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Fire Extinguishing Robotic Vehicle

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ABSTRACT: Fire assumes a significant job in human life however alongside that it is hazardous too. Fire occurrence is a catastrophe that can cause the loss of human life, property harm, and lasting incapacity to the influenced casualty. Firemen are principally entrusted to deal with the fire occurrence, yet regularly they presented to the higher dangers when quenching fire particularly in dangerous conditions, for example, in atomic force plant, oil treatment facilities, and gas tanks. Additionally, they confronted with different troubles especially when the fire happens in a tight and limited region, as it is important to investigate the vestiges of structures and obstructions to smothering the fire and spare the person in question. Our project aims to extinguish fire by using a robot having embedded systems in it that can quench the fire without the requirement for firemen. Proposed system will have a fire sensor (IR Sensor) to identify the fire, Smoke Sensor (MQ6) to detect gas and Ultrasonic sensor (HCR04) to detect obstacles by using a V380 camera. Also, the system will control the movement of the robot with the assistance of a Bluetooth module (HC05) and the robot is customized to distinguish the fire and object automatically, and also it can be done manually.

KEYWORDS: Fire robot, fire extinguish, fire accidents, obstacle detection, ultrasonic sensor (HC04), flame sensor (4-pin IR sensor), Bluetooth module (HC05), smoke sensor (MQ6), Water float sensor, servo motor (SG-90), 12V DC motor, water pump (12V DC pump), L298 motor driver, V380 camera.

I. INTRODUCTION

Fire accidents are too common and hazardous that can cause a major loss in environment. Although there are a lot of precautions taken for fire accidents, these natural/man-made disasters do occur now and then. In the event of a fire breakout, to rescue people and to put out the fire we are forced to use human resources which are not totally safe. With the advancement of technology especially in Robotics it much possible to implement robots with human intelligence that can be able to take proper decisions to deal with on-site fire incidents. It will improve the efficiency of fire-fighter's and would also prevent them from risking human lives. So we are going to build a Fire Fighting Robot using Arduino UNO, which will automatically sense the fire and start the water pump. Also, there are some of the additional features on how we have to complete the procedure of extinguishing fire and other peripheral activities and objectives needed to achieve. This project comes up with the advancements that are unique and not implemented in the till now existing fire extinguishing robot. It is for sure easy to handle as well with a user-friendly GUI is developed. This project works in the environment at which the fire has been caught and perform its stated operation. The vehicle can be operated manually using the app to take it to the location of the fire incidents to perform the operation and also vehicle is designed to be automatically perform to give the desired output. The app will be able to operate the vehicle using Bluetooth. Camera used to monitor the surrounding can help to monitor the surrounding of the vehicle. During the automated process the obstacle detection mechanism has been implemented so that it can avoid the obstacles automatically that are in its path while carrying out the operation. It is made to be operated in a specific room to extinguish fire caught at a particular place in the room.

II. LITERATURE REVIEW

2.1. Survey of Existing System

Anam Sheikh, Gopal Purohit, Vaishnavi C. Raut, Rehan Rashid Abdul, Prof. C. H. Kidile (2022) had presented a Fire Fighting Robot that was totally automatic system base and could extinguish the fire without any human intervention. The robot carries four main functions. Firstly, it initializes the sensors as the power is supplied. Then the robot starts sensing the surrounding to check the level of temperature and identify the fireplace. After that, robot sends the information about the sensed fire by the sensor and system navigate itself towards the fireplace.

Prince, Ahmed Tamim Zabir, Kabir, Kazi Shahadat, Nabil, Md. Abdullah (2021) had presented the simulated system design of the fully automated robot that could extinguish fire using the software Proteus 8.9 Professional and Arduino IDE. It is designed in a way that it could sense any kind of fire/smoke with the help of sensors and extinguish it by spraying water continuously until the fire/smoke goes off. It used Arduino UNO, 3 Flame sensor, Gas Sensor, Buzzer, DC Motor, Servo Motor, L293D, DC Pump and Logic State Switch. Firstly, the coding of the Arduino Uno was done in Arduino IDE. Then, in the Proteus software the connections were made by selecting the components according to the need. The 5V supply voltage was given in each flame and gas sensors and 12V to the L293D.

