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DESIGN AND DEVELOPMENT OF FIRE FIGHTING ROBOT USING ARDUINO UNO

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ABSTRACT

Fire incident is a disaster that can potentially cause the loss of life, property damage and permanent disability to the affected victim. Firefighting is a momentous and perilous job. The fire has to rapidly & safely extinguish by a firefighter to prevent more damage and destruction. Fire detection and extinguishment are the hazardous job that invariably put the life of a fire fighter in danger. One of the most efficient tools for early extinguishing of fire is fire fighter robot. In most of the Industries fire sensing is very essential to prevent heavy losses. Robots with this type of embedded systems can save life of Engineers in industrial sites with dangerous conditions. It is desirable to design a robot that can detect fire and extinguish the fire as quickly as possible.

The Fire Fighting Robot project aims to develop a versatile and efficient robotic system for detecting and extinguishing fires in various environments. The system incorporates an Arduino Uno microcontroller as the central processing unit, along with a range of sensors including DHT11 for temperature and humidity monitoring, fire and smoke sensors (MQ-135) for fire detection, and an ESP32-CAM module for visual surveillance.

The addition of a Bluetooth module enables remote control and monitoring capabilities, while a Wi-Fi module facilitates connectivity for data transmission and remote operation. Real-time data is displayed on an LCD screen for easy monitoring. The robot is equipped with motor drive mechanisms to enable movement, a DC motor-powered pump for water spraying, and a relay for controlling external devices. In case of fire detection, the system triggers a buzzer alarm and activates the water pump to extinguish the fire autonomously. This project combines hardware components and software algorithms to create an intelligent and effective fire-fighting solution suitable for diverse applications.

KEYWORDS:
Fire-Fighter, Robot, Extinguishment, Robot, Arduino Uno, Sensors.

INTRODUCTION

The Fire Fighting Robot project addresses the critical need for efficient and timely fire detection and extinguishing mechanisms in various environments. Traditional fire-fighting methods often face challenges in reaching remote or hazardous areas promptly, posing risks to human lives and property. This project introduces a robotic solution empowered by advanced technologies to autonomously detect and combat fires.

Utilizing components such as Arduino Uno microcontroller, sensors including DHT11 for environmental monitoring and MQ-135 for fire and smoke detection, and communication modules like Bluetooth and Wi-Fi, the system offers a comprehensive approach to fire prevention and mitigation. Additionally, the inclusion of an ESP32-CAM module provides visual surveillance capabilities, enhancing situational awareness for effective response strategies.

By integrating hardware components with sophisticated software algorithms, this project aims to deliver a versatile and intelligent fire-fighting robot capable of operating in diverse environments. The utilization of motor drive mechanisms, a DC pump for water spraying, and a relay for controlling external devices enables the robot to navigate and extinguish fires autonomously. In summary, this project represents a significant advancement in fire-fighting technology, offering a robust and adaptable solution to enhance fire safety measures and minimize the risks associated with fireincidents.

LITERATURE SURVEY

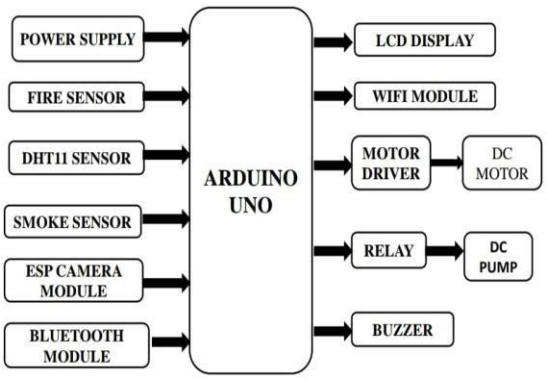
1."Design and Implementation of a Fire Fighting Robot Based on Arduino" by Alaa A. H. Al-Ramadhany, Ahmed R. Al-Dulaimi, and Alaa Abdul-Hameed Al-Hamadani. This paper presents the design and implementation of a fire-fighting robot using Arduino microcontroller. It discusses the integration of various sensors for fire detection, navigation algorithms, and firefighting mechanisms.

2. "Fire Fighting Robot with Wireless Camera and Temperature Sensor" by V. S. Sumitha, R. Senthil Kumar, and S. Shanthi. This paper describes the development of a fire-fighting robot equipped with a wireless camera and temperature sensor for remote monitoring and fire detection. It discusses the use of Arduino Uno and Bluetooth module for communication.

"Design and Implementation of an Autonomous Fire Fighting Robot Using Arduino and Raspberry Pi" by Arun R., Jayan

T. Joseph, and Vishnu V. This study presents the design and implementation of an autonomous fire-fighting robot utilizing Arduino and Raspberry Pi. It discusses the integration of sensors, motor control, and communication modules for efficient firefighting operations.

3. "Intelligent Fire Fighting Robot with Vision and Sensor Guidance" by Yuxuan Xiao, Shangqi Guo, and Ming Luo. This research focuses on the development of an intelligent fire-fighting robot equipped with vision and sensor guidance systems. It explores the use of advanced algorithms



for navigation, obstacle avoidance, and fire detection.

