FABRICATION OF AUTOMATIC FIRE PROTECTION SYSTEM

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ABSTRACT

This fire detection system uses robotics in the fields of electrical and mechanical engineering. It consists of a fire detector, micro-controller, stepper motor, DC motor, and an AGV. The fire detector identifies fires and sends the information to the micro-controller. The micro-controller, programmed with a fuzzy logic algorithm, determines the direction for the firefighting apparatus's head movement. A stepper motor rotates the head clockwise or anticlockwise as directed. A DC motor controls the valve in the nozzle to regulate the flow of extinguishing agents. The AGV autonomously moves the system along a predetermined path. In summary, this system automates fire detection and response using a fire detector, micro-controller, motors, and an AGV.

Keywords—AGV, Fire detector robot

INTRODUCTION

Large factories, storage facilities, and artificial production installations are at risk of fires, which can have disastrous consequences, including financial losses and loss of life. To address this, aimable and controllable high-capacity water sprayers called Fire Observers are installed. Unlike portable fire extinguishers, Fire Observers are permanently fixed in place. Fire protection systems play a crucial role in preventing and managing fires. While different systems may operate in various ways, they all share the common objective of detecting fires and protecting structures, occupants, and valuables. A typical fire protection system includes a flame sensor and sprinklers. When the sensor detects flames, the sprinkler system activates, and in the case of fire-induced smoke, the detector triggers the sprinklers. The water from the sprinklers helps suppress the fire and prevent its spread. For critical equipment or special hazards,

automatic fire suppression systems that utilize clean agents are preferred. These systems detect and suppress fires without leaving any residue. The primary goal of a fire protection system is to safeguard the occupants of a structure and minimize fire-related damages. It provides a crucial window of time for safe evacuation and helps reduce potential costs. Traditional fire observer systems often require a person to manually adjust the direction of the water spray. However, advanced fire observers are equipped with RF control and onboard cameras, enabling operators to control them from a safe distance. This feature enhances safety by allowing operators to operate the fire observer remotely. In summary, fire protection systems, such as Fire Observers, are essential in safeguarding large facilities against fires. These systems aim to detect fires, protect structures and occupants, and facilitate safe evacuation. They can utilize sprinklers or clean agents, depending on the specific requirements. Advanced features like remote control and onboard cameras further enhance their effectiveness and safety.

The firefighting apparatus is implemented on a vehicle that automatically moves along a fixed path, transporting the system from one location to another. The fuzzy logic algorithm employed helps sense the fire and directs the snoot to spray in the fire's direction. The same stepper motor facilitates the snoot's rotational movement, while the valve controlled by the DC motor opens to release the extinguishing agents. Furthermore, the overall movement of the robot is achieved with the assistance of a motor.

In our design, we use a detector to detect fire, which sends the information to a micro-controller, which is written with a program grounded on fuzzy logic algorithm, which turns snoot head of the fire fighter to that direction. One stepper motor is used for the clockwise and anticlockwise gyration. A valve opens in the snoot, which is controlled by the D.C Motor. The vehicle is moving from one place to another place automatically (i.e. Fixed Path). Fuzzy sense algorithm then used is to sense the fire and to spark the snoot in the direction of fire, one stepper motor is used for the clockwise and the anticlockwise gyration. A stopcock opens in the snoot, which is controlled by the same. Fuzzy logic algorithm used then's to sense the fire and to spark the snoot in the direction of fire. Also the stir to the robot is attained with the help of the motor.

The system incorporates two motors along with a powerful sprayer motor, a piping system, and an onboard wireless streaming camera. These components work together to operate the system effectively. The two motors are specifically utilized to control the movement of the nozzle, allowing for directional adjustments. The user has the ability to transmit movement commands using a wireless remote. The receiver circuitry, mounted on the system, receives these commands and operates the motors accordingly, enabling the desired motion.

Furthermore, the receiver also controls the pump motor, responsible for starting and stopping the spray. The sprayer nozzle itself can be adjusted to modify the water spray outlet, providing flexibility in its functionality. The sprayer mechanism is designed to operate in two degrees of freedom (2 DOF), allowing for adjustments in the x and y directions. This configuration ensures a 360-degree coverage of water spray, maximizing its effectiveness in suppressing fires.

