



Robot that fights fires, finds smoke, and sprays water automatically

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Abstract: Fires in factories, homes, and businesses can be very dangerous for people and property. This project shows off a Fire Fighting Robot that can find smoke and automatically spray water using ESP32 and BlynkIoT. It is made to find fire hazards and then react quickly with as little help from people as possible. The system has sensors for smoke and flames that keep an eye on the area for manifestations of fire all the time. The ESP32 microcontroller handles the sensor data and turns on a water spraying system able to put out the fire when it detects smoke or fire. At the same time, the BlynkIoT app for mobile devices sends real-time alerts to the user. You can control the robot from a distance with the Blynk app, which lets you move it toward the fire. This smart technology combines IoT, wireless transmission, automation, along with robotics to make recognizing a fire and fire fighting easier and cheaper.

I. INTRODUCTION

Fire accidents remain one of the most dangerous hazards in both residential and industrial environments, causing significant loss of life and property. Conventional fire-fighting methods often rely on human intervention, which may not always be effective due to delayed response time, inaccessibility to hazardous locations, and high risk to firefighters. To address these challenges, autonomous fire-fighting robots have emerged as an advanced solution for rapid and precise fire detection and suppression. This project presents an IoT-based fire-fighting robot powered by the ESP32 microcontroller, capable of operating in both automatic and manual modes. The system is equipped with IR flame sensors to detect fire sources, DC motors for mobility, and a servo-controlled water pump for extinguishing fires. The integration of Blynk IoT technology allows users to

remotely monitor sensor data and control the robot's movements and fire-extinguishing mechanism through a mobile application. In automatic mode, the robot autonomously patrols the area, scanning for fire using its flame sensors. Upon detecting a fire, it stops, orients itself towards the source, and activates the servo-controlled water pump to extinguish the flames. The robot continuously monitors the environment to determine whether the fire is successfully suppressed before resuming patrol. In manual mode, users can remotely navigate the robot using the Blynk mobile application, with directional controls for movement (Forward, Backward, Left, Right, and Stop) and a manual activation switch for the water pump. This feature ensures precise control, allowing operators to tackle fires in specific locations that may not be efficiently handled by automation alone. The ESP32 microcontroller ensures seamless Wi-Fi connectivity, enabling real-time data exchange between the robot and the user interface. The Blynk cloud platform provides a dashboard for live monitoring of sensor readings, mode selection, and command execution. This project is designed to be a cost-effective, scalable, and efficient solution for fire safety in various applications, including:

Industrial Fire Safety – Deploying robots in factories or chemical plants to detect and suppress fires in hazardous areas. Residential Fire Prevention – Assisting in smart home fire detection and emergency response.

Disaster Management – Supporting firefighters by navigating through high-risk zones without endangering human lives.

Warehouses and Data Centers – Providing early fire suppression in facilities where traditional



fireextinguishing methods may be slow or ineffective.

This project demonstrates the potential of IoT, automation, and remote control in enhancing fire-fighting efficiency while minimizing risks to human personnel. Future enhancements may include AI-based navigation, thermal cameras for precise fire detection, and obstacle avoidance mechanisms to improve the robot's effectiveness in complex environments.

II. RELATED WORK

"Domestic Smart Fire Fighting Robot with Multisensory Fire Detection and Warning System Using Python IDE"

Syed Musthak Ahmed, Durga Sai Shiva and Vinit Kumar Gunjan.

Today every residential house is equipped with one or more domestic appliances such as lights, fans, stoves, gas heaters etc. Controlling/maintaining of these appliances is sometimes forgotten and/or neglected by the users. Such negli-gence sometimes may lead to short circuit or fire accidents. Detecting and preventing such instances is very important to avoid any disasters. The present work is to find a solution in preventing such disasters. The present work is implemented using Rasp-berry pi and Robot chassis. Also the robot chassis move towards the place of disaster and operates a pump and sprinkles the water. An Ultra Sonic sensor is also incorporated as a special feature so as the chassis moves to the required direction. In other words the robot chassis senses the incidence of fire or smoke and performs the task of putting off fire, by automatically moving towards the spot and quenching the fire by sprinkling water. This avoids human intervention, to put down the fire there by saving life and property of people at residential areas .

"Design & Implementation of RF based Fire Fighting Robot"

Mrunalini B. Morwal, Karishma K. Malewar, Shubham R. Gadpal and Nilesh S. Panchbudhe.

