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Arduino Controlled Fire Detection Robot

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Abstract

An Arduino controlled firefighting robot is an innovative solution to combat fire incidents. This robot is designed to detect and extinguish fires in hazardous environments, thereby reducing the risk to human life. It is equipped with various sensors, including smoke and heat detectors, that enable it to detect fires quickly and accurately. The robot is also equipped with an Arduino microcontroller, which enables it to process and analyze the sensor data to make decisions on how to approach the fire. The robot is capable of navigating through narrow passages and obstacles to reach the fire and extinguish it using a water spray mechanism. The use of Arduino microcontroller allows for easy customization and modification of the robot, making it an ideal platform for research and development in the field of firefighting robotics. Overall, an Arduino based firefighting robot is an effective solution for combating fires in hazardous environments and protecting human life.

Keywords

Arduino UNO, Chassis, Flame sensor (IR sensor), Motor driver, Water pump.

INTRODUCTION

Fires can be devastating, causing loss of life and property damage. In many cases, fires occur in hazardous environments, such as chemical factories, power plants, and high-rise buildings, where the risk of injury to human firefighters is high. To address this problem, the use of robots for fire fighting has gained attention in recent years. One such innovative solution is an Arduino based firefighting robot. This robot is designed to detect fires and extinguish them without human intervention, thereby reducing the risk of injury to firefighters. The robot is equipped with various sensors and an Arduino microcontroller, which enables it to detect fires, process sensor data, and make decisions on how to approach the fire. This robot is capable of navigating through narrow passages and obstacles to reach the fire and extinguish it using a water spray mechanism. In this way, the Arduino based firefighting robot provides a safe and effective solution for combating fires in hazardous environments. This paper will discuss the design, implementation, and testing of an Arduino based firefighting robot, and its potential for use in the field of firefighting.

The ability to respond quickly and effectively is crucial. To address this challenge, engineers and robotics experts have developed an Arduino-based autonomous firefighting robot. This robot is designed to navigate through burning buildings and extinguish fires, reducing the risk to human firefighters and minimizing property damage. In this topic, we will explore the technology behind this innovative solution and how it is changing the landscape of firefighting.

The Arduino platform is an open-source electronic prototyping platform that is widely used by hobbyists, students, and professionals to create a wide range of electronic projects. Arduino-based robots are becoming increasingly popular due to their flexibility and affordability. These robots can be programmed to perform a wide range of tasks, including navigating through complex environments, detecting objects, and manipulating them.

An autonomous firefighting robot built on the Arduino platform is designed to navigate through a burning building on its own, locate the fire, and extinguish it. The robot is equipped with sensors that allow it to detect heat, smoke, and flames. Once it detects a fire, it uses its water or foam spray system to extinguish it.

One of the key advantages of an autonomous firefighting robot is that it can go where human firefighters cannot. For example, it can navigate through narrow passages, climb stairs, and move through areas that are too dangerous for humans. This makes it an effective tool for fighting fires in tall buildings or other structures where human access is limited.

Overall, an Arduino-based autonomous firefighting robot represents a significant advancement in firefighting technology. It has the potential to save lives and reduce property damage by responding quickly and efficiently to fires in a safe and effective manner.

Figure 1 shows the design module for Arduino based autonomous firefighting robot.

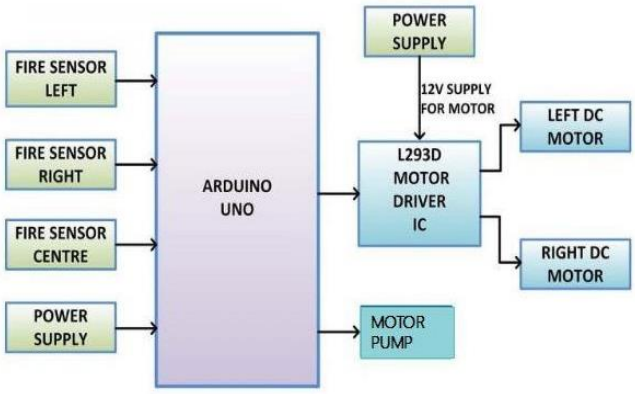

Figure 1. Design Module

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PROBLEM FORMULATION

The problem formulation for an Arduino based firefighting robot is to design and develop a robot that can detect and extinguish fires in hazardous environments. The robot must be equipped with sensors that can detect smoke and heat, and an Arduino microcontroller that can process sensor data and make decisions on how to approach the fire. The robot must also be capable of navigating through narrow passages and obstacles to reach the fire and extinguish it using a water spray mechanism. The robot must be autonomous and capable of operating without human intervention. Additionally, the robot must be customizable and easily modifiable to allow for future research and development in the field of firefighting robotics. The goal is to develop a cost-effective and efficient solution for combating fires in hazardous environments and reducing the risk of injury to human firefighters.

