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Fire Fighting Robot

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ABSTRACT

Fire incidents present significant challenges and risks to human lives and property. To address these challenges, the development of fire fighting robots has emerged as a promising solution. This abstract provides a concise overview of fire fighting robots, highlighting their design, capabilities, and contributions to fire suppression efforts. Fire fighting robots are specialized machines equipped with advanced technologies and functionalities to combat fires autonomously or under remote human control. These robots are designed to navigate hazardous environments and access areas that may be difficult or dangerous for human fire fighters to reach. These robots employ various fire suppression mechanisms such as high-pressure water cannons, foam-based extinguishing systems, or even aerial water deployment through drones. By utilizing these capabilities, fire fighting robots can efficiently suppress fires, limit their spreads, and prevent further damage.

I. Introduction

In recent years, the development of advanced technologies has revolutionized various industries, and one such remarkable innovation is the fire fighting robot. A fire fighting robot is an autonomous or remotely operated machine specially designed to combat and mitigate the risks associated with fire incidents. These cutting-edge robotic systems are engineered to navigate through hazardous environments, suppress flames, and assist human firefighters in their life saving missions. The primary purpose of a fire fighting robot is to enhance the effectiveness and safety of fire suppression operations. These robots are equipped with state-of-the-art sensors, and specialized tools to perform tasks that would otherwise be perilous for humans. With their ability to withstand extreme heat, toxic gases, and unstable structures, fire fighting robots provide invaluable support in emergency situations. One of the key advantages of fire fighting robots is their ability to access area that may be challenging for human firefighters to reach. They can navigate narrow passages, climb stairs, and move through debris, enabling them to quickly locate and combat fires in hard-to-reach locations. This capability significantly reduces response time, allowing for a more efficient and timely intervention.

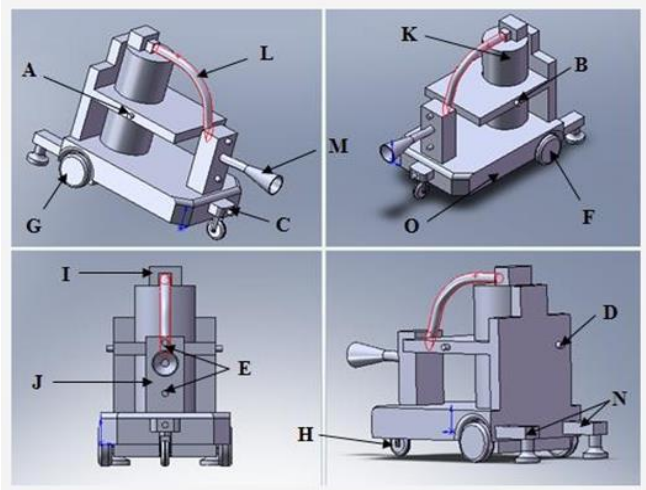
II. Methodology

The subject of this article is fire detection and extinguishing without human intervention. The Methodology is works in three parts. First part is in mechanical part followed by hardware and finally software part. All three of these parts were assembled and tested to create a system capable of extinguishing a fire.

- **Mechanical Part:**

This subtopic covers the design of the mechanical part of the firefighter robot. The body gear is used to protect the electronic circuit from obstacles, especially liquids, which can cause the electronic circuit to malfunction.

1. **Robot Design Platform**: This robot has two wheels at the back and one free wheel at the front. The free wheel is used to stabilize the robot and is used for 360° rotation. The image shows the design of the main body of the robot using Solid Work software.



CODE	FUNCTION
A	Right view
B	Left view
C	Front view
F	Left wheel
G	Right wheel
H	Front wheel
I	Clipper
J	Actuator
K	Fire extinguisher
L	Hose
M	Nozzle
N	Stabilizer
O	Electronic circuit

2. **Body Gear Structure:** The body gear is used to protect the electronic circuit from obstacles, especially liquids, which can cause the robot's electronic circuit to malfunction. The regular season design of the robot was based on the following ideas:

- Based on the actions taken by the robot.
- Determine where you place the internal components needed to the robot work.
- Minimize the loading weight of the robot to reduce the power requirements of the robot.
- Minimizes the center of gravity for easy identification of stability points in stationary or moving conditions.

