# SMART FIRE FIGHTING ROBOT

## A DESIGN PROJECT REPORT (EEB4233)

**Submitted by**


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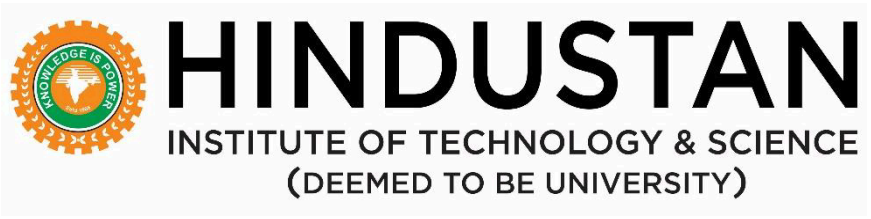
*In partial fulfillment for the award of the degree*

*of*

**BACHELOR OF TECHNOLOGY**

*in*

**ELECTRICAL AND ELECTRONICS ENGINEERING**





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HINDUSTAN
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# BONAFIDE CERTIFICATE

Certified that this design project report titled "SMART FIRE FIGHTING ROBOT" is the bonafide work of S.AJAY KUMAR (18117014)and B.GURU PAVAN (18117015) who carried out the design project work under my supervision. Certified further that to the best of my knowledge the work reported here does not form part of any other design project on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

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The design Project Viva-Voce Examination is held on …….

**INTERNAL EXAMINER** **EXTERNAL EXAMINER**

**ABSTRACT**

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 2010-2014. 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. Today we are going to build a Fire Fighting Robot using Arduino, which will automatically sense the fire and start the water pump

## ACKNOWLEDGEMENT

First and foremost we would like to thank the Lord Almighty for his presence and immense blessings throughout the design project work.

It's a matter of pride and privilege for us to express our deep gratitude to the management of HITS for providing us the necessary facilities and support.

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# CHAPTER 1

# INTRODUCTION, SCOPE & OBJECTIVES OF THE INVESTIGATION

## 1.1 INTRODUCTION

### 1.0.1 What is an FIRE FIGHTING ROBOT?

simple robot using Arduino that could move towards the fire and pump out water around it to put down the fire. It is a very simple robot that would teach us the underlying concept of robotics; you would be able to build more sophisticated robots once you understand the following basics.

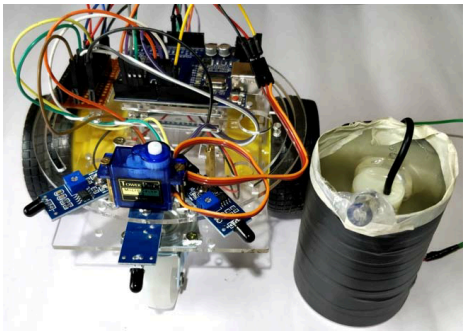


Fig 1.1 FIRE FIGHTING ROBOT

The main brain of this project is the Arduino, but in-order to sense fire we use the Fire sensor module (flame sensor) that is shown below.

### 1.0.2 BASIC WORKING PRINCIPLES OF INVERTER

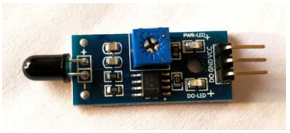
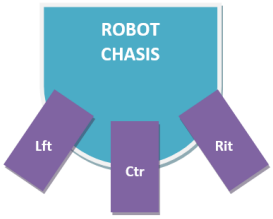


Fig 1.0.2 Fire sensor module

As you can see these sensors have an IR Receiver (Photodiode) which is used to detect the fire. How is this possible? When fire burns it emits a small amount of Infra-red light, this light will be received by the IR receiver on the sensor module. Then we use an Op-Amp to check for change in voltage across the IR Receiver, so that if a fire is detected the output  pin (DO) will give 0V(LOW) and if the is no fire the output pin will be 5V(HIGH).

So, we place three such sensors in three directions of the robot to sense on which direction the fire is burning.




