



SELF-DIRECTED FIRE FIGHTING ROBOT USING INTERNET OF THINGS AND MACHINE LEARNING

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Abstract

Now a day, fire accidents in houses, apartments and communities, threatening to the victims and property. As it is a very dangerous job to involve any person like fire fighters during fire accidents, that potentially cause loss of property and human lives due to lack of technology innovation. Hence the firefighting robots are used to rescue the operation instead of humans. In our project, a Firefighting robot is used to alert whenever fire accidents are detected and moves in the direction of flame or smoke to extinguish it. Hence the firefighting robot operation is to rescue victims and stop the fire in a house within a little span of time. Thus, it reduces the risk of injury to the victims and also property damage. This device includes various sensors like Proximity Infrared Sensor (PIR), flame sensor, ultrasonic sensor, MQ2 (LPG) sensor, and actuators like Motors and buzzer.

Keywords : Firefighting robot, Proximity Infrared Sensor, flame sensor, ultrasonic sensor, MQ2 (LPG) sensor, Internet of Things.

I. Introduction

We have come to know a lot of fire accidents happened around us [VI]. The places where frequent accidents occur are go-downs, fuel storage areas, short circuits in houses, etc. In most of the cases there was a huge loss financially and in lives [IX] [V] [X]. Thus, Robotics is the better way to protect our live, property and surroundings [VIII]. Instead of having water sprays in every fire system for

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every building, however, these sprays have disadvantages. For example; it'd damage computers, paper and therefore the furniture within the targeted place. Moreover, in some cases a delay for assistance from the designated department of local government could happen. The aim of this proposal is to extinguish the fire by the firefighter robot directly after detecting it by the sensors and before the fire occur everywhere, to forestall and/or reduce losses and price, facilitate the work for the hearth department as they arrive and to save lots of firemen lives by overcome their jobs, in some critical cases they cannot afford. We'd like to style a hearth warning device that everyone members of the family can use it in their residences. It should be able to detect fires in the least number of places, residents should be able to activate it from convenient places and should warn residents of all indicated parts of houses and also store information in the Thing Speak cloud [II] [III] [IV].

Methodology

The Fire Fighting Robot is designed using ESP32 microcontroller. This is used to detect the flame, smoke and also gases in the emergency situations. Whenever fire/flame, smoke, gases is noticed it gives the buzzer as an alert to nearby people. It is controlled through the Arduino programming. It is an automatic Fire Fighting robot is used to rescue the victims who are struck in the fire affected house. Flame sensor connected to the micro-controller detects the flame in its surroundings. The number of flame sensors can be used for more range of detecting the flame in all directions. The specified flame sensor detects the flame if in its direction. For now we used two flame sensors in the forward and backward direction. The water pump is connected to the pipe so that it is able to reach the area to spray easily [VII]. This Fire Fighting Robot is made of fire resistant material so that it could even enter into the fire to save the victims. Here the speed of motors can be controlled by Pulse Width Modulation technique [I]. Thus, our project is able to reduce the injury to victims and also property damage to certain extent. The block diagram of proposed system is shown in figure 1.

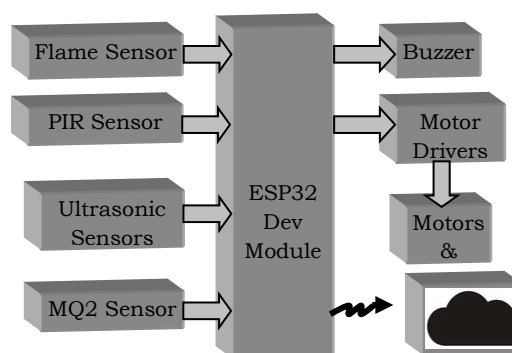


Fig. 1: Block Diagram of proposed System

Hardware Tools:

ESP32:

ESP32 is a series of low-cost, low-power system on chip micro-controllers with integrated Wi-Fi and dual-mode Bluetooth. Using ESP32 we can store the data in the cloud because it is having in-built Wi-Fi module. All the hardware components are connected to it. This is the Micro Controller Unit (MCU) where all the computations take place. The ESP32 development module is shown in figure 2.



Fig. 2: ESP32 Development Module

L293D:

L293D is the motor driver IC. It can be used to control two motors using single module but, here we used this module to run the pump. So, this IC is used to extinguish the flame whenever detected. The L293D Driver module is shown in figure 3.



Fig. 3: L293D Driver Module

L298:

The L298N Motor Driver Module is provided with high voltage Dual H-Bridge circuit. Its input of 12V and its output is 5V. Here we used this module to run the motors of robot. The L298 Driver module is shown in figure 4.

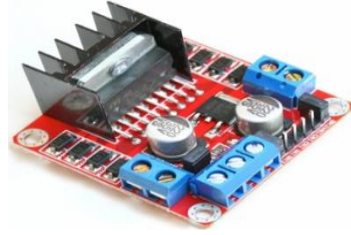


Fig. 4: L298 Driver Module

FLAME SENSOR:

Flame sensor is used to detect the flame. Here, we used two Flame sensors. Instead we can use multiple sensors to increase the range and directions. It consists of 4 pins: Vcc, Gnd, digital and analog pin. It has a wavelength of 700nm to 1100nm. It detects the flame at 60 degrees range. The flame sensor module is shown in figure 5.



Fig. 5: Flame Sensor

Motor:

Motors are used to move the robot chassis. The movement in robot required to detect and extinguish the flame. The DC motor is shown in figure 6.

