

Development of Fire Fighting Robot

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ABSTRACT

Fire is a fatal incident happens all the time repeatedly again and again all around the world. They are caused either by natural causes or manmade causes. Many people lost their lives in such incidents; they are common people or the crew of the fire fighters as the drones are used in many scenarios across the world. So we decided to build a robotic vehicle which can go at those parts during a fire where man cannot go unlike whether the fire started due to natural causes or manmade causes. Our main aim is to reduce the life loss and property loss happened in the event of fire broken in any area. It will be a robotic vehicle which can go to the place of fire and extinguishes the fire by pumping the water. It will minimize the human casualty at a greater extent as it's a machine so it can operate in the area where temperature is very high due to fire.

Keywords: Fire fighting robot, ultrasonic sensor, flame sensor, remote control

INTRODUCTION

A robot is an electronic device which performs functions usually attributed to humans or machines tasked with repetitive or flexible set of actions. Various studies have shown that robots can be beneficial in medicine [1], rehabilitation [2-6], rescue operation [7,8] and industry [9]. Since the invention, robotic machines have 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 [10]. In line with the Fourth Industrial Revolution [11], there is demand for a one system that can control, communicate and integrate different robots regardless of their types and specifications. Machine learning has also increased interest in robotics. Recent robotic development project has embedded machine learning algorithm [11-15] to increase the intelligence in robots. This will increase

the productivity in industry while reducing the cost and electronic waste in a long run.

We studied various methods to minimize fire fighters' injuries and deaths as well as increasing productivity, safety, efficiency and quality of the task given [13]. This robotic vehicle is designed to navigate and carry out operations with the help of human beings [12,15]. In the meantime, autonomous robots can play out the task independently and get the power from the environment, instead of android robots which are worked to mimic people. [15]

We have proposed a fire fighting robot. The main function of this robot is to become an auxiliary support vehicle, designed to search and extinguish fire. There are several existing types of vehicles for fire fighting at home and extinguish forest fires [11]. Our proposed robot is designed to be able to work on its own or be controlled remotely. By utilizing such robots, fire ID and rescue activities should be possible with higher security without

setting fire fighters at high hazard and dangerous conditions. In other words, robots can reduce the need for fire fighters to get into dangerous situations. Additionally, having a compact size and automatic control also allows the robot to be used when fire occurs in small and narrow spaces with hazardous environments such as tunnels or nuclear power plants.[12,15]

In the study, a compact and small fire fighter robotic vehicle has been developed. This robot is which a form of auxiliary support robotic vehicle is. This robot can evade obstacles, search and extinguish fire. Moreover, this robot can expand the profitability, security, effectiveness and quality of the task given

METHODOLOGY

The methodology is divided into two parts. First section is on the mechanicals schematics, followed by hardware description and the finally on the programming design. All parts were assembled together and experiments were then performed to determine the optimal distance to extinguish the fire were carried out.

Mechanical Design Structure

For the main structure of the robot, to get the preferred movement and speed, it has two wheels at rear side and two wheels at front side. The wheels have the ability to stabilize the robot and make rotation until 360 degrees. The body of the robot is made by using acrylic plate to safeguard the electronic circuit. The acrylic sheet is resistant to heat of up to 200°C. This gives the ability to use and work with (cut and drill). The body of acrylic chassis contains holes that make it easier to mounting of various types of sensors and other mechanical components.

The ultrasonic sensor and flame sensor were installed at front of the robot to avoid hitting any obstacles and to detect the fire respectively. In addition, mini camera was installed in front side of the robot to monitor the way and condition of the location and is linked to the smart phone to monitor the structure of fire distinguisher robot.

