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Fire Extinguisher Robot

Mayank Jha, Badal Chauhan, Yagyesh Rai, Hasan Phudinawala

Student, Dept. Information technology, Niranjana Majithia college of commerce, Mumbai, India.
Student, Dept. Information technology, Niranjana Majithia college of commerce, Mumbai, India.
Student, Dept. Information technology, Niranjana Majithia college of commerce, Mumbai, India.
Assistant Professor, Dept. Of Information technology, Niranjana Majithia College of Commerce, Mumbai, India.

ABSTRACT: In today's modern, commercial, industrial and domestic world, Automation plays an important role, it is an arrangement of different elements in order to regulate, direct, sense, and command itself to achieve a desired result. Detecting fire and extinguishing the same is a dangerous job for a fire extinguisher on the field, it often risks the life of that person. This project aims are giving a technical solution to that problem, which will be helpful in future. A robot is a mechanical design that is able of carrying out series of actions automatically, especially once programmed by a computer. Our fire extinguisher robot is a Dual Tone Multi-Function (DTMF) controlled robot. This Automated mobile robot is controlled using a mobile phone through DTMF tones for its movement and reaching the fire. In our bot we have also introduced an extinguishing system consisting of a tank that is filled with water. The flame sensor detects the fire and gives us the further signal to the extinguishing units to trigger the pump to extinguish the fire. Keeping all above factors in mind the Robot is capable of being remotely controlled and live video streaming to the user i.e., we can see live the condition happening inside, whether it is worsened or alright.

KEYWORDS: DTMF (Dual Tone Multi-Function), Arduino UNO board (ATmega328P microcontroller), ThermostatTechnology, WIFI enabled Esp32 camera, Wireless navigation.

I. INTRODUCTION

Firefighting is an extremely difficult and dangerous task but still often is carried out by human operators, thus is putting human life, extremely valuable as it is, in a very precarious and vulnerable situation. Various numbers of researches have already been conducted to minimize the fire accidents and to reduce the demolition in fire accidents.

The fire security of the home, office, and building are important aspects of human life. Fire disasters may occur anytime, anyplace, anyhow and result in high losses of life and property. Every year we are losing important life and property which not only results to personal loss but in fact a social and mental loss. It was found that the mean FRI (Fire Risk Index) are 2.8 on a scale of 5.0 for the fire hazard condition, which indicates an extremely alarming condition. Due to that, Robots are designed to find a fire, before it rages out of control [5]. It is often referred that fire fighters cannot access the source of fire due to the damage happened to the building and very high temperature, or even due to the presence of explosive materials, and as we expect human life to be more valuable than a machine it is better to say that odds are very much towards it. With such limitations and high life risk in the handling of the fire, a technical breakthrough can help fighting the fire is necessary areas of our life.

Hence, it is highly recommended that the practice of routine and basic fire-fighting tasks to be replaced or at least be partially assisted by AFER (Automated Fire Extinguisher Robot). Our proposed robot is designed to work on its own or be controlled through a remote**.** A wireless robot can conduct successful work, allowing the robot to be operated from a distance through a remote. The firefighting robot is programmed to scan and extinguish fires in affected areas [8]. The main function of this bot is to be operated automatically as an unmanned vehicle or even be controlled manually in case of any malfunctions. This bot is developed to search and extinguish fire. The robotic vehicle is equipped with water tanks and a water pump that is operated by wireless communication device which can be controlled manually. By using such robots, fire identification and rescue activities can be done with higher security without placing fire fighters at high risk and dangerous conditions [8]. A robot can function by itself or be controlled from a distance, which means that firefighting and rescue activity could be executed without putting fire fighters' lives at risk by using robot technology instead.

