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Autonomous Fire Fighting Robot Using Arduino

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***Abstract*: A fire breakout is a dangerous act that has a wide range of repercussions. Detecting and extinguishing a fire as soon as feasible can help avert a variety of accidents. We have been reliant on human resources till now. This frequently results in the human's life being jeopardised. As a result, fire safety becomes critical in order to save human lives. A fire extinguishing robot has been proposed and constructed in this study work, which identifies the fire location and extinguishes the fire using sprinklers after initiating the water pump. For effective fire detection, this robot has three) flame sensors. This suggested form of Arduino-based Autonomous Fire Extinguishing Robot detects the presence of fire and extinguishes it without the need for human intervention. It has gear motors and a motor driver that regulate the robot's motions when it senses a fire and starts the water pump to extinguish it. This miniature robot is equipped with a water ejector that can squirt water over the flames. A servo motor can be used to move the water ejector pipe in the direction necessary. An Arduino Uno microcontroller is in charge of the entire setup.**

***Keywords*: Arduino Uno, DC pump, Fire sensor, L293D motor driver, Servo motor.**

1. Introduction

One of the most essential characteristics in a fire catastrophe is life, which refers to lives lost in the process of saving others. Because of explosive materials, smoke, and high temperatures, it is often hard for firefighters to reach the scene of a fire. A quick reaction time to a fire may save a lot of money and time.

It is clear from the diagram (Fig. 1) that fire can occur in both household and industrial settings. A little spark can cause a big fire to erupt. Because of a poor fire control system, not only the lives of industrial workers but also the lives of domestic workers are at danger. Many individuals can perish in a fire, and many more can be injured for the rest of their lives. It may, however, be avoided by employing true fire-fighting techniques.

A fire-fighting robot is proposed for such conditions. Many robots are planned and built-in today's society to replace humans in risky and harmful jobs. Robots are increasingly being used to do labour-intensive or life-threatening tasks for humans. IoT (Internet of Things) technology is used to create a fire extinguishing robot. We plan to construct a robot that can extinguish a tiny flame by sensing and moving to the spot itself in Fire Extinguishing Robot.

With the use of flame sensors, it will immediately identify a fire. It navigates itself to the fire source and extinguishes the fire using the built-in fire extinguishing system once it recognises the location of the fire breakout. It employs three flame sensors for fire detection. The left one is for left, the forward one is for forward, and the right one is for right. When a fire detector senses a fire, the fire extinguishing system is engaged. When the water pump detects a fire, it will begin ejecting water. The primary function of this system is to offer fire surveillance in order to avoid severe fire mishaps and reduce human life loss.

2. Problem Formulation

A fire disaster is one of the most serious situations that may cause significant financial and human damage. Because of explosive materials, smoke, and high temperatures, accessing a fire scene can be hazardous at times. Firefighters are also at danger in such scenarios. Firefighting robots can be beneficial in such situations. This Fire Extinguishing Robot is powered by Internet of Things (IoT) technology. In Fire Extinguishing Robot, we want to create a system that can detect and go to the source of a tiny flame and extinguish it. Delays in the arrival of fire fighters can have a variety of repercussions. The Fire Extinguishing Robot constantly checks the surroundings and extinguishes the fire as soon as possible.

3. Literature Survey

Tawfiqor Rakib and M. A. Rashid Sarkar developed a firefighting robot model that includes a foundation platform made of 'Kerosene wood,' an LM35 temperature sensor, flame sensors to detect the fire, and a 1 litre water container constructed of a strong cardboard that is water resistant. Two wheels driving the robot forward. [1]

Nagesh M. S, Deepika T. V, Stafford Michahial, and M Shivakumar proposed a fire extinguishing robot that uses DTMF (Dual Tone Multi Frequency Tones) technology for navigation and a flame sensor for fire detection that can detect flames with wavelengths ranging from 760 to 1100 nm and sensitivity ranging from 10 cm - 1.5 feet. [4]

Sushrut Khajuria, Rakesh Johar, Varenyam Sharma, and Abhideep Bhatti suggested an Arduino-based firefighting robot with RF-based remote control of the robot and waterpump. Within a 7-meter range, the operator may operate the robot. It also has a wireless camera that assists the operator in moving the robot in the desired direction. [5]

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Amphibious Autonomous Vehicle was proposed by Khaled Sailan, Prof. Dr lng. Klaus-Dieter Kuhnert, and Simon Hardt as an obstacle avoidance robot. This robot uses a fuzzy controller to avoid static obstacles in real time. Its mission is to guide the robot or vehicle along its intended path while avoiding any impediments.