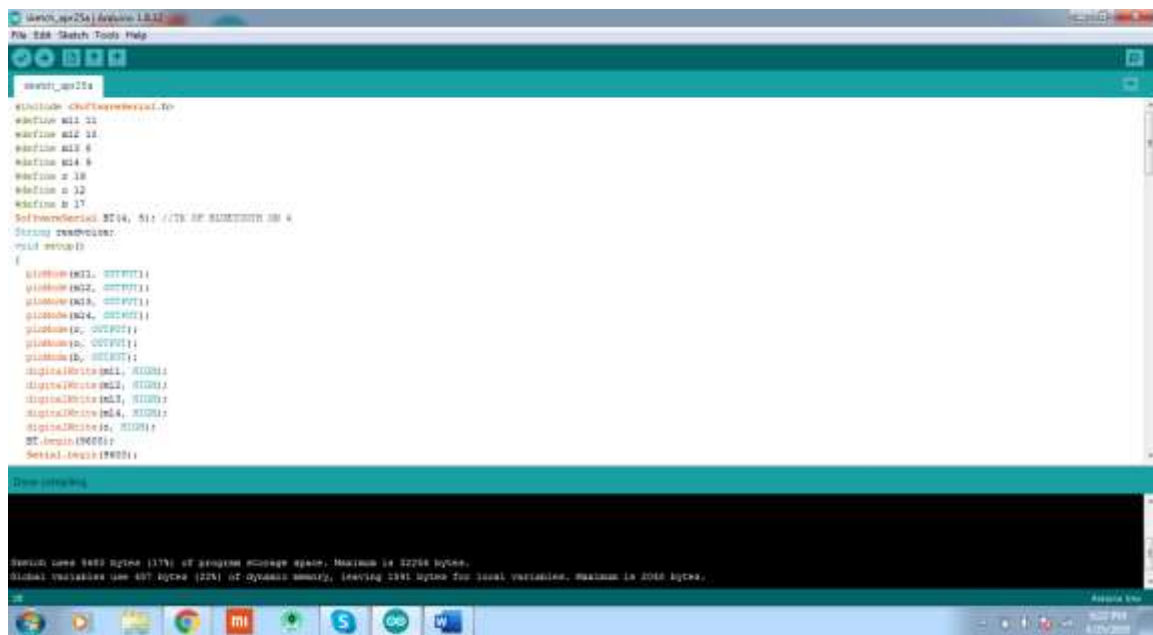
Code Used to operate this Fire fighting vehicle.

```
#include<SoftwareSerial.h>
#define m111
#define m1210
#define m138
#define m149
#define r19
#define o12
#define b17
SoftwareSerialBT(4,5);//TX OF BLUETOOTH ON 4
String readvoice;
void setup()
{
  pinMode(m11,OUTPUT);
  pinMode(m12,OUTPUT);
  pinMode(m13,OUTPUT);
  pinMode(m14,OUTPUT);
  pinMode(r,OUTPUT);
  pinMode(o,OUTPUT);
```

```
pinMode(b,OUTPUT);
digitalWrite(m11,HIGH);
digitalWrite(m12,HIGH);
digitalWrite(m13,HIGH);
digitalWrite(m14,HIGH);
digitalWrite(o,HIGH);
BT.begin(9600);
Serial.begin(9600);
}
//-----//
voidloop()
{
  readvoice="";//Reset the variable
  if(BT.available())
  {
    while(BT.available())
    {
      //Check if there is an available byte to read
      delay(10);//Delay added to make thing stable
      charc=BT.read();//Conduct a serial read
      readvoice+=c;//build the string- "forward", "reverse", "left" and "right"
    }
  }
  if(digitalRead(6)==HIGH)
  {
    digitalWrite(o,LOW);
  }
  else
  {
    digitalWrite(o,HIGH);
  }
  if(readvoice.length()>0)
  {
    Serial.println(readvoice);

    if(readvoice=="*forward#"||readvoice=="FF"||readvoice=="FORWARD")
    {
      digitalWrite(m11,HIGH);
      digitalWrite(m12,LOW);
      digitalWrite(m13,HIGH);
      digitalWrite(m14,LOW);
    }
    elseif(readvoice=="BB"||readvoice=="*backward#"||readvoice=="BACKWARD")
    {
      digitalWrite(m11,LOW);
      digitalWrite(m12,HIGH);
      digitalWrite(m13,LOW);
      digitalWrite(m14,HIGH);
      Serial.println(readvoice);
    }
  }
}
```

```
elseif(readvoice=="*right#"||readvoice=="RR"||readvoice=="RIGHT")
{
    digitalWrite(m11,HIGH);
    digitalWrite(m12,LOW);
    digitalWrite(m13,LOW);
    digitalWrite(m14,HIGH);
}
elseif(readvoice=="*left#"||readvoice=="LL"||readvoice=="LEFT")
{
    digitalWrite(m11,LOW);
    digitalWrite(m12,HIGH);
    digitalWrite(m13,HIGH);
    digitalWrite(m14,LOW);
}
elseif(readvoice=="*stop#"||readvoice=="SS"||readvoice=="STOP")
{
    digitalWrite(m11,HIGH);
    digitalWrite(m12,HIGH);
    digitalWrite(m13,HIGH);
    digitalWrite(m14,HIGH);
}
elseif(readvoice=="SWS"||readvoice=="RUN WATER") //
{
    digitalWrite(o,HIGH);
}
elseif(readvoice=="SwS"||readvoice=="STOP WATER") //
{
    digitalWrite(o,LOW);
}
elseif(readvoice=="SUS")
{
    digitalWrite(r,HIGH);
}
elseif(readvoice=="SuS")
{
    digitalWrite(r,LOW);
}
elseif(readvoice=="SVS")
{
    digitalWrite(b,HIGH);
}
elseif(readvoice=="SvS")
{
    digitalWrite(b,LOW);
}
}
}
```