PROBLEM STATEMENT

In recent times, there have been situations where firefighting personnel face difficulties in accessing the point of a fire due to high temperatures or the presence of explosive materials. These challenging environments can result in significant property damage and loss of life. In such scenarios, the utilization of firefighting robots has proven to be advantageous in extinguishing fires and safeguarding the lives of firefighters. Firefighting robots are specifically designed to operate in areas where it is unsafe for human firefighters to intervene. These robots can navigate through hazardous environments, such as those containing petrochemicals, dangerous chemicals, toxins, or potential explosive materials. By deploying firefighting robots in these situations, the risk of extreme danger to firefighters is mitigated, as the robots can handle the firefighting tasks while keeping the human personnel out of harm's way. Additionally, the use of firefighting robots contributes to reducing injuries and fatalities caused by fires. By employing these robots, human firefighters are protected from direct exposure to the dangerous elements of the fire, thereby minimizing the potential for severe injuries.

OBJECTIVE

- To design and develop a fire protection system.
- To provide a low cost fire protection systemfor society.
- To use microcontroller circuit that has fire sensors and motor driver interfaced with the controller.
- To prevent occurrence of fire and explosion.

To reduce the risk of damage caused by fire

LITERATURE SURVEY

Kayode faith et al., In the field of robotics has facilitated the development of innovative solutions for safety purposes. Fire detection systems offer faster and non-contact detection capabilities, although false alarms remain a challenge. Fire fighting robots play a crucial role in safeguarding human lives and environments from fire accidents, mitigating risks faced by firefighters and providing efficient fire suppression capabilities.

S.Sridevi et al., our goal is to develop an intelligent fire fighting robot that utilizes multiple flame sensors for fire detection. The robot continuously monitors temperature readings, alerts personnel through sound and messages, and autonomously moves towards the hottest area of the fire to extinguish it using a water pump system. This sensor-based approach offers improved accuracy and effectiveness compared to traditional smoke detectors.

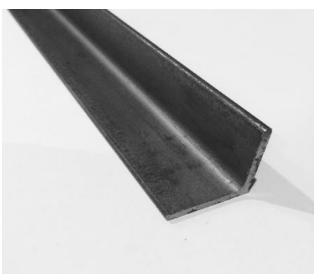
COMPONENTS

The following are the main elements of the automatic360-degree fire protection

- Frame structure
- Rotating Frame
- Dc gear motor
- Spray Jet nozzle
- Flame sensor
- Diaphragm double side DC pump
- Wheels
- Water tank
- Pipes and fittings
- Lead Acid Battery
- Bearing with bearing cap
- Micro controller

1. FRAME

The fire fighting robot's frame structure is made of mild steel, providing strength and durability. The bearings are carefully bored and aligned during the manufacturing process, and provisions are made to cover them with grease, promoting optimal performance and reducing friction.



2. *DC GEAR MOTOR*

The roller shaft of the fire fighting robot is driven by a motor, which is connected to a large pulley around which a belt runs. The motor's specific details and characteristics are outlined in the design phase, ensuring the motor meets the requirements of the robot's operation.

3. *D.C. MOTOR (PERMANENT MAGNET)*

An electric motor is a device that transforms electrical energy into mechanical energy through the interaction of magnetic fields and electric currents. It operates based on the fundamental principle that when a current-carrying conductor is placed in a magnetic field, it experiences a force. This force, according to Fleming's left-hand rule, determines the direction of motion. When an electric motor is running, it generates torque, which is a rotational force. This torque enables the motor to produce mechanical rotation and perform useful work. DC (direct current) motors, similar to generators, can be classified into different types such as shunt wound, series wound, or compound wound motors, depending on their specific construction and winding configurations.

4. *SPRAY JET NOZZLE*

A jet spray nozzle is designed to produce a flat, uniform layer of liquid. These nozzles are constructed as one-piece units, which makes them resistant to clogging and able to withstand pressure fluctuations. They offer a wide range of options and can be selected based on specific requirements.

Flat jet spray nozzles are particularly effective in delivering a strong fluid impact. The energy of the jet is concentrated over a small surface area, allowing for efficient cleaning or washing applications. These nozzles are commonly used to wash objects that are moving on conveyors, as the nozzles can be arranged transversely to the direction of the pipe. This setup often involves a large number of nozzles connected to one or more manifolds, creating a flat jet spraying system.

1. *FLAME SENSOR*

A flame sensor is a type of sensor that is highly sensitive to normal light and is commonly used in flame alarms. It is designed to detect flames by sensing wavelengths within the range of 760 nm to 1100 nm emitted from a light source. However, it is important to note that this sensor can be easily damaged by high temperatures, so it is typically placed at a safe distance from the flame being detected.

