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Autonomous Fire Detector and Extinguisher Robot

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ABSTRACT A fire outbreak is a risky behavior that has many negative effects and causes fatalities. Early fire detection and suppression can help avert a number of accidents and hazards. We have relied on nature and human resources thus far. This frequently puts both human life and financial resources at danger. Fire safety therefore becomes crucial in order to protect lives and valuable assets. This work proposes and designs a fire detection and extinguishing robot that can detect the location of a fire and put it out using a water sprinkler system mounted to the robot by activating a pump. To detect fires accurately, this robot employs a number of flame sensors. This suggested design for a fire detector and extinguishing robot uses an Arduino or Node MCU to detect the existence of fire and extinguish it automatically at the initial stage without any risk to humans. When it finds any sign of flame, it will immediately activate the pump, determine the precise location of the fire, and manage the movement of the robot using gearmotors and a motor driver. This particular model of robot contains a water ejector that can spray water during the earliest stage of a fire outbreak. Using a servo motor, the water ouster pipe can be moved in the desired position. An Arduino UNO or node MCU micro controller is used to manage the entire procedure.

KEYWORDS Flame sensor; Motor driver; Node MCU/Arduino UNO; water pump.

I. INTRODUCTION

The loss of life while trying to save the life of another is one of the most significant factors in fire hazards. Because of explosive substances, electric circuits, fumes, and high temperatures that pose a risk to human life, it is occasionally impossible for firefighters and other employees to reach the scene of a flame. Unusual things can be avoided with a quick, immediate response to the flame. The statistics show that fires can occur at the home level much more frequently, leading to the deaths of several innocent people and the destruction of significant financial resources. Once it gets past the initial stage, fire can also erupt at the industrial level and do very large damage to the commodities and resources, making it very challenging to control. A typical spark has the ability to ignite a large flame and wreak enormous damage [1]. Poor fire management systems not only put the life of an industrial workers but also the life of domestic workers in danger; this is mostly because of pricy firefighting equipment. Every month, a number of lives can be lost to fire, and countless others can suffer lifelong injuries. However, it can be readily avoided by employing the right fire control methods. Fire-fighting robots are made for these kinds of environments. To eliminate the risk of fire and the loss of human lives from hazardous and lethal employment, several robots are proposed and created today [2]- [6].

Robotics usage is on the rise in modern society. It is relatively simple to use and safely replaces humans in dangerous or intense tasks. Based on IOT technology, a fire detector and extinguishing robot is created. In Fire detector and Extinguisher robot, we want to create a model that can put out a tiny fire by sensing the area and moving toward it. With the use of smoke and flame sensors, it will automatically detect the fire [7]. The built-in fire extinguishing system, which comprises of a water tank and pump, is used to put out the flame once it has located the right location of the flame. It employs a number of flame sensors and smoke sensors for fire detection. The first flame sensor is for the right, the second is for the backward direction, and the third and fourth are for the left and forward direction, respectively. When a fire is detected within the system's range, the fire extinguishing system will activate. The water pump will then begin ejecting water when it senses flame when it reaches the breakout point. The fundamental function of this system is to offer fire safety and surveillance so that catastrophic fire accidents can be avoided or addressed promptly, minimizing the danger of human casualties [8]- [11]

The study focuses on adaptable fire detectors and extinguishers that operate in response to heat or smoke detected by a smoke and fire sensor and that disperse a fire suppression system over a fire source using a pump nozzle. There have been various models proposed using servo motors and self-activating fire extinguishers, however the majority of these earlier designs have often been either very expensive or inefficient. Therefore, the current innovation of a novel, cost-

effective self-activating fire extinguisher design meets all the requirements of such a system while minimizing the shortcomings of a previously offered design [12]

Above figures shows how the small spark can cause the hazardous and tremendous disaster. The figure shows the how dangerous it can be if it can't be treated at the earlier stages the fig 3 shows the several reasons that cause fire. With the development of robotic applications, certain activities may call for swift and effective action, and one of these is putting out a fire [13]. A system as a robot is a multifunctional manipulator that can be programmed or calibrated to move objects such as materials, tools, or special gadgets through changeable calibrated motions. It can also be referred to as an automatic device that mimics human behavior. This system is the study is an automatic fire detector and extinguisher, which uses various sensors, including a flame sensor, a smoke sensor, and others, to sense and put out fires [14].

