# PROJECT REPORT

**On**

# Arduino-Based Emergency Fire Protection System

Submitted by

**Group 18**

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Under the Guidance of

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# CERTIFICATE

This is to certify that the following students have successfully completed the Dissertation entitled "**Arduino-Based Emergency Fire Protection System"** under my supervision in the partial fulfilment of Bachelor's Degree in Mechanical Engineering of Savitribai Phule Pune University.

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**BE MECHANICAL B**

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## ABSTRACT

The security of home, laboratory, office, factory, and building is important to human life. We develop an intelligent multi-sensor-based security system that contains a firefighting robot in our daily life. The destructive burnt caused by electrical is the highest source. It is because the security system can't detect abnormal and dangerous situations and notify us. The difficulties to detect the small burnt area and location that is hard to be reach by the user sometimes tough automatic water canon for example spaces are hard to see. So, "the automatic water Canon (movable) for fire extinguishing" is design with water canon for the intelligent building to be controlled by a microcontroller. This robot will move to the fire source when the flame sensor detects the fire and water is sprayed automatically at 45 degrees for upper side and 45 degrees for the lower side.

# CHAPTER – 1

## 1.1 INTRODUCTION

Firefighting and rescue activity are considered as very dangerous missions. Injured firefighters and civilians inside hazard buildings are risky to rescue and evacuate. Sometimes, firefighters face serious challenges to get in the hazard building to automatic water cannon, and locate the civilians, because in most cases, firefighters do not have a prior knowledge about the hazard building infrastructure. Firefighters 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 firefighters have been injured during practicing their duties, including automatic water cannon, and rescuing civilians. There is an ideal target for robot technology to keep away firefighters from danger. Robotics is the branch of mechanical engineering, electrical engineering and computer science that deals with the design, construction, operation, and application of robots, as well as computer systems for their control, sensory feedback, and information processing. These technologies deal with automated machines that can take the place of humans in dangerous environments or manufacturing processes, or resemble humans in appearance, behaviour, and or cognition. Many of today's robots are inspired by nature contributing to the field of bio-inspired robotics. Rescue robotics has been suggested by DARPA study as an application domain for the research in human robot integration. This project presents a prototype robotic system designed to navigate firefighters in unknown terrain.

## Need

In this project, a firefighting robot is proposed. The main function of this robot is to become an unmanned support vehicle, developed to search and automatic water cannon. There are several existing types of vehicles for firefighting at home and automatic water cannon. Our proposed robot is designed to be able to work on its own or be controlled remotely. 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. 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.

## 1.2 Problem Statement

Fire disaster is one of the dangerous problems that can lead to heavy loss both financially and by taking lives. Sometime it becomes difficult for fighters to access the site of a fire because of explosive materials, smoke, and high temperatures. Such situations risk the lives of fire fighters too. In such environments, fire-fighting robots can be useful. This Automatic Water Canon Robot is based on IOT Technology. In Automatic Water Canon Robot, we intend to build a system that could water canon a small flame by sensing and moving to the location itself. Sometime delay in the arrival of fire fighters leads to numerous consequences. The Automatic Water Canon robot continuously monitors the environment and water canon it without delay.

## 1.3 Objectives

- Design of fire sensing and automatic water Canon (movable) machine for fire extinguishing.
- To design and develop the prototype with the help of CATIA V5 R20 software.
- Analysis of base frame of fire sensing and automatic water Canon machine.
- To select the components and materials accordingly after doing the calculations.
- Manufacturing of small fire sensing and automatic water Canon (movable) machine for fire extinguishing.

## 1.4 Project construction

- The system makes use of 2 motors coupled with a powerful sprayer motor with piping system 2nd motors are used to control the nozzle direction movement.
- The sprayer mechanism is built to operate in a degree of freedom operation and achieve 360-degree water spray coverage.
- In this project use a wireless remote to transmit movement commands. The receiver circuit is mounted on system receives user command and also receiver operates the pump motor to start and stop the spray
- Temperature sensor device detect and measures hotness and coolness.

## 1.5 Methodology

### 1.5.1 Semester I

- We started our work with literature survey.
- Searched for existing projects in this field and decided what modifications we can do.
- Some reference research papers used :
- 3D model of the robot was designed using CATIA v5 software.
- We did analysis of firefighting robot in ANSYS.
- Simultaneously we have done work of report for stage I.

### 1.5.2 Semester II

- We selected the components required for the model.
- We did some changes in the project.
- We started with the manufacturing.
- We will submit the final project to company for analyzation and implementation purpose.
- Submission of final project to college for evaluation.

# CHAPTER -2

## 2.1 LITERATURE REVIEW

### 2.1.1"Development of DTMF Centred Remotely Located Fire Extinguishing Robot" By P. Surya Chandra, V. Revathi, A. Sireesha, N. Suresh Kumar

The hazardous situation such as conflagration makes the humans' life most inconvenient and risky. It is an unavoidable situation and it is very difficult for humans to face such situations. But mechanical devices can handle such situations without Human intervention. Sometimes it is also difficult to reach fire place at remote location. A robot can easily handle such situations and can efficiently work in hazardous units. The robot can easily reach the places where man cannot reach. In the present paper a fire extinguisher robot is developed to detect fire and the robot smidgens water on flames. The robot is operated and controlled with mobile phone. Dual Tone Multi Frequency tones are produced to control the movement of the robot. In the present work an Arduino UNO microcontroller is interfaced with fire sensors and generates sequence of steps to control robot movements, direction, and pumping of water. The robot movement and other operations are controlled from remote location. In the present work an electro-mechanical device is used to meet the current objective. When the electro-mechanical device is automatically control its functionalities by artificial intelligence and easily reprogrammable then the device is called as robot. In the present work a robot is developed which can automatically detect any ignition or flames and take decision whether to sprinkle or not to sprinkle water or any material to off the flames. The robot need artificial intelligence to control and manage its functionalities assigned to it. The artificial intelligence is incorporated through programming which is saved in Arduino UNO microcontroller and treats as platform to produce various commands. These Arduino commands are used to control the movement, direction of the robot and takes appropriate action in response to the fire sensors.

### 2.1.2"Design and Fabrication of an Autonomous Fire Fighting Robot with Multisensor Fire Detection Using PID Controller" By Tawfiqur Rakib, M. A. Rashid Sarkar

Recently, Multisensor Fire Detection System (MSFDS) is one of the important research issues. Here, a fire fighter robot is fabricated providing extinguishment platform. The base of the robot is made of the wood of 'Rashed tree', locally known as 'Kerosene wood'. There is about 1 liter water reserving capacity. 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. Two sensors: LM35 and Arduino Flame Sensors are used to detect the fire and distances on its way towards fire. Sensitivity of these sensors at different day times and distances is

tested through analog reading of the serial monitor. Industrial development in Bangladesh has become a key figure to obtain progress and to cope up with developed countries. But recently, the development of industries has faced serious difficulties due to accidental situations like fire havoc. Prevention of and intervention in such scenarios are the most talked topics in the field of technology and science. Sometimes it is almost impossible to intervene in a these situations without the help of robot. Because robot has some size and sensing advantages that human lacks of. It is not feasible to appoint a person to patrol for accidental fire where a robot can do the patrolling [1]. So a robot is made to patrol for fire detection and early warning in domestic, industrial and environmental cases. Our effort is to develop an autonomous fire fighter robot which is constructed by locally available fire resistant and water-proof materials and performs on an arduino based fire detection and extinguishment algorithm. The robot is also fabricated so that it can save itself from fire by keeping safe distance from the source. At different distances from the fire and at different day time, the performance of the robot is evaluated by performing sensitivity tests on the sensors taking serial monitor readings in Arduino.

### 2.1.3“Android Controlled Firefighting Robot using Arduino” By Snehal Adsul, Ujjwala Lokhande, Snehal Motghare, Pranita Dagale, Prof. M. D. Sale.

Nowadays, fire accidents are very common and sometimes it becomes very hard for a fireman to protect someone’s life. It is not possible to appoint a person to continuously observe weather accidental fire has started where robot can do that. Robot will detect fire remotely. These robots are mostly useful in industries . The proposed vehicle is able to detect presence of fire and extinguishing it automatically by using temperature sensor. The proposed robot has a water spray which is capable of sprinkling water in 1800 angle. The sprinkler can be move towards the required direction . At the time of moving towards the source of fire it may happen that it will come across some obstacles ,then it has obstacle avoiding capability. It detects obstacles using ultrasonic sensors . Communication between the mobile phone and robot will take place through Bluetooth ,which will have GUI to control the movement of robot . When mobile gets connected to Bluetooth firstly it will set module name, baud rate .It is feasible to implement Bluetooth communication between smartphones and micro-controller. Android controlled robot can be used easily in everyday life such as in homes, market ,companies etc. The development of apps for Android in Android SDK is easy and free of cost. Now a days mobile robots are very useful in construction sites, warehouses and manufacturing plants. Mobile robots can also be used in material handling applications which applications are growing day by day. For analyzing different items and for handling materials mobile robots can be used. Wireless navigation is also possible for movements of mobile

robot, can be controlled through android. Fuzzy logic control mechanism is used to control robot. That model does not need any mathematical model controlling. Previously Fire Fighting Robots were controlled by using different electronics devices .But this reduces the scope of control of fire fighting robot .However ,with the advanced techniques we can build the same robot by using android application to control the actions of the robot . With the help of such robots, fireman's work really decreased and movements of robot are so much effective. By using an android app fireman man detect the fire and can able to extinguish it .At the same time robot can detect the obstacles and can avoid them by using ultrasonic sensors . Our project is designed to build an android application which can control operations of the fire fighting robot . Fireman can send commands to robot through Bluetooth module which is mounted on robot itself. Smart phones has facility of Bluetooth, through that Bluetooth fireman can control the movement of firefighting robot . For fire detection it is using two sensors . One is temperature sensor and second is smoke detector. Fire extinguishing system will be get activated when fire detection system detects fire .Sprinkler will start sprinkling water when it detects fire . At the transmitting end android application is used and at receiving end two motors are interface to micro-controller.

### 2.1.4"Arduino Based Fire Fighter Robot" By Sushrut Khajuria, Rakesh Johar, Varenyam Sharma, Abhideep Bhatti

The purpose of this paper is to provide a design for a Arduino based Fire Fighter Robot. Arduino is an open-source electronics platform that is based on easy-to-use hardware and software. Arduino board can be controlled by sending a set of instructions to the microcontroller. It has been designed to develop a fire fighting robot using Arduino technology for remote operation. Firefighting is the act of extinguishing fires, i.e.; our robot sprinkles water on to fire. The robotic vehicle is loaded with the water tanker and a pump which is controlled by wireless communication to throw water. An Arduino Mega microcontroller issued for the desired operation. A firefighter robot suppresses and extinguishes fires to prevent loss of life and destruction of property and the environment. The project consists of a user controllable fire fighter robot which has a water tank and a gun attached to it for extinguishing fires. For this purpose, the system uses an RF remote, to remotely control the robot along with microcontroller circuit based on RF for operating the robotic vehicle to move in all the directions. With the help of the RF remote, the user commands are sent by RF signals, which are sent by the wireless remote transmission unit. The commands that are sent by the user are received by the receiver circuit on the robot chassis and then decode them. It then forwards it to the microcontroller. After that, the microcontroller processes these instructions and then instructs the vehicle motors to run the vehicle in desired directions. The robot operates within a 17 feet range of the remote.

### 2.1.5 “Fire Protection System Operating Experience Review for Fusion Applications” By L. C. Cadwallader.

This report contains a limited review of fire protection system operating experiences for use by fusion system designers and safety analysts. Representative types of events found in published operating histories, safety concerns for fire suppression systems, failure rates for fire protection components, and system failure frequencies are discussed. Fire protection systems are necessary for both inertial confinement and magnetic confinement approaches to fusion due to the hazards undertaken and the costs of equipment involved. Therefore, this report should be of interest to a wide group of designers and safety personnel. Fire protection for fusion research was previously required by US Department of Energy (DOE) direction in Order 5480.7A ("Fire Protection", February 17, 1993), and still is for many DOE facilities. However, this order has been superseded by DOE Orders 420 (Facility Safety, October 1995) and 440 (Worker Protection Management for DOE Federal and Contractor Employees, September 1995), but facilities that have already contracted with the DOE must still meet the older regulation. Most US fusion experiments are protected by automatic water sprinkler systems and Halon gas systems. The prevailing attitude in Europe favors good alarm systems and fire brigade response instead of sprinkler systems. However, the International Atomic Energy Agency publication on fire protection for nuclear fission power plants favors automatic sprinklers for new construction. 1" 1 . Safety concerns with fires in fusion experiments are numerous. There are many electrical power supply systems and large numbers of cables and electrical distribution switchgear whose faults could start a fire. There are usually many equipment items requiring lubrication (pump and valve motors, fans, compressors, etc.) that could possibly suffer a fault (mechanical or electrical) and start a fire. There can be combustible solvents in use for maintenance cleaning or decontamination, and solvent vapors could catch fire. Demineralizer resins from water cleanup systems might be combustible. The many control systems also pose a fire threat if a "hot" short circuit developed in the system. Fusion facilities also handle hydrogen, which is a combustible gas, and perhaps lithium metal, which, when molten, is extremely reactive with air and water. 1 "2 Then there are the more typical industrial fire problems of welding or brazing activities, careless cigarette disposal, poor housekeeping, lightning strikes, vehicle fires (forklift, truck, etc.), spontaneous combustion of cleaning rags or other materials, and other causes. All of these fire hazards can be properly managed with attention to fire protection in design and with good operating practices. This report is not intended to be a complete discussion on fire risk assessment or fire hazards analysis, nor is it a chronicle of all significant fire events or all fire equipment failure rates. Resources are too limited for such a complete treatment. This work does give a representative view of fire protection system experiences from a safety viewpoint.