This paper present the design and implementation of powerful and secure fire protection system for building based on RF technology. Detecting the fire as well as extinguishing it is a difficult job and that puts lives of fire fighters at risk. There are many fire accidents in which fire fighter loses their lives in the line of duty every year. Now a day, fire accidents are quite common and sometimes it becomes very tough

for a fireman to save someone's life. It is not possible to appoint a person to every time observe for accidental fire where robot can do that. Therefore in such cases fire fighting robot becomes a powerful device to handle this. These types of robots are mostly useful in Manufacturing, Industries etc. where possibilities of accidental fire is more. Fire disaster is a common threat to lives, house and goods and hence Robots are implemented to save all of this. Hence, Robotics can be used to help fire fighters for finish the task of fire fighting and so minimize the various types of risk and the limitations that are faced by human fire fighters. This Fire fighters system is having more efficient and effective method of firefighting

"Voice Operated Intelligent Fire Extinguishing Vehicle"

Madhavi Pednekar, Joel Amanna, Jino John, Abhishesh Singh and Suresh Prajapati.

At present all the works of human beings are replaced by the robots. Generally robotics are classified into service robotics and industrial robotics. Nowadays all fields are occupied by robotics including, hospitals, agriculture, defense, hazardous environment and office. The Robots are used where ever human does not do their work efficiently and safely such as handling poisonous and explosive products in industries. The direction of the robotic vehicle and the spraying of water in the fire is controlled by the voice command. The communication between the vehicle and humans are established through the NODE MCU and ARDUINO. The vehicle consists of three major components such as the NODE MCU, ARDUINO, and water level indicator (on vehicle). This Robotic vehicle is involved to rescue the human beings and extinguishing the fire where fire fighters are not able to enter into the fire accidental area.

"Android controlled Firefighting Robot"

S. Jakhti Priyanka and R. Sangeetha

Nowadays , fire accidents are very common and sometimes it becomes very hard for a fireman to protect someone's life. It is not possible to appoint a person to continuously observe weather accidental fire has started where robot can do that. Robot will detect fire remotely. These robots are mostly useful in industries . The proposed vehicle is able to detect presence of fire and extinguishing it automatically by using temperature sensor. The proposed robot has a water spray which is capable of sprinkling water in 1800 angle. The sprinkler can be move towards the required direction . At the time of moving towards

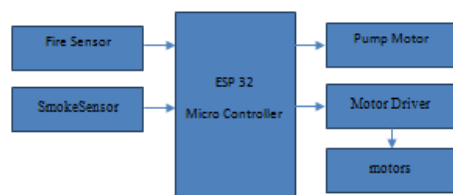


the source of fire it may happen that it will come across some obstacles, then it has obstacle avoiding capability. It detects obstacles using ultrasonic sensors. Communication between the mobile phone and robot will take place through Bluetooth, which will have GUI to control the movement of robot. When mobile gets connected to Bluetooth firstly it will set module name, baud rate. It is feasible to implement Bluetooth communication between smartphones and micro-controller. Android controlled robot can be used easily in everyday life such as in homes, market, companies etc. The development of apps for Android in Android SDK is easy and free of cost.

III. IMPLEMENTATION

The proposed system introduces a smart fire fighting robot controlled using an ESP32 microcontroller and BlynkIoT platform. The robot is equipped with smoke sensors and flame sensors to detect fire hazards. Upon detection, the ESP32 automatically triggers a water pump and spraying mechanism to extinguish the fire. The robot can also be manually navigated using the Blynk mobile application, enabling precise movement toward the fire source. Alerts and sensor status updates are transmitted in real time to the user's smartphone via Wi-Fi. This dual-mode operation—automatic fire suppression and remote IoT control—enhances safety, responsiveness, and operational efficiency. The system is designed to be cost-effective, scalable, and suitable for real-time deployment.

Block Diagram



Working

The Fire Fighting Robot system works by integrating fire and smoke detection sensors with an ESP32 microcontroller to provide rapid response during fire hazards. The sensors continuously monitor the environment, and when smoke or flames are detected, the ESP32 processes the data and automatically activates a water spraying mechanism to suppress the fire. At the same time, real-time alerts are sent to the user via the Blynk IoT mobile application, ensuring

immediate awareness. The robot can also be remotely navigated through the Blynk app, allowing users to direct it toward the fire source. By combining IoT, automation, and robotics, this system delivers a cost-effective, efficient, and smart solution for fire detection and firefighting applications.

HARDWARE REQUIREMENTS

ESP-32

ESP32 is the SoC (System on Chip) microcontroller which has gained massive popularity recently. Whether the popularity of ESP32 grew because of the growth of IoT or whether IoT grew because of the introduction of ESP32 is debatable. If you know 10 people who have been part of the firmware development for any IoT device, chances are that 7–8 of them would have worked on ESP32 at some point. So what is the hype all about? Why has ESP32 become so popular so quickly? Let's find out.



