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Automated Fire Fighting Robot

[1]Akshata Hate, [2]Devendra Ghawat, [3]Mohit Bhoir, [4]Sakshi Nirbhavane

[1,2,3,4] *Dept. of CSE (AI&ML), Smt. Indira Gandhi College of Engineering, Navi Mumbai, Maharashtra, India*

Abstract - *This article uses robotics technology to present the automated firing control system. The fact that this technology requires less labour from humans makes it more safe. The Arduino technology is used to create the suggested firefighter robot. Robots employ sensors to detect fires and transmit that information to a microcontroller, which then sends the signal to control circuitry to move the robot into the designated fire zone and use an extinguisher or water pump to put out the fire.*

Key Words: Arduino Board, DC Motor, Flame Sensor.

1. INTRODUCTION

Robots are now more frequently employed to lessen human labour. The necessity of a fire extinguisher robot that is capable of autonomous fire detection and extinguishment. One of the engineering specialties with the fastest current growth is robotics. Robots are made to function in hazardous or labour-intensive environments and to replace humans in certain situations. The development of such a device can reduce the amount of damage caused by the fire while saving lives and property. It is our responsibility as engineers to create a prototype that can recognize a fire and put it out on its own.

The purpose of the Fire Fighter Robot is to find and put out fires in homes and businesses. The robot's primary task is to be placed in a fire-prone region; if it senses a fire breakout, it will begin to operate autonomously. When entering a fire-prone region is extremely challenging for service personnel, this prototype aids in rescue efforts during fire incidents. There are many kinds of vehicles available to put out forest fires and combat flames at home. Our suggested robot can operate independently or under remote control. These robots provide for increased security in fire detection and rescue operations without putting firefighters in danger.

Stated differently, firefighters may not need to enter as many hazardous situations when there are robots around. A lack of scientific innovation has resulted in innumerable and tragic losses. Furthermore, despite intensive training, the methods used in firefighting today are insufficient and ineffective because they mostly rely on people, who are prone to making mistakes. The use of robots rather than people to tackle fire dangers is a recent and increasingly prevalent trend. This is mostly due to the fact that they might be employed in circumstances that are too risky for any one person.

Our project involves creating a robot that can find fire and put it out in a specific setting. Throughout its journey, the robot navigates the terrain and stays clear of any obstacles. The Arduino board serves as the control circuitry's central nervous system. The two sensors that are interfaced in the control circuitry make up the robot. The robot is moved to the fire spot by sensors that identify areas that are prone to fire in all directions. A pump extinguisher that is attached to the robot activates to put out the fire as it approaches the fire zone.

This paper describes the construction of a firefighting robot that can put out a fire without putting firefighters in needless danger. The robot is called robot. In order to facilitate small site access and a deeper reach for extinguishing fires in tight spaces, robots are intended to be smaller than other traditional fire-fighting robots. In addition, the robot has an ultrasonic sensor to prevent collisions with nearby items and obstacles, and a flame sensor is fixed to detect fires. As a result, the robot displayed the ability to remotely put out fires at a specific distance and to autonomously recognize fire places. Robot is designed to locate the fire and halt when it is 40 cm or less from the flames. A human operator can monitor the robot by using camera which connects to a smartphone or remote devices.

The perilous work of detecting and putting out fires endangers the lives of fire fighters. Every year, there are several fire incidents worldwide in which firefighters are forced to die while performing their duties. Robotics is the result of study and development in the field of artificial intelligence. Robots are used in many different fields, including manufacturing, industries, and medicine. Therefore, robotics can help firefighters carry out this work of combating fires and thereby lower the risk to their lives. One robot made for usage in these kinds of harsh environments is called Fire Fighter.

2. LITERATURE SURVEY

A firefighting robot model was proposed by Tawfiqur Rakib and M. A. Rashid Sarkar. It comprises a base platform composed of "Kerosene wood," an LM35 sensor for temperature detection, flame sensors for fire detection, and a one-liter water container made of sturdy cardboard that is water resistant. The robot can move on its two wheels.

The Atmega2560 microcontroller concept put forth by Saravanan P. Soni Ishawarya divides the robot into three

primary sections based on its intended use: a locomotive unit, a fire detection unit, and an extinguisher unit. Every unit carries out its assigned duties with the goal of putting out fires. With the aid of four infrared and four ultrasonic sensors, the locomotive unit moves the robot and helps it avoid obstacles. The temperature sensor and LDR are employed by the fire detection device to identify fire. The extinguishing equipment uses a BLDC motor and a water container to put out the fire. In order to navigate, the robot also has a Bluetooth module that is linked to smartphones.