## 2.1.6“Design and Development of Engineered Fire Suppression System” By Dr. M. K. Marichelvam, Mr. K. Maheswaran.

Fire is one of the important element in nature without which world will not function. Despite of all the benefits still the loss occurred due to fire is unaccountable. Due to the fire incident so much of life, property are damaged heavily. So every step is taken universally to control the fire. Fire occurring is a combination of Oxygen, Fuel, and Heat. Fire extinguishers are used to extinguish the fire. Commercially different types of fire extinguishers are used based on the applications. Most of the accidents occurred due to improper handling of fire extinguishers. Fire fighters are af ected heavily by severe injury and loss of life in order to reduce accidents while firefighting. This paper attempts to partially replace human by semiautomated machine for the firefighting operations. The firefighting process involves, fire protection system by attaching a small nozzle to the moving arm and is controlled by semi- automatic process that replaces the firefighter to perform the firefighting activities. This firefighting system is to reduce the direct contact of the fire fighter to the fire hazards and also to reduce consumption of water during firefighting process. Fire fighters overcomes dangerous situations in extinguishing the fire and while rescuing the victims. This semiautomatic fire suppression system will evaluate the fire fighter to execute at a distance from fire which give comfort and lower risk to the firefighting people. Fire is the rapid oxidation of a material in the exothermic chemical process of combustion, releasing heat, light, and various reaction products. Slower oxidative processes like rusting or digestion are not included by this definition. At a certain point in the combustion reaction, called the ignition point, flames are produced. The flame is the visible portion of the fire. Flames consist primarily of carbon dioxide, water vapor, oxygen and nitrogen. If hot enough, the gases may become ionized to produce plasma. Depending on the substances alight, and any impurities outside, the color of the flame and the fire's intensity will be different. Fire in its most common form can result in conflagration, which has the potential to cause physical damage through burning. Fire is an important process that affects ecological systems around the globe. The positive effects of fire include stimulating growth and maintaining various ecological systems. Fire has been used by humans for cooking, generating heat, light, signaling, and propulsion purposes. The negative effects of fire include hazard to life and property, atmospheric pollution, and water contamination. If fire removes protective vegetation, heavy rainfall may lead to an increase in soil erosion by water. Also, when vegetation is burned, the nitrogen it contains is released into the atmosphere, unlike elements such as potassium and phosphorus which remain in the ash and are quickly recycled into the soil. This loss of nitrogen caused by a fire produces a long- term reduction in the fertility of the soil, which only slowly recovers as nitrogen is "fixed" from the atmosphere by lightning and by leguminous plants such as clover.

### 2.1.7“Fire Fighting Robot” By S. Kavitha , Krishnarajendra sagar , Mohamed Tousif, Nishanth C.R

It's necessary and very dangerous work to fight against flames. The implementation of this project is automatized as well as manualized. This project uses ARM7. In sectors such as nuclear power plants, petroleum refineries, gas tanks, chemical plants and other large-scale industries, the majority of fire incidents occurs, which results to complex situations. More number of people have lost their lives because of such incidents. We are mounting a Wi-fi module (Node MCU) for mobile communication and many other sensors to detect the fire and smoke. We use the BLYNK/TCP terminal program for mobile control of the robot. The size of the robot is around 20 cm long and 10 cm tall, capable of carrying an extinguisher (gas). 12V 1.3Ampere hours of battery power. Keil M Vision 4, Flash Magic and Embedded C are the applications used for this project. The Fire Fighting Robots are most popularly searched to prevent the fire injuries and to improve the effectiveness of the robot. In order to determine the lead of the fire to the robot , smoke and fire (thermal) reflections can be clued. The project aims to design a robotic fire extinguishing vehicle that can be operated both wirelessly and manually. The main objective of the project is to automatically or manually design and implement a fire fighter robot to extinguish fire. The robot is equipped with sensors that help us detect fire, smoke or any obstacles in its path. The proposed vehicle has a gas spray which, compared to water, is able to extinguish fire at a faster rate. The robot control system presented here can be used for various robotic applications.

### 2.1.8 “Fire Design of Single Storey Industrial Buildings” By Dr Andrew H Buchanan

This report aims to establish a design methodology for meeting basic fire safety objectives within single storey industrial buildings using a 'common-sense' approach. A wide range of fire safety issues are addressed, ranging from environmental protection to life safety and structural performance. The emphasis is on meeting the performance requirements of the New Zealand Building Code for fire safety and hazard management. Given that industrial buildings are likely to fall into a high fire hazard category, alternative fire engineering design methods are deemed necessary for Building Code compliance. Attention is also given to issues that are not part of Building Code requirements or acceptable solutions. A fire safety strategy is recommended for an industrial site, with the focus on establishing a level of 'acceptable loss'. A risk assessment provides the means to meet loss control objectives. This should form the basis for a new buildings' fire protection design, plus the on-

going fire safety management programme. Automatic alarms are considered essential for life safety and property protection, with sprinklers being the only method of controlling a fire within a typical industrial complex. The Fire Service cannot be expected to attack and suppress a fire from receiving an alarm call without sprinlder support. The Fire Service can, however, be expected to control the spread of fire to neighbouring property given certain conditional events work in their favour. The act of prewetting neighbouring combustible surfaces and thereby increasing the critical radiation intensity for pilot ignition, is considered very effective in preventing fire spread. Increasing fire rating requirements fo_r boundary walls based on withstanding equivalent fire severities for the 'design' fire, is considered overly conservative. A maximum rating of 4 hours is recommended for any boundary wall. This recommendation is based on maximum values used in overseas Codes and assumes that boundary walls are connected to primary support structures and adjoining wall panels, so that if they fail they collapse inwards as one complete unit. The report provides a comprehensive list of conclusions that expand on the above overview, plus recommends areas for future research.

## 2.1.9“Research on fire protection methods and a case study "Futurum” By J. Outinena , J. Samecb and Z. Sokolc

A common way of handling structural fire protection and design is using the so called standard fire as basis for prescriptive design. For this, a wide experimental research with also a large amount of numerical simulations has been carried out in Finland to gather experience of using automatic water extinguishers as a protective method against fire. This research, test methods and the results are presented in this paper. A more modern way of evaluating building's fire resistance is performance-based fire design. This can be carried out in many levels and using different fire models. One way is to use zone models to calculate the temperatures in structures. A case study, now under construction, concerning the use of zone models and Ozone software is presented in this paper. Research concerning the fire protection of steel structures in standard fire exposure was carried out in Finland. Structural fire protection of steel structures was studied using automatic water extinguishing systems. Several different sprinkler types were used to study the temperatures in selected steel structures. The research was carried out with fire tests and also simulations. The aim was to study the possible fire resistance rating to the system and according to the research results; fire rating of R90 was accomplished. Temperature calculation using two models at FUTURUM shopping mall is presented. The localised fire model was used as the sprinklers prevent flashover and the fire remains localised. Temperature of the steel elements is based on the hot zone calculated using the OZone software to predict the temperature “far away” from the fire. Model of localised fire was used for calculation of temperature of steel elements directly above the fire. The effect of localised fire was more significant than the effect of the hot zone. In any case,

temperature of the steel structure did not exceed 550°C, which allowed using unprotected steel structure for the roof of the shopping mall.

### 2.1.10"Study of Fire Fighting System in Public Building" By Tejas Kadam, Darshan Khambale, Suraj Kunke, Sainath Dhadam

Among different types of occupancies, a commercial high-rise building presents a greater challenge to fire protection due to its functionality, complexity and economic value. The key objective of the present paper was to examine the situation of physical (as opposed to non-physical) fire protection systems in fourteen randomly selected commercial Highrise buildings in the Nairobi CBD for fire safety optimization. Methods used include; physical observations, document review and interviews. A multi-attribute evaluation model/approach was applied to establish sufficiency and/or suitability of fire protection systems in the light of the national regulations and approved standards. The study findings show that, save for the facilities of the disabled and the firefighting/evacuation lifts, other fire protection systems are mainly provided in the buildings. However, insufficient maintenance and/or unsuitable elements renders their safety performance low. The results of the analysis showed that portable fire extinguishers had the highest performance with 78.57% of the buildings sufficiently and suitably in terms of number, locations, servicing etc., while 0% of the building was sufficiently and/or suitably installed with a sprinkler system i.e. they all exhibited some deficiency in terms of coverage and maintenance issues. This could be associated with the cost factor. The results of other systems were as follows: Fire detection and alarm (14.29%); Escape route (50%); Emergency lighting (64.29%); Smoke control System (50.00%); Compartmentation (64.29%), Riser mains, hose reels and hydrants (64.29%); Fire Brigade access and facilities (64.29%); Safety signs and notices (7.14%); Portable fire extinguishers and Fire assembly points (28.57%). In view of the findings, it's recommended that increased efforts in inspection and maintenance of fire protection systems are considered to address the identified shortfalls throughout the project life. Provision for firefighting/evacuation lifts and facilities for the disabled persons should be considered during design of the commercial high-rise buildings. Fire and smoke are among the major reasons of the accidental casualties. Fire detection is important as the fire causes serious damages to both human life and non-living assets. Most of houses lack the fire alarm systems that causes the resident a serious risk on fire breakout in homes. The fire breakout can also occur in absence of the residents. Most of fire alarm system, available in market, are in wired connection mode. This type of system needs installation and investment and have its own limitations. It also does not meet the new automatic smart home's requirements. Thus, an intelligent wireless fire alarm system is needed to be developed with lower maintenance along with safer and easier. The methodology is discussed in the next section.

# CHAPTER - 3

### 3.1 CAD Model

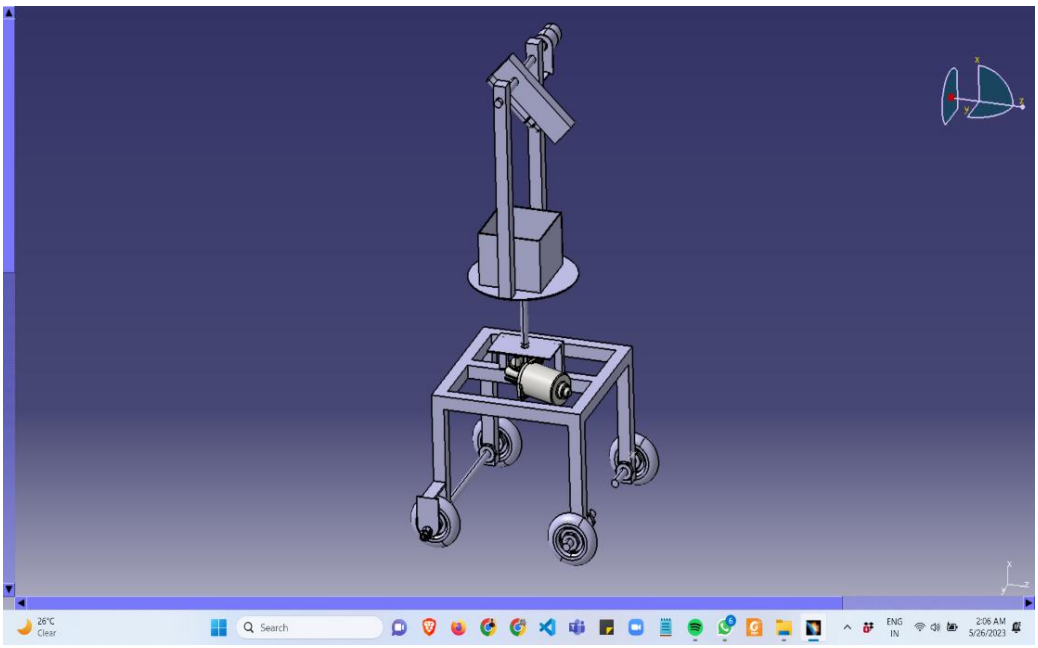


Fig 3.1 CAD Model (Isometric view)