II. LITERATURE REVIEW

This chapter discusses a study on an earlier project that was based on a firefighter robot thesis. The entire undertaking has been researched and evaluated. Robots are machines that resemble humans and carry out a variety of difficult activities. Let's now take a close look at current firefighting robots. A virtual adaption of the competition robot that competed in the 2006 PANITIA KONTES Robot CERDAS is the Virtual Reality Simulation of Fire Fighting Robot [15]- [16] . The "Virtual Reality Toolbox" plug-in was used to create this system in MATLAB/Simulink. It is designed to test controlling algorithms from their very beginning. It's vital to note that the low level of formalization of the environment means that not even the robot itself has sufficient functionality. Only one fire source is meant and there are auxiliary marks on the ground, that mean for example room corners. POKEY the Fire-Extinguisher Robot is the fire-extinguisher robot, that made its way through several competitions, and became more "remarkable" than other models. The employed equipment is described in depth, along with the fundamental operational procedures. Robots operate in buildings, thus they are outfitted with the appropriate sensors [17]. For instance, a line sensor might not be effective in a dense smoke environment. The use of two different types of fire sensors and the use of sophisticated firefighting equipment are the key benefits of robots; the main drawbacks are the narrow working range of the sensors. The fire could only be detected at a distance of 1.5 meters; at greater distances the sensors perform poorly, according to the developers, who also lament the onboard computer's low efficiency, which can only handle basic operations without extension or complexity, as well as the lack of optical means of environment perception. Robots are organized in a more complicated way than the one in the example above, and they are designed to do a wider range of jobs. The key benefits of the system are the adoption of more complicated fire detection algorithms. Utilizing a sound sensor to activate. the existence of certain more navigational sensors [18]. Lack of a home-return algorithm, a low-power chassis, a lack of mapping, and a low-efficiency computer are the key drawbacks. Fire-Extinguisher Robot is a Trinity College of America project that was only at the early stage in 2008. It was intended for this robot to operate alone for a maximum of 15 minutes before returning to the supply station. This method is among the finest for battling fires in residential and non-industrial buildings. The biggest drawbacks include: low supply of water; short working hours.

III. FORMULATION OF PROBLEM

One of the risky and volatile issues that can result in significant loss of both resources and life is fire. Sometimes explosives like LPG cylinders, smoke, and high temperatures make it impossible for firefighters to reach and control the fire's location. They run the danger of dying in these scenarios. Firefighting robots can be effective in these situations since human lives are not at danger. IOT technology based this fire detector and extinguisher robot. We want to create a model in Fire Detector and Extinguishing Robot that could put out a tiny flame by detecting it and going to the location on its own. Firefighters' arrival delays can have a variety of effects, and they can also occasionally be the result of their own hectic schedules. The fire-extinguishing robot continually scans the surroundings and puts out fires as soon as they reach their earliest, most manageable stages [19].

IV. RELATED WORK

1) A fire fighting and extinguisher robot prototype was created by Tawfiqur Rakib and M. A. Rashid Sarkar. It consists of a base platform with LM35 sensors for temperature and fire detector, fire sensors to detect the flame, and a water container with a capacity of 0.5 to 1.5 liters that is made of sturdy cardboard or acrylic sheet, making it accurate and water resistant. For movement, the robot has four wheels.
2) A prototype provided by Saravanan P., Soni-Ishawarya employs the Atmega2560 microcontroller and divides the robot into three basic systems based on their respective functions: movement system, fire detecting system, and extinguishing system. Each system completes its function in order to get the intended result of putting out fire. With the aid of four IR(flame sensor) and ultrasonic sensors, the moving portion is employed for the robot's mobility and obstacle avoidance. The flame detection system uses temperature, smoke, and LDR sensors to detect fire. The fire is put out by the extinguishing device using a water tank and a BLDC motor. Additionally, the robot has a Bluetooth module that connects to smartphones so that it can navigate.
3) An android-controlled fire detecting and extinguishing robot is provided by S. Jakthi Priyanka R. Sangeetha using an Arduino UNO. The robot has a gas sensor to detect fires, a gear motor and motor driver to move the system, a Bluetooth module to link the system to an Android device, and a android control module. This system also makes use of a water system. An open-

source programme called Arduino IDE is needed to programme and execute instructions for the Arduino UNO.