An Arduino UNO R3-powered android-controlled firefighting robot was proposed by S. Jakthi Priyanka and R. Sangeetha. The robot's components include a gas sensor for detecting fires, a gear motor and motor drive for movement, and a bluetooth module for controlling the robot from a smartphone and connecting it to an Android device. Sprinklers and a water pump are also utilized in this. Programming and implementing code on the Arduino UNO requires the use of the Arduino IDE, an open source program.

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

Sushrut Khajuria, Rakesh Johar, Varenyam Sharma, Abhideep Bhatti proposed an arduino based fire fighter robot which consists of RF based remote operation to operate the robot and water pump. The robot is controlled by the user within a range of 7 metres. It also consists of a wireless camera which helps user to move the robot in the required direction.

Khaled Sailan, Prof. Dr.-Ing. Klaus-Dieter Kuhnert, Simon Hardt proposed an obstacle avoidance robot named as Amphibious Autonomous Vehicle. In this robot, a fuzzy controller is used to avoid static obstacle in real time. It aims to guide the robot or vehicle along its path avoiding all the obstacle that comes along the path.

J Jalani1, D Misman1, A S Sadun1 and L C Hong1 proposed a automatic fire fighting robot with notification. This robot consists of three flame sensors for fire detection in left, right and center direction. It also consists of three ultrasonic sensors for obstacle detection and avoidance. When the robot detects fire it also sends a warning notification to the user using Bluetooth.

3. PROPOSED SYSTEM

Every input/output system is processed using an Arduino UNO. Fire, smoke, UV, water level, voltage, and Bluetooth modules are used as data inputs in this system. Servo motors, DC motors, buzzers, and LEDs are used as output modes. There are two modes of control for this Fire robot: Auto and Manual. In manual mode Robots are controlled using Bluetooth modules, which provide commands for both pump motor and robot control. Android apps using Bluetooth provide current sensor data. When a fire or smoke is detected in the auto mode, a servo motor scans the area using a smoke and fire sensor. The robot then puts out the fire. When the ultrasonic sensor detects an obstacle, it attempts to avoid it by making the appropriate judgment. Motor Driver IC L298 controls every aspect of movement control, including turning on the spray motor and controlling its direction via a servo motor. Additionally, a voltage sensor is used to alert the user when the battery is about to discharge. To access live video, utilize the Data access app on the V380 IP Camera.

Pins A0 and A1 on the Arduino are connected to the Bluetooth module HC05, which is used to communicate with the Arduino over a serial communication protocol. The fire sensor is linked to pin A2, which provides a low- or high-logic input to the microcontroller indicating whether or not a fire is detected. The purpose of the water level sensor, which connects to pin A3, is to determine whether water is present in the tank. It is a digital sensor that outputs a logic high or low. ADC value from 0 to 1023, with 10bit ADC for setting 12volt battery level to 5volt DC as input, is provided to the microcontroller via pin A4, which is used for the battery level monitor.

Pin 00 turns the motor off, and Pins 4 and 5 turn the motor clockwise, while Pin 10 turns the motor anticlockwise. The motor driver is connected to pins 4,5, 6, and 7, which are used to regulate the left and right motor directions. The motor control command that is supplied to my microcontroller in either manual or automatic mode also applies to the other motor. The DC water pump motor is attached to pin 3, and it only turns on when a fire is detected or when the user manually controls it through an Android app. Buzzer attached to pin 8 that activates in response to fire, low battery, and water level. It is controlled by Arduino pin low, which activates the buzzer, and pin high, which activates it for one hour. The same red and green LED's that connect to pins 12 and 13 for normal and warning processes also function.