4."A Review on Fire Fighting Robot"by Alok K. Verma and Saurabh Yadav. This review article provides an overview of existing fire- fighting robot technologies, including their components, functionalities, and challenges. It discusses various approaches to fire detection, navigation, and extinguishing mechanisms employed in different robotic systems.

EXISTING WORK

- In existing system cause of injury and death in fires.
- Fire disaster is one of the most dangerous problems that can lead to heavy loss.
- Sometimes, it becomes difficult for fighters to access the site of a fire because of explosive materials, smoke and high temperature.
- Delay in the arrival of the fire fighters leads to numerous consequences.

PROPOSED SYSTEM

- In our Proposed system we designed to automatically sense the environmental fire and extinguish it without human intervention.
- The fire fighting robot continuously monitors the surroundings and helps in extinguishing the fire.
- It reduce the time delay in reaching fire affected area .
- Reduce human effort, reliable and economical.
- This model is able to detect presence of fire using flame sensor and moves the robot to fire accident location.
- Sensors have long life time and less cost.

SYSTEM OVERVIEW

Fig 1: Block diagram of system overview

WORKING

Arduino Uno initializes all components when power supply is given .LCD display shows the status or mode of the robot DHT11, fire sensor, and MQ-135 continuously monitor the environment for temperature, fire, smoke, and harmful gases respectively.If fire or smoke is detected, the Arduino Uno triggers an alarm using the buzzer. It may also activate the DC pump to spray water on the detected area .The robot can be

controlled remotely via Bluetooth or Wi-Fi. Bluetooth module allows direct control from a nearby device. Wi-Fi module enables control from anywhere with an internet connectionESP32-CAM streams live video footage to a remote device for better situational awareness.

It can also capture images for later analysis.DC motors are controlled by the Arduino Uno via the motor drive. The robot moves towards the detected fire or smoke to extinguish it LCD display provides real-time feedback on the robot's status sensor readings, and actions taken

HARDWARE IMPLEMENTATION

Fig 2: Arduino UNO

Arduino is an open-source electronics platform based on easy-to-use hardware and software. The Arduino UNO is a standard board of Arduino. Arduino UNO is based on an ATmega328P microcontroller.It can run on both online and offline platforms.

Fig 3: DHT11 sensor

DHT11 is a low-cost digital sensor for sensing temperature and humidity. DHT11 is small in size with operating voltage from 3 -5 volts. The maximum current used while measuring is 2.5mA.

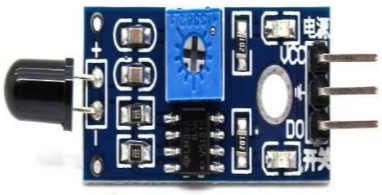


Fig 4: Flame sensor

A flame detector is a sensor designed to detect and respond to the presence of a flame or fire ,allowing flame detection.Working voltage is between 3.3v and 5.2v DC.It used for fire alarm purpose

Fig 5: MQ-135 sensor

The MQ-135 gas sensors are used in air quality control equipments and are suitable for measuring of NH3, alcohol, benzene, smoke, CO2. Working voltage is 5v.

Fig 6: DC motor

A DC motor is an electrical machine that converts electrical energyinto mechanical energy. In a DC motor, the input electricalenergy is the direct current which is transformed into the mechanical rotation.

Fig 7: LCD display

A liquid-crystal display (LCD) is a flat-panel display that uses the light-modulating properties of liquid crystals. LCD's consumes less amount of power. LCDs are of low cost & Provides excellent contrast.

Fig 8: DC pump

DC water pumps are small pumps powered by a battery. Their primary use is to circulate, pressurize, and emulsify liquids. They are useful in environments where water needed. Operating voltage is 3 to 6 volt

The AC mains voltage will be stepped down by the transformer, rectified by bridge and filtered by capacitor to obtain a steady DC level .The output will be regulated by the 7805 to obtain a steady 5V DC.In this way both 12V and 5V DC are obtained.

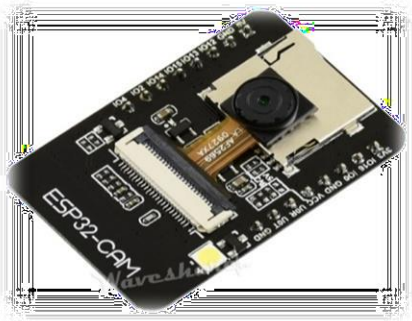


Fig 9: ESP32-CAM

The ESP32-CAM is a small size, low power consumption camera module based on ESP32. Onboard ESP32-S module, supports Wi-Fi + Bluetooth. Power supply: 5V

Fig10: Buzzer

The electric buzzer was invented in 1831 by Joseph Henry.A piezo buzzer is a type of electronic device that's used to produce a tone, alarm or sound. It's lightweight with a simple construction and a low cost product.

Fig 11: L293D Motor drive

L293D is a Motor driver which allows DC motor to drive on either direction.It works on the concept of H-bridge.H-bridge is a circuit which allows the voltage to be flow in either direction.