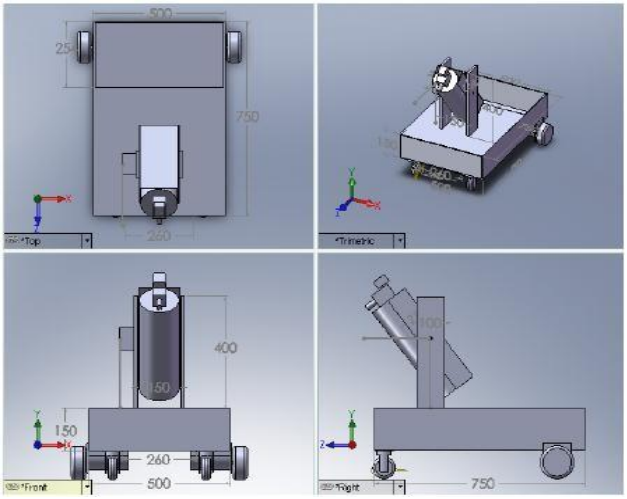


Figure: Design of the main body of the fire fighting robot with mixed operating software

Control Method:- Control method is important for the robot to locate and extinguish the destructive burned area. These methods help the firefighter robot achieve its goal of completely extinguishing the fire.

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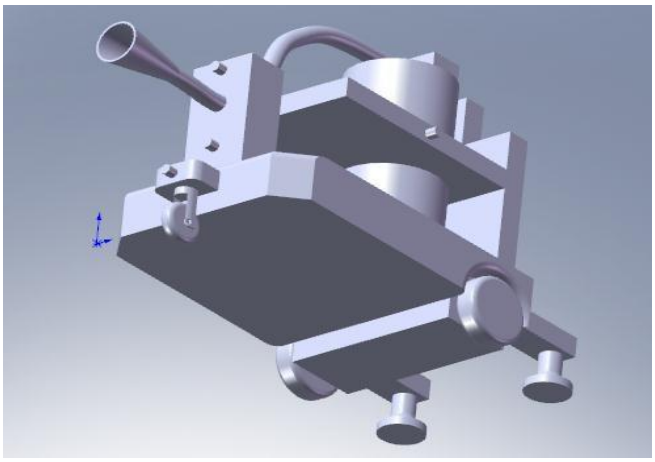
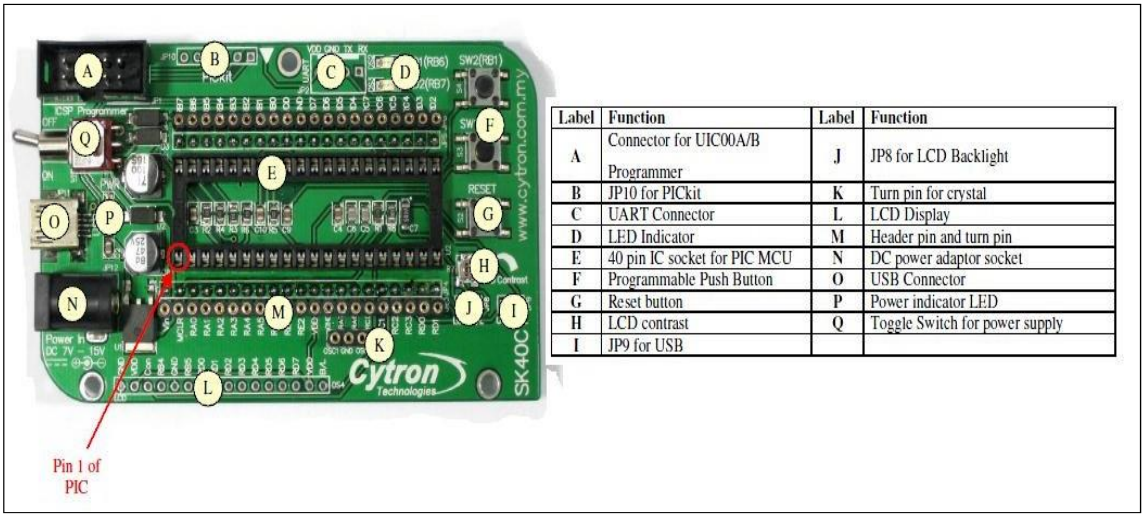


Figure: The wheel structure of the fire fighting robot, where the front wheel helps the robot move in any direction and the two rear wheels are attached to help the robot reach its destination.