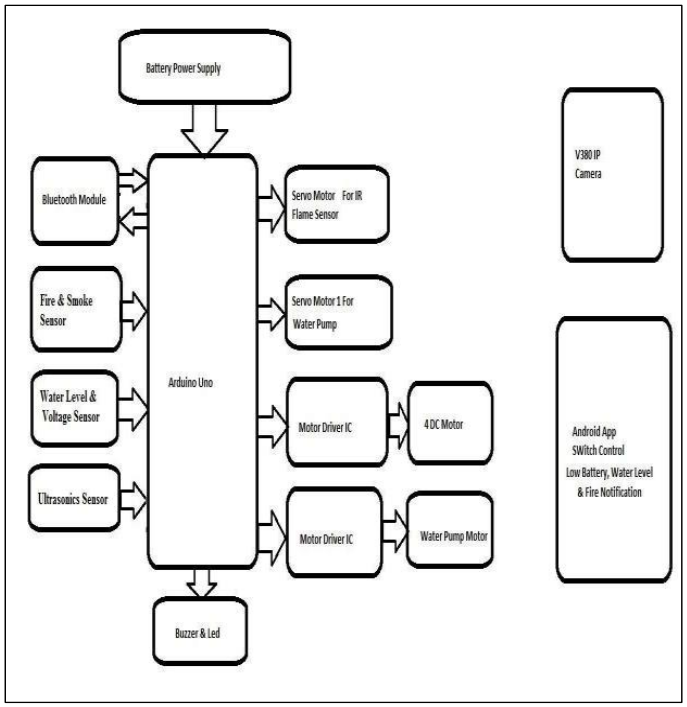

Fig 1- System Architecture

4. HARDWARE COMPONENTS

Following are the components that will be used for the main operation of the system:

Arduino UNO:

The Arduino UNO, which is based on the ATmega328P, is the primary processor of the system that is in use. It receives inputs according to the mode in which the car has been operating—manual or automatic. The inputs are processed to provide the right output to fulfill a specific goal.

IR Flame sensor:

A tiny electronics device known as a flame or fire sensor module is capable of detecting powerful light sources, including fires. In essence, this sensor picks up infrared (IR) light, which is released by a fire flame or other light source and has a wavelength between 760 and 1100 nm.

Smoke sensor:

The MQ6, sometimes referred to as the Gas sensor, is a sensor that detects smoke in the air and notifies the user of its presence. The gas modifies the resistance across the circuit and provides a reading after the sensing material in the sensor ionizes any gases that come into contact with it.

Servo motor:

A feedback signal corresponding to the load's current position is provided by the position sensor. Usually, this sensor is a potentiometer, which uses a gear mechanism to generate the voltage equal to the motor shaft's absolute angle. After then, the error amplifier's input is subject to the feedback voltage value.

Motor Driver module and DC motor:

The car's wheels will be adjusted using a DC motor and a motor drier IC as needed. It will function in accordance with the instructions that it receives. A motor driver functions as a mediator between the microcontroller and the motor.

Water pump motor:

Small submersible water pumps are typically used in residential settings, and because of their weight and size, smaller DC motors are typically used in conjunction with them. They are made to force water upward through the top of the roof and are typically located at the bottom of water tanks.

Water float sensor:

It serves as a warning to the user regarding the tank's water level. It functions by sending an electrical signal to activate a water level alarm through the opening and closing of dry contacts.

Bluetooth Module:

We have chosen Bluetooth technology to facilitate communication between the software program and the system since it is simple to use, inexpensive, and reliable. It facilitates communication between the Arduino UNO and software applications.

Camera:

The environment within the system must be continuously monitored, regardless of whether the system is in manual or automatic mode. The system uses a camera V380 to monitor its surroundings. The ability to see both day and night is this camera's specialty. It may also be shifted left, right, up, and down to observe the surroundings from all angles.

Buzzer and LED:

The user is notified when a fire, smoke, or obstruction is detected through the activation of both the 5V LED and buzzer.

5. ARDUINO PROGRAMMING

The TimerOne library is included at the beginning of the code. In the Arduino environment, timer configuration and manipulation functions are provided by the TimerOne library. The interrupt function Sec_1() is created using the TimerOne package. The Sec_1() function reads sensor

readings, prints them to the serial monitor, and sends sensor values via serial connection to a remote device. It is called once per second. The servo motor's position is managed by the Servo library.

Subsequently, the code lists several pin numbers for diverse functions, including buzzer, LEDs, fire, smoke, ultrasonic, battery input, water level sensing, motor control, and pump control. In order to save the data that is received from the serial connection, the code additionally establishes a string variable named inputString. When the string is complete, it is indicated by a boolean variable named stringComplete.

The code initializes several variables, including pins for sensors and motors. These variables are used throughout the program to interact with the robot's hardware.

