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Autonomous Fire Fighting Robot Using Arduino UNO

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Abstract

In the age of technology, the world is slowly turning towards the automated system and self-traveling vehicles, firefighters are constantly at risk of losing their life in many dangerous situations. Fire spreads rapidly if it is not controlled. In case of a gas leakage there even maybe an explosion. So, to overcome this issue, safeguard the life of firefighters this paper comes into the picture. This advanced firefighting robotic system independently detects and extinguishes fire. This firefighting robotic system is powered by an Arduino Uno - AtMega328 development board it consists of a fire flame sensor LM393 comparator chip for detecting the fire and approaches through voice command which is enabled using Bluetooth Module HC-05. A water spraying nozzle can be mounted on the servo motor to cover a maximum area as a further advancement.

Keywords —Fire Fighting, Arduino UNO, AtMega328, LM393

1 INTRODUCTION

According to National Crime Records Bureau (NCRB), it is estimated that more than 1.2 lakh deaths have been caused because of fire accidents in India from 2018-2020. Even though there are a lot of precautions taken for Fire accidents, these natural/man-made disasters do occur now and then. In the event of a fire breakout, to rescue people and to put out the fire we are forced to use human resources which are not safe. With the advancement of technology especially in Robotics, it is very much possible to replace humans with robots for fighting the fire. This would improve the efficiency of firefighters and would also prevent them from risking human lives. This firefighting robotic system is powered by an Arduino Uno development board it consists of the HC-05 Bluetooth module mounted on a servo motor for voice-enabled navigation, it is also equipped with the fire flame sensor for detecting and approaching fire it can also make use of a water tank and spray mechanism for extinguishing the fire. We can use a water spraying nozzle is mounted on a servo motor to cover the maximum area. Water is pumped from the main water tank to the water nozzle with the help of a water pump, this prototype helps in detecting the fire and can be further developed into a full-fledged fire fighting robot.

In this work, we introduce a novel design of a multi-purpose fire-fighting robot which, with the help of a streaming video camera attached to it, transmits live video from its surroundings to a remote location from where the robot can be controlled. The robot can be mobilized and directed to the spot of the fire and throw water at the fire. It uses an RF signal for communication and it is capable of performing three different functions related to firefighting operation. First, it can remove smoke from the location of fire using a suction vacuum fan and a cylinder attached to it, so people do not suffocate from smoke inhalation. Second, it takes continuous snaps of its surroundings to detect human faces using the Viola-Jones face detection algorithm, so the rescue squad can know from a safe distance if there are trapped people who need to be rescued. Third, it can throw water at the fire at any angle using a rotating nozzle controlled by a remotely controlled servo motor. This multi-purpose fire-fighting robot is inexpensive but reliable. It can effectively reduce the human risk of the fire-fighting operation. The design of the robot is cost-effective, which makes it especially attractive for deployment in developing countries.

This paper examines and leverages the potential of automation in hazardous but important occupation as firefighting. Robots are designed to find the location of the fire before it goes out of control. It could be used to work with firefighters to reduce the risk of injury to victims. This paper presents the Fire Fighting Robot. The development of a robot is divided into three elements which is the hardware, electronics, and programming. The robot has two DC motors

for the driving system and a castor wheel for giving direction. A 12 Volt DC pump for suction and spraying of water. Servo Motor (SG90) for axial spraying of water. (0 degrees to 60 degrees) Various sensors are also interfaced with Arduino Uno Board. For the programming part, Arduino IDE language was used to determine the robot movement from the sensor's input.

2 LITERATURE SURVEY

In today's era fire-fighting is a dangerous issue. Many authors are working on different techniques for fire-fighting. Author Ratnesh Malik et al. has developed an approach towards the fire-fighting robot. The robot is designed and constructed which can extinguish the fire. The robot is fully autonomous. It implements the concept likes environmental sensing and awareness, proportional motor control. The robot processes information from its sensors and hardware elements. Ultraviolet, Infrared and visible light is used to detect the components of the environment. The robot is capable of fighting tunnel fire, industry fire, and military applications that are designed and built. Ultraviolet sensors are used to detect fire. Once the fire is detected, the robot sounds an alarm. Then the robot activates an electronic valve which releases sprinkles of water on the flame. The detailed concept of a robot is explained which automatically detects fire and extinguishes it in a short time by the use of sensors, microcontroller, etc. This robot is used in places where human lives are at high risk.

Author Kristi Kokaish et al. has developed an intelligent fire-fighting tank robot. The tank robot is made from acrylic, plastic, aluminum, and iron. Robot components are two servo motors, two DC motors, ultrasonic sensors, compass sensors, flame detector, thermal array sensor, white detector (IR and phototransistor), sound activation circuit, and microswitch sensor. The objective is to search certain areas, find and extinguish the flame for different flame positions, room configuration with disturbance. The robot is activated through the DTMF transmitter and receiver.