Before we delve into the actual reasons for the popularity of ESP32, let's take a look at some of its important specifications. The specs listed below belong to the ESP32 WROOM 32 variant.—

- Integrated Crystal— 40 MHz
- Module Interfaces— UART, SPI, I2C, PWM, ADC, DAC, GPIO, pulse counter, capacitive touch sensor
- Integrated SPI flash— 4 MB
- ROM— 448 KB (for booting and core functions)
- SRAM— 520 KB
- Integrated Connectivity Protocols— WiFi, Bluetooth, BLE
- On-chip sensor— Hall sensor
- Operating temperature range— $-40 - 85$ degrees Celsius
- Operating Voltage— 3.3V
- Operating Current— 80 mA (average)



With the above specifications in front of you, it is very easy to decipher the reasons for ESP32's popularity. Consider the requirements an IoT device would have from its microcontroller (μC). If you've gone through the previous chapter, you'd have realized that the major operational blocks of any IoT device are sensing, processing, storage, and transmitting. Therefore, to begin with, the μC should be able to interface with a variety of sensors. It should support all the common communication protocols required for sensor interface: UART, I2C, SPI. It should have ADC and pulse counting capabilities. ESP32 fulfills all of these requirements. On top of that, it also can interface with capacitive touch sensors. Therefore, most common sensors can interface seamlessly with ESP32.

Secondly, the μC should be able to perform basic processing of the incoming sensor data, sometimes at high speeds, and have sufficient memory to store the data. ESP32 has a max operating frequency of 40 MHz, which is sufficiently high. It has two cores, allowing parallel processing, which is a further addition. Finally, its 520 KB SRAM is sufficiently large for processing a large array of data onboard. Many popular processes and transforms, like FFT, peak detection, RMS calculation, etc. can be performed onboard ESP32. On the storage front, ESP32 goes a step ahead of the conventional microcontrollers and provides a file system within the flash. Out of the 4 MB of onboard flash, by default, 1.5 MB is reserved as SPIFFS (SPI Flash File System). Think of it as a mini-SD Card that lies within the chip itself. You can not only store data, but also text files, images, HTML and CSS files, and a lot more within SPIFFS. People have displayed beautiful Webpages on WiFi servers created using ESP32, by storing HTML files within SPIFFS.

Finally, for transmitting data, ESP32 has integrated WiFi and Bluetooth stacks, which have proven to be a game-changer. No need to connect a separate module (like a GSM module or an LTE module) for testing cloud communication. Just have the ESP32 board and a running WiFi, and you can get started. ESP32 allows you to use WiFi in Access Point as well as Station Mode. While it supports TCP/IP, HTTP, MQTT, and other traditional communication protocols, it also supports HTTPS. Yep, you heard that right. It has a crypto-core or a crypto-accelerator, a dedicated piece of hardware whose job is to accelerate the encryption process. So you cannot only communicate with your web server, you can do so securely. BLE support is also critical for several applications. Of course, you can interface LTE or

GSM or LoRa modules with ESP32. Therefore, on the 'transmitting data' front as well, ESP32 exceeds expectations.

With so many features, ESP32 would be costing a fortune, right? That's the best part. ESP32 dev modules cost in the ballpark of ₹ 500. Not only that, the chip dimensions are quite small (25 mm x 18 mm, including the antenna area), allowing its use in devices requiring a very small form factor.

One very big advantage with ESP32, which has aided its quick adoption and massive popularity, is the provision for programming the ESP32 within the Arduino IDE.

Now, I should point out here that Arduino is not the only IDE that helps you compile code for ESP32 and flash it into the microcontroller. There is ESP-IDF which is the official development framework for ESP32, which provides much more flexibility in terms of configuration options. However, it is hardly as intuitive and user-friendly as the Arduino IDE, and if you are starting out with ESP32, Arduino IDE is ideal to get your hands dirty. Also, with the number of supporting libraries built for ESP32 in Arduino, courtesy of the huge developer community, there's hardly any functionality of ESP32 which can't be realized with the Arduino IDE. ESP-IDF is more suitable for the more advanced and experienced programmers, who need to stretch ESP32 to its limits. If you are one of those, you are looking for the ESP-IDF Getting Started Guide. Others can follow along.

FIRE SENSOR/ FLAME SENSOR:

A flame-sensor is one kind of detector which is mainly designed for detecting as well as responding to the occurrence of a fire or flame. The flame detection response can depend on its fitting. It includes an alarm system, a natural gas line, propane & a fire suppression system. This sensor is used in industrial boilers. The main function of this is to give authentication whether the boiler is properly working or not. The response of these sensors is faster as well as more accurate compare with a heat/smoke detector because of its mechanism while detecting the flame.

Working Principle

This sensor/detector can be built with an electronic circuit using a receiver like electromagnetic radiation. This sensor uses the infrared flame flash method,



which allows the sensor to work through a coating of oil, dust, water vapor, otherwise ice.