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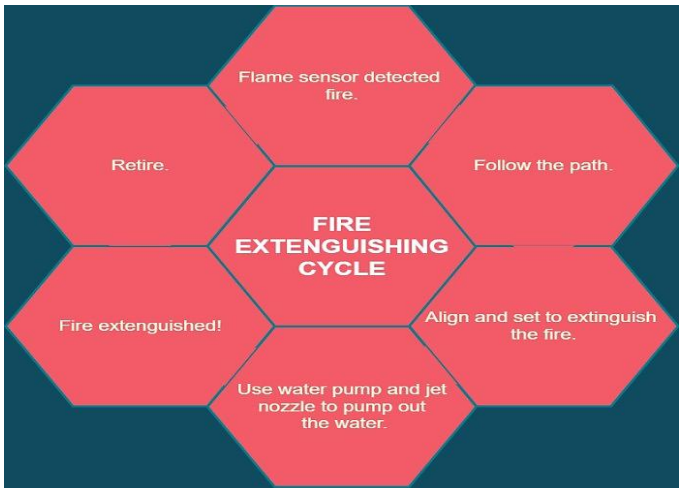

Fig no. 1 Fire Extinguish Cycle

II. RELATED WORK

In today's modern high-tech world there are variety of ideas of such robots that are in the market which can be used in hazardous situation, and be really helpful to Humankind with their advance technologies. These robots can also enhance and updated from particular time to time. Some works of such functioning robots are described in the following sections.

Jet Fighter is a type of Autonomous Fire Fighting Mobile Platform that is introduced by Tokyo Fire Department [1]. It can be operated and controlled by remote user and has the ability to extinguish flame after locating the source of fire. It is equipped with a monitoring system and operates through a wireless communication system [1]. It is equipped with an obstacles avoidance system embedded into its autonomous navigation system [1].

Furthermore, there is another type of portable Autonomous Fire Fighting Mobile Platform that is specifically designed to be thrown into the fire site to collect data and information, search for victims and evacuate them from the fire site [2]. It can be controlled by the operator and the victims are able to communicate with the operator by using the built-in microphone and speaker system during emergency cases [2]. Also, this system contains the camera to capture the scene of fire site, sensors for temperature measurement, CO2 and O2 concentration measurement [2]. Since it is specially designed to be thrown into the fire site, it can withstand with high temperature, over 15000 C, waterproofed and has impact resistance feature [2].

BEAR (Battlefield Extraction-Assist Robot) by Vecnarobotics is a type of rescuing robot built in form of a humanoid that can lift and carry victims for casualty extraction, unsafe building evacuation, and also searching and rescuing work. However, its cost is prohibitive [3].

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III. PROPOSED SYSTEM.

This section describes the methodology of developing the system. The very first step is to assemble and organize each and every component and we need to make sure all the components are connected to a power supply through an external device. The robot remains in an ideal state before it starts to move around the area and start detecting the presence of fire presence with the help of flame sensor. If the object is not within the range, it moves towards the object with the help of wireless remote control and then again checks the presence of object within range. The signal is sensed to the flame sensor and the ultrasonic sensor and then the command is passed on to the main circuit that yes, we are within the range.

After this process the Arduino Uno commands the motor drive to turn on the water pump through which we can easily extinguish the fire within our range. After the fire is extinguished, which we will be able to understand from the flame sensor and even the Camera on the front of the bot, the bot would retire and the process would be termed successful.