We detect the direction of the fire we can use the motors to move near the fire by driving our motors through the L293D module. When near a fire we have to put it out using water. Using a small container we can carry water, a 5V pump is also placed in the container and the whole container is placed on top of a servo motor so that we can control the direction in which the water has to be sprayed. Let’s proceed with the connections now

**Circuit Diagram**

The complete circuit diagram for this Fire Fighting Robot is given below

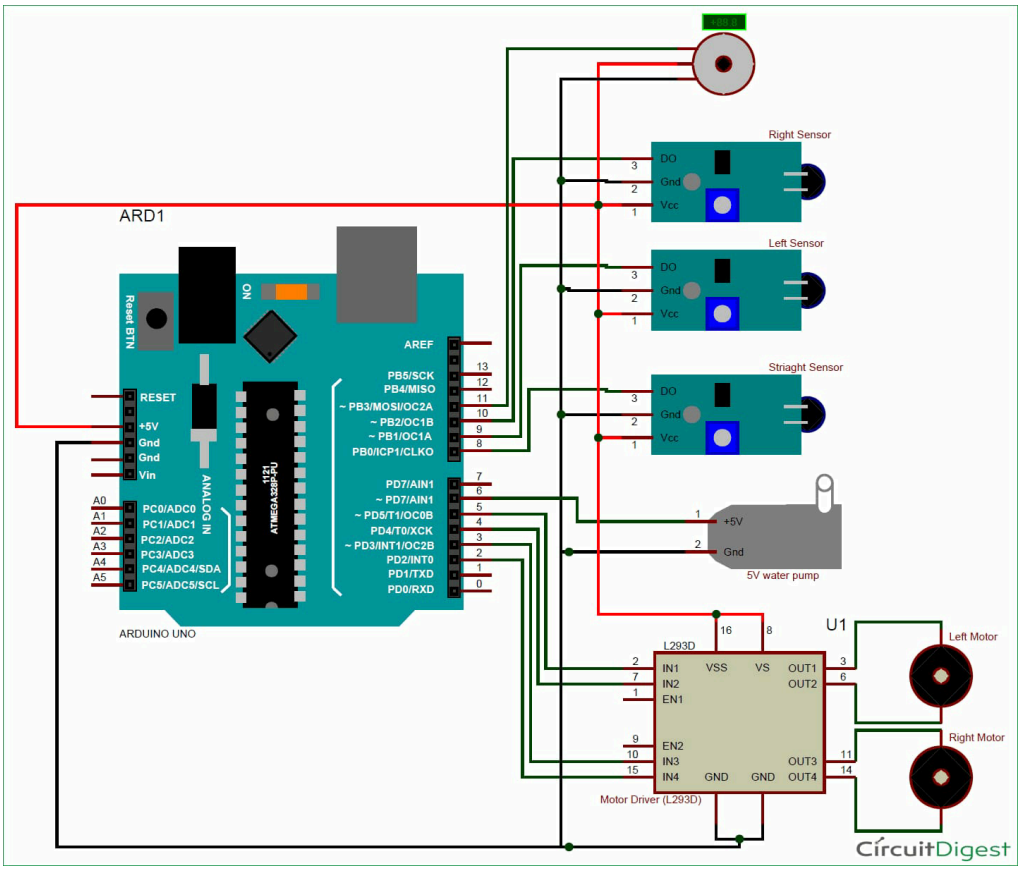



Fig 1.3 Fire Fighting Robot Circuit diagram

You can either connect all the shown connections for uploading the program to check the working or you can assemble the bot completely and then proceed with the connections. Both ways the connections are very simple and you should be able to get it right.

Based on the robotic chassis that you are using you might not be able to use the same type of container that I am using. In that case use your own creativity to set up the pumping system. However the code will remain same. I used a small aluminium can (cool drinks can) to set the pump inside it and poured water inside it. I then assembled the whole can on top of a servo motor to control the direction of water. My robot looks something like this after assembly.

**Applications of Inverter**

- The proposed fire fighting robot is a semi-autonomous vehicle. The robot is controlled using android application, to extinguish fire.
- Arduino, gas sensor, motor driver, gear motor, Relay driver, Bluetooth module, pump and sprinkler are used.