4) A fire detecting and extinguishing robot developed by Nagesh MS, Deepika TV, Stafford Michahial's, and Dr. M. Shivakumar uses DTMF (Dual Tone Multi Frequency Tones) technology to locate itself and a fire sensor that can detect flames at wavelengths between 750 and 1050 nm with a range of sensitivity between 12 cm and 1.4 ft.
5) An Arduino-based fire detector and extinguisher robot created by Sushrut Khajuria, Rakesh Johar, and Varenyam Sharma features RFbased remote control to control the robot and water system. Additionally, the robot can be manually operated within a 7 meter radius. A wireless camera and water system are also included, enabling users to control the robot in the desired directions and put out fires.
6) A robot for avoiding obstacles called the Amphibious Autonomous Vehicle was created by Khaled Sailan, Prof. Dr. Ing. Klaus-Dieter Kuhnert, and Simon Hardt. This robot uses a joystick to instantly avoid both static and moving obstacles. Its primary goal is to move the robot along its course while avoiding any obstacle in its way.
7) A notification-equipped autonomous firefighting 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 give the user a warning notice when it senses fire.
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V. OVERVIEW OF THE SYSTEM

Below figure shows the block diagram of the system. Node MCU is used as a microcontroller that takes data from several sensors used in the system, it tracks and drives DC motors on the track. Smoke and fire sensors are used to detect fire hazard and smoke it sense the temperature increase in surrounding. It can also be used to connect the system through the mobile with the help of Bluetooth module through which it can send data of the fire on user's mobile. Extinguisher system is used to spray water or any other chemical composition. Towards the source of fire to extinguish it. Bluetooth module and buzzer gives notification to aware the people about fire [20].

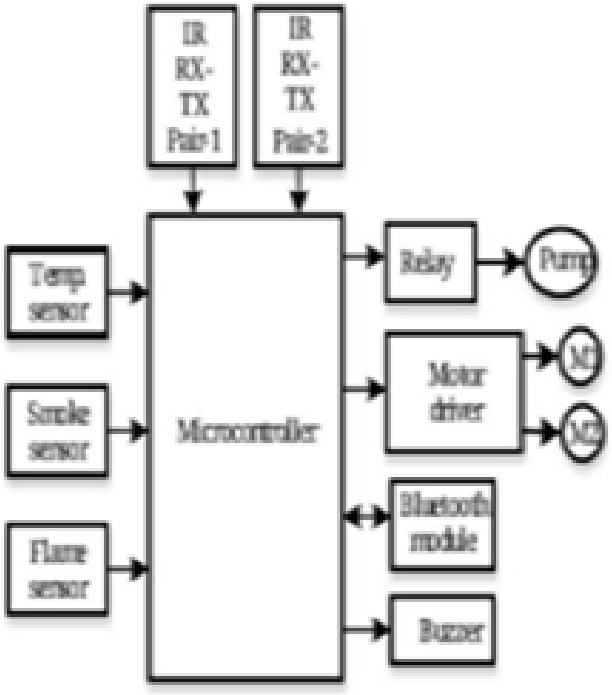

FIGURE 1: Block diagram of the system used.

VI. APPROACH OF THE SYSTEM

Methodology or approach of the system is described in this section of the fire detector and extinguisher system. The initial phase of robot involves data reception from different sensors of the system like fire/flame sensors, smoke sensors, proximity/ultrasonic sensors, the second phase is to send the data from the sensors to the driving pump through controller and the final phase completes the circuit of the system. The diagrams are given below in the section.