The serial port and the sensor and motor pins are initialized by the setup function. Additionally, it establishes the servo motors' starting positions. The servo motors are connected to the appropriate pins and all pin modes are initialized by the setup() method. To show that the robot has started, the code prints a message on the serial monitor.

The data is read from the serial port by the loop() method, which then puts it in the inputString variable. After the string is finished, the code verifies the data's correctness and, if it is, sets the Valid_Data variable to 1. After verifying the input data, the algorithm acts accordingly based on the input. For instance, the robot mode is set to auto mode if the input data is *A#>, and to manual mode if the input data is *M#>.

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The code verifies the input data for pump and motor control if the robot mode is manual. The input data indicates whether the robot is stopped, moves forward, turns left or right, stops all actions if the input data is *o#>, turns left or right, turns left if the input data is *l#>, turns right, or turns on the pump if the input data is *P#>. The pump is turned off if the input data is *p#>.

6. RESULTS

Our system is designed to put out a fire in the event of an emergency and to assist firefighters in performing their duties when they become hazardous or challenging. While the majority of systems were designed to operate in either automatic or manual mode. Both manual and auto mode options are available in our designed system. The user may choose whichever option best suits their needs at the time. The switch provided in the system-developed mobile application can be used to select this operation.

When in Auto mode, the car operates without the need for human input. With the assistance of fire sensors positioned in the front and rear of the car, it advances autonomously and stops when a fire is detected. The buzzer and LED on the car alert people to the fire. Typically, the pipe rotates 180 degrees to sprinkle water until the fire is extinguished when a fire is detected at the front. It is possible for the vehicle to detect a fire from the back, in which case it will turn 180 degrees and put out the fire directly.

When an obstruction is detected, the LED and buzzer alert the user to the presence of the obstacle. When this occurs, the car stops moving. The ultrasonic sensor turns to detect the distance to the right and left, respectively, and compares the two readings to determine which way to go to travel the farthest. When the two measured distances are similar, the car moves a little backward before measuring the two distances once more and making the appropriate moves.

The operation is carried out by the vehicle without the need for human assistance. With the assistance of fire sensors positioned in the front and rear of the car, it advances autonomously and stops when a fire is detected. The buzzer and LED on the car alert people to the fire. Typically, the pipe rotates 180 degrees to sprinkle water until the fire is extinguished when a fire

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Fig. 2 Side View

Fig. 3 Front View

7. CONCLUSION

The project focused on automatic fire extinguisher systems that represents a significant advancement in supporting fire safety procedures by combining cutting edge technology, interdisciplinary cooperation, and unwavering research efforts. The thorough analysis of state-of-the-art developments in suppression agents, sensor technology, data analytics, and system integration reveals the revolutionary potential that these systems hold to reduce fire risks and strengthen the safety of people and property. Automatic fire extinguisher systems have the potential to provide previously unheard-of levels of accuracy, effectiveness, and flexibility in the fire detection, suppression, and management domains through the clever application of cutting-edge technologies like as artificial intelligence, the Internet of Things, and edge computing.

Furthermore, continued research initiatives that target system resilience, environmental issues, and regulatory compliance highlight a strong dedication to the continuous improvement and sustainability of fire safety engineering techniques. The project on automatic fire extinguisher systems is a symbol of progress as we look to the future, one in which communities will flourish with unwavering confidence and built environments will thrive with heightened resilience, and fire-related risks will be minimized.

8. FUTURE WORK

In the upcoming years, artificial intelligence and machine learning will be used to further advance the field of robotics. They can be designed to be able to recognize fire, navigate dangerous settings, and take the proper action when necessary. These are a few of the developments that can be applied to the construction of an intelligent firefighting robot. The majority of Arduino firefighting robots are now controlled remotely. Future advancements in robotics and artificial intelligence, however, might make it possible for these robots to function independently, increasing their efficiency and lowering the need for human interaction.

More sophisticated fire detection and suppression technology, including laser-based fire detection or sophisticated fire suppression chemicals, may be incorporated into future fire-fighting robots. In the future, greater fires and a wider area may be tackled by a team of firefighting robots. In dangerous locations where it might not be safe for people to enter, like chemical industries, oil refineries, or nuclear sites, fire-fighting robots can be deployed. The current systems simply use cameras to monitor their environment and make decisions based on human judgment. Technological advancements such as the use of machine learning in human detection can save the lives of individuals stranded at accident scenes.

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