Authors N. Tejaswi, Dr. A. Ranganayakulu, G. Lakshmi Kumari, E. Alekhya, K. Tejasri A. Pradeep Sai (2020) had presented a fire extinguishing robot that uses an Android application for controlling the system. This system is controlled manually. In some cases, due to wrong readings of the sensors, the robot can fail to perform its task of extinguishing the fire. In this paper, the RF based firefighting robot is designed to be operated wirelessly and more efficiently. The entire working of the system is based upon ARM processor. It is controlled manually using a mobile application and extinguishes the fire. An oscillator provides an A.C. motion over its yield terminals without requiring any contribution. The power supply is provided to the system. The fire sensor senses the fire and the sprays the water on it. The system uses Bluetooth module for the vehicle to operate using the app. The app can be used to control the vehicle moment and also the manual operations.

J Jalani¹, D Misman¹, A S Sadun¹ and L C Hong have also done a similar project. In their model, the flame sensors can solely activate to notice fireplace once the robot is on. The in-operation voltage for the flame sensing element is 5V. The voltage will decrease from 4.8V to 0.1V, if the voltage continues to decrease till reached 0.1V, the sensing element can recognize the input as "fire" and send digital knowledge to Arduino. The Arduino can confirm that sensors are causing the info and send commands to the motor driver for activated the DC motor, therefore the DC motor triggered consistent with that sensing element detective work fireplace initial. The robot can move toward the fireplace till it reaches and puts off the fire. Once the robot reached the destination, it will start to pump the water.

Aftab Nagarji, Aniket Vani, Pratik Kumathe, Prof. N. S. Nadaf, developed a robot with main operation is to find fire and move towards it to extinguish it from a secure distance. This robot's movement and behavior are going to be totally controlled by Arduino microcontroller[6]. This vehicle-shaped automaton can find and extinguish fires by moving right, left, front, and rear. The project goals are to develop a Fighter automated robot that may be accustomed to extinguish fire automatically, and works with Bluetooth. Implementation of this automaton is with high temperature to assess the affectability of distinguishing that subsequently cancels the flame by utilizing water instrument.

Diwanji, M., Hisvankar, S., & Khandelwal, C. have also made a similar model. Three flame sensors namely left flame sensor, right flame sensor and center flame sensor are interfaced with the Arduino Uno board as the input components. L293D motor driver module is used for driving the two geared DC motors namely the Left DC Motor and the Right DC Motor. These motors are used to give direction to the robot according to the fire i.e., the input received from the flame sensors. The 12V DC Pump driven by an external battery through a 5V Relay Module is used to extinguish fire. A servo motor (SG90) is used to give axial direction to spray the water on fire.

III. PROPOSED SYSTEM

A. Introduction

Application of robotics in day-to-day life can make work of the human beings easy. Taking help of the robotics in the fire accidents can be very helpful to overcome the risk of human lives and also working out task on the places where human resources can't be reached. The systems developed before were either based

on automatic working or manual operation. We have developed the project that uses both the methods and also some of the additional features that will benefit the efficiency of the operation. The developed robot would be used to extinguish fire without firemen being at the site. It is a robotic vehicle that would perform the actions automatically while in auto mode. Also, firemen can monitor the site with the help camera and would be able to control the operations using developed software application. Following flowchart gives the idea of the complete working of the project.

B. Flowchart

To explain the working of project, below is the flowchart given:

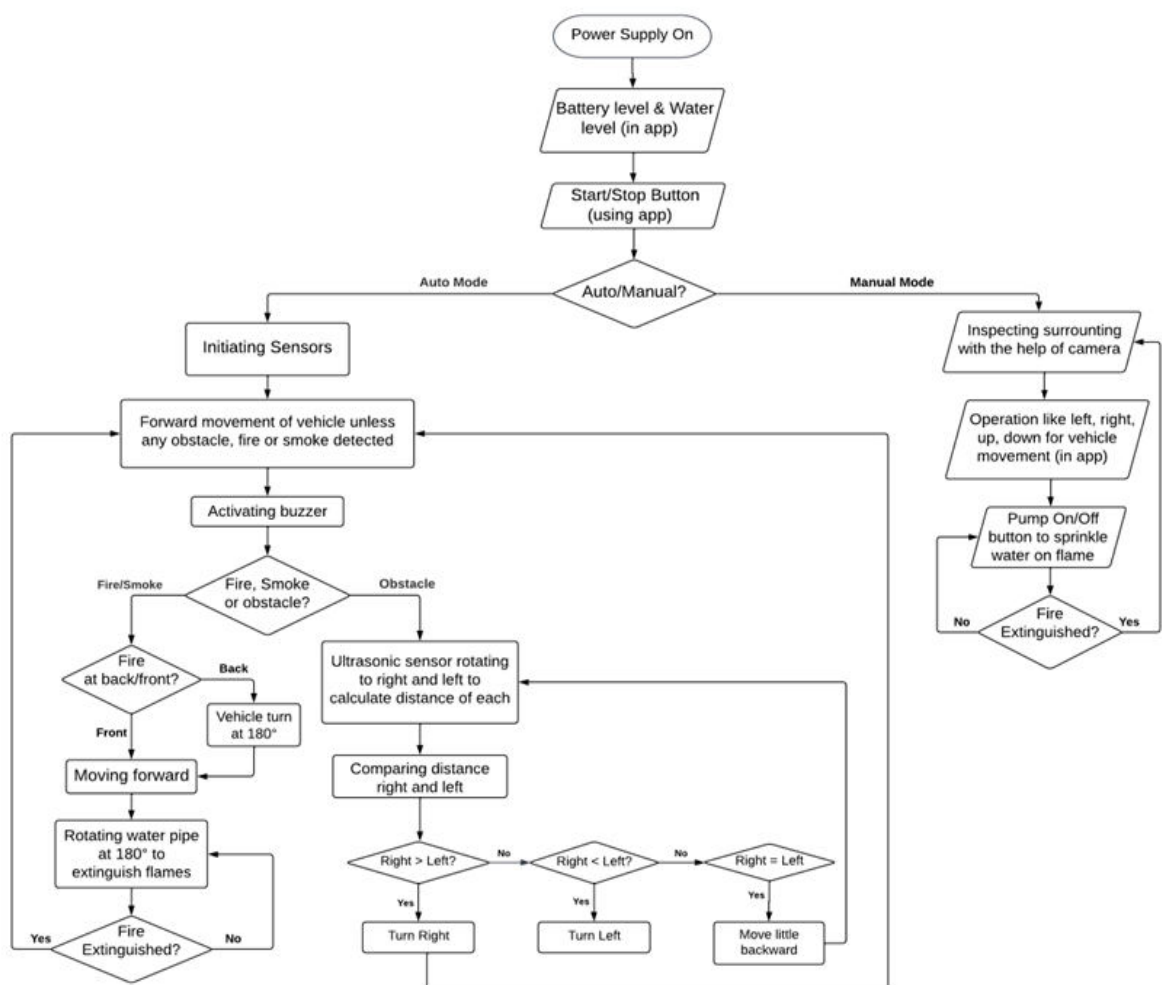


Fig. 3.1 Flowchart

Arduino UNO

The main brain of the system that is been used in the system is Arduino UNO based on ATmega328P. It takes inputs based on what mode vehicle is been working that can be manual or auto. The inputs are processed to give appropriate output that would complete certain objective.

Software application

It has option to select manual/auto mode. When the system gets started the robot initializes itself in Manual mode. In this mode the operations such as vehicle movement in direction left, right, forward,

backward and the operation of pumping water can be operated manually using software application developed for the system. Also, GUI shows the battery percentage and water level in the container.

When the vehicle is selected in Auto mode the following components play important role to achieve the objectives of the system:

Fire Sensor

Fire sensor component that would be using to detect the fire on the site of fire accident. 2 sensors that would rotate at 180 degrees using servo motor to detect the flames in the surrounding. The sensor used by us is 4-pin sensor. It has 4 pins power, ground, digital output and enable pins. Being active type of sensor, it uses radar technology and it emit and receive radiation. The radiation sent bounces back to receiver of the device. This sensor is capable of separately detecting the actual flames & the non-flame radiations thus the results provided are accurate by avoiding background radiation.

Smoke sensor

The sensor MQ6 is also known as Gas sensor is used to detect the smoke in the air that would be notified to the sensor. The sensor consists of a sensing material that ionizes the gases that comes in its contact, then the gas adjusts the resistance across the circuit and gives result.

Ultrasonic sensor

There can be a situation where the vehicle can come across the obstacle. To detect these obstacles, we have used ultrasonic sensor HC-SR04. The transmitter of this sensor transmits an ultrasonic signal that reflects on to the object and bounce back to receiver that would major the distance based on this time duration. Once the obstacle is detected the sensor would rotate to right and major the distance and then to the left for majoring distance using servo motor. Comparing these two distances, it would turn the vehicle to the direction with greater distance. If the distance measured is same for both ways then it would move a bit back and then again perform the same process.