- **Hardware:-** Using the robot requires a combination of electronic circuits. All devices used in this project are explained in the following subsection.

1. **Cytron SK40C Board:-** The Cytron SK40 board is a microcontroller development board designed for educational and hobbyist purposes. It is based on the popular PIC18F4550 microcontroller from microchip technology and provides a convenient platform for learning and experimenting with embedded systems and microcontroller programming. The SK40 board offers various features and peripherals that make it suitable for a wide range of projects. It includes a power circuit, a crystal oscillator for accurate timing, and an RS232 interface for serial communication. The board also provide access to all the I/O pins of the PIC18F4550 microcontroller, allowing users to connect and control external devices such as sensors, actuators and displays.



Label	Function	Label	Function
A	Connector for UIC00A/B Programmer	J	JP8 for LCD Backlight
B	JP10 for PICkit	K	Turn pin for crystal
C	UART Connector	L	LCD Display
D	LED Indicator	M	Header pin and turn pin
E	40 pin IC socket for PIC MCU	N	DC power adaptor socket
F	Programmable Push Button	O	USB Connector
G	Reset button	P	Power indicator LED
H	LCD contrast	Q	Toggle Switch for power supply
I	JP9 for USB		

Figure: Cytron SK40C Board

2. **PIC18F4550 Microcontroller:-** The PIC18F4550 microcontroller is a versatile and widely used microcontoller from PIC18 family of microcontrollers manufactured by microchip technology. It is based on a high-performance enhanced flash core, offering a range of features and capabilities suitable for various embedded systems applications.

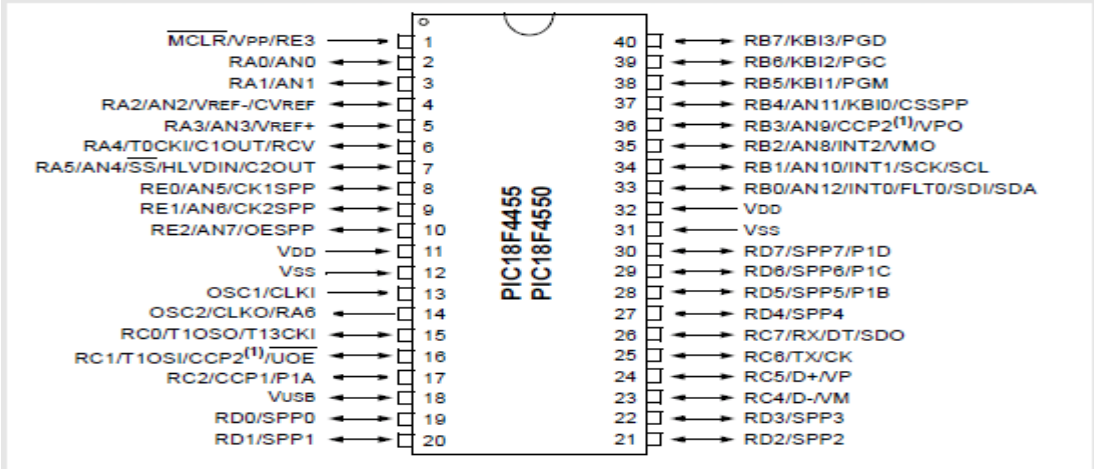
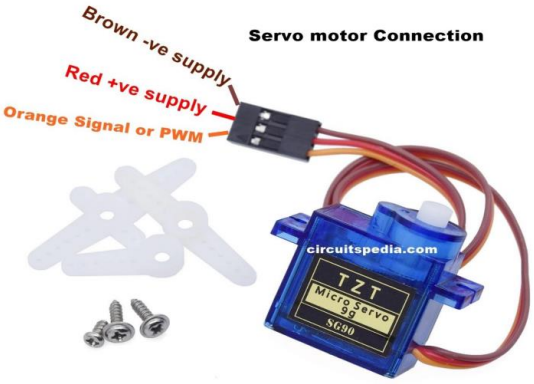
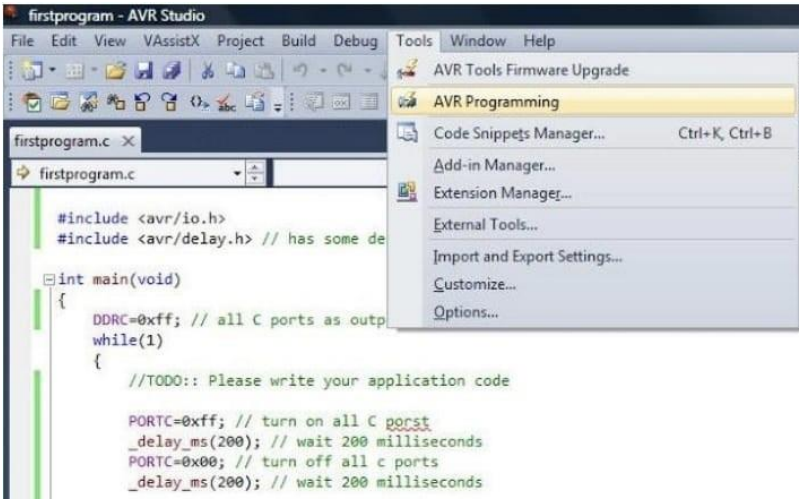