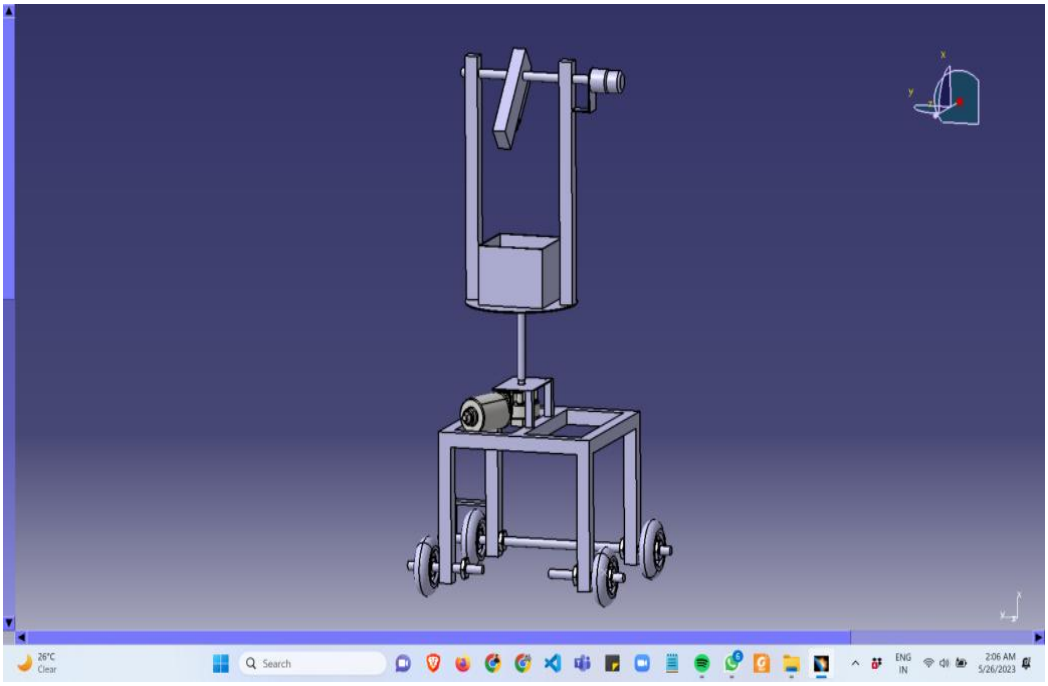


Fig 3.2 CAD Model (Front view)

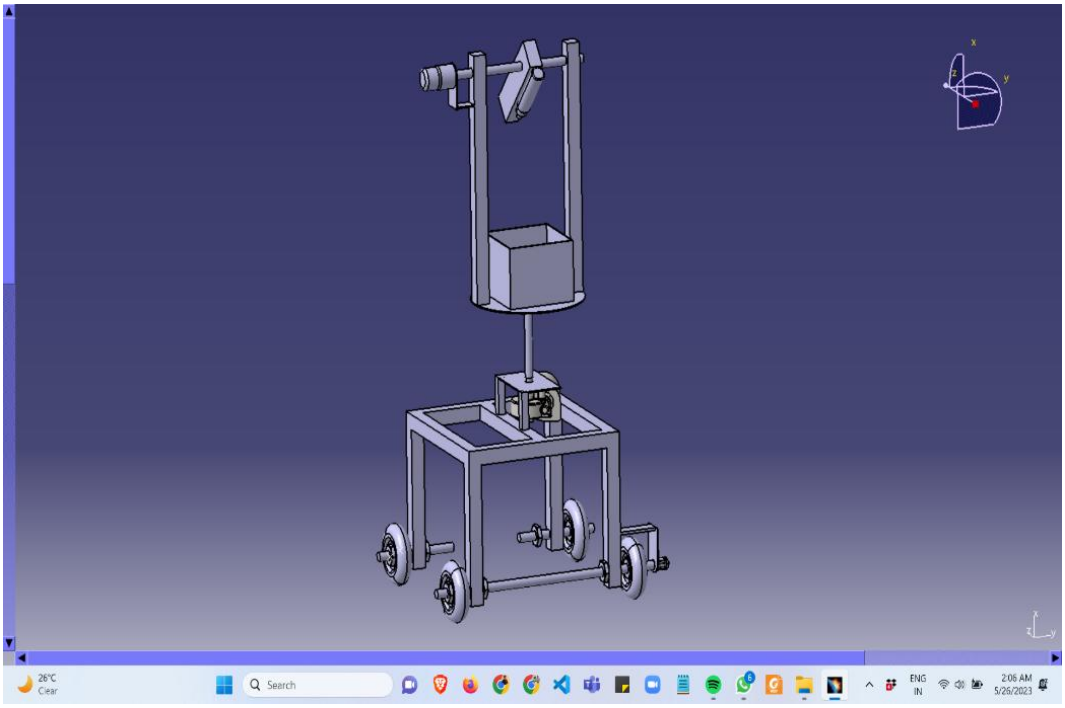


Fig 3.3 CAD Model (Side view)

## 3.2 ANSYS Analysis

**Geometry**

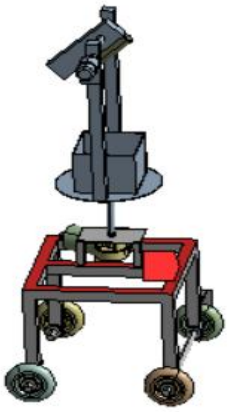
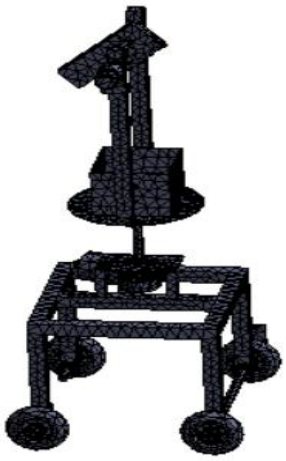


Fig 3.4 ANSYS Geometry

**Mesh**



| Statistics | |
|---|---|
| Nodes | 63332 |
| Elements | 33409 |

Fig 3.5 ANSYS Mesh

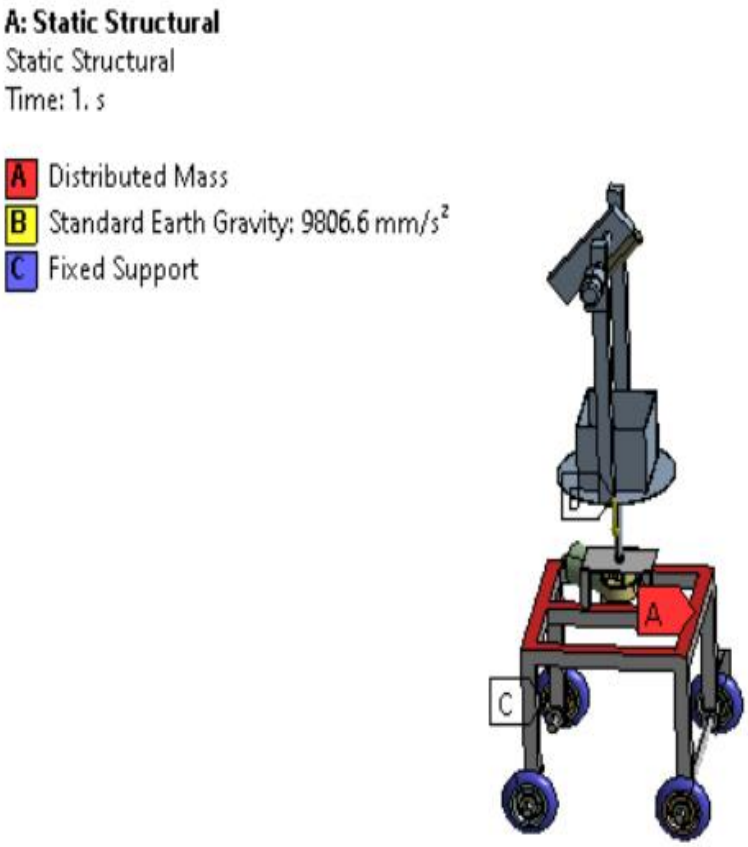



Fig 3.6 Static Structural Boundary Conditions

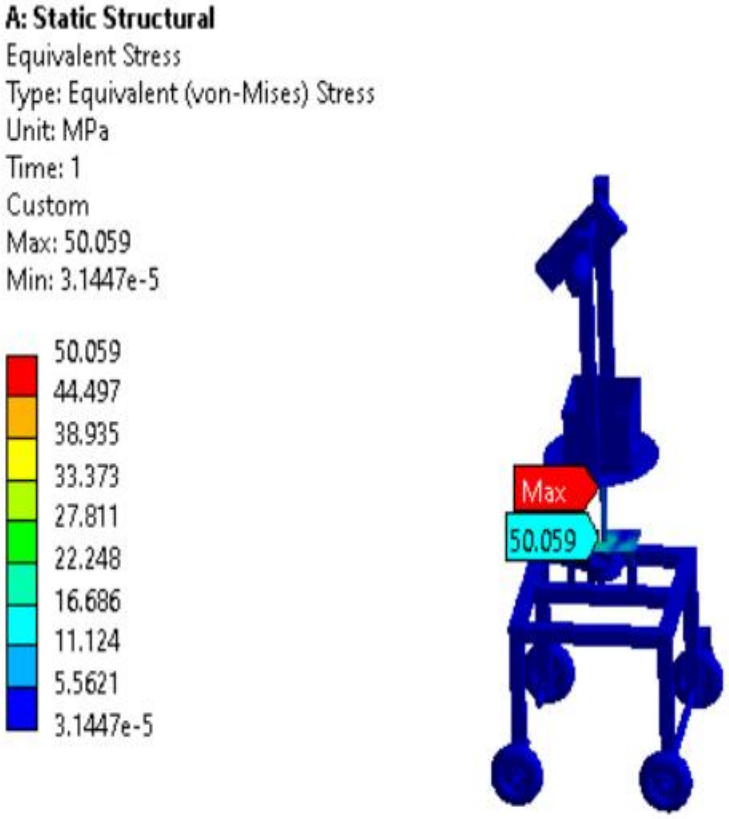



Fig 3.7 Equivalent Stress

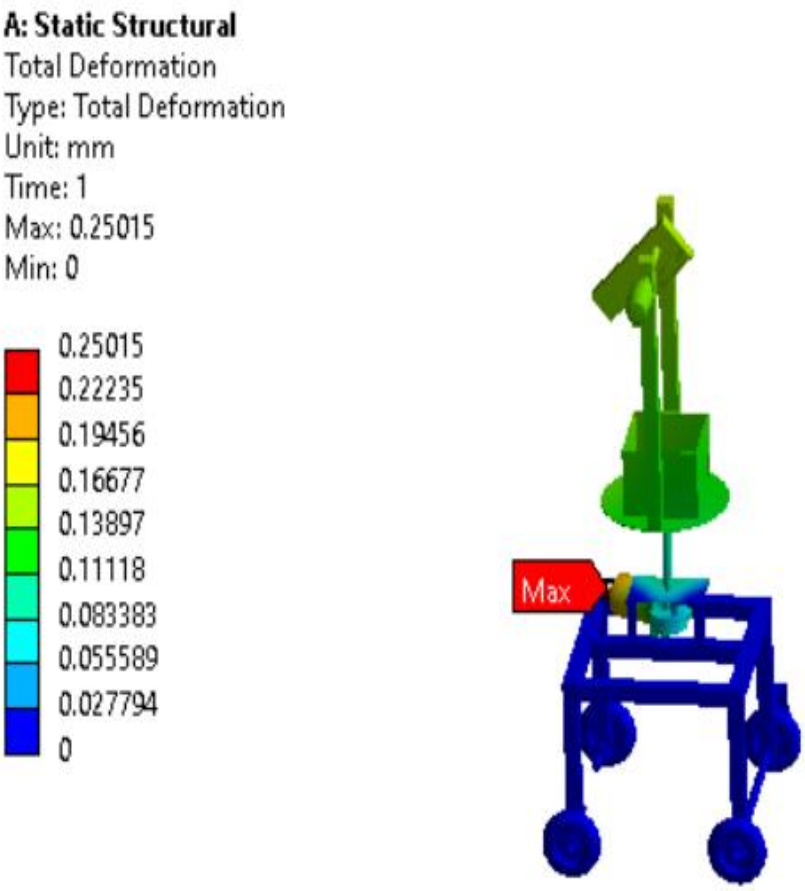



Fig 3.8 Total Deformation

## 3.3 Design Calculations

1. Wiper motor

Power = 120W

Voltage = 12V

$P = 2 \pi (rpm/ 60) T$

$120 = 2* 3.14* T/60$

$T = 20.83$ Nm.

$T = \tau * (\pi/16) *d^3$

$20.83 * 10^3 = 70 * \pi *d^3 / 16$

$d^3 = 1515.51$

$d = 11.48$

Hence, we selected 12 mm for the setup.

Total weight of setup = 15 kg

$15 * 10 = 150$ N

$150 / 2 = 75$ N

T = force * Radius =75 * 50

T =3.750 N/M

Diameter of shaft

$3.750 * 10\ 3 = 70 * 3.14 * d\ 3 / 16$

$d\ 3 = 3.750 * 10\ 3 * 16 / 70 * 3.14$

$d\ 3 = 6.4$ mm

Hence, we find the diameter for the shaft is 6.4 mm.

## 3.3 Arduino

The **Arduino Uno** is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc and initially released in 2010. 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. Arduino in the project is used to control various operations.