Hardware Implementation The electronic part is one of the vital parts in the development of. It includes the several types of sensors, microcontroller, DC motor with wheel, Transmitter and Remote control and Water pump. Arduino Uno is used as a microcontroller that connected with other components. Motor Driver (L298N) is used to activate the moving of the gear motor while Transmitter Remote Control will give output of the system. Flow of water and fire extinguisher were pump after being controlled by the operator. On the other hand, the operator can monitor the robot movements by using camera which connects to a smartphone.

Flame Sensor

In utmost fire fighting robots, fire sensors play out a fundamental part in examinations, which are constantly utilized as robot eyes to discover sources of fire [1]. It can be utilized to identify fire based on wavelength of the light at 760 nm to 1100 nm. The detection angle and distance are roughly 60 degrees and distance 20 cm (4.8V) to 100 cm (1V) respectively. Flame sensor has two signal pins that are Digital Output (DO) and Analog Output (AO). DO pins will give two kind of information that it's has flame or non-flame while AO pins will detect exact wavelength of different light.

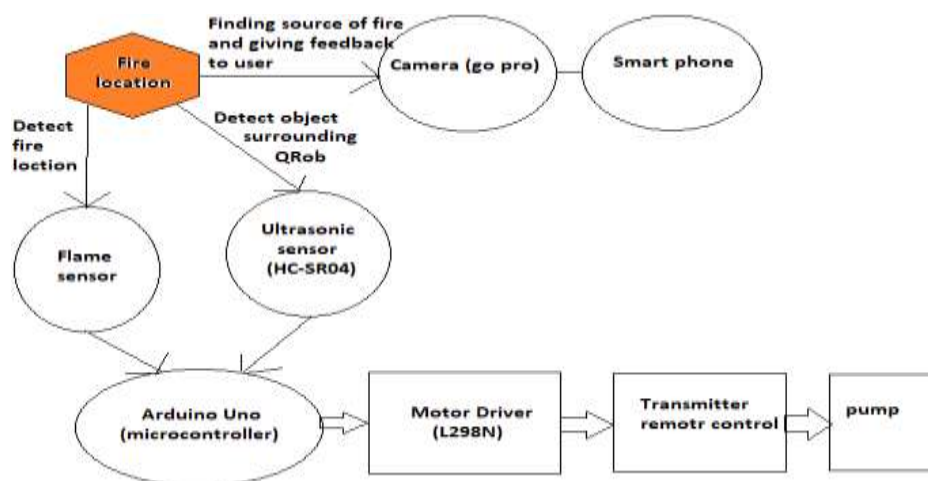


Fig. 1: Block Diagram of Fire Fighting Robot.

Ultrasonic Sensor

One of the most crucial aspects in inventing an autonomous target detection robot is a barrier and obstacle avoidance. A sensor must be minimal, low cost, easy to create and functional on a larger scale. Moreover, it should be able to sense things with enough limits to let robots to react and travel appropriately. The existing sensors that suit all these requirements are ultrasonic sensors. The HCSR04 ultrasonic sensor is utilized in this study to determine the distance within the range of 2 cm to 400 cm with an angle 15 degree. This sensor transmits waves into the air and receives reflected waves from the object. It has four output pin such as reference voltage (VCC) (operate around 5V), ground pin (GND), digital output (DO) and analog output (AO).