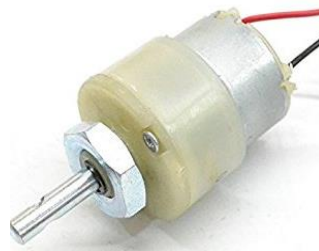


Fig. 6: DC Motor

Buzzer:

The buzzer consists of an external housing with two pins to connect it to the power supply and to the ground. We used buzzer in our project as a alert when flame is detected. The buzzer is shown in figure 7.



Fig. 7: Buzzer

Pump:

We immerse the pump in water, connect a suitable pipe to it and power the motor with 3-6V to start pumping water. This pump is powered ON by the microcontroller to extinguish the flame or smoke whenever detected.

Ultrasonic Sensor:

Ultrasonic sensor is a type of proximity sensor which measures the distance from the target object. The sensor first emits a short Ultrasonic Pulse (sound waves) and waits for the echo. When echo is returned, the sensor detects the target by measuring the time delay between transmitted pulse and the return echo. Then sensor calculates the distance between sensor and the target object. Formula used: $\text{Distance} = (\text{Time} \times \text{Speed of Sound}) / 2$. The ultrasonic sensor module is shown in figure 8.



Fig. 8: Ultrasonic Sensor

Software Tools:

Arduino:

We used the Arduino software to write the program. The Arduino Integrated Development Environment (IDE) is an open source application which is used to develop and upload programs to Arduino compatible boards. It has standard syntax to develop programs and it contains various Libraries for various functions based on the microcontroller. The programming Language C and C++ are used to write the programs. Arduino IDE supports various libraries for interfacing different modules and shields with Arduino compatible boards.

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Thing Speak Cloud:

Thing Speak is basically an IOT platform that lets us store the data in the cloud and develop internet of things (IOT) applications. We will create a channel on Thing Speak, and after connecting the ESP32 to our Wi-Fi network, we will send the data to the Thing Speak IP address and write API key. While the data is sending to the Thing Speak platform, it will display the summary of the channel fields, and specialized visualizations and pre-built widgets.

Implementation and Results:

The Self-Directed Fire Fighting Robot is successfully designed with all the sensors and actuators with microcontroller unit. The hardware implementation of the system is shown in figure 9.

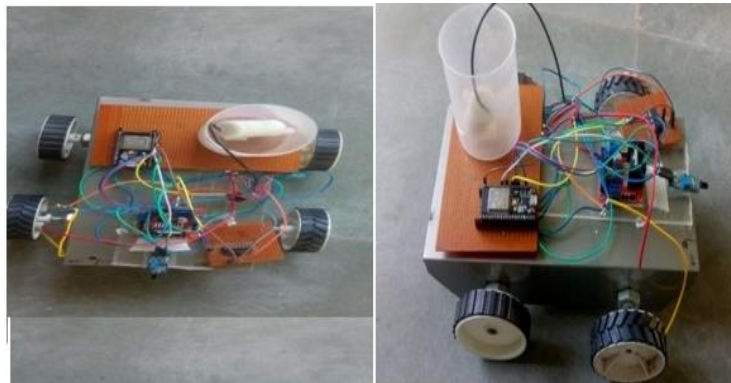


Fig. 9: Hardware Implementation

The hardware components includes ESP32 microcontroller, sensors like Proximity Infrared Sensor (PIR), flame sensor, ultrasonic sensor, MQ2 (LPG) sensor, are designed to capture the changes in physical parameters in the environment including person detection, object detection, flame and gases, and actuators like Motors and buzzer are designed to control the direction of motors, water pump, fire extinguisher and alert information. The Self-Directed Fire Fighting Robot is successfully tested in the room of “center for embedded systems and internet of things”. Once the device is powered up, it will check for flame or gas continuously. When the flame or gases are detected by the device, then the self-directed robot moves near to the flame to extinguish the flame with the help fire extinguisher and water pump and also enables the buzzer. The robot, while travelling towards the flame detected, it can change the direction automatically by identifying the objects and persons, because of trained machine learning algorithm code stored in the microcontroller. Parallel, the sensors and actuators status is stored in the Thing Speak cloud platform to analyze the data as shown in the figure 10. Thus the Self-Directed Fire Fighting Robot is successfully tested in the lab.

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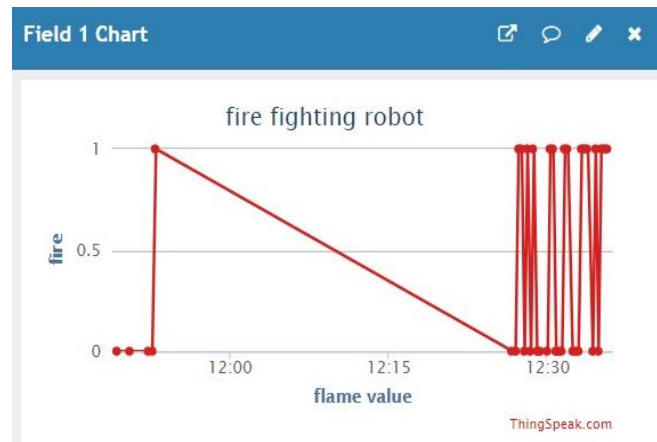


Fig. 10: Flame Sensor data Stored in the cloud

Conclusion

Since the project is prototype development in fire accidents to rescue the operation instead of humans. This system can be developed on large space like in apartments and organizations with real time considerations. Thus the Firefighting robots could able to save the mankind, wealth and property. In the future they come up with the most advanced features that could help us in the very dangerous situations where human is helpless. Therefore, the firefighting robot project will also generate the interest and scope in the field of robotics.

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