## 3.4 Arduino IDE

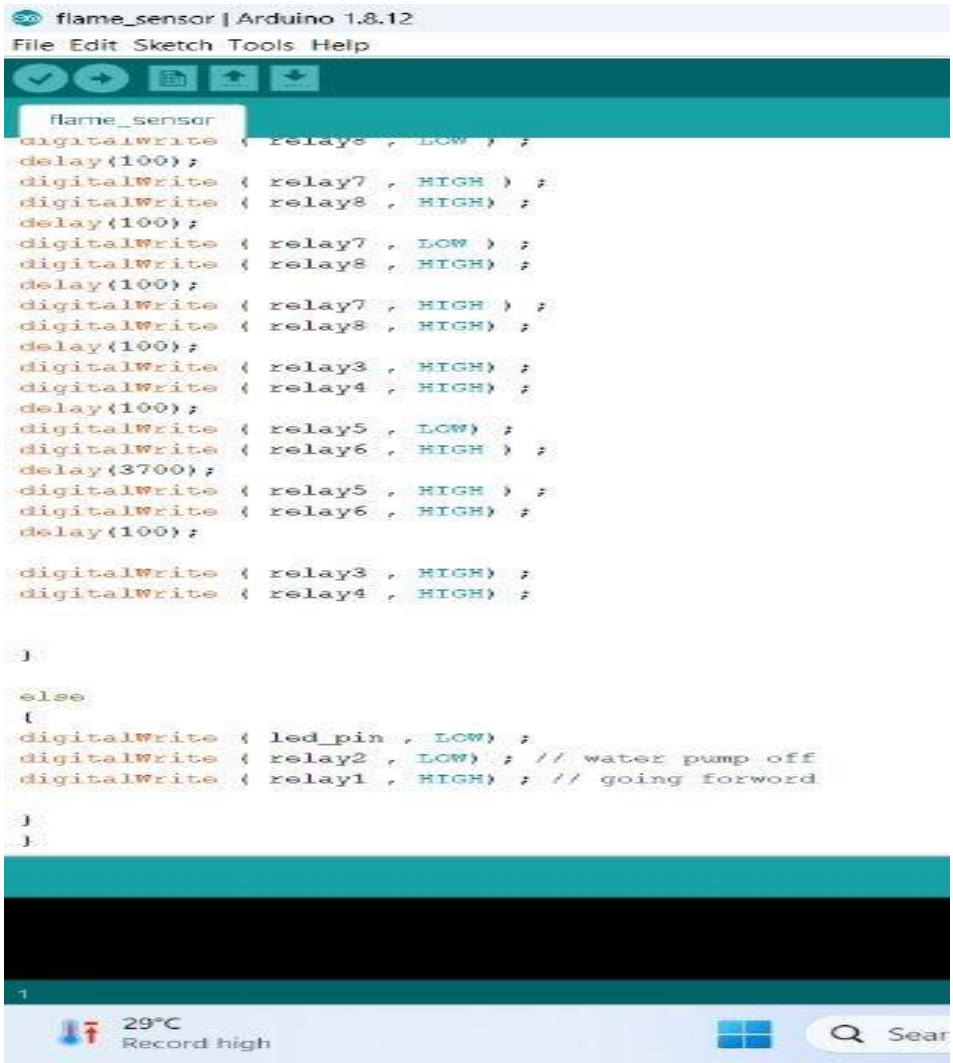



Fig 3.9 Arduino IDE a

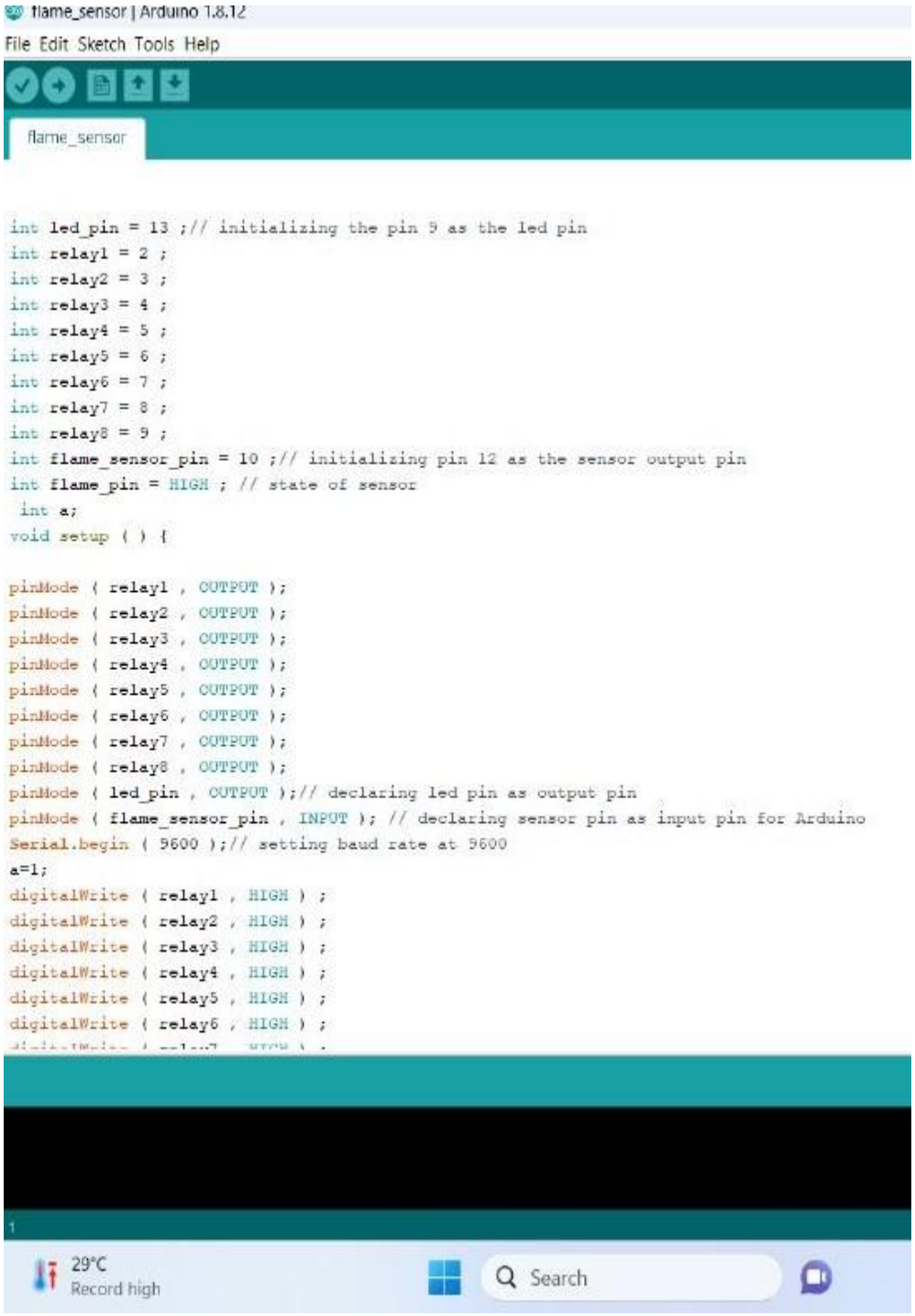



Fig 3.10 Arduino IDE b

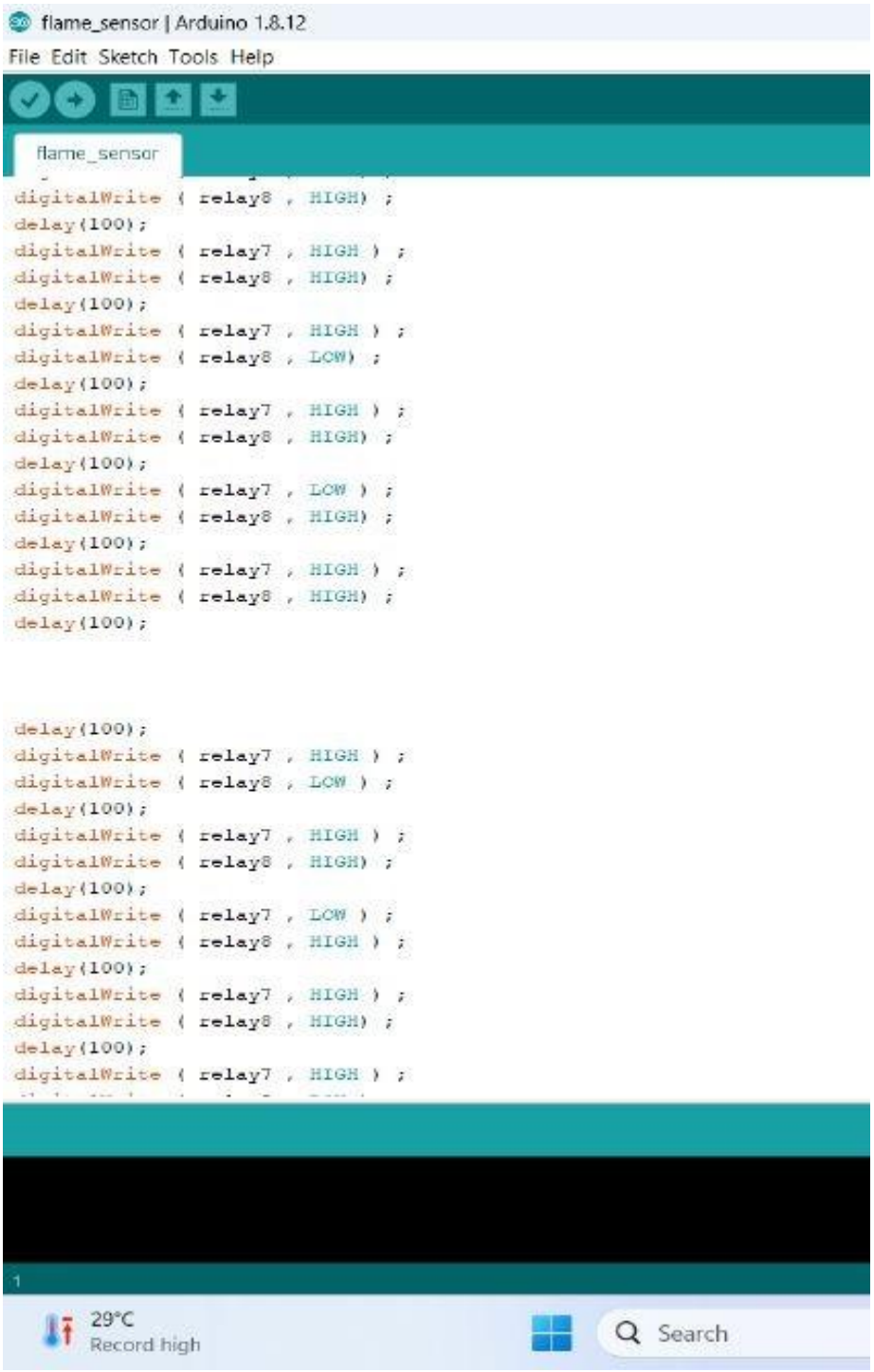



Fig 3.11 Arduino IDE c

## 3.5 Arduino Uno Code:

```
int led_pin = 13 ;// initializing the pin 9 as the led pin
int relay1 = 2 ;
int relay2 = 3 ;
int relay3 = 4 ;
int relay4 = 5 ;
int relay5 = 6 ;
int relay6 = 7 ;
int relay7 = 8 ;
int relay8 = 9 ;
int flame_sensor_pin = 10 ;// initializing pin 12 as the sensor output pin
int flame_pin = HIGH ; // state of sensor
 int a;
void setup ( ) {

pinMode ( relay1 , OUTPUT );
pinMode ( relay2 , OUTPUT );
pinMode ( relay3 , OUTPUT );
pinMode ( relay4 , OUTPUT );
pinMode ( relay5 , OUTPUT );
pinMode ( relay6 , OUTPUT );
pinMode ( relay7 , OUTPUT );
pinMode ( relay8 , OUTPUT );
pinMode ( led_pin , OUTPUT );// declaring led pin as output pin
pinMode ( flame_sensor_pin , INPUT ); // declaring sensor pin as input pin for
Arduino
Serial.begin ( 9600 );// setting baud rate at 9600
a=1;
digitalWrite ( relay1 , HIGH ) ;
digitalWrite ( relay2 , HIGH ) ;
digitalWrite ( relay3 , HIGH ) ;
digitalWrite ( relay4 , HIGH ) ;
digitalWrite ( relay5 , HIGH ) ;
digitalWrite ( relay6 , HIGH ) ;
digitalWrite ( relay7 , HIGH ) ;
digitalWrite ( relay8 , HIGH ) ;
}
```

```
void loop ( ) {

flame_pin = digitalRead ( flame_sensor_pin ) ;
if (flame_pin == LOW)
{


  digitalWrite ( led_pin , HIGH) ;
  digitalWrite ( relay1 , HIGH) ; // stop movinh forword
  digitalWrite ( relay2 , HIGH) ;
  //pump on
digitalWrite ( relay5 , HIGH ) ;
digitalWrite ( relay6 , LOW ) ;  // main arm
delay(4000);
digitalWrite ( relay5 , HIGH ) ;
digitalWrite ( relay6 , HIGH ) ;
delay(100);
digitalWrite ( relay3 , LOW ) ;
digitalWrite ( relay4 , HIGH) ;
delay(100);
digitalWrite ( relay7 , HIGH ) ;
digitalWrite ( relay8 , LOW ) ;
delay(100);
digitalWrite ( relay7 , HIGH ) ;
digitalWrite ( relay8 , HIGH) ;
delay(100);
digitalWrite ( relay7 , LOW ) ;
digitalWrite ( relay8 , HIGH ) ;
delay(100);
digitalWrite ( relay7 , HIGH ) ;
digitalWrite ( relay8 , HIGH) ;
delay(100);
digitalWrite ( relay7 , HIGH ) ;
digitalWrite ( relay8 , LOW ) ;
delay(100);
digitalWrite ( relay7 , HIGH ) ;
digitalWrite ( relay8 , HIGH) ;
delay(100);
digitalWrite ( relay7 , LOW ) ;
digitalWrite ( relay8 , HIGH) ;
delay(100);
digitalWrite ( relay7 , HIGH ) ;
```

```
digitalWrite ( relay8 , HIGH) ;
delay(100);
digitalWrite ( relay7 , HIGH ) ;
digitalWrite ( relay8 , LOW) ;
delay(100);
digitalWrite ( relay7 , HIGH ) ;
digitalWrite ( relay8 , HIGH) ;
delay(100);
digitalWrite ( relay7 , LOW ) ;
digitalWrite ( relay8 , HIGH) ;
delay(100);
digitalWrite ( relay7 , HIGH ) ;
digitalWrite ( relay8 , HIGH) ;
delay(100);
digitalWrite ( relay7 , HIGH ) ;
digitalWrite ( relay8 , LOW) ;
delay(100);
digitalWrite ( relay7 , HIGH ) ;
digitalWrite ( relay8 , HIGH) ;
delay(100);
digitalWrite ( relay7 , LOW ) ;
digitalWrite ( relay8 , HIGH) ;
delay(100);
digitalWrite ( relay7 , HIGH ) ;
digitalWrite ( relay8 , HIGH) ;
delay(100);

delay(100);
digitalWrite ( relay7 , HIGH ) ;
digitalWrite ( relay8 , LOW ) ;
delay(100);
digitalWrite ( relay7 , HIGH ) ;
digitalWrite ( relay8 , HIGH) ;
delay(100);
digitalWrite ( relay7 , LOW ) ;
digitalWrite ( relay8 , HIGH ) ;
delay(100);
digitalWrite ( relay7 , HIGH ) ;
digitalWrite ( relay8 , HIGH) ;
delay(100);
digitalWrite ( relay7 , HIGH ) ;
digitalWrite ( relay8 , LOW ) ;
```

```
delay(100);
digitalWrite ( relay7 , HIGH ) ;
digitalWrite ( relay8 , HIGH) ;
delay(100);
digitalWrite ( relay7 , LOW ) ;
digitalWrite ( relay8 , HIGH) ;
delay(100);
digitalWrite ( relay7 , HIGH ) ;
digitalWrite ( relay8 , HIGH) ;
delay(100);
digitalWrite ( relay3 , HIGH) ;
digitalWrite ( relay4 , HIGH) ;
delay(100);
digitalWrite ( relay5 , LOW) ;
digitalWrite ( relay6 , HIGH ) ;
delay(3700);
digitalWrite ( relay5 , HIGH ) ;
digitalWrite ( relay6 , HIGH) ;
delay(100);

digitalWrite ( relay3 , HIGH) ;
digitalWrite ( relay4 , HIGH) ;
}

else
{
digitalWrite ( led_pin , LOW) ;
digitalWrite ( relay2 , LOW) ; // water pump off
digitalWrite ( relay1 , HIGH) ; // going forword
}
}
```

# CHAPTER - 4

## 4.1 MATERIAL INFORMATION

### 4.1.1 Uses For Mild Steel

There are many different grades of steel, all of which can be summarised into a few key types of steel. One of these is **mild steel**, which has become an in-demand material in the past few years. This is due to its exceptional weldability and machinability, amongst other qualities. In this blog post, Baker Steel Trading's expert team of steel fabricators will outline the essential facts about the material, including how it's made and the uses for mild steel

### 4.1.2 What is Mild Steel?

**Mild steel** is a type of carbon steel that contains a low level of carbon. Otherwise known as low carbon steel, mild steel contains roughly between 0.05% and 0.25% of carbon by weight. This is opposed to high carbon steel, which can be composed of up to 2.5% carbon by weight. As mild steel doesn't contain large amounts of any elements other than iron and ferrite, it is not an alloy steel.

### The Properties of Low Carbon Steel

The particular composition of **mild steel** means that it has specific properties, which makes it ideally suited to certain types of projects which require steel fabrication.

### 4.1.3 Physical Properties of Mild Steel

The combination of materials that create low carbon steel gives the metal particular qualities that make it suitable for a variety of industrial projects and also make it a popular type of steel for steel fabrication companies to work with. Some of the physical properties of mild steel include:

Fig 4.1 Picture of Mild steel pipes

- **Ductile** – The low amount of carbon used to create mild steel and the absence of any alloying elements results in a very ductile product. This means that low carbon steel can be deformed and shaped without losing its toughness, making it a very pliable type of steel that can be used for various purposes.

- **Machinable and Weldable** – The ductile nature of mild steel also means that it is particularly suitable for various steel fabrication processes, including welding. The lower percentage of carbon that is within the steel, the more malleable that the steel becomes. Baker Steel Trading provide mobile welding services that you can request along with your mild steel order, so take a look at our services page for more information.

- **Affordable** – Mild steel requires very few resources and ingredients, so it is a particularly cost-effective type of steel, which many steel fabrication customers use to complete their industrial projects.

- **Magnetic** – A bonus quality that comes from the high amounts of iron and ferrite used to create mild steel bars is that they are magnetic. Keep this in mind when deciding which type of steel to request when ordering from steel suppliers such as Baker Steel Trading.