Servo motor

For rotating components in 0 10 180 degrees, we have used servo motor SG90 that is attached to them.

Buzzer and LED:

When the fire/smoke or the obstacle is detected the Buzzer and LED both of 5V, is activated to notify it to user.

Water pump:

Once the fire is detected the 12V DC Water pump used centrifugal force that is generated by high speed rotated impeller to lift water from the container and sprinkle the water using the pipe to extinguish fire.

Water float sensor:

It is used to notify user about the water level in the tank. It works by opening and closing dry contacts that will send an electrical signal to set on a water level alarm.

Bluetooth Module:

For the communication between software application and the system we have used Bluetooth technology as it works smoothly and is of low cost and easy to implement.

L298 motor driver module:

It is used as an interface between Arduino and DC motor. It can operate 2 DC motors at a time with speed and direction control.

DC motors:

The 12V DC motors are attached to the wheels of vehicle for the moment. DC motor is lightweight, resistant abrasion with metal material torque and tough features, durable and reliable to use it for a long time. It also has low noise, low resistance and higher efficiency.

Camera:

Though system is in manual or automatic mode, it is necessary for the surrounding in the system to be monitored continuously. Camera V380 is used in the system for monitoring surrounding. Day and night vision is the specialty of this camera. Also, it can be moved up down left and right to monitor the surrounding in all these directions.

IV. EXPERIMENTS AND RESULTS

Our developed system has been built to extinguish the fire in the case of fire accident and to help the firemen to carry-out the operations in the situation where it becomes difficult or risky. While most of the systems that were developed to function based on either manual or auto mode. Our developed system has both the options of manual and auto mode. User can select any one according to the situation they need. This operation can be selected using the switch given in mobile application developed for the system.

To control the vehicle in Manual mode we can use the android application which consists of several controls to move the vehicle in different directions like moving the vehicle front, back, up, down, start/stop and to perform various operations like “Pump” button for sprinkling the water also, it also has the battery indicator and water level indicator that displays the battery status and water level status in percentage.

In Auto mode, the vehicle performs the operation without any human intervention. It moves forward automatically and pause its movement when fire is detected with the help of fire sensors placed at both back and front of the vehicle it activates the buzzer and LED to notify the detected fire. Normally when the fire is detected at the front, the pipe then sprinkles the water by rotating in 180 degrees until fire is extinguished. There might be the case that the fire has been detected at the back side, then the vehicle moves itself at 180 degree and then perform the operation of extinguishing fire.

In case of obstacle, the buzzer and LED is activated to notify the used about the obstacle being detected. In this situation the vehicle pauses its movement then, the ultrasonic sensor rotates to right and left side to measure the distance respectively and then by comparing both the distances it decides to move to the maximum distance. In the case where both the distance measured are similar, the vehicle move itself in backward direction for a bit then again measure both the distances and move accordingly.

Camera is used to monitor the surrounding while performing the operation. The camera is independent of the mode. The camera-oriented application that is used to operate it. Also, the real- time view is captured by the camera is displayed on the app. Therefore, it becomes easy to operate the vehicle or to decide the action to perform in some immediate situation.

