A NOVEL FIRE FIGHTING ROBOT WITH ARDUINO

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ABSTRACT: Fire incident is a disaster that can potentially cause the loss of life, property damage and permanent disability to the affected victim. Firefighting is a momentous and perilous job. The fire has to rapidly & safely extinguish by a firefighter to prevent more damage and destruction. Fire detection and extinguishment are the hazardous job that invariably put the life of a fire fighter in danger. One of the most efficient tools for early extinguishing of fire is fire fighter robot. In most of the Industries fire sensing is very essential to prevent heavy losses. Robots with this type of embedded systems can save life of Engineers in industrial sites with dangerous conditions. It is desirable to design a robot that can detect fire and extinguish the fire as quickly as possible. In this work, a novel fire fighting robot with Arduino is presented. A novel Firefighting robot is designed and built with an embedded system. In this system, the fire detection system is designed using Two flame sensors in the Fire Sensing and Extinguishing Robot, and program for fire detection and extinguishing procedure using sensor-based method. The firefighting robot is designed using Arduino UNO, Flame Sensor, Water Dispenser and Bluetooth and Ultrasonic sensor as main components. This Robot can be moved Forward, Backward, Left and Right Direction using Bluetooth and Android based Application. This Robot stops on Detection of Obstacle and start again on clearance.

KEYWORDS: Fire-Fighter, Robot, Extinguishment, Robot, Arduino Uno, Sensors.

I. INTRODUCTION

Fire-Fighting is an extremely dangerous task but still often being carried out by human operators, thus putting human life, invaluable as it is, in a very precarious situation. In Industry oil and many other inflammable materials are used for production and other industrial purposes.

Under such conditions the chance of fire accidents are more. So a suitable protective measure to extinguish the fire in case of fire accidents within the workplace should be employed. The types of Fire that may occur in an industry can be classified as under: A: Class (Caused due to wood and wooden material) B:Class (Caused due to oil) C:Class (Caused due to fuel stored in tanks). In industry, the unfinished metal products are ground polished in the grinding section. More chances are there for the occurrences of fire accidents in the section, due to the fire sparkles produced while grinding of metals, especially when the temperature of the sparkles exceeds $87^{O}C$. The cables used in the electrical section also cause more dangerous fire due to the faults in the cables or in the power line.

When a fire hazard takes place inside the industry, the heat and temperature gradually increase and reach a peak which is very high enough to cause a severe damage. It is also dangerous for human beings to go near such a high temperature. The harmful gases such as carbon dioxide and carbon monoxide have tendency to affect even a healthy man. Under such circumstances robot can be used in a better manner to extinguish fire and to monitor the hazardous places.

Fire fighting and rescue activity are considered as very dangerous missions. Injured fire-fighters and civilians inside hazard buildings are risky to rescue and evacuate. Sometimes, fire-fighters face serious challenges to get in the hazard building to extinguish fire, and locate the civilians, because in most cases, fire-

fighters do not have a prior knowledge about the hazard building infrastructure. Fire-fighters face serious risks on the job, where they face flames, heat, high level of CO or CO_2, and physical and mental stress, A large number of fire fighters have been injured during practicing their duties, including extinguishing fire, and rescuing civilians [6].

A lot of work has been done in the past regarding the construction of autonomous fire fighting robots with an aim to use them in undergraduate education and to motivate the student teams to participate in mobile robot design activities. Such activities allow students to practically apply and hence strengthen their concepts in mathematics, feedback control, computer programming, signals and systems and basic robotics courses [1].

Numerous studies have shown that robot can be beneficial in medicine, rehabilitation, rescue operation and industry. Over the years, robotics has been introduced in various industries. The industrial robots are multi-function manipulators designed for more specialized materials, divisions, gadgets or devices through various programmatic movements to perform various tasks [2].

Today robotics is one of the fastest growing engineering fields and they are designed to remove the human factor from labour and dangerous work. The use of robots is more common today than ever before and Fire extinguisher robot becomes essential to protect the human life. Robot is a device, which performs human task or behave like a human-being. It needs expertise skills and complex programming to design. For designing a fire fighter robot, many sensors and motors were used [4].

The robot can detect and extinguish a fire by its self. Fire Fighting is a very dangerous task and it involves working in a dangerous environment comprising of dense smoke, oxygen deficient atmosphere and elevated temperatures etc. Most of Fire Fighters suffer serious burn injuries, dense smoke obscures their vision [3].