- **Machinery Parts** – One of the most desirable traits of low carbon steel is its malleability, which makes it ideally suited to use during the creation of steel sheets within car body kits, along with other machinery elements.
- **Pipelines** – Mild steel tubes are a popular choice when looking to create steel pipes for various projects. This is due to their excellent ductility, making the pipes easily weldable whilst being flexible enough to not break under pressure. These pipes can also be insulated to maintain their performance in colder weather, helping to boost the long term quality of the pipework.
- **Structural Steel** – Low carbon steel can be used for situations that require structural steel fabrication, as it has a very consistent yield strength and is also easier to shape. Due to these qualities and the metals cost-effectiveness, mild steel can be preferable to structural steel in smaller structural applications.

**Stress Strain Curve**

When steel is curved, it is important to keep the stress-strain curve ratio for mild steel in mind. Below is a stress-strain graph that reviews the properties of steel in detail.

If tensile force is applied to a steel bar, it will have some elongation. If the force is small enough, the ratio of the stress and strain will remain proportional. This can be seen in the graph as a straight line between zero and point A – also called the **limit of proportionality**. If the force is greater, the material will experience elastic deformation, but the ratio of stress and strain will not be proportional. This is between points A and B, known as the elastic limit.

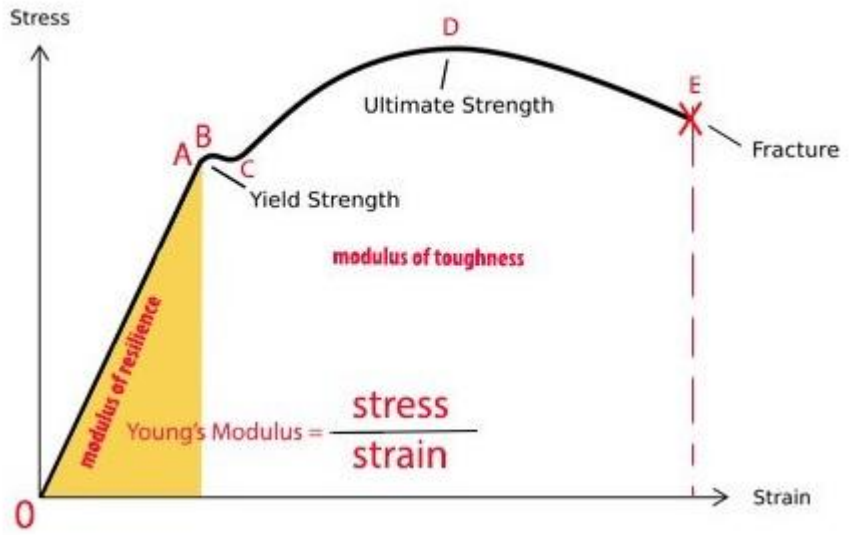



Fig 4.2 Stress-Strain curve of Mild steel

Beyond the elastic limit, the mild steel will experience plastic deformation. This starts the yield point – or the rolling point – which is point B, or the upper yield point. As seen in the graph, from this point on the correlation between the stress and strain is no longer on a straight trajectory. It curves from point C (lower yield point), to D (maximum ultimate stress), ending at E (fracture stress).

Now, we'll look at each individual measure on the graph above and explain how each is derived.

- **Stress**: If an applied force causes a change in the dimension of the material, then the material is in the state of stress. If we divide the applied force (F) by the cross-sectional area (A), we get the stress.

The symbol of stress is σ (Greek letter sigma). For tensile (+) and compressive (-) forces. The standard international unit of stress is the pascal (Pa), where 1 Pa = 1 $N/m^2$. The formula to derive the stress number is $\sigma = F/A$.

For tensile and compressive forces, the area taken is perpendicular to the applied force. For sheer force, the area is taken parallel to the applied force. The symbol for shear stress is tau (τ).

- **Strain:** Strain is the change in the dimension ($L-L_0$) with respect to the original. It is denoted by the symbol epsilon (ε). The formula is $\varepsilon = (L-L_0) / L_0$. For a shear force, strain is expressed by γ (gamma)

- **Elasticity:** Elasticity is the property of the material which enables the material to return to its original form after the external force is removed.

- **Plasticity:** This is a property that allows the material to remain deformed without fracture even after the force is removed.

The definitions below are important for understanding the Stress-Strain interactions as seen in the graph.

**4.2 *Hooke's* Law:** Within the proportional limit (straight line between zero and A), strain is proportionate to stress.

**4.3 Young's modulus of elasticity:** Within the proportional limit, stress = E × strain. E is a proportionality constant known as the modulus of elasticity or Young's modulus of elasticity. Young's modulusis a measure of the ability of a material to withstand changes in length when under lengthwise tension or compression. E has the same unit as the unit of stress because the strain is dimensionless. The formula is $E = \sigma / \varepsilon$ Pa.

**4.4 Modulus of Resilience**: The area under the curve which is marked by the yellow area. It is the energy absorbed per volume unit up to the elastic limit. The formula for the modulus of resilience is $1/2 \times \sigma \times \varepsilon = 0.5 \times (FL/AE)$.

**4.5 Modulus of toughness**: This is the area of the whole curve (point zero to E). Energy absorbed at unit volume up to breaking point.

# CHAPTER - 5

## 5.1 Components of the project

### 5.1.1 DC motor

A **DC motor** is any of a class of rotary electrical motors that converts direct current (DC) electrical energy into mechanical energy. The most common types rely on the forces produced by induced magnetic fields due to flowing current in the coil. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current in part of the motor.

DC motors were the first form of motors widely used, as they could be powered from existing direct-current lighting power distribution systems. A DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field windings. Small DC motors are used in tools, toys, and appliances. The universal motor, a lightweight brushed motor used for portable power tools and appliances can operate on direct current and alternating current. Larger DC motors are currently used in propulsion of electric vehicles, elevator and hoists, and in drives for steel rolling mills. The advent of power electronics has made replacement of DC motors with AC motors possible in many applications.

**1. Application of DC Series motor**

- Cranes.
- Air compressor.
- Lifts.
- Elevators.
- Winching system.
- Electric traction.
- Hair drier.
- Vacuum cleaner and in speed regulation application.

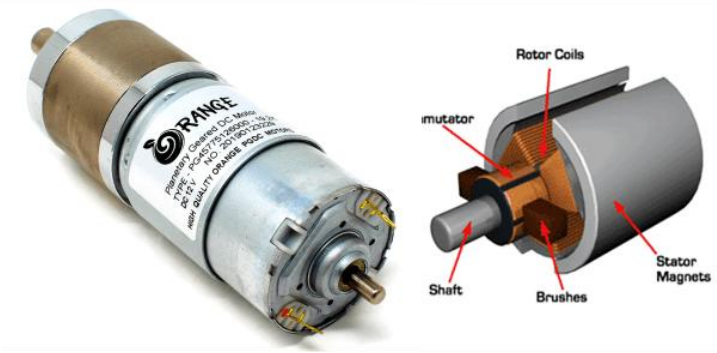



Fig 5.1 DC Motor and Construction

### 5.1.2 Johnson DC electric motor

Johnson DC electric motor. The Johnson motor uses a stationary permanent magnet and a rotating coil as the armature. Voltage switching is accomplished by the commutator on one end of the coil. When the coil is energized a magnetic field is induced in the coil. This magnetic field reacts with the magnetic field of the permanent magnet creating a torque. The torque causes the coil to rotate to align with the magnet. Inertia causes the coil to continue in the direction of rotation.

Fig 5.2 Johnson DC electric motor

Description:

The Johnson Geared Motor gives very good torque at an affordable price hence they are widely applicable in Pan/Tilt camera, auto shutter, welding machines, water meter IC card, grill, oven, cleaning machine garbage disposers, household appliances, slot machines, money detector, automatic actuator, coffee machine, towel disposal, lighting coin refund devices, the peristaltic pump and so on. Also, they are best suitable with highly developing capable robots or robotic platform, various automation purposes.

Features:

10RPM 12V DC motors with Metal Gearbox

18000 RPM base motor

6mm shaft diameter

Gearbox diameter 37 mm.