The flame sensor is capable of detecting flames from a distance of up to 100 cm and has a detection angle of 60 degrees. The output of the sensor can be in the form of an analog signal or a digital signal, depending on the specific sensor module used.

These flame sensors find applications in firefighting robots, where they serve as flame alarms. They provide a crucial detection capability, enabling the robot to identify and respond to the presence of flames accurately.

5. *DIAPHRAGM DC DOUBLE MOTOR PUMP*

Diaphragm DC Double Motor Pump - This is portable dc water pump. It is having 220 PSI pressure. It is self-priming pump.

Multi-Purpose Use - DC the High Pressure Diaphragm Pump serves as a reliable and efficient solution for car washing, AC service cleaning, and misting systems. Its ability to generate and deliver high-pressure water or cleaning solutions makes it a valuable tool in these applications, Agriculture Drip Irrigation System, Bike Washing, Solar Panel Kit, Shower, Agriculture Spray, Floor Cleaning in House, Tank Filling, Aquarium andas a Sprinkler in Garden.

Auto- cut System Pump - Auto Cut System is available only when the output supply is Blocked. 220 PSI Pressure with 10.3 Bar Cut offOpen Flow is 10 Litre Per Minute.

User Guidance - To run this DC Pumpeffectively use minimum 12V fully charged Battery (Lithium ion or Lead - Acid Battery Only) and if want to use DC Adapter than onlyuse 12V / 5Amp capacity Adapter Only.

Do's and Don'ts - Don’t run this motor on direct AC supply power. Don't use this pump with lessthan 5-amp charger.

5. CASTORS WHEELS

The Elesa + Ganter line of industrial castors and wheels stands out for its wide variety of options, made possible through the combination of different manufacturing techniques and materials. These castors and wheels are designed to handle medium-heavy, heavy, and extra-heavy loads, and they are suitable for a range of sectors and surfaces.

6. PORTABLE WATER TANK

Portable water storage containers are made out of hygienic and odourless food-grade plastic.

- Capacity of water storage container: 5Litres (Pack of 1)
- Water storage bags are portable, foldable, convenient, lightweight, transparent, reusableand easy to store and carry. Fold collapsible andultra-light containers when empty into a smallersize for ease.
- Water containers with a large screw-on cap provide leak-proof sealing, have a large openingfor easy filling and pouring.
- Portable water containers are movable water containers that are ideal for storing water, petrol,diesel, juices, and other drinks for camping, hunting, hiking, picnics, BBQs, etc. They can also be used for storing petrol in case of emergency.

7. BATTERY

Batteries are used to store energy that is used toenergize the components such as microcontroller, pumpetc.

Nominal battery voltage: 14V
Weight of battery: 2.2kg

METHODOLOGY

MOVEMENT OF WHEELS

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FIRE FLAME DETECTION BY SENSORS

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TRANSMISSION OF SIGNAL FROM SENSOR TO MICRO-CONTROLLER

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EXECUTION OF PROGRAM

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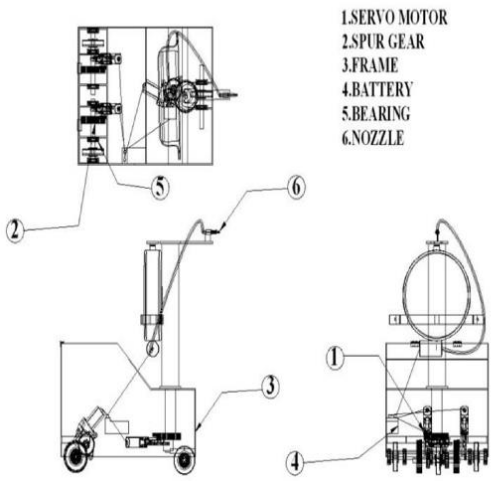
FIRE MONITORS AND SPRAYERS ARE DESIGNED TO BE AIMABLE AND CONTROLLABLE

WORKING PROCEDURE



The diagram illustrates the working of a fire protection system in the order of operations. The system consists of a vehicle that moves along a fixed path. When a fire flame is detected by the sensor, the vehicle automatically stops, and the following steps are executed:

- Fire detection: The flame sensor detects the presence of a fire flame and sends a signal.

