Fire Detection and Water Discharge Activity for Fire Fighting Robots using IoT

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Abstract — A fire is a calamity that can result in the loss of life, property damage, and the victim’s lasting incapacity. Our obstacle remover and fireman Robot has been declared. In the case of a fire, we are compelled to employ human resources, which are not safe, to rescue people and put out the fire. With the advent of technology, particularly in robotics, it is now possible to respond quickly to fire locations and combat fires. This would increase firefighter efficiency while simultaneously preventing them from putting their lives in danger. In this project, we created a prototype robot using Arduino that detects and extinguishes fires autonomously. When the flame sensor detects a fire, the water pump and servo motor are activated. The capacity to detect fire sites automatically and extinguish fire remotely at a distance of 20 cm from the fire. The robot is designed to locate fires and spray water into them in order to decrease the amount of damage.

Keywords — Arduino Uno, Fire fighter robot, IoT, Microcontroller, Sensor.

I. INTRODUCTION

Due to the vast diversity of fire occurrences, including fires affecting structures, vehicles, aircrafts, ships, and wild areas, a number of robotic devices are being developed to assist firefighters. We employed these robots to detect and extinguish fires using several sensors. Because firefighters are constantly exposed to risky situations in order to save lives, the use of robotic systems in firefighting is becoming more researched. A robotic system is a mechanical device that accomplishes a job by sensing its surroundings and controlling the robot using computer programming.

Robots have been demonstrated to be effective in medical, rehabilitation, rescue operations, and industry in several studies. Robotics has been used in a variety of sectors over the years. Industrial robots are multi-function manipulators that use multiple programming motions to accomplish various jobs on more specific materials, divisions, gadgets, or equipment. According to the Fourth Industrial Revolution (4IR), there is a need for a single system that can operate, communicate, and integrate several robots of various sorts and specifications. Machine learning has sparked interest in robotics, however only a small fraction of recent robotics advancement can be attributed to it. Machine learning algorithms have been implemented in a recent robotic development effort to boost the intelligence of robots [1].

The primary distinction is that the robot provides feedback via video, sound, and other data. As a result, tele-presence robots are extensively utilized in many industries that need monitoring capacity, such as childcare and education, as well as enhancing the social and everyday activities of elderly adults. A mobile robot is meant to move and do activities without the assistance of humans. In contrast to android robots, which are designed to resemble humans, autonomous robots can complete tasks autonomously and get power from the environment. Furthermore, the robot's tiny size and autonomous control enable it to be employed in small and tight locations with dangerous situations, such as tunnels or nuclear power facilities, where fires occur. Termite and Fire Rob are two modern firefighting robots that have seen extensive application in industry [2].

Using a teleoperated robot at a fire station, Yoshihiro Tamura and his colleagues compared the cognitive ability of ten firemen (five novices and five specialists) in attenuating the leaking flammable gas, the latter of the two jobs. Experts were more multifarious in their judgment of flammable gas attenuation than novices, according to the results of the trial [3]. Nivennesh A/L Sathiabalan and his colleagues created a paper that aims to investigate the function of an intelligent robotics system in gathering and analyzing early data from fire events. Initial findings from this ongoing experiment suggest that having a constantly updated map of interior circumstances increases route planning accuracy and, perhaps, workers' ability to reach victims and stabilize the structure more quickly [4]. Natalie Friedman and his colleagues discussed functional needs for robot clothing, as well as considerations and parameters for robot clothing designers and essential reference examples for robots in clothing. Then we talk about what robot clothing can do for the realm of interactive system design in particular [5]. The first technique created by Ned Barker and his colleagues is analytical, including the establishment of three "filters" to understand the complexity of the social and sensory dynamics of touch in situ while tracking scattered mediating impacts of

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modern technology introduction. The second is empirical, looking for patterns in touch’s sociosensorial dynamics that connect with gender, race, and class and are related to touch’s technological mediation [6].

The major goal of this project is to create an obstacle-removal firefighting robot that can reduce fatalities as much as possible. Our primary aim was to develop and build an electromechanical robot capable of locating and extinguishing a flame. So, there are certain pressing goals for this project, such as ensuring safe operation and starting the water pump if a fire is detected by the sensor robot.

The goal of this project is to design and build an obstacle remover and firefighting robot system that uses an Arduino mega unit with flame sensor, a motor driver (L293D) module with water pump and servo motor capabilities, and an Arduino mega unit with flame sensor [7]-[10].

II. FIRE INCIDENTS IN BANGLADESH

In the previous ten years, at least 16,000 fires have occurred in Bangladesh; the number of fires has grown more than thrice across the nation since 1997, with a daily average of 53 in 2018. According to the online database Data complete, over 250,000 fires occurred in the nation between January 1, 1997 and December 31, 2018, according to Fire Service and Civil Defense figures. The nation suffered a financial loss of roughly Tk6,400 crore as a result of the flames. According to available fire department data, at least 1,970 persons were died in nearly 200,000 fires across the country between 2004 and 2018.

Prior to incident, a major fire erupted in ancient Dhaka's Chawkbazar in February, causing widespread devastation. It also includes the installation of a fire extinguisher machine or any other alternative arrangement at a visible location throughout the structure, as well as fire alarms as a warning to evacuate.

The Fire Prevention and Extinction Act of 2003 is reinforced by the Fire Prevention and Extinction Rules of 2014, which provide that the building's owner must apply for an occupancy certificate at the completion of construction (Rule 22). These allow the authority to inspect the building and determine if the owner complied with all of the building code's criteria for public safety. If an owner fails to include these essential safety features in the building's structural design, his application will be denied, yet they manage to acquire permission and move forward. In response to a writ case filed in 2010, Bangladesh's High Court Division [17]-[19].