LITERATURE SURVEY

Varenyam Sharma, Abhideep Bhatti, Sushrut Khajuria, and Rakesh Johar suggested an Arduino-based firefighter robot that uses RF-based remote control to run the robot and water pump.Within a 7 metre radius, the user can control the robot.Additionally, it has a wireless camera that enables users to control the robot in the desired directions. [1]

An obstacle-avoiding robot called the Amphibious Autonomous Vehicle was proposed by Khaled Sailan, Professor Dr.-Ing. Klaus-Dieter Kuhnert, and Simon Hardt. This robot uses a fuzzy controller to instantly avoid static obstacles.It seeks to steer the robot or vehicle down the path while avoiding every obstruction in the way. [2]

A notification system for an automatic fire fighting robot was proposed by J. Jalani1, D. Misman1, A. S. Sadun1, and L. C. Hong1.Three flame sensors are used by this robot to detect fires in the left, right, and centre directions.Three ultrasonic sensors are also included for detecting and avoiding obstacles.The robot uses a bluetooth module to send the user a warning notification when it senses a fire. [3]

The Rolly Firefighter Robot was created by William Dubel, Hector Gongora, Kevin Bechtold, and Daisy Diaz to search for fire in a small house's floor plan, put out the fire (by covering the LEDs with a cup), and then make its way back to the front of the building. The information from a line tracker and ultrasound transducers is used to guide the robot through the residence. Servo-controlled custom arm is used to implement the extinguishing device deployment. [4]

The Viet Do, Ryan Norder, and Ryan Spraetz team created the Fire Protection Robot, a robot that can enter a room and look for areas of intense heat that could be the result of a fire. The robot will again use the colour camera as soon as it enters the room to locate an area with a lot of light. The heat sensor is turned on after the robot has approached the light source to see if a lot of heat is being produced. If too much heat is produced, the fan is activated and immediately rotated with a servo motor to extinguish the flame. The fan will turn if the flame is not extinguished. [5]

Robotic vehicle that can recognise and respond to fire published by Nik Md. Hafizul Hasmi B. Md. Suhaimi. In this project, we'll talk about creating a mobile robot that can be used to teach and manage an autonomous, multipurpose robot. The robot learns the fundamentals of navigation as well as how to spot and put out fires. A microcontroller, PlC16F84A, is used to manage this robot, and RC circuits are used to support it and act as drivers for DC motors and other electronic parts. This robot has a fire sensor that is expandable and attractable, enabling it to detect fires and respond by activating a water pump system. This robot also includes a battery monitoring circuit to simplify monitoring. [6]

H. C. Moon et al. (2018) proposed a firefighting robot that uses an Arduino microcontroller to control its movements and water spray mechanism. The robot was equipped with a smoke sensor, a temperature sensor, and a flame sensor, which allowed it to detect fires and extinguish them using a water spray mechanism. The study demonstrated the effectiveness of the robot in detecting and extinguishing fires in a simulated environment. [7]

S. K. Kim et al. (2019) proposed a firefighting robot that used an Arduino microcontroller and a Raspberry Pi computer for data processing. The robot was equipped with sensors that could detect smoke, temperature, and flame. The robot was also equipped with a water spray mechanism and a robotic arm that could be used to open doors and remove obstacles. The study demonstrated the effectiveness of the robot in detecting and extinguishing fires in a simulated environment. [8]

J. A. Silva et al. (2019) proposed a firefighting robot that used an Arduino microcontroller and a Raspberry Pi computer for data processing. The robot was equipped with sensors that could detect smoke, temperature, and flame. The robot was also equipped with a water spray mechanism and a fan to control the direction of the spray. The study demonstrated the effectiveness of the robot in detecting and extinguishing fires in a simulated environment and highlighted the importance of customization and modifiability in the development of firefighting robots. [9]

A fire extinguishing robot was proposed by Nagesh MS, Deepika T V, Stafford Michahial, and Dr. M Shivakumar. The robot uses DTMF (Dual Tone Multi Frequency Tones) technology for navigation and a flame sensor for fire detection that can detect flames with a wavelength range of 760 to 1100 nm and sensitivity ranging from 10cm to 1.5feet. [10]

METHODOLOGY

The methodology for developing an Arduino based firefighting robot typically involves several stages, including design, implementation, testing, and evaluation. The following is a general overview of the methodology for developing an Arduino based firefighting robot:

1. Design: In this stage, the overall concept and design of the robot are determined. The design includes the

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selection of appropriate sensors, Arduino microcontroller, motor drivers, water spray mechanism, and other components required for the robot.