- Signal amplification: The signal from the sensor is amplified and prepared as basic information for the microcontroller.
- Microcontroller execution: The microcontroller receives the amplified signal and executes the program based on the signal received.
- Fire monitor and sprayer: The system incorporates a high-capacity water jet fire monitor that is permanently installed and cannot be moved. Unlike traditional fire monitors, this system is equipped with RF control and an onboard camera. This allows the user to operate the monitor remotely from a safe distance. The system utilizes two motors to control the direction of the nozzle movement. A wireless remote is used by the user to transmit movement commands. The receiver circuitry on the system receives these commands and operates the motors accordingly. The receiver also controls the pump motor, starting and stopping the spray. Adjustability of the sprayer nozzle: The sprayer nozzle can be adjusted to regulate the water spray outlet. This ensures precise targeting of the firefighting agent. The sprayer mechanism operates in two degrees of freedom (2 DOF), allowing adjustment in the x and Y directions to achieve a complete 360-degree water spray coverage.

In summary, this fire protection system utilizes sensors, amplifiers, microcontrollers, and motorized sprayers to detect and combat fires. It incorporates advanced features such as remote operation, adjustable nozzles, and comprehensive water spray coverage to effectively suppress and extinguish fires.

ADVANTAGES:

- 360-degree range of fire detection in all directions.
- Adjustable nozzles allow the use of various firefighting agents.
- Compact and swift response due to the implementation of a microcontroller.
- No need for external devices to control the system.

DISADVANTAGES:

- Inability to determine the nature of the fire.
- Limitations in extinguishing large-scale fires.
- DC motor operates only on a 12V supply, restricting its applications.

APPLICATIONS:

- Rescue operations: Firefighting robots can assist in search and rescue missions during emergencies.
- Military applications: These robots can be utilized in military operations to combat fires in hazardous environments.
- Schools and colleges: Fire protection systems can be installed in educational institutions to enhance safety measures.
- All industries: Firefighting robots are suitable for deployment in various industries to protect personnel and assets from fire hazards.

FUTURE SCOPE

The project includes the integration of advanced technologies and techniques to enhance the firefighting capabilities and efficiency. Some potential areas of development are:

- Sensor-Assisted Firefighting: Implementing advanced sensors, such as thermal imaging cameras and gas detectors, to improve fire detection accuracy and provide real-time information about the fire dynamics.
- High-Pressure Water Mist Systems: Exploring the use of high-pressure water mist technology, which can generate fine water droplets that rapidly cool the fire and suppress the flames effectively.
- Drones for Firefighting: Integrating drones equipped with fire extinguishing agents or thermal cameras to provide aerial support in firefighting operations, allowing access to hard-to-reach areas **and** assisting in situational awareness.
- Wireless Devices and Communication: Improving wireless communication systems between firefighting robots, control units, and emergency response teams to enhance coordination and data transmission in real-time.
- Sound-Triggered Devices: Investigating the use of sound-triggered devices that can detect specific fire-related sounds or patterns, enabling early fire detection and prompt response.
- By incorporating these advancements, the project can continue to evolve and contribute to more effective and efficient firefighting capabilities in the future.

CONCLUSION

The fire detection system described combines the fields of electrical and mechanical engineering to automate the process of fire detection and response. By utilizing a fire detector, micro-controller, stepper motor, DC motor, and an AGV, this system enhances the efficiency and effectiveness of firefighting efforts.

The fire detector plays a crucial role in identifying the presence of fires by detecting various factors such as heat, smoke, or flames. The micro-controller, equipped with a fuzzy logic algorithm, processes the information received from the fire detector and determines the direction for the movement of the firefighting apparatus's head.

The stepper motor translates the instructions from the micro-controller into rotational movement, allowing the head of the firefighting apparatus to adjust its position and target the detected fire accurately. The DC motor, on the other hand, controls the valve in the nozzle, regulating the flow of extinguishing agents to effectively suppress and control the fire.

With the AGV's autonomous navigation capabilities, the entire system can move along a predetermined path, autonomously reaching different areas within the environment. This mobility and automation enable the fire detection system to respond to fires promptly and efficiently, without relying on human intervention.

Overall, this integrated robotic system enhances fire safety by automating the detection and response process. It not only improves the speed and accuracy of fire detection but also optimizes the deployment of firefighting resources, minimizing the risk to human life and property. By combining electrical and mechanical engineering principles, this system represents an innovative approach to fire safety in various environments.

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