## 1.2 OBJECTIVES

The objective of this project is to;

1. Design of fire fighting robot
2. Construct an fire fighting robot
3. Test the robot

### 1.1.1 METHODOLOGY

- A fire fighter robot is one that has a small fire extinguisher added to it. By attaching a small fire extinguisher to the robot, the fire detection and controls are automatic. The robot works with sensor for searching the fire and when fire is detected then automatically spray the water over it.

# CHAPTER 2

# LITERATURE SURVEY

Detecting fire and extinguishing it is a dangerous job that puts life of a fire fighter at risk. ... Hence, Robotics can be used to assist fire fighters to perform this task of fire fighting and thus reduce the risk of their lives. Fire Fighter is a robot designed to use in such extreme conditions.

# CHAPTER 3

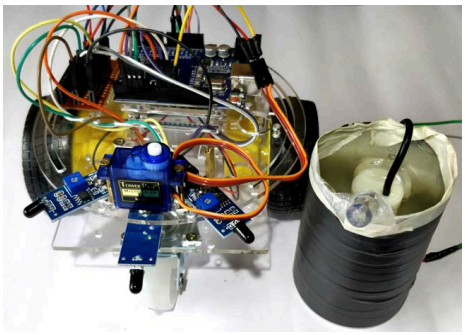
# OPERATING PRINCIPLE OF FIRE FIGHTING ROBOT

With the development in the field of robotics, human intrusion has become less and robots are being widely used for safety purpose. In our day-to-day life, fire accidents have become common and sometimes may lead to hazards that make it hard for the firemen to protect human life. In such cases, a fire fighting robot is used to guard human lives, wealth, and surroundings from the fire accidents. This fire fighting robot project is an advanced project for engineering students, who are interested in robotics. This project project incorporates RF technology for remote operation and also uses 8051 microcontroller. A fire fighting robot is capable of detecting fire if a house catches fire while someone in the house is either sleeping or not present in the house. By means of this fire fighting robot, people and properties can be saved from fire accidents.

There are several possibilities of fire in any remote area or in an industry. For instance, in garments godowns, cotton mills, and fuel storage tanks, electric leakages may result in immense fire & harm. In the worst of cases & scenarios, fire causes heavy losses both financially and by taking lives. Robotics is the best possible way to guard human lives, wealth and surroundings. A Firefighting robot is designed and built with an embedded system. It is capable of navigating alone on a modeled

floor while actively scanning the flames of fire. The robot could be used as a path guide in a fireplace device or, in normal case, as an emergency device. This robot is designed in such a way that it searches a fire, & douses it before the fire could spread out of range & control.

This type of firefighting robot will sooner or later work with firefighters, thus greatly reducing the danger of injury to victims. Apart from this, this Firefighting robotic project will also help generate interest along with the innovations in the field of robotics while operating towards a sensible and obtainable solution to save lives and mitigate the danger to property.



You can either connect all the shown connections for uploading the program to check the working or you can assemble the bot completely and then proceed with the connections. Both ways the connections are very simple and you should be able to get it right.

Based on the robotic chassis that you are using you might not be able to use the same type of container that I am using. In that case use your own creativity to set up the pumping system. However the code will remain same. I used a small aluminium can (cool drinks can) to set the pump inside it and poured water inside it. I then assembled the whole can on top of a servo motor to control the direction of water. My robot looks something like this after assembly.

## 3.1PROGRAMMING CODE USED

```
#include <Servo.h>
Servo myservo;

int pos = 0;
boolean fire = false;

/*-------defining Inputs------*/
#define Left_S 9      // left sensor
#define Right_S 10      // right sensor
#define Forward_S 8 //forward sensor

/*-------defining Outputs------*/
#define LM1 2       // left motor
#define LM2 3       // left motor
#define RM1 4       // right motor
#define RM2 5       // right motor
#define pump 6

void setup()
{
  pinMode(Left_S, INPUT);
  pinMode(Right_S, INPUT);
  pinMode(Forward_S, INPUT);
  pinMode(LM1, OUTPUT);
  pinMode(LM2, OUTPUT);
  pinMode(RM1, OUTPUT);
  pinMode(RM2, OUTPUT);
```

```
  pinMode(pump, OUTPUT);

  myservo.attach(11);
  myservo.write(90);
}

void put_off_fire()
{
    delay (500);

    digitalWrite(LM1, HIGH);
    digitalWrite(LM2, HIGH);
    digitalWrite(RM1, HIGH);
    digitalWrite(RM2, HIGH);

   digitalWrite(pump, HIGH); delay(500);

    for (pos = 50; pos <= 130; pos += 1) {
    myservo.write(pos);
    delay(10);
  }
  for (pos = 130; pos >= 50; pos -= 1) {
    myservo.write(pos);
    delay(10);
  }

  digitalWrite(pump,LOW);
  myservo.write(90);
```