Fig 12: Relay module

A relay module is an electrical switch .It is operated by electromagnet. The is activated by a low-power signal from a microcontroller. When activated, the electromagnet pulls to either open or close an electric circuit.

Fig 13: HC05 Module

It is used to short-range wireless connection . The transfer rate of the data can vary up to 1Mbps and is in range of 10 meters. The HC-05 module can be operated within 4-6V of power supply.

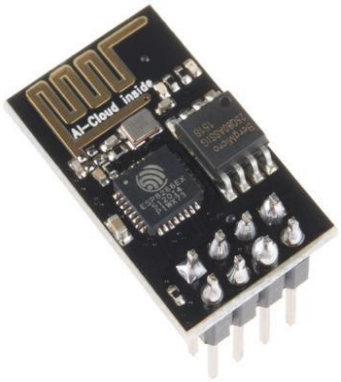
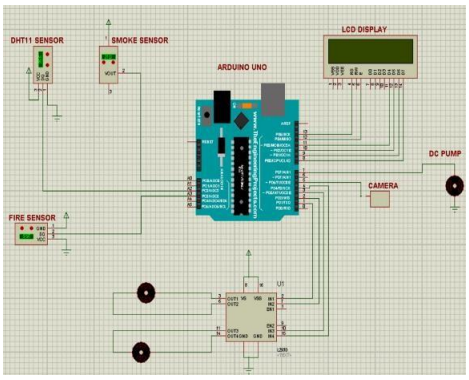


Fig 14: ESP8266 Wi-fi Module

The ESP8266 is a very user friendly and low cost device to provide internet connectivity in projects. The module can work both as a Access point (create hotspot) & as a station (connect to Wi-Fi), hence it can easily fetch data & upload it to the internet making IOT as easy as possible.

CIRCUIT DIAGRAM



RESULT

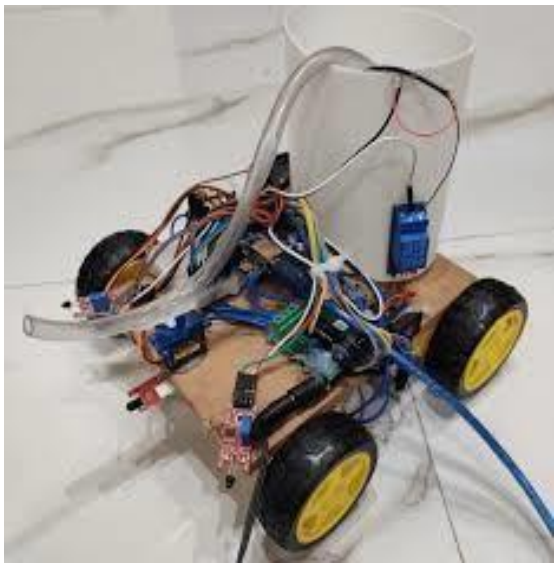


Fig 15: Output

Detects fires and smoke autonomously. Navigates towards the fire source efficiently. Suppresses fire with water or extinguishing agents. Allows remote monitoring and control via Bluetooth and Wi-Fi. Provides real-time feedback and alerts for user safety.

CONCLUSION

In conclusion, the Fire Fighting Robot project has demonstrated the successful integration of various hardware components and software algorithms to create a versatile and efficient autonomous system for fire detection and extinguishing. Through the use of sensors such as DHT11 and MQ-135 for fire detection, coupled with motor drive mechanisms and a DC pump for navigation and firefighting, the robot exhibited effective performance in detecting and extinguishing fires autonomously. The inclusion of communication modules like Bluetooth and Wi-Fi enabled remote monitoring and control, enhancing the system's usability and accessibility.

With its user-friendly interface provided by the LCD display and alarm system for alerting nearby individuals, the robot offers a comprehensive solution for enhancing fire safety measures in diverse environments. Further refinement and testing may be necessary to optimize performance and address any identified challenges, but the project represents a significant advancement in fire-fighting technology with promising potential for practical application.

FUTURE SCOPE

1. Advanced Sensor Integration: Incorporating more advanced sensors such as infrared cameras for improved fire detection accuracy and early warning systems.

2. Artificial Intelligence (AI) Implementation: Integration of AI algorithms for intelligent decision-making, allowing the robot to adapt its firefighting strategies based on real-time data and environmental conditions.

3. Autonomous Navigation: Development of advanced navigation algorithms to enable the robot to navigate complex environments autonomously, including obstacle avoidance and path planning capabilities.

4. Multi-Robot Collaboration: Exploration of swarm robotics concepts to deploy multiple fire-fighting robots that can collaborate and coordinate their efforts to extinguish larger fires more efficiently.

5. Enhanced Communication: Integration of long-range communication technologies such as LoRa or satellite communication to extend the range and coverage of remote monitoring and control capabilities.

6. Environmental Monitoring: Expansion of the robot's functionality to include environmental monitoring capabilities beyond fire detection, such as air quality sensing or hazardous gas detection.

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