2. Implementation: Once the design is finalized, the components are assembled, and the programming code is written for the Arduino microcontroller. The robot's hardware and software are integrated to ensure proper functioning.
3. Testing: The robot is tested in a simulated environment to ensure that it can detect fires accurately and extinguish them using a water spray mechanism. The robot's performance is evaluated under different conditions, such as different types of fires, varying environmental conditions, and obstacles.
4. Evaluation: Once the testing is complete, the robot's performance is evaluated based on its ability to detect and extinguish fires accurately and its effectiveness in navigating through narrow passages and obstacles. Modifications may be made to improve the robot's performance.
5. Refinement: Based on the evaluation, modifications may be made to improve the robot's performance. The robot is tested again to ensure that the modifications have improved the robot's performance.
6. Deployment: Once the robot is deemed to be effective, it can be deployed in actual fire incidents to assist human firefighters in combatting fires and reducing the risk of injury to human firefighters.

Overall, the methodology for developing an Arduino based firefighting robot involves a systematic approach to design, implementation, testing, evaluation, refinement, and deployment. This approach ensures that the robot is effective in detecting and extinguishing fires in hazardous environments and reducing the risk of injury to human firefighters.

Fig-2. Fire Fighting Robot

DESIGN

Stages of working

1. Movement stage.
2. Flame tracking stage.

a. After we test the movement model we integrate the flame sensor to the model.
b. Flame sensor detects the fire from front, left and right. So, in this step the robot will not move until the flame sensor sense the fire.
c. Three flame sensors used to detect fire from front, left and right as shown in figure 3. To be accurate we read three values for each one and evaluate the average and we must wait few milliseconds before start reading new values from the sensors.

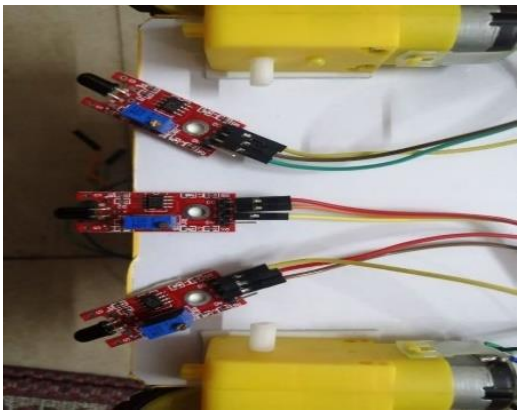

Figure 3. Flame sensors

3. Extinguishing Fire stage.
   - When the fire is detected by the robot stop and turn on the pump.
   - Read from front sensor if it's less than specified value go forward. Else stop and find new route.
   - Find new route by going backward Read left and right sensors. If left distance less than right distance then turn left else turn right.
   - Go back to first step as shown in figure 4.
   - While the water pump is running the robot will keep sensing the fire if no flame (fire) then it will turn off the buzzer and pump