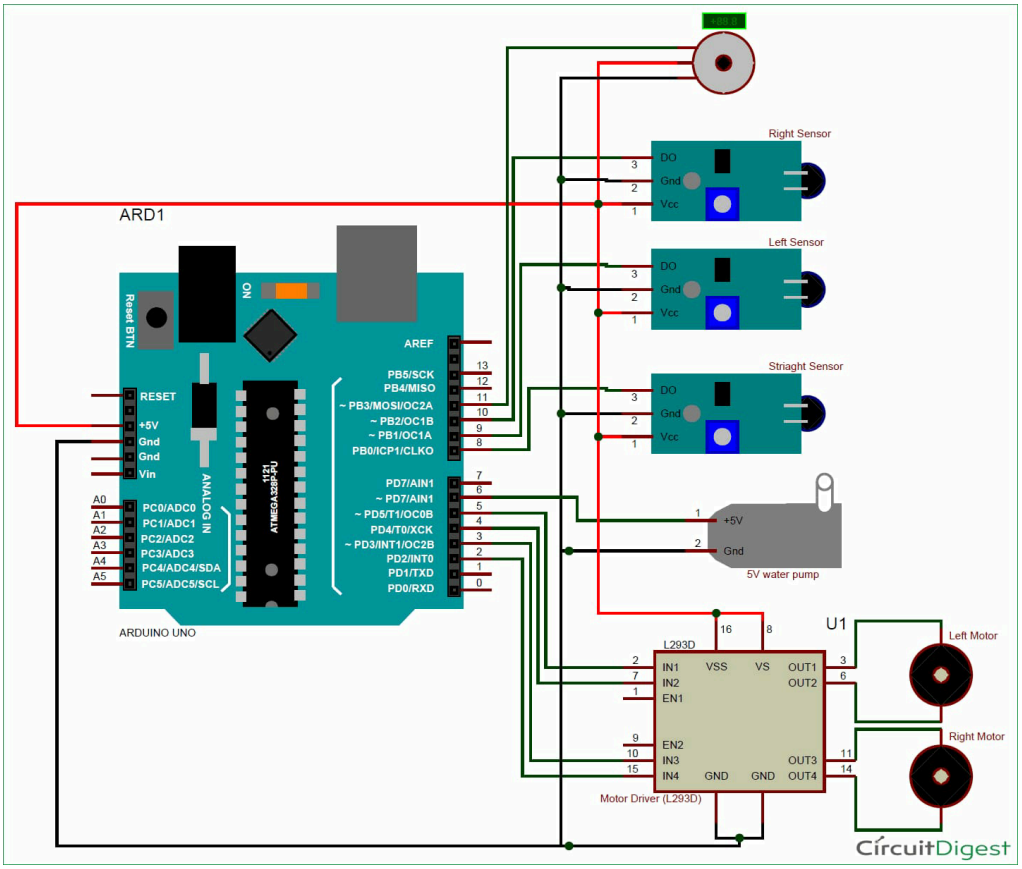
```
  fire=false;
}

void loop()
{
   myservo.write(90); //Sweep_Servo();

    if (digitalRead(Left_S) ==1 && digitalRead(Right_S)==1 &&
digitalRead(Forward_S) ==1) //If Fire not detected all sensors are zero
    {
    //Do not move the robot
    digitalWrite(LM1, HIGH);
    digitalWrite(LM2, HIGH);
    digitalWrite(RM1, HIGH);
    digitalWrite(RM2, HIGH);
    }

    else if (digitalRead(Forward_S) ==0) //If Fire is straight ahead
    {
    //Move the robot forward
    digitalWrite(LM1, HIGH);
    digitalWrite(LM2, LOW);
    digitalWrite(RM1, HIGH);
    digitalWrite(RM2, LOW);
    fire = true;
    }
```

```
    else if (digitalRead(Left_S) ==0) //If Fire is to the left
    {
    //Move the robot left
    digitalWrite(LM1, HIGH);
    digitalWrite(LM2, LOW);
    digitalWrite(RM1, HIGH);
    digitalWrite(RM2, HIGH);
    }

    else if (digitalRead(Right_S) ==0) //If Fire is to the right
    {
    //Move the robot right
    digitalWrite(LM1, HIGH);
    digitalWrite(LM2, HIGH);
    digitalWrite(RM1, HIGH);
    digitalWrite(RM2, LOW);
    }

delay(300); //Slow down the speed of robot

     while (fire == true)
     {
      put_off_fire();
     }
}
```