J. Jalani, D. Misman, A. S. Sadun, and L. C. Hong, presented a firefighting robot with notification. Three flame sensors on this robot detect fire from the left, right, and centre. Three ultrasonic sensors are also included for detecting and avoiding obstructions. When the robot detects fire, it sends a warning message to the user through the Bluetooth module.

4. Methodology

The goal of this study is to detect an environmental fire and extinguish it without the need for human involvement. The approach is broken down into three sections. The design structure is covered first, followed by the hardware description, and lastly the programming design. All three elements were put together, and tests were run to see if a mechanism could be built to put out the fire.

A. Design Structure

The prototype of a robotic system is shown in this part, which includes IR flame sensors, servo motors, submersible water pump, motor driver, tiny breadboard, BO motors, rubber wheels, CPU, and communication module for data exchange between the fire-fighting robot and Arduino software. The basic prototype of our firefighting robot is shown in figure 1. The robot's primary functions are as follows: It first initialises itself, that is, its sensors are initialised as soon as the power is turned on. Second, the robot detects the surrounding environment (for example, temperature) and recognises the fireplace. Third, the robot transmits navigational data and begins moving itself toward the fireplace. Finally, using servo motors and a submersible water pump, the robot begins to extinguish the fire.

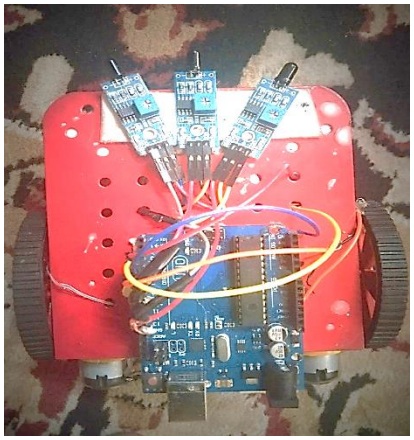

Fig. 1. A robot that fights fire

B. Implementation of Hardware

One of the most important aspects of the construction of a firefighting robot is the hardware. Arduino UNO, IR flame sensors, servo motors, submersible water pump, motor driver, small breadboard, BO motors, and rubber wheels are among the components. The block design of a firefighting robot in Figure 2 displays three IR flame sensors as the system's input. The Arduino UNO is a microcontroller that is used to link other components. The L293D Motor Driver is used to drive motors and can simultaneously operate two DC motors (Left DC motor and Right DC motor).

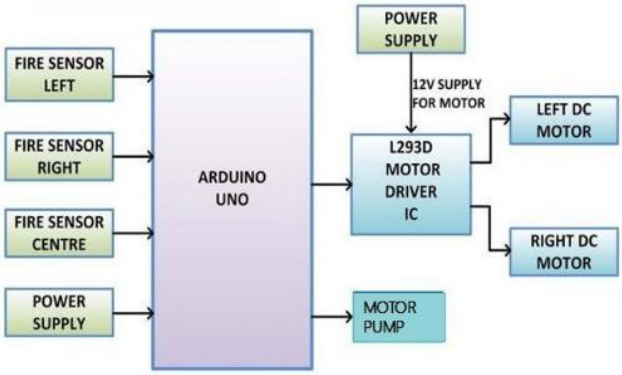

Fig. 2. Firefighting robot block diagram

5. Hardware Used

1) ATmega328P IC (Arduino UNO)

Fig. 3. The Arduino UNO

The Arduino UNO board is shown in Figure 3. It's essentially a microcontroller kit for obtaining data from peripheral devices (sensors, motors, etc.). The ATmega328P IC is used in the Arduino UNO Microcontroller board. The ATmega328P is an excellent platform for robotics applications that require a robot to put out a fire in real time. The Arduino UNO board is made up of a set of digital and analogue pins that may be used to connect to expansion boards and other circuits. It has everything you'll need to run the microcontroller.

2) IR Flame Sensor

The IR Flame Sensor is shown in Figure 4.

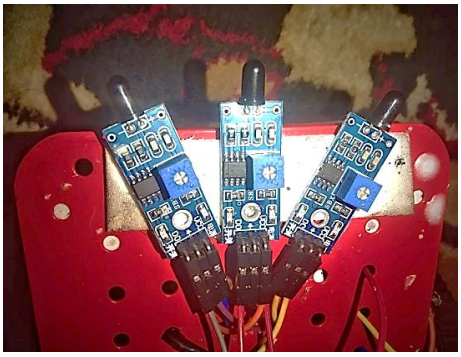

Fig. 4. Infrared flame sensor

The IR flame sensor detects the presence of fire or flame by sensing the surroundings. The module is based on an infrared receiver and detects flammable and toxic gases such as nitrogen, hydrogen, and carbon monoxide. The detecting capability of the signal may be adjusted. Three flame sensors are included in the robot.