Motor Diameter 28.5 mm

Length 63 mm without shaft

Shaft length 15mm

300gm weight

10kgcm torque

No-load current = mA(Max), Load current = uptoÂ 9.5 A(Max)

### 5.1.3 Horizontal Mini Micro Submersible Motor Pump New Water Pumps DC 3-5V

### 1. Description:

New arrived mini pump, delicate and light, very perfect for experiment, aquarium, fish tank and fountain etc. Make the water level higher than the pump, too low water level may cause high temperature and noise of the pump. Item only includes the pump without power supply , please adapt it to 3V~4.5V power supply. Please allow some error due to manual measurement. Thanks for your understanding. Monitors are not calibrated same, item color displayed in photos may be showing slightly different from the real object. Please take the real one as standard.

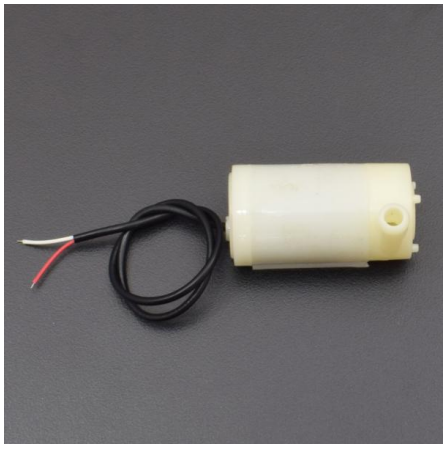


Fig 5.3 Submersible motor pump

**2. Specifications:**

Rated Voltage: 3.0 VDC

Operating Voltage: 2.5-6V dc

Rated Current: 60mA – 90 mA @ Rated Voltage

Operating Temp Range: -20 °C ~ +60 °C

Mechanical Noise: 50 dB(A) Max

Rated Speed: 9,000 RPM / 150Hz @ Rated Voltage

Rotation: CW and CCW

Dimensions: 12.0mm (diameter) x 2.8 mm (thickness: including sticky tape)

Wire Length: ~13mm cm

**3. Features:**

Micro mini submersible water pump 3v to 6v

DC water pump for DIY

DC pump for HOBBY kit

Applications:

Controlled fountain water flow

Controlled Garden watering systems

Hydroponic Systems

Fresh water intake or exhaust systems for fish aquarium

### 5.1.4 L298 Motor Driver Circuit Board

**1. Product description**

This is a high-power motor driver module for driving DC and stepper motors. This module consists of an L298 motor driver IC and a 78M05 5V regulator. It can control up to 4 DC motors, or 2 DC motors with directional and speed control. It is designed to provide bidirectional drive currents of up to 4A at voltages from 2.5 V to 46 V.

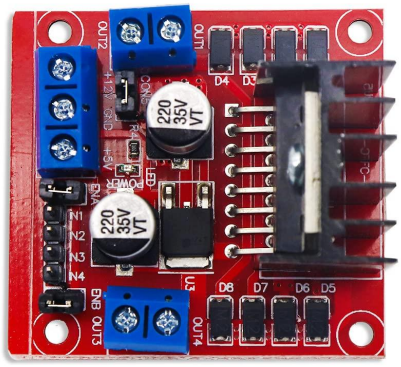



Fig 5.4 Motor driver circuit board

### 2. Features

Driver module : L298

Driver chip : Double H bridge

Motor supply voltage (Max.): 46V

Motor supply current (Max.): 2A

Logic voltage :  5V

## 5.1.5 Flame Sensor

### 1. Product Description

This tiny Flame sensor infrared receiver module ignition source detection module is Arduino compatible can use to detect flame or wavelength of the light source within 760nm~1100nm also useful for Lighter flame detect at the distance 80cm.

Greater the flame, farther the test distance. It has the Detect angle of 60 and very sensitive to flame spectrum.

It produces the one channel output signal at the D0 terminal for further processing like an alarm system or any switching system. The sensitivity is adjustable with the help of blue potentiometer given on the board.

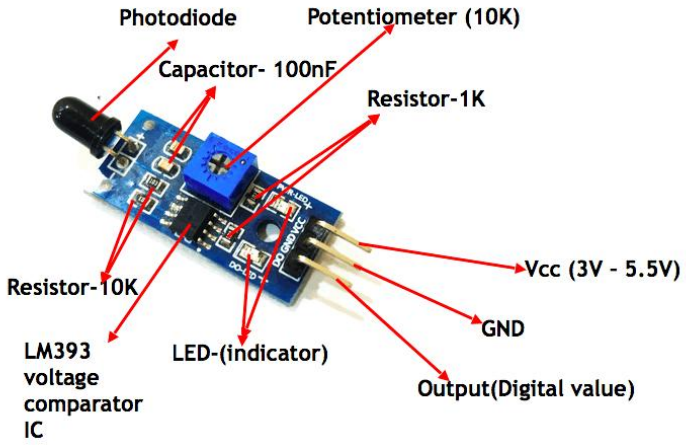



Fig 5.5 Flame Sensor Construction

## 2. Features :

1. Indicator light: a green one for the switch, a red one for power.
2. Built in a potentiometer for sensitivity control.
3. Onboard signal output indication, output effective signal is high, at the same time the indicator light up, the output signal can directly connect to microcontroller IO.
4. Can detect fire or wavelength in 760 ~ 1100 nm nano within the scope of the light source.
5. Detection angle about 60 degrees, the flame spectrum especially sensitive.
6. The flame of the most sensitive sensors flame, the regular light is also a response, generally used for fire alarm purposes.

## 3.Specifications :-

| | |
|---|---|
| Output Channel | 1 |
| Operating Voltage (VDC) | 3.3 ~ 5 |
| Mounting Hole(mm) | 3 |
| Length (mm) | 32 |
| Width (mm) | 14 |
| Weight (gm) | 3 |

### 5.1.6 12V 55 Rpm Windscreen Wiper Motor

## 1. Description

12V high powered DC motor can be used for windscreen wiper motor of various autos. Also, the motor is suitable for various land robots and high-powered projects

Motor speed is 55 Rpm.

There are 3 6mm screw hole for immobilizing.

Fig 5.6 Windscreen wiper motor

## 2. Features:

Motor Operation Voltage:12V

Speed: 55 Rpm

No load current: 2A

Stall current: 10A

Stall Torque: 45 kg-cm

Motor Power: 120W

Shaft diameter: 10mm

Shaft dimension: 29mm

Weight:1280gr

### 5.1.7 Arduino UNO Board

## 1. What is an Arduino?

## 2. Introduction

Arduino is an open-source platform used for building electronics projects. Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (Integrated Development Environment) that runs on your computer, used to write and upload computer code to the physical board.

The Arduino platform has become quite popular with people just starting out with electronics, and for good reason. Unlike most previous programmable circuit boards, the Arduino does not need a separate piece of hardware (called a programmer) in order to load new code onto the board -- you can simply use a USB cable. Additionally, the Arduino IDE uses a simplified version of C++, making it easier to learn to program. Finally, Arduino provides a standard form factor that breaks out the functions of the micro-controller into a more accessible package.

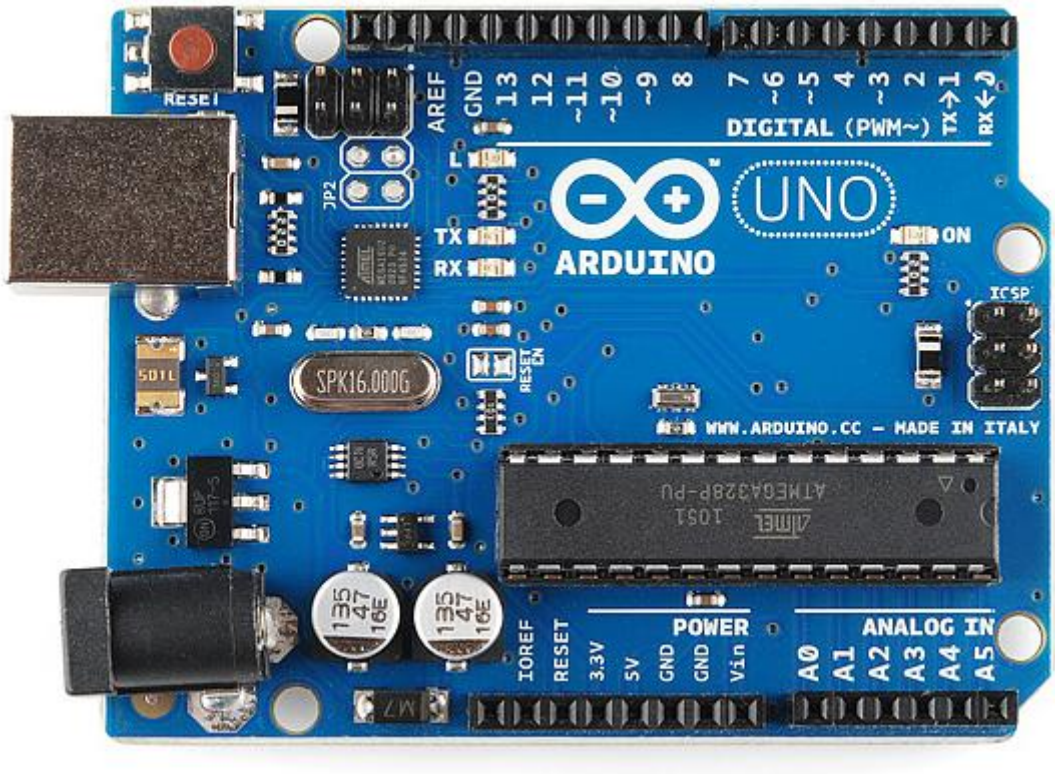



Fig 5.7 Arduino UNO board

The Uno is one of the more popular boards in the Arduino family and a great choice for beginners. We'll talk about what's on it and what it can do later in the tutorial.

3.What's on the board?

There are many varieties of Arduino boards (explained on the next page) that can be used for different purposes. Some boards look a bit different from the one below, but most Arduinos have the majority of these components in common:

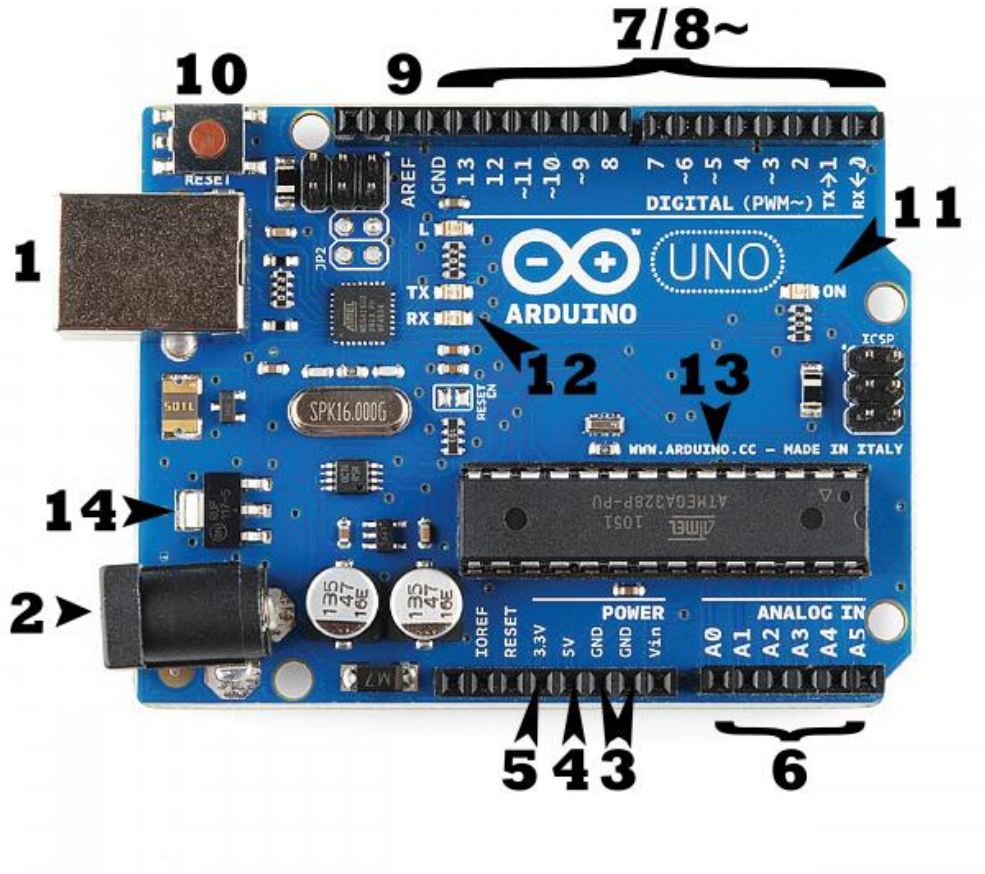



Fig 5.8 Arduino UNO Digital and Analog pins

Power (USB / Barrel Jack)

Every Arduino board needs a way to be connected to a power source. The Arduino UNO can be powered from a USB cable coming from your computer or a wall power supply (like this) that is terminated in a barrel jack. In the picture above the USB connection is labeled **(1)** and the barrel jack is labeled **(2)**.

The USB connection is also how you will load code onto your Arduino board. More on how to program with Arduino can be found in our Installing and Programming Arduino tutorial.

**NOTE:** Do NOT use a power supply greater than 20 Volts as you will overpower (and thereby destroy) your Arduino. The recommended voltage for most Arduino models is between 6 and 12 Volts.

