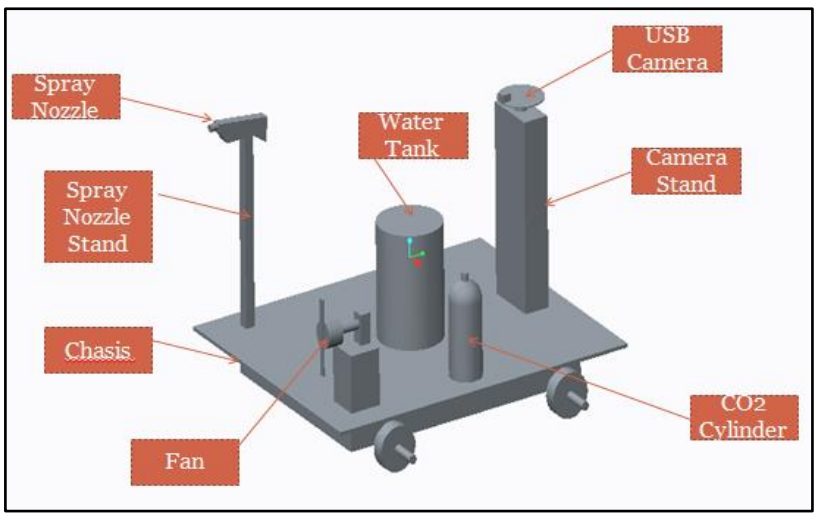


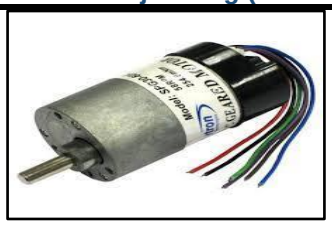
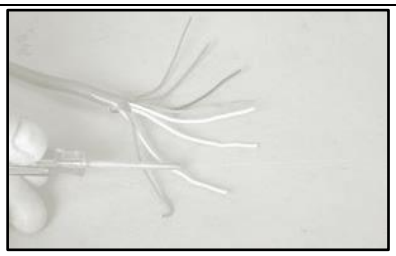
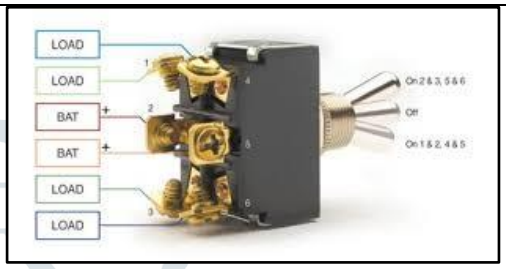
Fig 4: 3D View of FFR

Table 1: Material list and specification

Sr. No.	Part name	QTY
1	Frame of Robot (Chassis)	01
2	Fire resistive Insulation	--
3	Gear motors	05 Nos.
4	Wire Cable	8 coded
5	DPDT switches (Dual Pole Dual throw)	03 Nos.
6	Wheel base	01 Nos.
7	Water tank (Storage)	01 Nos.
8	Water pump	12 Volts
9	DC motors	12 Volts
10	Camera	01 Nos.
11	Fan	01 Nos.

Table 4.2 Description of part usage in FFR

Sr. No.	Parts Name	Details	Details of Image
1.	Frame of Robot (Chassis)	Size: 29 cm x 23.5 cm x 8 cm Material Composition: MILD STEEL	
2.	Fire resistive Insulation	Material – Aluminum Foil Length: 5 mtr.	

3.	Gear motors	Power – 12 V Speed – 150 rpm Shaft Dia. – 06 mm (Approx.) Speed : 100 rpm	
4.	Wire Cable	06 Coded Wired Length: 20 mtr Price: 20/- Rs. Per mtr	
5.	DPDT switches (Dual Pole Dual throw)	Electric signal pass in both direction Pole for switch Through for ON or OFF	
6.	Wheel base	Outer Dia. – 70 – 80 mm Inner Dia. - 06 mm Material - Fired proof	
7.	Water tank (Storage)	Storage of water 02 LTr. Material: Plastic	
8.	Water pump	Supply the water 12 voltage operated	
9.	DC motors	12 volt DC motor for 360 degree camera rotation	

10.	Camera	USB 2.0 Compact Portable Wireless	
11.	Fan	50 CFM 300 rpm	

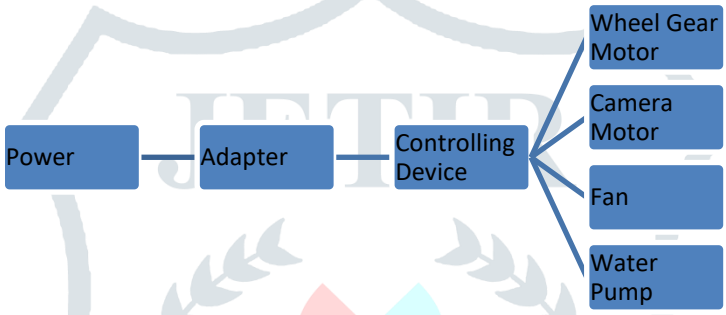


Fig 5: Block diagram of electric power supply

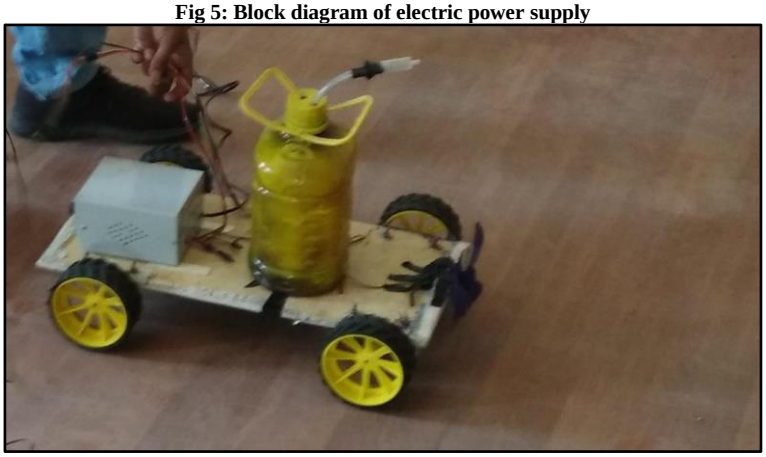


Fig 6: Images of Experimental setup of FFR

3. Conclusion

The purpose of this project is to develop and design a Fire Fighting Robot guided by these following objectives: To help generate interests as well as innovations in the fields of robotics. While working towards a practical and obtainable solution to save lives and reduce the risk of property damage. The fire in a specific room, approaches the fire at a very fixed distance, extinguishes it. The robot could be used to enter small spaces that are impossible to be accessed by a human. The firefighting robot could be used to fight fires in hazardous locations, which can't be accessed safely. • We use different techniques for extinguishing fires at any place. Force air, Water Spray, extinguish cylinder (Carbon dioxide), Visualization in mobile display of fireplace using camera. Use highly resistive material from FIRE. Portable robot that was operated by remote controller.

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