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DIRECTION RE-ORIENTATIONAL AND FIRE FIGHTING ROBOT

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ABSTRACT

The current work aims to enhance fire control by utilizing robotic vehicles, particularly in industries prone to major fire incidents, such as nuclear power plants, petroleum refineries, gas tanks, and chemical factories. These incidents pose significant risks, including loss of life, property damage, and permanent disability for victims. The implementation of robotics in firefighting can potentially reduce the need for human intervention, improving safety in high-risk scenarios. Advancements in robotics have paved the way for increased automation in various fields, and safety applications are no exception. Fire accidents are unfortunately common in everyday life, and in certain situations, it becomes challenging for firefighters to rescue individuals. In response to this challenge, a firefighting robot project has been initiated. Arduino Uno with a microcontroller inside was programmed using Python language in Arduino Uno software to send, receive and process signals from the interfaced sensors. Omni-directional movement of the robot was achieved using DC motors with rolling wheels attached to each of them. Experimental results show that the developed system can avoid obstacles at a certain distance of 15cm from its standpoint. Results also show that the robot at 30cm apart can sense and extinguish fire.

Keywords – Arduino Uno, Firefighting Robot, Python, Obstacle Detection, Sensors.

I. INTRODUCTION

Fire and its handling becoming a critical challenges and have spurred significant attention within the robotics industry. Today, robots are increasingly deployed to alleviate human effort, especially in handling fire-related incidents. There's a growing demand for Fire Extinguisher Robots capable of autonomously detecting and extinguishing fires. Robotics, one of the fastest-growing engineering fields, aims to reduce human involvement in laborious or risky tasks, especially in hard-to-reach environments. The creation of such a device holds promise for saving lives and properties by minimizing the impact of fire. Engineers are tasked with designing prototypes that autonomously sense and combat fires. The Fire Fighter Robot is specifically engineered to swiftly locate and extinguish fires in various settings residences or industrial spaces. Upon deployment in fire-prone zones, the robot acts automatically upon detecting a fire outbreak, aiding in rescue operations where human access is challenging.

Existing firefighting vehicles handle home or forest fires, but our proposed robot operates autonomously or under remote control. These robots enhance safety during fire identification and rescue operations, reducing risks for firefighters in hazardous conditions. Ultimately, robots serve to diminish the necessity for human exposure to perilous situations. The firefighting sector has historically faced significant risks due to limited technological advancements. Current firefighting methods, relying heavily on human intervention, often prove insufficient and error-prone despite extensive training. The emerging trend of utilizing robots instead of humans in hazardous situations is gaining popularity due to robots' capacity to navigate treacherous environments.

This project features a developed robot adept at identifying and extinguishing fires within a designated environment. Utilizing an Arduino board as the control system's core, the robot integrates two sensors within its control circuitry to detect fire-prone areas from all directions. Upon reaching a fire zone, the robot activates an attached pump extinguisher, effectively combating the fire.

I.I LITERATURE

The outbreak of a fire incident poses severe risks to lives, properties, and the well-being of those affected. Firefighters, who are essential in managing such emergencies, often face heightened dangers, especially in hazardous environments like nuclear power plants, petroleum refineries, and areas with limited access. Negotiating confined spaces and obstacles to combat fires and rescue victims adds complexity to their tasks. To address these challenges, this paper introduces the development of Robot, a firefighting robot aimed at reducing risks faced by firefighters by minimizing their exposure to danger [1].

Robot stands out due to its compact design, allowing it easy entry into narrow spaces compared to traditional firefighting robots. Equipped with an ultrasonic sensor, Robot manoeuvres adeptly, avoiding collisions with obstacles or surrounding objects. Moreover, it includes a flame sensor for detecting fire occurrences. This enables Robot to autonomously identify fire locations and remotely extinguish fires from a safe distance [2].

Programmed to approach fires and stop at a maximum distance of 40 centimetres, Robot operates autonomously. A human operator can monitor Robot's activities through a camera connected to a smartphone or remote devices, providing remote oversight and control. This technological innovation aims to enhance firefighting capabilities while reducing risks for human responders, ensuring a safer and more efficient approach in managing fire incidents [3].