Pins (5V, 3.3V, GND, Analog, Digital, PWM, AREF)

The pins on your Arduino are the places where you connect wires to construct a circuit (probably in conjuction with a breadboard and some wire. They usually have black plastic 'headers' that allow you to just plug a wire right into the board. The Arduino has several different kinds of pins, each of which is labeled on the board and used for different functions.

- **GND (3)**: Short for 'Ground'. There are several GND pins on the Arduino, any of which can be used to ground your circuit.
- **5V (4) & 3.3V (5)**: As you might guess, the 5V pin supplies 5 volts of power, and the 3.3V pin supplies 3.3 volts of power. Most of the simple components used with the Arduino run happily off of 5 or 3.3 volts.
- **Analog (6)**: The area of pins under the 'Analog In' label (A0 through A5 on the UNO) are Analog In pins. These pins can read the signal from an analog sensor (like a temperature sensor) and convert it into a digital value that we can read.
- **Digital (7)**: Across from the analog pins are the digital pins (0 through 13 on the UNO). These pins can be used for both digital input (like telling if a button is pushed) and digital output (like powering an LED).
- **PWM (8)**: You may have noticed the tilde (~) next to some of the digital pins (3, 5, 6, 9, 10, and 11 on the UNO). These pins act as normal digital pins, but can also be used for something called Pulse-Width Modulation (PWM). We have a tutorial on PWM, but for now, think of these pins as being able to simulate analog output (like fading an LED in and out).
- **AREF (9)**: Stands for Analog Reference. Most of the time you can leave this pin alone. It is sometimes used to set an external reference voltage (between 0 and 5 Volts) as the upper limit for the analog input pins.

Reset Button

Just like the original Nintendo, the Arduino has a reset button **(10)**. Pushing it will temporarily connect the reset pin to ground and restart any code that is loaded on the Arduino. This can be very useful if your code doesn't repeat, but

you want to test it multiple times. Unlike the original Nintendo however, blowing on the Arduino doesn't usually fix any problems.

Power LED Indicator

Just beneath and to the right of the word "UNO" on your circuit board, there's a tiny LED next to the word 'ON' **(11)**. This LED should light up whenever you plug your Arduino into a power source. If this light doesn't turn on, there's a good chance something is wrong. Time to re-check your circuit!

TX RX LEDs

TX is short for transmit, RX is short for receive. These markings appear quite a bit in electronics to indicate the pins responsible for serial communication. In our case, there are two places on the Arduino UNO where TX and RX appear -- once by digital pins 0 and 1, and a second time next to the TX and RX indicator LEDs **(12)**. These LEDs will give us some nice visual indications whenever our Arduino is receiving or transmitting data (like when we're loading a new program onto the board).

Main IC

The black thing with all the metal legs is an IC, or Integrated Circuit **(13)**. Think of it as the brains of our Arduino. The main IC on the Arduino is slightly different from board type to board type, but is usually from the ATmega line of IC's from the ATMEL company. This can be important, as you may need to know the IC type (along with your board type) before loading up a new program from the Arduino software. This information can usually be found in writing on the top side of the IC. If you want to know more about the difference between various IC's, reading the datasheets is often a good idea.

Voltage Regulator

The voltage regulator **(14)** is not actually something you can (or should) interact with on the Arduino. But it is potentially useful to know that it is there and what it's for. The voltage regulator does exactly what it says -- it controls the amount of voltage that is let into the Arduino board. Think of it as a kind of gatekeeper; it will turn away an extra voltage that might harm the circuit. Of course, it has its limits, so don't hook up your Arduino to anything greater than 20 volts.

## 4.Flame sensor

The flame sensor module has a total of 4 pins. Two power pins and two signal pins. The **pinout of a flame sensor module** is as follows:

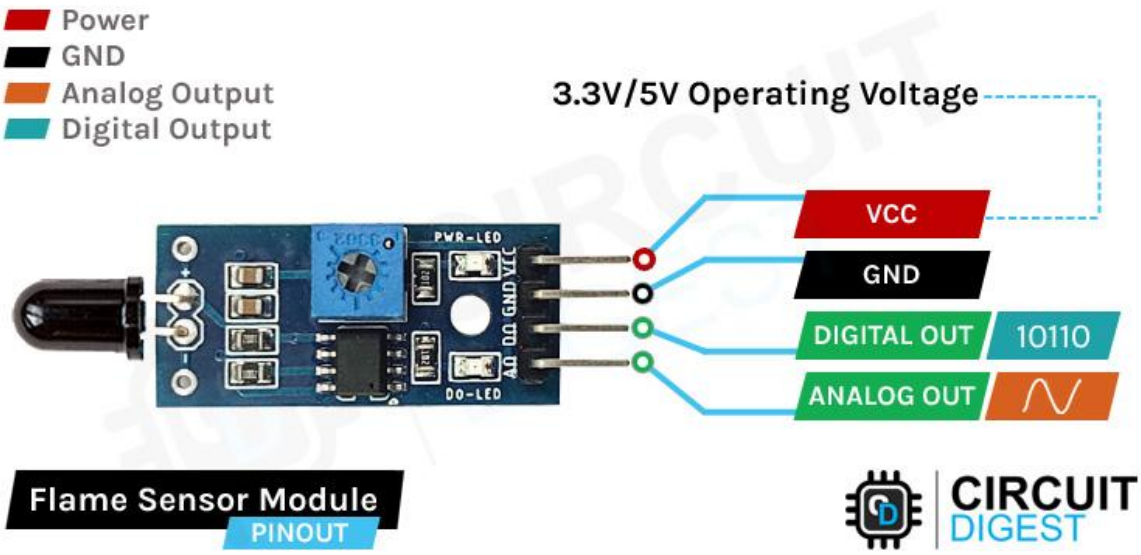



Fig 5.9 Flame sensor pin diagram

VCC Provides power for the module, Connect to the 5V pin of the Arduino.

GND Ground Connected to Ground pin of the Arduino.

DO Digital Output Pin.

AO Analog Output Pin.

### 4.Flame Sensor Module Parts

The flame sensor module has only very few components, which include an IR photodiode, an LM393 comparator IC, and some complimentary passive components. The power LED will light up when the module is powered and the D0 LED will turn off, when a flame is detected. The sensitivity can be adjusted with the trimmer resistor onboard.

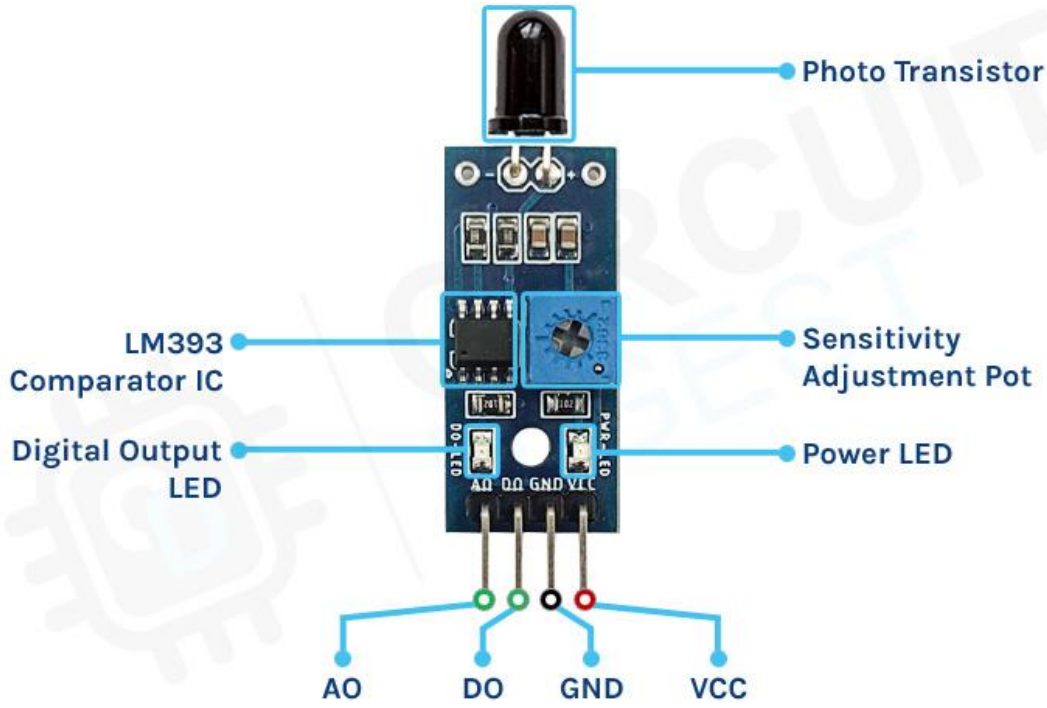



Fig 5.10 Flame sensor element

**Commonly Asked Questions about Flame Sensor**

**How does a flame sensor work?**

The flame sensor works based on infrared radiation. The IR photodiode will detect the IR radiation from any hot body. This value is then compared with a set value. Once the radiation reaches the threshold value, the sensor will change its output accordingly.

**What does the flame sensor detect?**

This type of flame sensor detects Infrared radiation.

**Where are flame sensors used?**

The flame sensors are used where ever there is a chance for a fire. Especially in industrial areas.

**5.Flame Sensor Module Circuit Diagram**

The schematic diagram for the flame sensor module is given below. As mentioned earlier, the board has a very low component count. The main components are the IR photodiode and the comparator circuit.

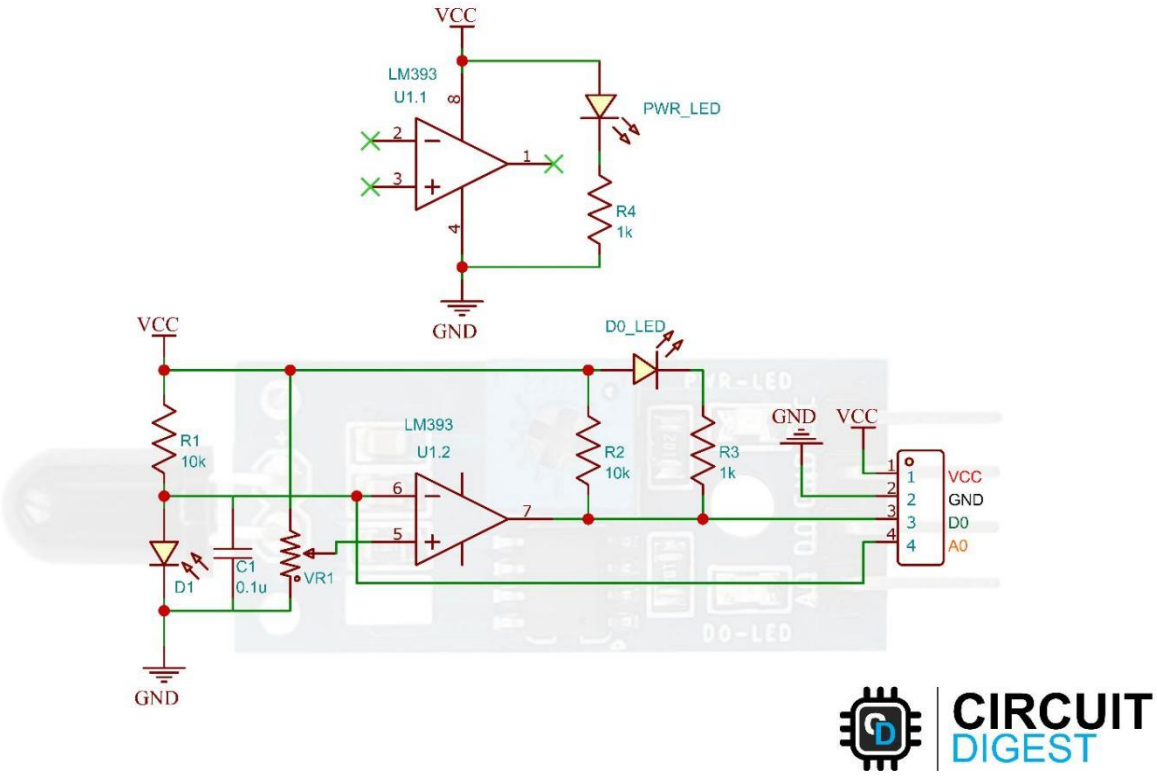



Fig 5.11 Flame sensor circuit diagram

**6.How does the Flame Sensor Module Works?**

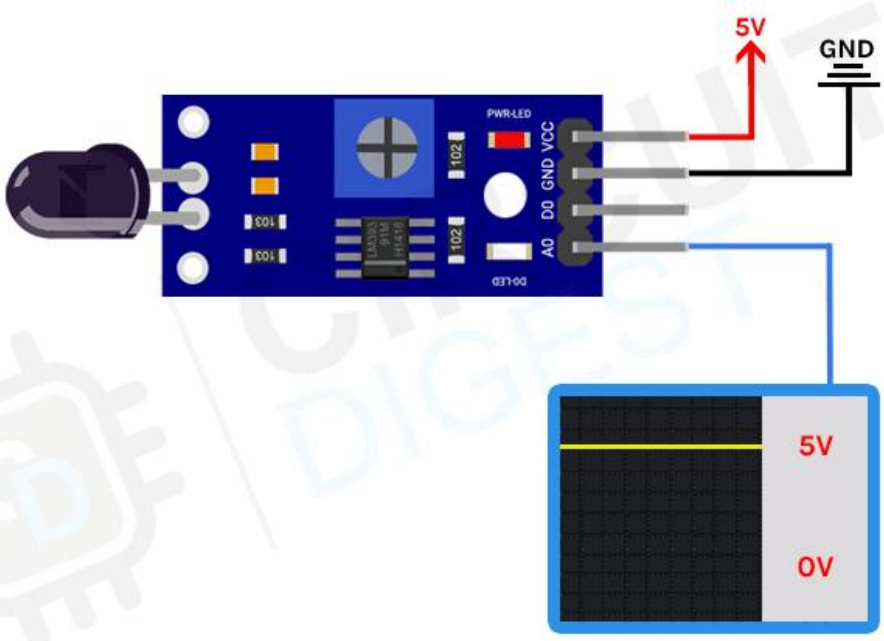



Fig 5.12 Flame Sensor Construction

The working of the flame sensor module is simple. The theory behind it is that a hot body will emit infrared radiation. And for a flame or fire, this radiation will be high. We will detect this IR radiation using an infrared photodiode. The conductivity of the photodiode will vary depending on the IR radiation it detects. We use an LM393 to compare this radiation and when a threshold value is reached the digital output is changed.