Control of An Autonomous Industrial Fire Fighting Mobile Robot is developed by H.P. Singh et al. The paper describes the construction and design of a mobile fire-fighting robot. The system contains two optically isolated D.C. motors. The robot performs analog to digital conversion of the data provided by infrared sensors. Five infrared sensors are used. Two sensors control the motion of the robots and three are for flame detection. The extinguisher comprises of D.C water pump and a water container. The basic theme of the paper is to sense the flames of fire and extinguish them. This infrared sensor is used as an input sensor that senses the infrared rays coming out of the fire. The microcontroller controls the extinguishing system.

Author Swati Deshmukh et al developed a wireless fire-fighting robot. It comprises a machine that can detect fire and extinguish it. The fire-fighting robot can move in both forward and reverse directions and can be turned in left and right directions. Thus firefighters can operate the robot over a long distance and there is no need for humans near the area on fire. Light-dependent resistors are used for the detection of fire. These resistors are highly sensitive devices and are capable of detecting very small fires. The robot provides security at home, buildings, factories, and laboratories. It is an intelligent multisensory-based security system that contains a fire-fighting system in daily life.

Author Lakshay Arora developed a Cell phone-controlled robot with fire detection sensors which consist of a mobile phone which controls a robot by making a call to the mobile phone which is attached to the robot. During the call activation period, if any button is pressed on the phone, the tone corresponding to the button pressed is heard at the other end of the call that is placed on the robot. The robot perceives Dual-Tone Multiple-Frequency (DTMF) tone with the help of a phone mounted on the robot. The received code is processed by the microcontroller and then the robot performs actions accordingly. In the proposed system DTMF technology is used to position the shaft of the motor at a required point with different sensors, each performing its task. A rugged, simple, and cost-effective system is proposed here.

Author Arpit Sharma et al developed an Android Phone controlled Robot Using Bluetooth. Various techniques of Human-Machine interaction using gestures are presented. Gestures are captured by using the accelerometer. The paper analyses the motion technology to capture gestures using an android smartphone that has an inbuilt accelerometer and Bluetooth module to control the kinetics of the robot. The microcontroller controls the signals of the Bluetooth module. Features like user-friendly interface, lightweight and portability OS-based smartphone has overtaken the sophistication of technologies like a programmable glove, static cameras, etc making them obsolete.

Author Saravanan P has designed and developed an Integrated Semi-Autonomous Fire Fighting Mobile robot. The System controls four D.C. motors powered by Atmega2560 and controlled autonomously by a navigation system. The navigation system comprises integrated ultrasonic sensors and infrared sensors. The robot is fitted with a wireless camera that captures the video and transmits it to the base station. The fire detection comprises LDR and temperature sensors. If there is a fire the sensor detects it and the robot will be moved to the source and extinguishes. The extinguishing system consists of a BLDC motor with a water container. The SABOT can be operated manually for extreme conditions. It comprises GUI support through which the robot can be controlled from the base station.

Remote Controlled Fire Fighting Robot developed by Phyo Wai Aung describes the functions of remote control fire-fighting robot. It contains two main parts that are transmitter and receiver in which two sets of RF modules are used. One RF module is used to transmit the data to the motor driver and another RF module is used to know the condition on fire. Microcontroller PIC16F887 is used to operate the whole system of the fire-fighting robot. The motors are driven by the L298 and ULN2003 drivers in this system. The operator controls the robot by using a wireless camera mounted on the robot. If the temperature of the fire site is above 40 degrees Celsius, the alarm will be ringing so that operator can control the fire-fighting robot and avoid the damage of heat.

3 PROJECT DESCRIPTION

The block diagram of the proposed system is shown in Fig. 1.

COMPONENTS USED

- Arduino UNO
- Fire sensor or Flame sensor (1 No.)
- L293D Motor Driver Module
- Mini DC Submersible Pump
- HC-05 Bluetooth Module
- Robot chassis with motors(2) and wheels(2) (any type)
- PCB Board
- LCD
- Connecting Wires