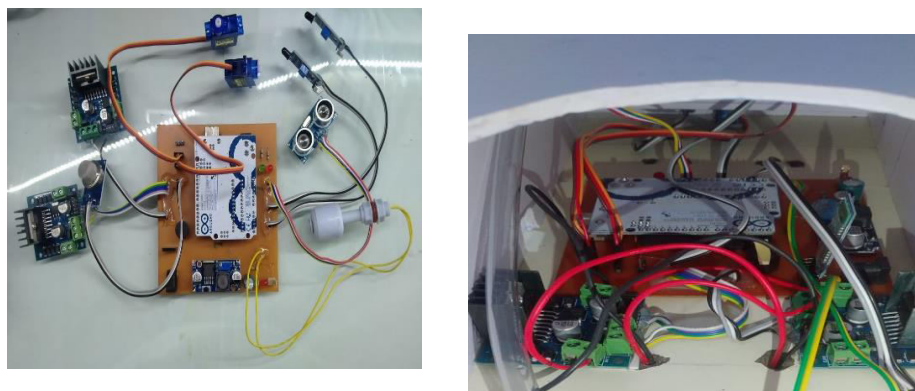


Fig. 4.1 Circuit of the Project



Fig.4.2 Fire Fighting Robotic Vehicle

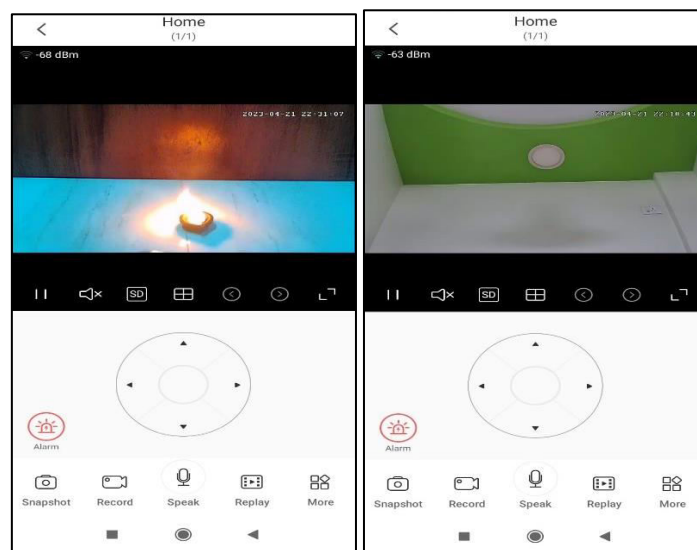


Fig. 4.3 Camera View through app

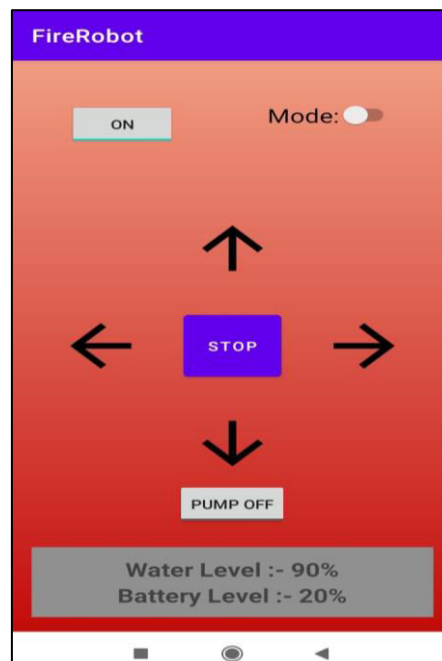


Fig.4.4. Application for the Robot

V. CONCLUSION

This project presents the advancement of putting out fires Robot utilizing embedded systems that can quench the fire without the requirement for firemen. As robot can sense fire as well as smoke for carrying out operation. Our implemented robot can reliably be used in different hazardous places as it uses both Auto and Manual mode. If in case, the sensors are not able to react then the manual mode can be used and, in some cases, when robot will be at the far distance where, controlling it using manual inputs through app would not work then auto mode can be used. Fire sensors being at both front and back it is more efficient to detect and extinguish fire in robot's surrounding in 360 degrees. If fire is detected at the back, then robot rotates itself at 180 degree and then extinguish the fire. Also, implemented obstacle detection in such a way that, if the obstacle is detected, then ultrasonic would reacts efficiently to avoid it. The android app developed performs well to control robot according to the user need. The battery level and water level indicators are displayed on the app so that user will be aware of system need of power supply and water refilling to monitor the system accordingly. Thus, we have attempted to implement the objectives that have been assumed during the survey and also the suggestions that were taken into consideration after the discussion with the mentors were planned, designed and implemented efficiently. The advancements implemented in the system makes it outstanding than the existing systems that have been developed till now.

VI. FUTURE SCOPE

In coming years, the field of robotics would be enhancing to the greater extend using artificial intelligence and machine learning. They can be developed in such a way that it can navigate threatful environments, detect fire and accordingly perform appropriate operation. Here are some of the advancements mentioned that can be used to build an intelligent fire-fighting robot. Currently, most Arduino fire-fighting robots are remotely operated. However, future developments in artificial intelligence and robotics may enable these robots to operate automatically, making them more efficient and reducing the need for human intervention. Future fire-fighting robots may incorporate more advanced fire detection and suppression technologies, such as laser-based fire detection or advanced fire suppression chemicals. In the future, multiple fire-fighting robots may work together to tackle larger fires and cover more ground. Fire-fighting robots can be used in hazardous environments such as chemical factories, oil refineries, or nuclear plants, where it may not be safe for humans to enter. The existing systems uses camera only to monitor the surrounding and take actions based on human decision. The advancement like implementing human detection using machine learning as a feature in it can help rescue the life of people stuck on the site of accident.

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