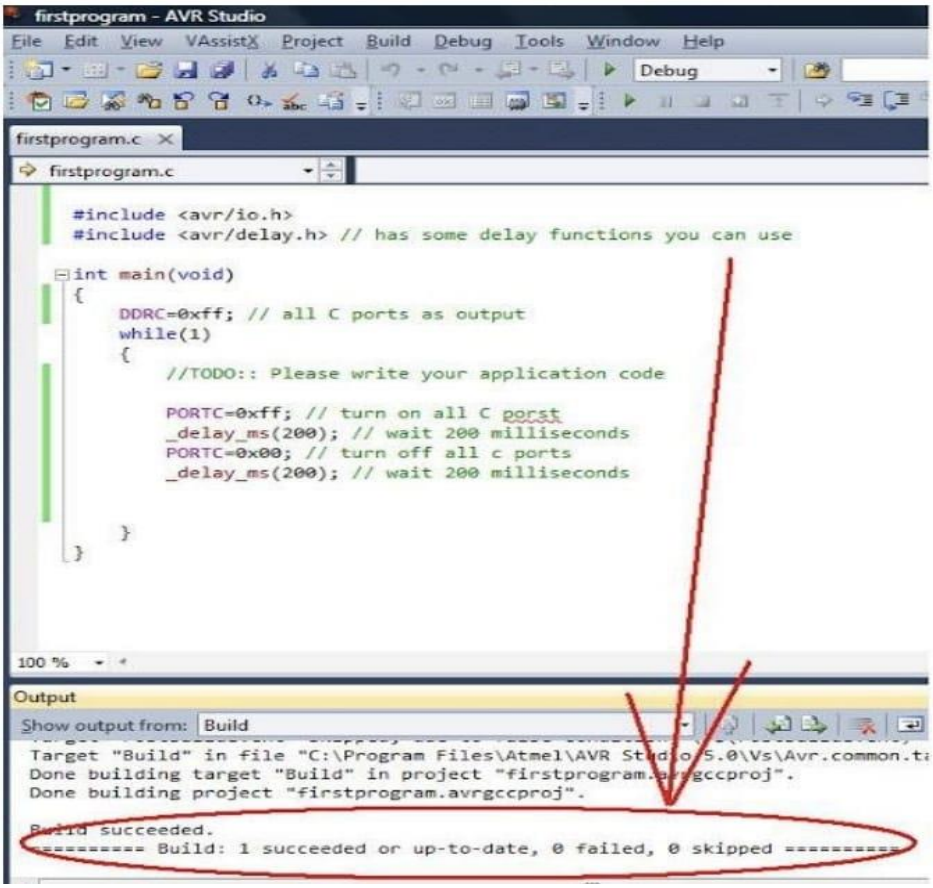
Figure: Pinouts of PIC18F4550

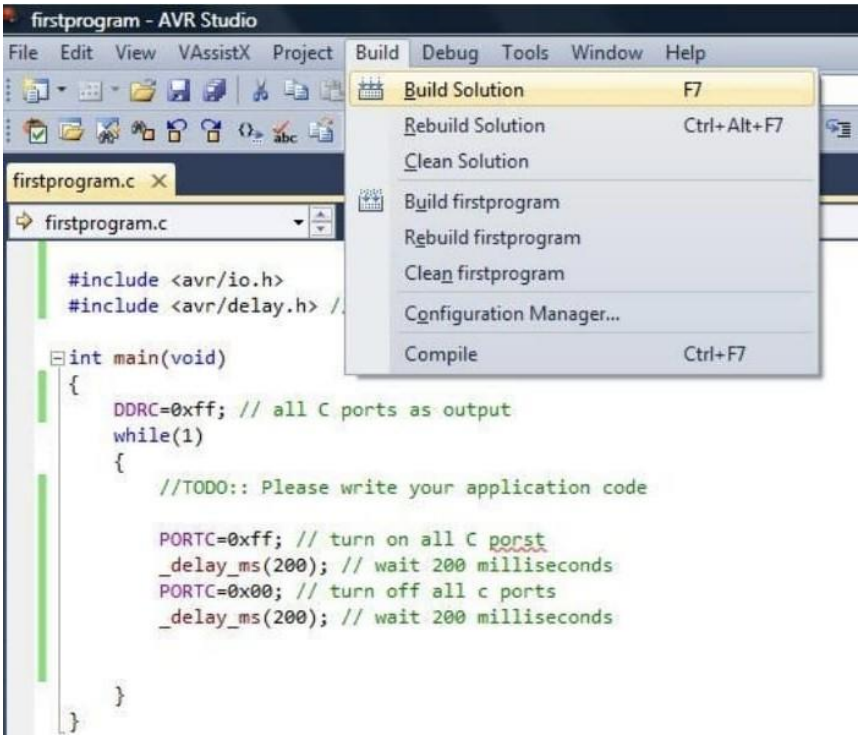
3. **Servo Motor:-** A servo motor is a type of motor that is commonly used in various applications, including robotics, automation and electronics. It is known for its precise control of angular position and ability to maintain that position with high accuracy. Servo motors are widely used in systems that require precise and controlled movement, such as robotics arms, RC vehicles, CNC, machines and camera gimbals.



- **Programming Part:-** Develop the software necessary for the operation of the robot. It includes software components such as observation and detection, localization and mapping, path planning and navigation, fire detection and monitoring, fire prevention strategies, human-machine interface, and communication protocols. Apply algorithms and techniques suitable for specific functions of the fire robot. The languages of this robot are C and C++. Here are the programming codes to control the fire robots:







3. Future Scope

The Future scope of firefighting robots is bright. Advancements in sensing technologies, artificial intelligence, and swarm robotics hold tremendous potential for improving their performance and versatility. Enhanced mobility, adaptability, and autonomous operation will enable robots to access challenging terrains and carry out complex tasks, complementing the efforts of human firefighters. Furthermore, improved communication and

coordination capabilities along with extended situational awareness, will facilitate seamless integration with existing firefighting infrastructure and systems. This will enable a more efficient and effective response to firefighting emergencies.

4. Conclusion

In conclusion, firefighting robots have emerged as a promising solution to enhance firefighting capabilities and mitigate risks for firefighters in hazardous environments. These robots are designed to perform a range of tasks, including fire detection, fire suppression, search and rescue operations, and situational awareness. Firefighting robots represent a significant advancement in the field extinguished. Continued collaboration between robotics researchers, industry experts, and firefighting professionals will be crucial in driving innovation and realizing the full potential of firefighting robots to enhance safety and save lives.

5. Acknowledgments

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