# CHAPTER 4

# SIMULATION RESULTS

## 4.1 SIMULATION CIRCUIT DIAGRAM AND OUTPUT

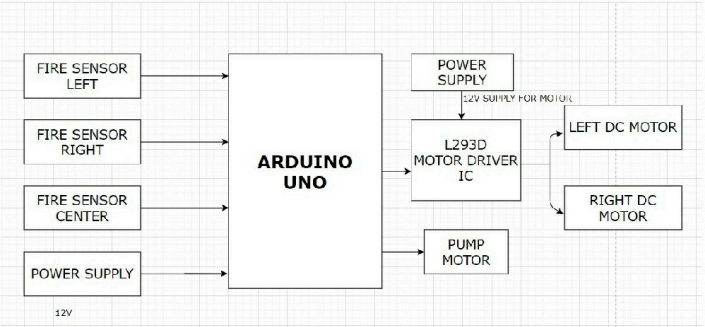


### 4.1.1 Title of the circuit

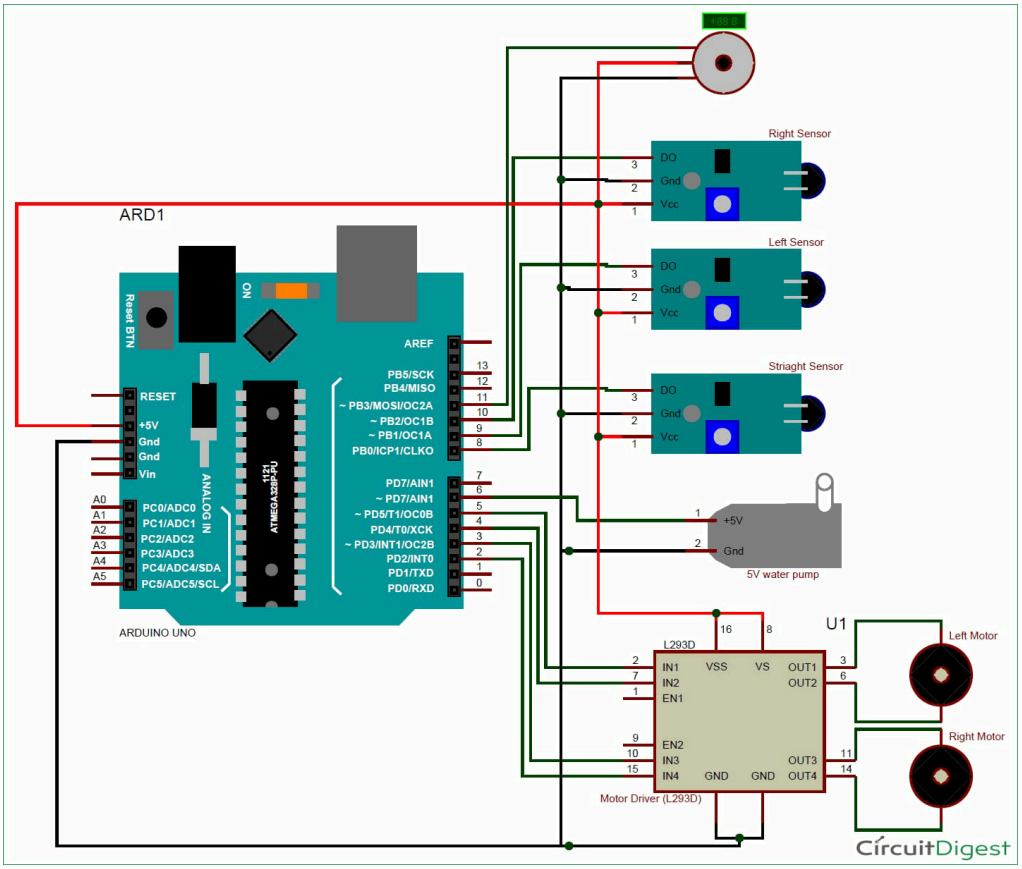
# CHAPTER 5

# HARDWARE DESCRIPTION

## 5.1 BLOCK DIAGRAM FOR HARDWARE CIRCUIT




## 5.2 CIRCUIT DIAGRAM OF HARDWARE




## 5.3 COMPONENTS REQUIRED AND COST DETAILS

1. **Arduino UNO**
2. **Fire sensor or Flame sensor (3 Nos)**
3. **Servo Motor (SG90)**
4. **L293D motor Driver module**
5. **Mini DC Submersible Pump**

6. **Small Breadboard**
7. **Robot chassis with motors (2) and wheels(2) (any type)**
8. **A small can**
9. **Connecting wires**

## 5.5 COMPONENTS DESCRIPTION

### 1. Arduino Uno

The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc.[2][3] The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits.[1] The board has 14 digital I/O pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable.[4] It can be powered by the USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts. It is also similar to the Arduino Nano and Leonardo.[5][6] The hardware reference design is distributed under a Creative Commons Attribution Share-Alike 2.5 license and is available on the Arduino website. Layout and production files for some versions of the hardware are also available.

The word "uno" means "one" in Italian and was chosen to mark the initial release of Arduino Software.[1] The Uno board is the first in a series of USB-based Arduino boards;[3] it and version 1.0 of the Arduino IDE were the reference versions of Arduino, which have now evolved to newer releases.[4] The ATmega328 on the board comes preprogrammed with a bootloader that