Flame Sensor Module

The pin configuration of this sensor is shown below. It includes four pins which include the following. When this module works with a microcontroller unit then the pins are



flame-sensor

- Pin1 (VCC pin): Voltage supply ranges from 3.3V to 5.3V
- Pin2 (GND): This is a ground pin
- Pin3 (AOUT): This is an analog output pin (MCU.IO)
- Pin4 (DOUT): This is a digital output pin (MCU.IO)

SMOKE SENSOR

A gas sensor is a device which detects the presence or concentration of gases in the atmosphere. Based on the concentration of the gas the sensor produces a corresponding potential difference by changing the resistance of the material inside the sensor, which can be measured as output voltage. Based on this voltage value the type and concentration of the gas can be estimated.



The type of gas the sensor can detect depends on the **sensing material** present inside the sensor. Normally these sensors are available as modules with comparators as shown above. These comparators can

be set for a particular threshold value of gas concentration. When the concentration of the gas exceeds this threshold the digital pin goes high. The analog pin can be used to measure the concentration of the gas.

PUMP MOTOR

A pump motor is an electro-mechanical device that converts electrical energy into mechanical energy to drive a pump, enabling fluid transfer by increasing pressure. It works by using electricity to spin an internal impeller or piston, creating a vacuum that sucks fluid in and discharges it under pressure. Common applications include industrial fluid transfer, agricultural irrigation, residential water supply, and hydraulic systems.



L298N MOTOR DRIVER IC

There are multiple kinds of motion we face in our daily life some are linear some are rotatory motion. Both motions have their importance in machines and our life. In the 19th century, the scientist started discovering/inventing some ways of producing current and motions when British physicist John Ambrose Fleming invented the right-hand rule.

L298N IC is known as a motor driver. It is a low voltage operating device like other ICs. The other ICs could have the same functions like L298N but they cannot provide the high voltage to the motor. L298N provides the continuous bidirectional Direct Current to the Motor. The Polarity

of current can change at any time without affecting the whole IC or any other device in the circuit. L298N has an internal H-bridge installed for two motors.

H-Bridge is an electrical circuit that enables the load in a bidirectional way. L298N Bridge is controlled by external low voltage signals. It may be small in size, but its power output capacity is higher than our expectation. It could control any DC motor speed and direction with a voltage range of 4.5 – 36 Volts. Its



diodes also save the controlling device and IC from back EMF. To control the max 600mA amount of current an internal “Darlington transistor sink” installed in it, which could be used to control a large amount of current by providing a small amount of current. It has also internal “pseudo-Darlington source” which amplifies the input signal to control the high voltage DC motor without any interception.



DC MOTOR

DC Motor is an electrical machine which, when provided with direct current electrical energy, converts it into mechanical energy. It is based on electromagnetic induction, where a conductor carrying current (normally a coil of wire) placed in a magnetic field experiences force to rotate. This rotation is used to perform mechanical work.

There are many applications for DC motors, they can be used in robotics; electric vehicles, and some industrial machinery as well as household devices. DC motor can be used at such places where speed control is required. That is why DC motors are often used in trolleys, electric train production systems, elevators, etc.



Fig: DC motor

Construction of DC Motor

DC motor has such basic components, as a stator (stationary part of the element producing magnetic field) and a rotor part that rotates carrying winding or coil. When a DC voltage is connected to the coil,

current flows through it and generates an electromagnetic field. When the magnetic field of this rotor interacts with that produced by the stator, a torque is induced which causes this piece to start spinning.

IV. RESULT ANALYSIS



Fig1: robot kit



Fig2: power on the robot

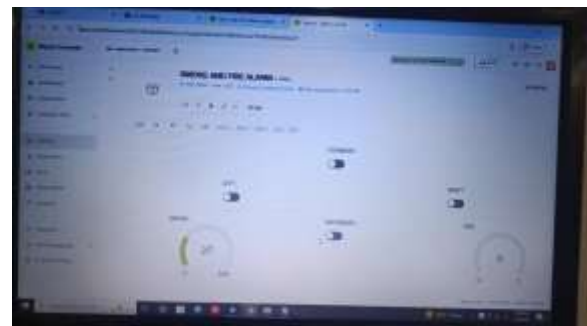


Fig4: IOT connectivity and buttons to control the robot

V. CONCLUSION



The Fire Fighting Robot with Smoke Detection and Automatic Water Spraying demonstrates how IoT and robotics can revolutionize safety systems. By integrating sensor-based detection, automated suppression, and remote control, the system ensures rapid and efficient firefighting while minimizing human risk. Its cost-effectiveness and scalability make it suitable for real-world deployment, contributing to safer industrial, residential, and commercial environments.

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