A wireless sensor network can be seamlessly integrated into a mobile platform, leveraging Zigbee wireless communication modules for efficient intra-system communication. These modules facilitate smooth data exchange within the robotic system. Notably, Zigbee technology enables substantial data transfer, accommodating the transmission of large volumes of video and audio from the robot to a remote-control centre. This capability is particularly crucial for applications requiring real-time visual and auditory information, such as surveillance [4].

The obstacle avoidance module is operationalized by converting the analog output produced by the ultrasonic sensor into a digital format. This conversion process utilizes the microcontroller's built-in 8-bit A/D converter. Following the conversion, the digital data is compared to a predetermined threshold value. This comparative

analysis is essential for assessing whether the Autonomous Fire-Fighting Mobile Platform (AFFMP) is in close proximity to any obstacles [5].

The standard fire extinguishing system in the Autonomous Fire Fighting Mobile Platform typically incorporates a DC fan [6]. This fan is employed to extinguish a candle flamecan be affectively handled by a robot.

II. MODELLING & METHODOLOGY

In the current study, the following hardware & software components are used to implement the actions of the firefighting robot.

Hardware components:

- Dc geared motors
- Motor wheels
- Ultrasonic sensor
- Flame sensors
- Motor Driver
- Water pump
- Servo Motor
- Car Chassis
- Jumper Wires
- Bread Board
- Batteries

Software Components:

- Arduino UNO Board
- Arduino UNO IDE (Software)

The process initiates with the setup of component ports. Turning on the power supply activates the circuit. Positioned strategically, three sensors are distributed: one at the centre, and the other two at the right and left sides of the chassis. When a fire event occurs, the sensors detect the corresponding values, registering a voltage drop to zero. Subsequently, the chassis manoeuvres towards the fire's location to extinguish it.

In the absence of a fire, the sensors detect no input, indicating a voltage level above zero. In this scenario, the robot's initial condition prompts it to move in a different direction, ensuring it navigates away from non-fire areas. This continuous monitoring and responsive movement based on fire detection, or lack thereof, ensures efficient fire suppression by directing the robot precisely towards the fire location while avoiding unnecessary movements in areas without fire.

Flame sensors: The Flame Sensor is purpose-built to detect and respond to fire or flames, comprising three sensors positioned at 30-degree intervals. Operating within a detection range of 700-1100 nanometres and with a 60-degree detection angle, it identifies the presence of fire effectively.

Ultrasonic Sensor: An IR Distance Sensor, exemplified by the Sharp GP2Y0A21 IR Infrared Distance Sensor, delivers precise distance measurements within a range of 10-80 centimetres. Employing infrared light, it detects reflections to determine proximity. Operating at 4.5V to 5V.

DC Geared Motors: The DC Geared Motor transforms DC electrical power into mechanical power, operating smoothly from 4V to 12V and offering a varied range of RPM and torque, delivering up to 500 RPM at 12V.

Motor Driver: The Driver Module equipped with four HG7881 chips allows control over four DC motors or two 4-wire 2-phase stepping motors, accommodating operating voltages from 2.5V to 12V.

Motor Pump: A motor pump is a mechanical device that uses an electric motor to pump the water in spray form location to destination.

Servo Motor: The function of the servo motor is to convert the control signal of the controller into the rotational angular displacement or angular velocity of the motor output shaft. Which the motor pipe is connected to servo motor and it can be rotated 0 to 180 degrees.

Arduino Uno: Arduino uno is a microcontroller. Then we use an amp to check for change in voltage across the IR receiver. If the fire is detected output pin will show 0 volts and if there is no fire it will shows 5 volts.