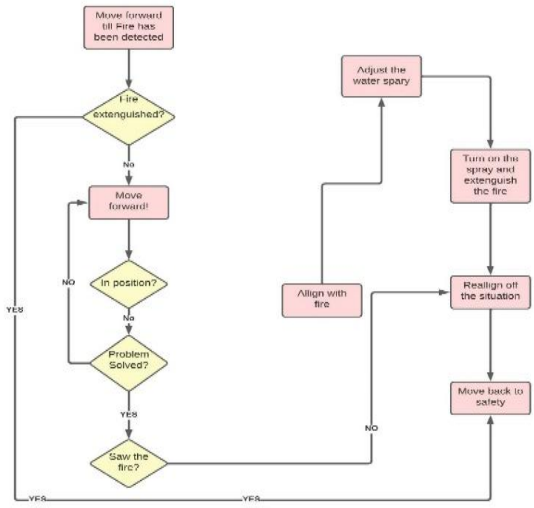

Fig no. 2 Working flowchart

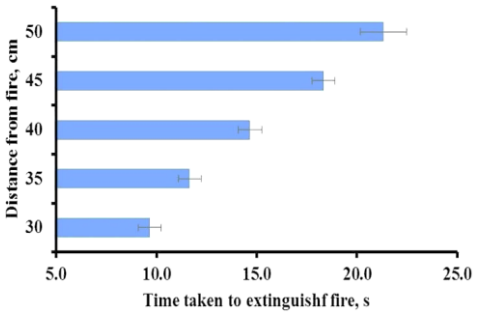

Fig no. 3 Distance-Time graph [10]

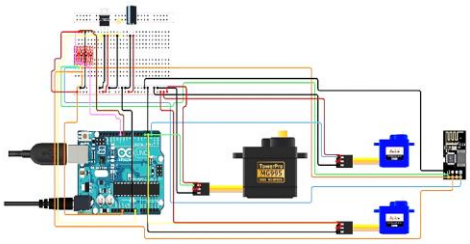

Fig no. 4 Arm circuit diagram

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IV. HARDWARE REQUIREMENTS.

Flame Sensors

In most firefighting robots, fire sensors perform an essential part in investigations, which are always used as robot eyes to angular or linear position and for specific velocity, and acceleration.

Mini Water Pump Motor

Small size Submersible Pump Motor which can be operated from a 2.5 ~ 6V power supply. Just connect pipe to the motor outlet, submerge the water pump motor in water and supply power to it.

ESP32 Camera

The ESP32-CAM is a small size, low power consumption camera module. It is a WIFI based camera that we can connect through IP address and can get the live footage of it.

Ultrasonic Sensor

This sensor will detect the object of their surroundings, and return the value back to Arduino for further action.

DC Motor

In a DC motor, the stator provides a rotating magnetic field that drives the armature to rotate. We would at least need 12v DC motor to drive the robot forward

Arduino UNOR3

A Microcontroller is a compact device with a processor, storage and configurable input/output devices on a single integrated circuit [11]. We'll be using the Arduino UNO board, which combines a microcontroller with all of the extras needed to quickly create and debug projects. The ATmega3288based UNO is a microcontroller board [11].

L293D Motor Driver

Motor drivers act as an interface between the motors and the control circuits [12]. Motor requires high amount of current whereas the controller circuit works on low current signals, So the function of motor drivers is to take a low- current control signal and then turn it into a higher- current signal that can drive a motor [12]. It can control 4 motors at a time.

Servo Motors

Servo motors are known, are electronic devices and rotary or linear actuators that rotate and push parts of a machine with precision. We would need 4 sg90 servo motors and 1 MG995 high torque servo motor for the base of the arm.

Jumper Wires

Jumper wires are simply connecting wiring that have connector pins at each end, allowing them to be used to connect two points to each other without soldering, we would be required to have all Male to male, male to Female, and Female to Female.

Breadboard

The breadboard has many holes into which circuit components like ICs and resistors, ESP32 camera can be inserted to upload the code.

Pipe

We would require the flexibly PVC water pipes for the outlet of the water tank through the motor.

Wires

Some connecting wires will be required to connect DC motors, motor driver, battery with each other.

Batteries

We would be needing 12v and at least a 5000 MAH battery to power the circuit.

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PVC pipes

Used to build the overall 3D model, PVC is comparatively cheaper and easier to get and it is also flexible to work with

Small Water Tank

Used to store small amount of water which happens to be at least 3 liters.