There are several possibilities of fire in any remote area or in an industry. In worst cases scenario, fire causes heavy loses both financially and by taking lives, robotics is the best possible way to guard human lives, a fire-fighting robot is designed and built with an embedded system The use of robots is one of the alternative mediums for reducing fireman casualties and enhancing fireman capabilities. The robot is designed in such a way that it searches fire and tries to extinguish it.

Hence in this work, A Novel Fire Fighting Robot with Arduino is presented. The rest of the work is organized as follows: The section II discusses the literature survey. The section III demonstrates A Novel Fire Fighting Robot with Arduino. The section IV evaluates the result analysis of presented approach. The conclusion is provided in section V.

II. LITERATURE SURVEY

Pushpendra kumar,Saurabh Verma, Pradeep Kumar, Sandeep et. al., [5] describes Automatic Fire Fighting Robot. Automatic Fire Fighting Robot" project has a electric thermostat technology for controlling the fire 24hrs. This project is cost effective with a explore application which will show the best result. It can be use very much in Industrial, commercial and as well as domestic purposes. Synchronization of various equipment involve in the system i.e. Fire Sensor, Water Jet, Wireless Remote and GSM module, arduino Uno, camera. Robot is capable of being remotely and automatically controlled and live video status.

Dr.J. Subash Chandra Bose,Dr.Marzougui Mehrez,Dr.Ahmed Said Badawy,Dr.Wade Ghribi et. al., [7] presents Development and designing of fire fighter robotics using

cyber security. Cyber-security robot is used for this particular application. It can be done in four components: First, the PIC16F876A Microcontroller is used in this project, programmed and controlled all other circuits and components. Second 12V, 300 rpm rated DC motor is used to move the robot forward, reverse, left and right. Third components consist of two sensors: one is to detect smoke and alarm the circuit and the other is to detect the fire and alarm the circuit to trigger the pump. The given Fire extinguish approach is applied to a Southern Province cement company and Saudi Electricity Company. The results are analyzed using CRO. As well real time experiments.

Tawfiqur Rakib, M. A. Rashid Sarkar et. al., [8] presents Design and Fabrication of an Autonomous Fire Fighting Robot with Multisensor Fire Detection Using PID Controller. An arduino based simple algorithm is used for detection of fire and measurement of distance from fire source while the robot is on its way to extinguish fire. When the fire is detected and the robot is at a distance near to fire, a centrifugal pump is used to throw water for extinguishment purpose. A water spreader is used for effective extinguishing. It is seen that velocity of water is greatly reduced due to the use of water spreader.

S.Sridevi, G.Manikandan, J.Dhanasekar, P.Sengottuvel et. al., [9] presents Design of Fire Fighting Robot. The fire fighting robot is equipped with four thermistors/flame sensors that continuously monitor the temperature. If the temperature increases beyond the predetermined threshold value, buzzer sounds to intimate the occurrence of fire accident and a warning message is sent to the respective personnel in the industry and to nearby fire station with the GSM module provided to it. Fire Fighting Robot continuously monitors the temperature at four sensors and if fire accident is true, the robot moves to the direction to which the temperature is recorded to be the relatively maximum among the four sensors and extinguishes the fire with water pump provided to it.

Teh Nam Khoon, Patrick Sebastian,Abu Bakar Sayuti Saman et.al., [10] presents Autonomous Fire Fighting Mobile Platform. This paper describes the development of an Autonomous Fire Fighting Mobile Platform (AFFMP) that is equipped with the basic fighting equipment that can patrol through the hazardous site via a guiding track with the aim of early detection for fire. When the fire source is being identified, the flame is promptly extinguished using the fire extinguishing system that is mounted on its platform. The tasks for the AFFMP once it navigates out of the patrolling route include the obstacle avoidance, locating for more precise location of fire source using front flame sensor and extinguish the fire flame. To detect for fire source, the input from flame sensors were finely-tuned in relation to the surrounding area, external interference and the mobility of the AFFMP prior the deployment of the platform.