allows uploading new code to it without the use of an external hardware programmer.

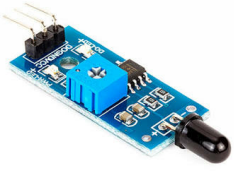
**FEATURES**

- The operating voltage is 5V.
- The recommended input voltage will range from 7v to 12V.
- The input voltage ranges from 6v to 20V.
- Digital input/output pins are 14.
- Analog i/p pins are 6.
- DC Current for each input/output pin is 40 mA.
- DC Current for 3.3V Pin is 50 mA.
- Flash Memory is 32 KB.

**Applications**

- Arduino Uno is used in Do-it-Yourself projects prototyping.
- In developing projects based on code-based control.
- Development of Automation System.
- Designing of basic circuit designs.

## FIRE SENSOR



Interfacing Flame Sensor with Arduino to Build a Fire Alarm System. ... Flame sensor module has photodiode to detect the light and op-amp to control the sensitivity. It is

used to detect fire and provide HIGH signal upon the detection. Arduino reads the signal and provides alert by turning on buzzer and LED.

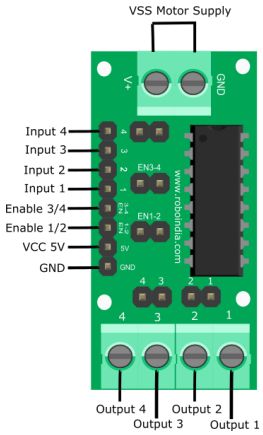
## SERVO MOTOR


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.

## MOTOR DRIVER MODULE(L293D)

The Motor Driver is a module for motors that allows you to control the working speed and direction of two motors simultaneously .This Motor Driver is designed and developed based on L293D IC.

L293D is a 16 Pin Motor Driver IC. This is designed to provide bidirectional drive currents at voltages from 5 V to 36 V.