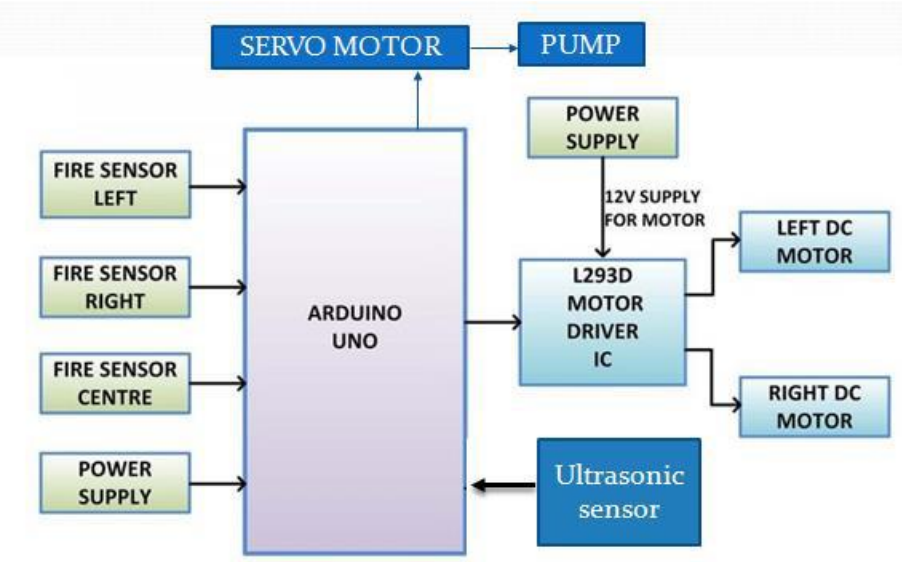

Fig. 1 System Circuit Diagram

III. EXPERMENTAL INVESTIGATIONS

Robot presented in the current study consists of different sensors, Arduino UNO Board and coupled to a microcontroller to control all the components of a robot. The proximity and potentiometers are used to detect the nearby objects, while the chromatic sensors are attached to identify the presence of fire in near by system thereof fire sensing and hydro sensing sensor elements are used to trace the fire and make it inflammable by spraying water and other fire inhibitors. Motor Driver is a motion controller coupled to the board to run the motors both to run the robot and to activate the water/ fire inhibitors. A proto model associated with the all possible features are prepared and presented in Fig. 2 and Fig.3.

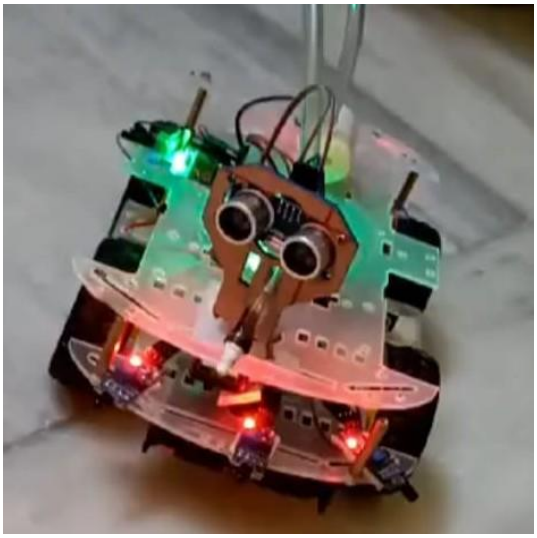

Figure 2 IR sensors to detect the fire/flame

Figure 3. Obstacle identifying and reorient its path of the Robot

Multiple tests runs are conducted on designed robot and obtained better outcome. It would be able to trace the obstacles and reorienting its direction and also able to identify the fire and activate the fire inhibitors.

IV. CONCLUSION

This project introduces a real-time firefighting robot designed to operate at a constant speed, autonomously identify fire, and subsequently extinguish it through a pumping mechanism. Highlighting its advantageous features, the robot possesses the capability to automatically detect the location of fire. Additionally, its compact and lightweight structure enables its use in areas with small entrances or confined spaces.

The system proves beneficial as a companion to firefighters, potentially preventing the outbreak of fires. Its compact design makes it well-suited for navigating through restricted spaces. Notably, the operator can remotely control the robot from a considerable distance, facilitating firefighting efforts. Furthermore, the operator has the ability to monitor environmental conditions using a camera during the firefighting process.

The experimental results demonstrate the robot's efficacy in accurately sensing smoke and fire promptly. This real-time firefighting robot stands as a promising solution for enhancing firefighting capabilities, particularly in scenarios with spatial constraints and the need for swift intervention.

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