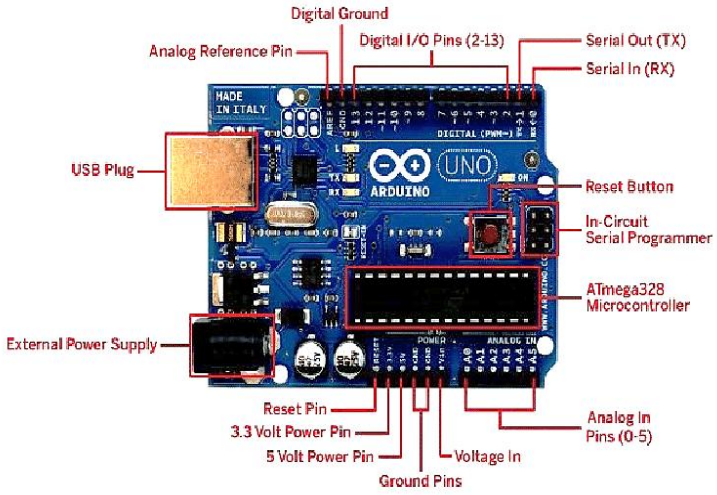

Fig No. 5 Arduino UnoR3 board [9]

L1	L2	L3	R1	R2	R3	Overall Movement
Forward	Forward	Forward	Forward	Forward	Forward	Forward
Forward	Forward	Forward	Stop	Stop	Stop	Turn right
Forward	Forward	Forward	Backward	Backward	Backward	Sharp turn right
Stop	Stop	Stop	Forward	Forward	Forward	Turn left
Backward	Backward	Backward	Forward	Forward	Forward	Sharp turn left
Backward	Backward	Backward	Backward	Backward	Backward	Backward
Stop	Stop	Stop	Stop	Stop	Stop	Stop

Fig no. 6 Table of movement

V. MODULE DIVISION

A *module* is a collection of source files and build settings that allow you to divide your project into discrete units of functionality [4], our modules of the projects are totally divided into 4 parts.

A. Manual Control Module

The Manual Control Module acts as the most important Central controller of all other Modules. It is formed to control all other functionality modules in the system. It lets the user control the Robot's direction. The controls consist of forward, backwards, Left turn and Right turn moments. In case of any malfunction of the Manual control module the Robot will Immediately and no harm will be done to robot or the surroundings and we will recover the robot safely.

B. Fire Detection Module

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This Module is probably the most important of all modules. This module will work with every other module and will let the robot be aware of the surroundings as it is important for the robot to detect the fire in order to extinguish it. The module when detects the fire will identify the intensity of the fire and will really the same to the next module. The intensity of can be determined by ESP32 camera and the fire can be detected by the flame sensor.

C. Fire Extinguishing Module

In this Module the Robot will work towards extinguishing the fire by using Water that would be stored in on board water tank using a water nozzle. The data collected from the previous module will help in this module to extinguish the fire. Once the fire is extinguished the module will stop working.

D. Live Footage Module

This Module lets us keep an eye on the on-going situations, the intensity of the fire, whether the fire has been extinguished and can also be used to detect the fire in order of the automated detection malfunction. We would use an ESP32 camera for the surveillance of the surroundings.

VI. FUTURE SCOPE

The firefighting robot will work with firefighters, which greatly reduce the danger of injury to Human lives and thus not putting it even in dangerous situations. It is an innovative work in the field of robotics that operates towards a sensible and obtainable access to save the lives and prevents the danger to property. In the present condition it can extinguish fire only in certain condition and ways and not in all the rooms. It can be extended to a real fire extinguisher by replacing the water carrying container by a carbon-di-oxide carrier and by making it to extinguish fires of all the room using microprogramming. Of course, the project has only just onto the scratched surface of various outcome possibilities. As in the design simplifications and the implementation of the constraints in suggest, our project is very much an advance proof-of-concept.

VII. CONCLUSION

The Arduino Uno based fire extinguisher robot is introduced in this paper. Since the robot is just a prototype it has some limitations. Experimental as well as theoretical results showed are very much evident an-d reliable proof that the robot is a credible instrument to be used to extinguish fire and result in saving various human lives. The minimalistic, simple and robust design of the robot allows for minimum maintenance work resulting in less capital investment post buying the robot and thus making it cost efficient. We design the fire detection system using sensors in the system, For minimum number of errors in the detection of fire. But still Efforts need to be made to encourage the use of firefighting robot by designing a low cost and good quality machine.

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