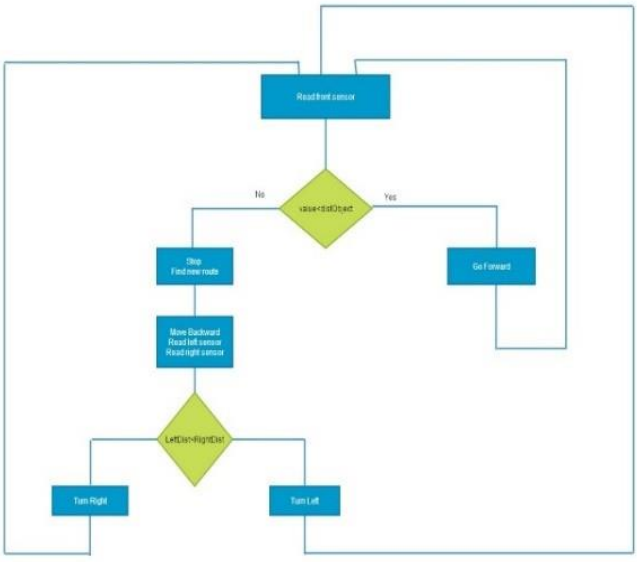

Figure 4. Movement algorithm

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PROGRAMMING

Arduino IDE (Integrated Development Environment): is a software platform that is used to program Arduino boards. It is an easy-to-use software platform that is designed to simplify the process of programming Arduino boards for beginners and experienced programmers alike. the Arduino IDE is based on the Processing programming language and uses a simplified version of the C++ programming language to write code for Arduino boards. The platform includes a text editor, a compiler, and a serial monitor that allows the user to send and receive data from the board.

To start programming an Arduino board using the IDE, the user must first connect the board to their computer using a USB cable. Once the board is connected, the user can open the IDE and create a new sketch (program) or open an existing one. The sketch is written in the Arduino programming language, which is based on C++. the programming language used in the Arduino IDE includes a set of pre-defined functions and libraries that make it easy to write code for common tasks such as reading and writing to digital and analog pins, controlling motors, and communicating with other devices. once the user has written their code, they can click on the "Verify" button to check for any syntax errors. If there are no errors, they can then click on the "Upload" button to upload the code to the Arduino board. The board will then execute the code and perform the tasks that were programmed. Overall, the Arduino IDE is a powerful and easy-to-use platform for programming Arduino boards. It provides a simplified version of C++ programming language, pre-defined functions and libraries for common tasks, and a user-friendly interface that makes it easy to write and upload code to the board of various sensors, it can detect fires with high accuracy, and its water spray mechanism can extinguish fires effectively. Additionally, it can navigate through narrow passages and avoid obstacles to reach the fire source quickly and safely. Good programming and control can also ensure that the robot can detect and extinguish fires effectively while avoiding obstacles and navigating safely. Although challenges and limitations exist, such as the need for optimized sensors and programming, the potential benefits of such robots make them a promising area for future research and development. Overall, Arduino based autonomous firefighting robots have the potential to save lives and property and can serve as a valuable addition to current fire-fighting methods.

RESULT AND DISCUSSION

Arduino based autonomous firefighting robot can provide an effective and safe alternative to human firefighters in hazardous environments. The accuracy of the sensors, the effectiveness of the water spray mechanism, and the navigation and obstacle avoidance capabilities can all be optimized to ensure optimal performance. Good programming and control can also help to ensure that the robot can detect and extinguish fires effectively while avoiding obstacles and navigating safely.

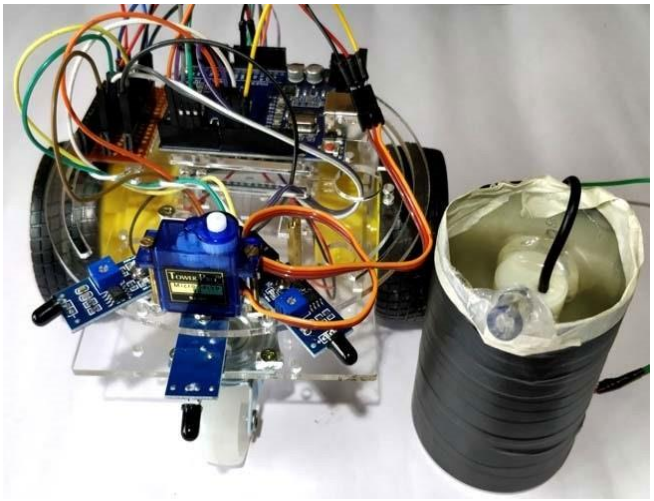

Figure 5. Fire Fighting Robot

CONCLUSION

An Arduino based autonomous firefighting robot is a viable solution for hazardous fire-fighting situations where human intervention is not possible. With the use of various sensors, it can detect fires with high accuracy, and its water spray mechanism can extinguish fires effectively. Additionally, it can navigate through narrow passages and avoid obstacles to reach the fire source quickly and safely. Good programming and control can also ensure that the robot can detect and extinguish fires effectively while avoiding obstacles and navigating safely. Although challenges and limitations exist, such as the need for optimized sensors and programming, the potential benefits of such robots make them a promising area for future research and development. Overall, Arduino based autonomous firefighting robots have the potential to save lives and property and can serve as a valuable addition to current fire-fighting methods.

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