III. A NOVEL FIRE FIGHTING ROBOT

In this section, A Novel Fire Fighting Robot with Arduino is presented. The fire-fighting robot is utilized to control any disaster caused by fire instead of risking a fire fighter's life. This project is mainly composed of Arduino UNO, Flame sensors, Temperature sensors, Motor Driver, Motors, Servo Motor, Water Tank, Relay Module, Water pump, Water tank. The power supply is connected to Arduino UNO and the motor driver. Once the fire is detected the robot will approach the fire and extinguish it. The workflow diagram of presented approach is shown in Fig.1.
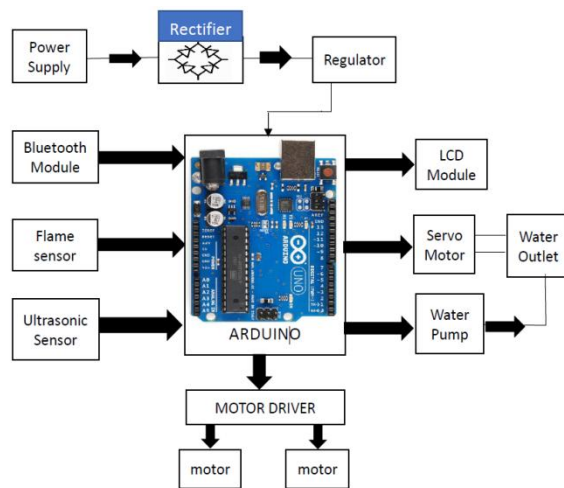
Fig. 1: Block Diagram of Novel Fire Fighting Robot with Arduino

This firefighting robotic system is powered by Arduino Uno development board it consists of the HC-SR04 ultra-sonic sensor for obstacles detection and it is also equipped with the fire flame sensor for detecting and approaching fire it also makes use of water tank and spray mechanism for extinguishing the fire. Water spraying nozzle is mounted on servo motor to cover maximum area. Water is pumped from the main water tank to the water nozzle with the help of water pump.

It consists of 12v transformer which is used to step down the 220v AC to 12v DC and also having rectifier which is used to convert AC supply to the DC. Regulator is used to divide the 12v and 5v supplies and they are given to the respective components. In the left side consists of inputs which are Bluetooth module, flame sensor, ultrasonic sensor. In the right side consists of outputs LCD module, servo motor, water pump, water outlet in between them having motor driver connected to two DC motors.

DHT11 sensor measures and provides humidity and temperature values serially over a single wire. It can measure relative humidity in percentage (20 to 90% RH) and temperature in degree Celsius in the range of 0 to 50°C. A flame-sensor is one kind of detector which is mainly designed for detecting as well as responding to the occurrence of a fire or flame. The flame detection response can depend on its fitting. It includes an alarm system, a natural gas line, propane & a fire suppression system. Flame detection distance, lighter flame test can be triggered within 0.8m, if the intensity of flame is high, the detection distance will be increased. The detection angle of the flame sensor module is about 60 degrees

HC-05 module is an easy-to-use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup. Serial port Bluetooth module is fully qualified Bluetooth V2.0+EDR (Enhanced Data Rate) 3Mbps Modulation with complete 2.4GHz radio transceiver and baseband. It uses CSR Blue core 04-External single chip Bluetooth system with CMOS technology.

Bluetooth is a short-range wireless technology standard that is used for exchanging data between fixed and mobile devices over short distances using UHF radio waves in the ISM bands, from 2.402 GHz to 2.48 GHz, and building personal area networks (PANs). This robot can be controlled by a user, through its Bluetooth controlled feature and can also function by itself whenever it is necessary. Range of Bluetooth module is 8 to 10 mts. Controlling Robot Movement (Forward, Backward, Left and Right) using Android Applications).

Servo Motors are used in applications where very high precision motion is required like assembly robots, computer numeric controls etc. Servo Motor can rotate approximately 180 degrees. (90 in each direction). A servomotor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration. It consists of a suitable motor coupled to a sensor for position feedback. The water pump is connected to the battery. The water pump's hose is attached to the servo motor which rotates it in the direction of the burning fire. The pump then sprays

water filled in the tank with which it is connected to put out the fire.

DC motor converts electrical energy in the form of Direct Current into mechanical energy in the form of rotational motion of the motor shaft The DC motor speed can be controlled by applying varying DC voltage; whereas the direction of rotation of the motor can be changed by reversing the direction of current through it. LCD is basically a display unit built using liquid crystal display When a real life/real world electronics-based projects is build then a medium/device is needed to display output values and messages.

A firefighter is a task given by someone or a team to extinguish a fire that occurs when building a building. The officer took the danger of fighting the fire with a fire engine equipped with a water sprayer. Because of these dangers, a robot is made to help put out the fire. The robot is driven by motor DC. It could detect the surrounding obstacles and possessed an ultrasound-based navigation system. If the ultrasound system detects an obstacle, the robot will automatically turn without colliding the obstacle or other things around it.