## 2. Connections with Arduino

1. Module 5V (VCC) – Arduino 5V.

2. Module GND – Arduino GND.

3. Module 1 – Arduino D8.

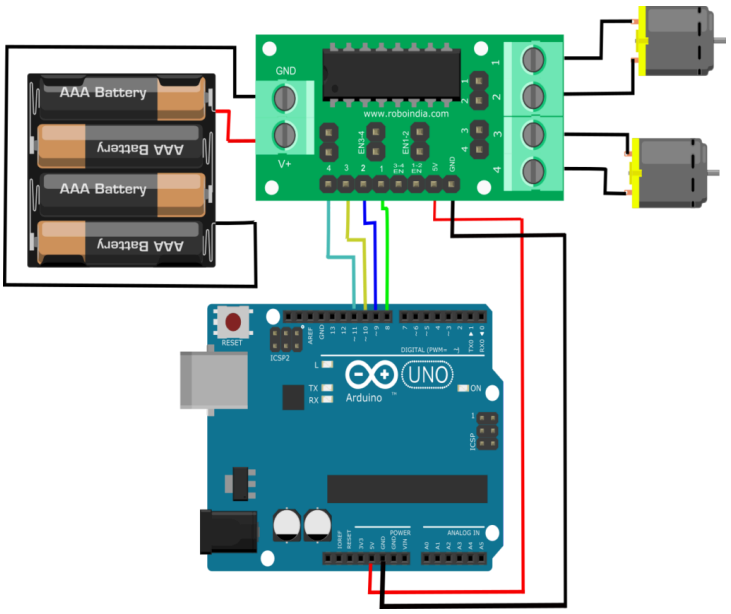
4. Module 2 – Arduino D9.

5. Module 3 – Arduino D10.

6. Module 4 – Arduino D11.

7. Module Motor terminals – DC motors.

8. Module VSS power terminal- External power source of 9V.




**MINI DC SUBMERSIBLE PUMP**

This is a low cost mini submersible type water pump that works on 3-6V DC. It is extremely simple and easy to use. Just immerse the pump in water, connect a suitable pipe to the outlet and power the motor with 3-6V to start pumping water. Great for building science projects, fire-extinguishers, fire fighting robots, fountains, waterfalls, plant watering systems etc.

This motor is small, compact and light. It can be controlled from a micro controller/Arduino using our DC Motor Drivers or one of our Relay Boards. You may use our 5V SMPS Power Supply Adapter to run this pump. You may also use our 6V Solar Panel to run the pump with appropriate a 6V voltage regulator.

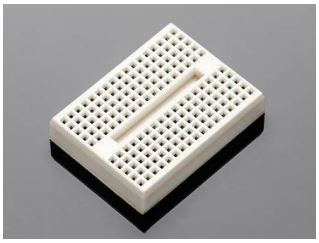
Note: Do not run the pump dry (without putting it in water) and do not use it to pump flamable liquids.

**FEATURES**

- Operating DC Voltage: 2.5-6V
- Maximum Water lift height: 40-110cm / 15.75"-43.4"
- Flow rate: 80-120L/H
- Outer Diameter of Water Outlet: 7.5mm / 0.3"
- Inside Diameter of Water Outlet: 5mm / 0.2"
- Pump Diameter: Approx. 24mm / 0.95"
- Pump Length: Approx. 45mm / 1.8"
- Pump Height: Approx. 30mm / 1.2"
- Wire Length: ~13mm cm

**SMALL BREADBOARD**

The modern breadboard is a plug-and-play way to make connections between electronic components. It gets its name from the long-dead practice of using a wooden board ( an actual bread-board if it was handy ) to prototype circuits.



**SMALL WATER CAN**

Used to  carry water for splitting on fire

**CONNECTING WIRES**

Wire used to extend the firing line or leg wires in an electric blasting circuit.