III. METHODOLOGY

A robot that executes behaviors or tasks with a high degree of autonomy is known as an autonomous robot (without external influence). Artificial intelligence, robotics, and information engineering are all considered subfields of autonomous robotics. Learn more about the environment. Work without human involvement over a lengthy period of time Move all or part of oneself within its operational area without human aid Until it is part of its design standards, avoid scenarios that are detrimental to people, property, or itself. An autonomous robot may also learn and develop new skills, such as adjusting for new ways to do tasks or adapting to changing environments [20].
To locate the source of a fire, an obstacle remover and firefighting robot has been designed. Using a flame sensor, the robot can eliminate obstacles and locate the position. The flame sensor is working to detect the presence of fire. Sensors are linked to an Arduino Mega, which controls the DC motor's movement. The DC motor will come to a halt 20 cm from the fire when the flame sensor detects it. The water pump and servo motor begin working automatically after that, and the fire is extinguished [21].

When an ultrasonic sonar sensor detects an item and a flame sensor detects a fire, the signal is sent to Arduino, who then sends it to a servo motor to remove the obstacle. If the obstacle does not move, the signal is sent to the motor driver, who then sends it to the left and right motors. Then, with the flame sensor in front of the fire, Arduino sends a signal to the servo motor and water pump.

Infrared heat radiation is released by suspected fires but not by infrared flame detectors. Other heat sources can obfuscate the fire, so to speak. All things with a temperature greater than the absolute minimum temperature (0 Kelvins or 273.15 °C) generate energy, and this heat is already a problem for the most sensitive infrared flame detectors at ambient temperature (300 K).

The HC-SR04 Ultrasonic sensor is a four-pin module with the pin designations Vcc, Trigger, Echo, and Ground, as illustrated above. This sensor is widely utilized in a variety of applications that involve measuring distance or sensing things. The Ultrasonic transmitter and receiver are formed by two eye-like projections on the front of the module. The sensor is based on the elementary school formula:

\[
\text{Distance} = \text{Speed} + \text{Time} \quad (1)
\]
Servos are controlled by transmitting a variable-width electrical pulse across the control line, also known as pulse width modulation (PWM). There are three types of pulses: minimum, maximal, and repetition rate. A servo motor can only rotate 90 degrees in either direction for a total of 180 degrees. Water pumps are essential for supplying water from subterranean sources in houses, constructions, and contemporary plants. The specific methods they operate are determined by the concept of usage for which they are necessary. Because these pumps are used for a variety of purposes, there are a variety of types available today [25].

We may either link all of the given connections to upload the software and test its functionality, or we can completely construct both and then proceed with the connections. The connections are relatively straightforward in both directions, and you should be able to do it properly.

| TABLE I. COST ANALYSIS OF THIS SYSTEM |
|----------------------------------------|
| **SN** | **Components** | **Quantity** | **Price** |
| 01     | Arduino Mega   | 01           | 900/=     |
| 02     | Motor          | 04           | 1920/=    |
| 03     | Hex & Mount    | 04           | 1040/=    |
| 04     | Motor Driver   | 02           | 300/=     |
| 05     | Relay Module   | 01           | 120/=     |
| 06     | Water Pump     | 01           | 100/=     |
| 07     | Servo Motor    | 02           | 600/=     |
| 08     | Flame Sensor   | 03           | 380/=     |
| 09     | Sonar Sensor   | 01           | 100/=     |
| 10     | Wheel          | 04           | 546/=     |
| 11     | Buzzer         | 01           | 15/=      |
| 12     | Led            | 04           | 04/=      |
| 13     | Charger & Battery | 01   | 1450/=    |
| 14     | Others         |              | 640/=     |
|        | Total          |              | 8115/=    |

IV. HARDWARE SETUP

After the entire design was completed, it was put to the test to check if it met the design specifications for fire detection and spot water spraying. This prototype concept is focused to providing for fire protection while being safe. The whole robot chassis and equipment is hand-assembled.
The goal of the project is to get the robot to move about in the vicinity of a fire. If the fire is on the right side, the right flame sensor will detect the fire temperature and send a signal to the Arduino. The robot will then travel right by using the left side wheel of the motor. The water pump used quite a lot of battery juice. The robot is running fine, but we are having some sensor sensitivities issues; in this case, we increased the resistivity of the sensor, and the accuracy of fire detection improved following the modification.

This robot has several advantages and disadvantages, which we will discuss below. The benefits are listed below. It has the ability to extinguish a fire swiftly and safely. It is a saving procedure. It has the potential to save firefighters' lives. Quick reaction. The technology we employ is really low-cost. Below are some disadvantages. It is unable to save himself from a dangerous scenario. There is no firefighting robot with a monitoring system.

Fig. 12. Hardware Implementation of this work.

V. CONCLUSION

As a result, we will create a robot that will be utilized to clear obstacles and combat fires. This opens up a lot of possibilities for automation, and it will be valuable in locations where humans can’t or shouldn’t go. An autonomous firefighting robot with water spray has been created and executed in this work, as requested. The project's objectives were satisfied, as evidenced by the design and test results. As a result, as stated, this research has supplied an innovative solution to the shortcomings of standard firefighting robots. The sensor used in this design delivers rapid reaction and great sensitivity while monitoring fire temperature. In this project, we want to lessen the impact of fires, which generally start with a little flame, saving people’s lives and money. The robot is able to locate fire and reach it without colliding with any obstacles. It may be used as a large vehicle in the future, with steel covering, a large water tank, and a variety of supplementary sensors and equipment such as smoke sensors, GSM systems, and so on. People are unable to enter factories, but robots can quickly prevent fires, making them perfect for industrial safety applications. On the other hand, it is equally appropriate for a market, a hospital, or any other common location.

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