- Battery
- Android app

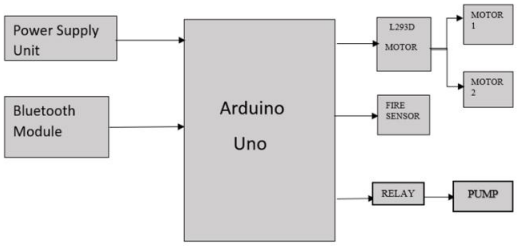

Fig. 1 Block Diagram of the Proposed System

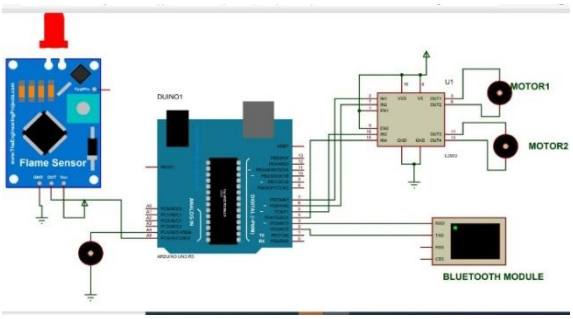

Fig. 2Schematic Diagram

- A flame sensor module that consists of a flame sensor (IR receiver), resistor, capacitor, potentiometer, and comparator LM393 is an integrated circuit. The Fire sensor is connected to the Arduino Uno board schematically. As the Fire sensor consists of r pins like Vcc,gnd,a0,d0, the d0 pin sensor is connected to a 5 pin of Arduino through PCB board (i.e. through a0n pin).Vcc pin of the fire sensor is connected to +5v of Arduino and gnd pin is connected to -5v of the Uno board. Working voltage is between 3.3v and 5.2v DC, with a digital output to indicate the presence of a signal. Sensing is conditioned by an LM393 comparator. And thus when the sensor detects a flame, it sends a certain signal to the Arduino which is shown in Fig. 2.
- L293D Module has an onboard 5V regulator which is either enabled or disabled using a jumper. If the motor supply voltage is up to 12V we can enable the 5V regulator and the 5V pin can be used as an output, Now +5v of l293 is connected to +5v of Arduino and the +12v is connected to+12v of Arduino, similarly, gnd is connected to -12v of Arduino Board. Due to this, the motors can run in clockwise and anti-clockwise directions simultaneously.
- Transmitter pin (tx) connected to 2nd and receiver pin to 3rd pin of Arduino. Vcc, gnd of BT is connected to +5v of Arduino. When the command is given through the application, the Bluetooth module HC-05 receives it and sends it to the Arduino board, which then sends the signal to the Driver module and thus the wheels move accordingly for example if the command is 'FORWARD' the motor moves in an anti-clockwise direction and vice-versa.
- Bluetooth Module is turned on and it's connected to the Bluetooth mobile tethering app. When the commands are given the Arduino will control the motor through the motor driver circuit. To rotate in either right or left direction, one motor will remain off and another one will move, thus resulting in rotation of the body. As soon as there is a fire. The LM35 sensor used here senses the heat and thus required measures are taken.

4 RESULT ANALYSIS

- Turn on the 'Bluetooth' in your device as soon as you turn on the Bluetooth module and pair your device.
- Now connect your device to the following address (HC-05) as shown in Fig. 3.

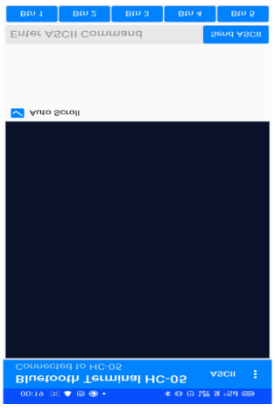

Fig. 3Address HC-05

- Now open the Bluetooth voice app and connect it to the HC-05
- Now the app is ready to give commands and the robot will act according to the commands which is shown in Fig. 4.

Fig. 4 Connected BT device

- Robot at stop after the command “stop” was given through the BT Voice app shown in the Fig. 5.

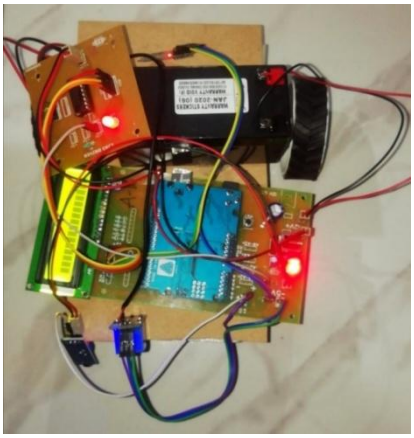

Fig. 5 Controlling of the robot using Mobile

- As soon as the fire sensor detects the flame it reacts to it from a certain distance and with the
- help of relay LED is turned on indicating the fire is detected as shown in Fig. 6.

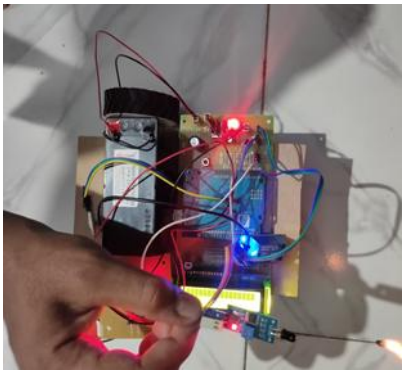

Fig. 6 Sensor detecting Fire

5 Conclusion

- The movement of this robot vehicle is controlled by MCU as per the program.
- This robot is helpful in those areas where natural calamity and bomb explosions where occurred.
- If the fire is detected with the help of LM393 sensors, MCU operates the water pump mechanism through a relay circuit.
- The Fire Fighting Robot is constructed with locally available materials and obstacle detection test and fire sensing working are checked to observe its effectiveness in a different situation.
- Fire sensors work better at darker places. It can detect fire abruptly before it spreads.
- The fire fighting robot is effective enough to fight against fire in a small area.

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