# CHAPTER 6
# CONCLUSION AND FUTURE SCOPE

## CONCLUSION

The developed Autonomous Fire Fighting Mobile Platform has shown to be a feasible project. Based on the

findings, integrating all the hardware such as flame sensors, motor driver circuitry, LDR sensors, the expected patrolling

and fire extinguishing tasks are possible to be carried out and executed with minimum level of error. By deploying the

AFFMP to monitor for hazardous site via patrolling process, it aids to share out the burden of fire-fighters in fire fighting

tasks as the fire-fighters can safely delegate the fire fighting tasks to AFFMP.

For future enhancements to the current project, additional features can be integrated onto the system, namely the

wireless communication module, so that it can communicate between the operator and the victims within the fire site; image

processing technique to analyze for fire source instead of using the flame sensors; utilisation of renewable source of energy

such as solar power to drive the main circuitry on the AFFMP's platform; ability to navigate on uneven surfaces; and ability

to climb staircases.

## FUTURE SCOPE

The firefighting robot will have future scope that it can work with firefighters, which greatly reduce the danger of injury to victims. It is a 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.

## REFERENCE


- P.H. Chang and Y.H. Kang, et al., “Control Architecture Design for Fire Searching Robot using Task Oriented Design Methodology”, SICE-ICASE

  2006, Oct. 2006.

- Daniel J. Pack; Robert Avanzato; David J. Ahlgren; Igor M. Verner; “Fire-Fighting Mobile Robotics and Interdisciplinary Design-Comparative

  Perspectives”, IEEE Transactions on Education, 3 August, 2004, Volume 47, No. 3.

- Young-Duk Kim; Yoon-Gu Kim; Seung-Hyun Lee;Jeong-Ho Kang; Jinung An; “Portable Fire Evacuation Guide Robot System”, Intelligent Robots

  and Systems, IEEE/RSJ International Conference, 11-15 October 2009. Pages:2789-2794.

- Kuo L. Su; “Automatic Fire Detection System Using Adaptive Fusion Algorithm for Fire Fighting Robot”, Systems, Man, and Cybernetics, IEEE
- International Conference, 8-11 October 2006, Pages:966-971.
- Vecna Robotics Co.; “Battlefield Extraction-Assist Robot (BEAR)”, Available:http://www.vecnarobotics.com/robotics/product-services/bear-robot/

  [Accessed : June 27, 2012]

- Jared Harwayne-Gidansky; Michael Sudano; “A Low-Complexity Navigation Algorithm for a Scalable Autonomous Firefighting Vehicle”, Research

  and Development, the 5th Student Conference-SCOReD 2007, 11-12 December 2007.

- Ting L. Chien; Jr H. Guo; Kuo L. Su; Sheng V. Shiau; “Develop a Multiple Interface Based Fire Fighting Robot”, Proceedings of International
- Conference on Mechatronics on 8-10 May2007, Pages:1-6.
- Igor M. Verner; David J. Ahlgren; “Education Design Experiments in Robotics”, World Automation Congress (WAC), 24-26 July 2006.
- Hongke Xu; Hao Chen; Chao Cai; Xunzhao Guo; Jianwu Fang; Zhu Sun; “Design and Implementation of Mobile Robot Remote Fire Alarm System”,

Intelligence Science and Information Engineering, 2011 International Conference, Pages:43-47.

- Scott Dearie; Kevin Fisher; Brian Rajala; Steven Wasson; “Design and Construction of a Fully Autonomous Fire Fighting Robot”, 2004 IEEE,

  Pages:303-310.

- Kashif Altaf; Aisha Akbar; Bilal Ijaz; “Design and Construction of an Autonomous Fire Fighting Robot”, 2007 IEEE.
- "Fire Extinguishers: The Different Types"[Online]. Available:http://www.mfs-fire-extinguishers.co.uk/types [Accessed : May 20, 2012]
- Shuying Zhao; Wenjun Tan; Shiguang Wen; Chongshuang Guo; “Research on Robotic Education Based on LEGO Bricks”, Computer Science and

  Software Engineering, 2008 International Conference, Pages:733-847.

- DFRobot Co. ; “Flame Sensor”, Available:http://www.dfrobot.com/index.php?route=product/product&filter_name=flame&product_id=195

  [Accessed : June 27, 2012]

- DFRobot Co. ; DFRobot Flame Sensor Technical Datasheet. [Accessed : June 27, 2012]