VII. CONSTRUCTION AND DESIGN

VIII. IMPLEMENTED BLOCK DIAGRAM

A. DIFFERENT COMPONENTS USED

1) Arduino UNO / Node MCU

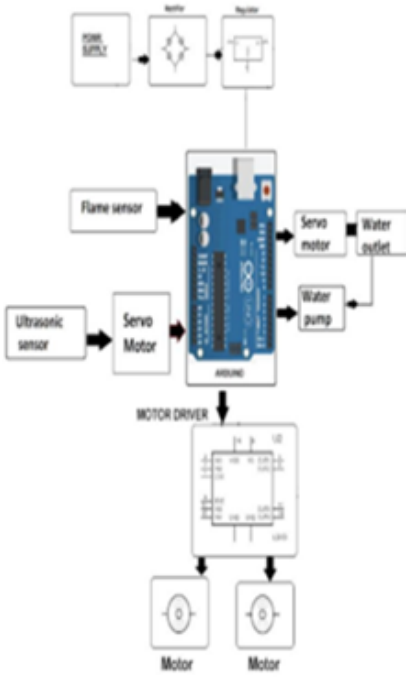

FIGURE 2: Elaborative Block diagram of the system used

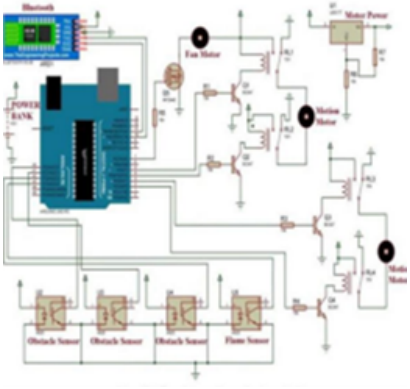

FIGURE 3: Circuit diagram of the system used

2) Driver Motors
3) Servo Motor
4) Flame Sensors
5) Smoke Sensors
6) Connecting wires
7) Ultrasonic Sensor
8) Water Tank
9) Water Pump

IX. PROPOSED WORK

1) Motivation to use Autonomous Fire Detector and Extinguisher Robot
2) System optimization - System should be accurate, cost saving and respond quickly to the fire and the range must cover the entire area to avoid human errors.

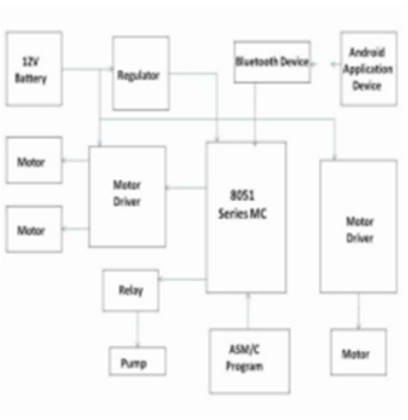

FIGURE 4: Circuit diagram of the system used

3) Reduced cost - cost of the system should be minimum so that everyone can afford the system and take the benefits.
4) System Advancement - The system uses several flame and smoke sensors which should provide the more accurate results as compares to previous systems. We can also implement the Bluetooth Module through which it can be connected to your mobile phone and send the update and notifications on the mobile and if the level of fire is exceeding the system can send the notifications to the firefighting department. The objective of the project is to reduce the cost to the minimum level and provide the maximum output.

X. CONCLUSION

The Fire Detector and Extinguishing Robot prototype model helps to lighten the load on fire fighters during the extinguishing duty. The primary objective of our suggested design is to create a real-time fire detection and extinguisher robot that moves at a steady pace, locates the precise location of the fire, and extinguishes it using water and chemicals via a pumping mechanism. The system's fundamental hardware components, which include the components mentioned above as well as many more, were used to aid in the detection and extinguishing. The first step in fire detection is the use of flame sensors. Second, to move the robot and get close to the fire, wheels and motors are combined. The robot finally puts out the fire with the help of a water pump, a servo motor that rotates the pump's direction, and a water pump that sprays water into the flames through a water tank [21].

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