IV. RESULT ANALYSIS

In this section, A Novel Fire Fighting Robot with Arduino is implemented. The result analysis of presented robot is evaluated here. The Fig. 2 shows the implemented novel fire fighting robot with Arduino. This Robot can be moved remotely within Bluetooth Range. The Robot Stops Immediately and Starts Water Sprinkler or Dispenser whenever Flame is detected through Sensor modules, This system is powered using 12V/4.5Ah Battery and Charging of this battery is done using 12V Transformer power supply. This system is also equipped with Ultrasonic sensor to avoid collision between Obstacles. This Robot stops on Detection of Obstacle and start again on clearance.
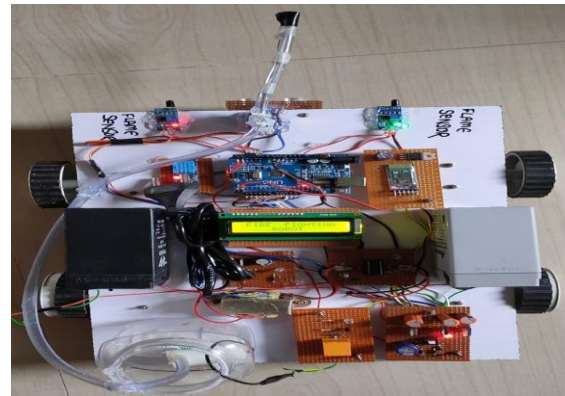

Fig. 2: Implemented novel fire fighting robot with Arduino

When the Robot is moves in forward direction, then Ultrasonic Sensor is used to find any obstacle in the path. The Fig. 3 shows the stacle in robot moving direction.

Fig. 3: Obstacles in Robot Moving Direction

If there is an obstacle in the path then the Robot will stop. Now, direction of the Robot is changed by clicking the options in the mobile app which is shown in Fig. 4. If there are no obstacles in path then Robot moves.
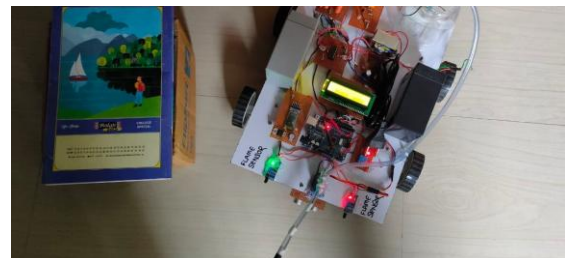

Fig. 4: Robot working in obstacles case

Flame Sensor is used to detect fire. The robot moves the direction of fire and the fire is detected then Water sprinkler will starts sprinkling of the water o the fire and
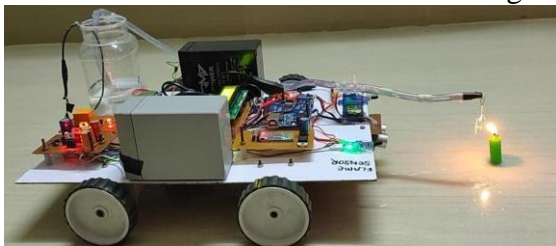
is   shown   in   Fig.5.

Fig. 5: Water Sprinkling during Fire

If the fire is stops, then Robot stops sprinkling the water. Now, the Robot is moved to other location, where the fire is existing. The result of the research showed that this fire extinguisher robot can detect fire as far as it successfully extinguishes the fire. This robot will reduce the risk of injury for firefighters and possible victims and decrease the monetary losses which increase considerably as fire duration increases. This Robot also avoids hitting obstacles or surrounding objects by using sensors. The robot can be used in a place that has a small entrance or in small spaces because it has a compact structure.

V. CONCLUSION

In this work, A Novel Fire Fighting Robot with Arduino is presented. This robot is developed to help firefighters in their duty. This robot can move in forward, backward, left, right and can stop also. It reduces human efforts and protect their property. Robot detects fire and extinguishes the fire with the help of sprinkler pump. This robot controlled by Android with the help of Bluetooth module it can secure the life of robot and save the money.   For extinguishing that fire robot has to reach up to there and it moves towards the target with the obstacle avoidance property. In this way robot can detects obstacle and avoid them also. The main heart of this system is controller i.e. Arduino UNO sicne it controls all the actions very accurately. This robot has advantageous features such as the ability to detect the source of fire, extinguish it and increase the knowledge about fire behavior from the incident area.   This will be good solution in implementing the firefighting robot to help people at the critical condition extinguish the fire.

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