Features:

1. The photosensitivity is really high.
2. There is a rapid reaction time.
3. The sensitivity can be changed.
4. The voltage range is 3.5V to 5V.
5. Accuracy may be tweaked.

3) Motor Driver L293D

The L293D Motor Driver is shown in Figure 5. The L293D is a Motor Driver (or Motor Driver IC) that controls the rotation of a DC motor in either direction. The L293D is a 16-pin IC that allows us to drive two DC motors in any direction at the same time.

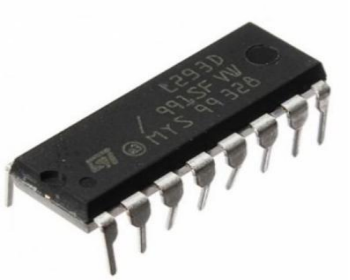

Fig. 5. L293D motor driver

Features:

1. 4.5 V to 36 V supply voltage range.
2. ESD protection on the inside.
3. Temperature range: 0°C to 70°C.

4) Servo Motors

The Servo Motors are seen in Figure 7. Servo motors are electrical devices that provide precise velocity and acceleration.

Features:

1. SG90 Servo Motor Model
2. PPM Control System
3. Frequency of operation: 1520s/50hz
4. (RX) Required Pulse: 3.3 5 Volt Square Wave Peak to Peak
5. Operating Voltage: DC Volts 4.8–6V
6. Speed of operation (4.8v): 0.15 sec/60 degrees
7. Operating Speed (6V) 0.12 Sec/60°
8. 1.3kg/cm stall torque (4.8v)
9. 1.5kg/cm stall torque (6v)
10. Type of Motor: Brushed DC Motor
11. Plastic Gears are the most common type of gear
12. Material of the Case: Plastic

5) Submersible water pump

The Submersible Water Pump is seen in Figure 7. The Arduino Submersible Water Pump is great for creating an autonomous watering system. The robot's water pump is crucial because it will pump water to put out the fire.

Fig. 7. Submersible water pump

6) BO motors: (Powered by a battery)

The BO Motor is seen in Figure 8. The BO Motor is a 300rpm twin shaft motor. Electrical energy is converted into mechanical energy using this device. It's a substitute for our DC motors with metal gears. Four dual shaft motors are used in our robot.

Fig. 8. BO motor

7) Programming

The Arduino software includes an integrated development environment (Arduino IDE) and essential libraries for programming. The Arduino IDE is a Java-based software tool that is built on the Processing platform. The Arduino IDE is a framework written in C and C++ and compiled using AVR Libc and avr-gcc. Writing code and uploading it to the Arduino Uno for execution is simple with the open-source Arduino IDE. It is compatible with all major desktop operating systems, including Windows, Mac OS X, and Linux. The Arduino IDE programmed is shown in Figure 9.

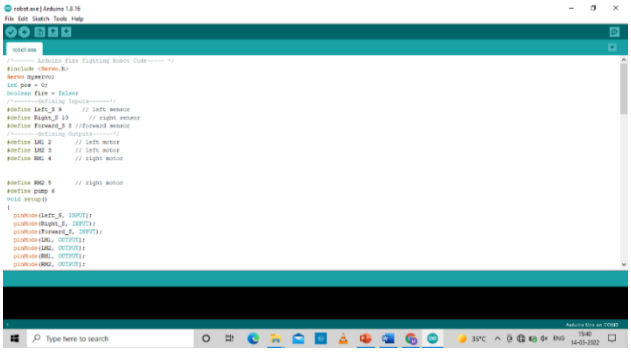

Fig. 9. Programming

6. Discussion of the Results

The goal of the Fire Fighting Robot is to save human lives by developing a system that can detect fire and extinguish it without the need for human involvement. The fireplace is identified using IR Flame sensors, which are coupled to an Arduino UNO, which controls the movement of the Motor

drive, which assists the robot in reaching the fireplace and extinguishing it with pumping mechanisms. At the event of a fire mishap in the workplace, someone must constantly monitor and correct the situation. In this procedure, every time delay causes irreversible loss in the industry. The firefighting robot keeps an eye on the surroundings and assists in putting out the fire.

7. Conclusion

This Fire Extinguishing Robot model helps to distribute the strain of firefighting tasks among firefighters. Our project intends to create a real-time firefighting robot that runs at a steady pace, detects a fire, and then uses a pumping mechanism to extinguish it. Basic hardware components attached to the robot were used to identify and extinguish the fire. For starters, infrared flame sensors are used to detect fire. Second, the robot is navigated to the fireplace using BO Motors and Rubber wheels. Finally, the robot uses a submersible water pump and servo motors to put out the fire.

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