DC Motor with Wheel

DC geared motor with rubber wheel are suitable material for this project. These DC motors are suitable to replace 2 WD and 4 WD car chassis. The working voltage for DC motor is around 5V to 10 V DC. While the ratio of the gear is 48:1. Suitable current for this motor is 73.2 mA. DC motor is used to transfer the robot to the fire location.

Water Pump

The water pump is important part in this robot as it will pump water or soap to extinguish the fire depending on the class of fire that occurs. Small-size and light-weight category of water pump has been selected for use in this project.

Moreover, it has low noise, high effectiveness and minimal power consumption. The optimal voltage for this water pump is 6V. Working voltage for this water pump is around 4V to 12V with the working current 0.8A.

Transmitter and Remote Control

In this study, the wireless remote control transmitter and receiver with 4 control modes will be used. Model number of this

receiver or remote is S4C-AC110. This remote have four buttons. The operating voltage for this remote control is AC 100 – 120 V, while the working voltage range of relay are AC 110 – 240 V or DC 0 – 28 V. The model number of the transmitter is C-4. The distance of the remote control is 100 m or 300ft. Power supply for this transmitter are 12 V. The transmitting frequency is 315 MHz / 433 MHz. By utilizing the transmitter and remote control, it can be controlled from distant places where the operator who controls it will be in a safe place while the robot will enter into a dangerous fire area.

RESULT

Fire fighting robot has been developed to find the location of fire and extinguish it. It has an ability to find the location by using flame sensor and ultrasonic sensor. The flame sensor is functioning to sense the location of fire while ultrasonic sensor is functioning to detect the presence of object around it. Both sensors are connected to Arduino Uno, which controlled the movement of DC motor.

At the point when flame sensor found the fire, the DC motor will prevent at 40 cm from the fire. The operator will be extinguishing the fire using remote control from the distance. The operator also can monitor the by using camera that connects to a smartphone.

Duration to Extinguish the Fire Depends upon the Intensity of Fire

It is successfully find fire location automatically and extinguish it by operator control. The operator can monitor the location of fire by camera that is connected to the smartphone. Figure shows the time to extinguish fire depends on distance between Robot and fire.

From the experimental results, it can be seen that when the distance between Robot and fire is greater, the longer it takes to

extinguish the fire. For future planning, it is needed to determine the optimal distance between Robot and fire. This is because to prevent Robot being too close to the fire and at the same time can extinguish the fire in a short time.

Capability to Find the Location of Fire and Extinguish it

It is equipped with ultrasonic sensor that allows it to avoid obstacles surround it. Thus, the maze has been designed to test whether the sensor works well and can avoid the barrier.

This indicates the time required to arrive at the fire location is depend on the distance route of Robot. From the experimental results, time taken to arrive at fire location is directly proportional to the distance route of Robot.

SUMMARY

This project focuses on the development of fire fighting robot. This fire fighting auxiliary support vehicle which will be deployed to minimize the human casualty during a ongoing fire extinguishing operation in the areas which were very troublesome to deal with. It will also help us in minimizing the loss of property. Ultimately it will help us in increasing our efficiency to deal with these types of incidents which occurs in our planet again and again.

CONCLUSIONS

The fire-fighting robot that can be controlled from some distance has been successfully developed. It has favourable features, for example, capacity to identify location of fire automatically next to having a conservative body and lightweight structure. It also has the ability to avoid hitting any obstacle or surrounding objects due to its provision of an ultrasonic sensor. The robot can be used at a place that has a small entrance or in small spaces because it has a compact structure. The operator is able to

extinguish fire utilizing remote control from longer distance. Operators can also monitor the environmental conditions during the process of fire fighting by using the camera that is connected to the smartphone. From the trial results, the robot can detect smokes and fire precisely in a short timeframe. As an end, the venture entitled "Development of Fire Fighting Robot" has accomplished its point and goal effectively.

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