Fig 5.13 Flame sensor LED

We can also use the analog output to measure the IR radiation intensity. The analog output is directly taken from the terminal of the photodiode. The onboard D0 LED will show the presence of fire when detected. The sensitivity can be changed by adjusting the variable resistor on board. This can be used to eliminate false triggering.

# CHAPTER- 6

## 6.1Actual Assembly of the Project

### 6.1.1 Wheel and Bottom DC motor Assembly

Fig 6.1 Rear wheel

Fig 6.2 Front wheel

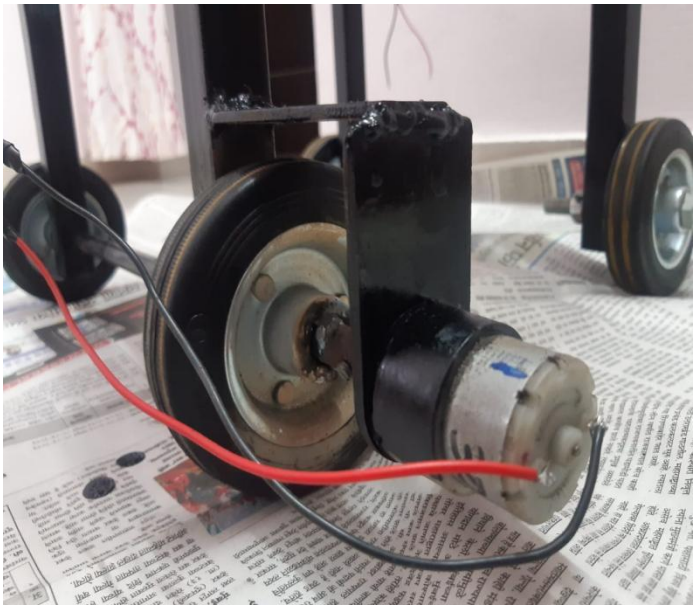


Fig 6.3 Front DC Motor wheel assembly

### 6.1.2 Wiper motor Assembly

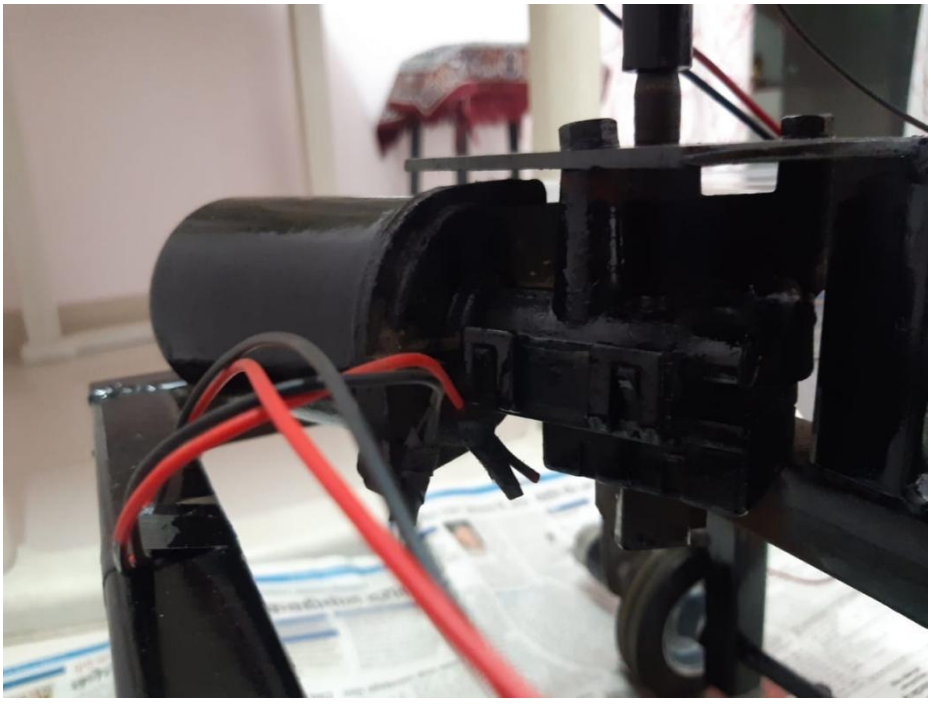


Fig 6.4 Wiper Motor assembly

### 6.1.3 Nozzle and Spray motor Assembly

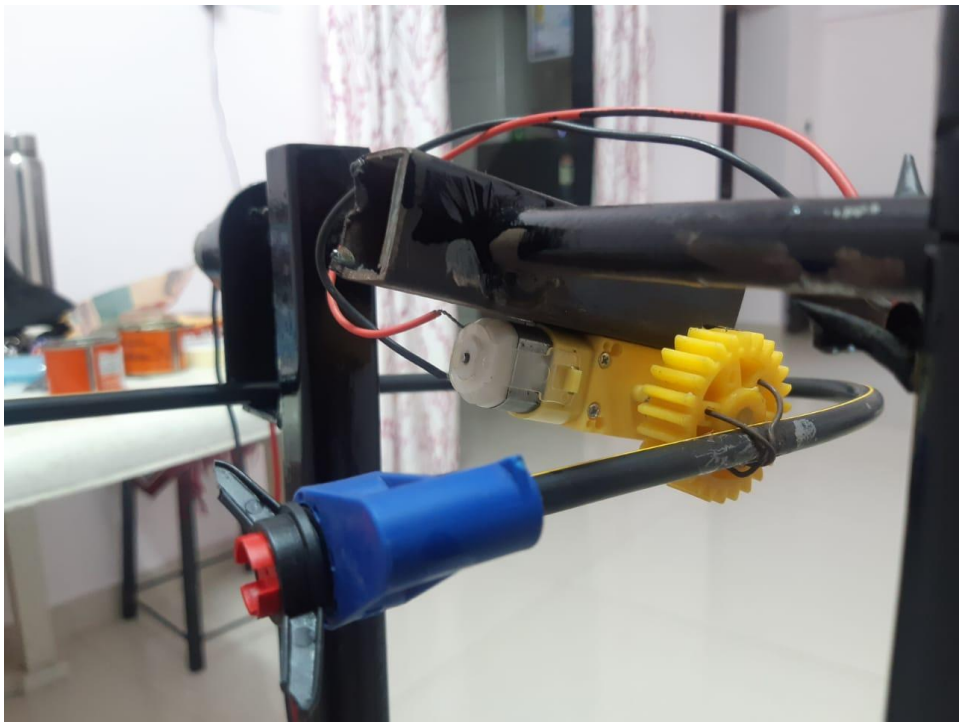


Fig 6.5 Nozzle and Spray Motor Mechanism 1

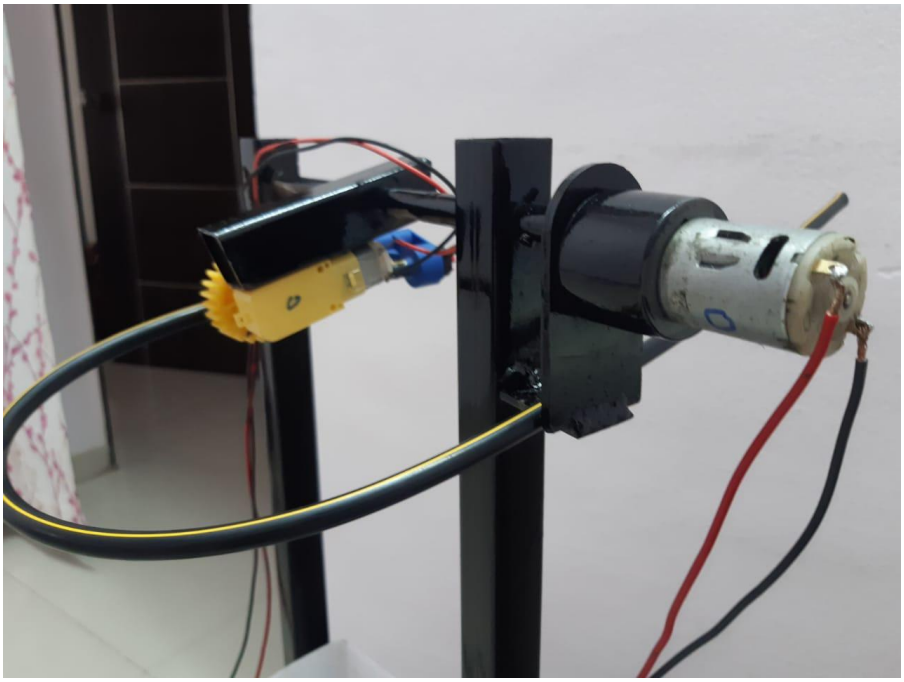


Fig 6.6 Nozzle and Spray Motor Mechanism 2

### 6.1.4 Arduino and Motor Driver Assembly

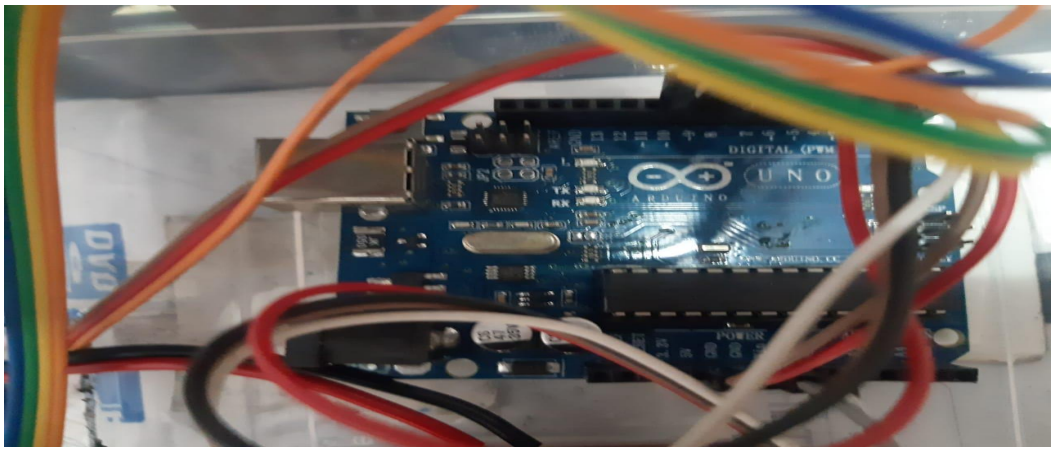



Fig 6.7 Arduino UNO board

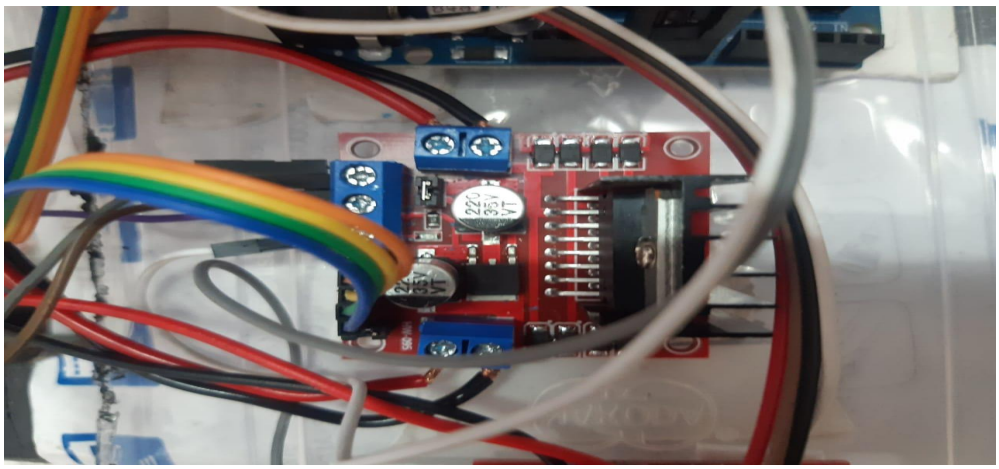


Fig 6.8 Motor driver 1 (Front DC motor, Wiper motor, Spray shaft motor)

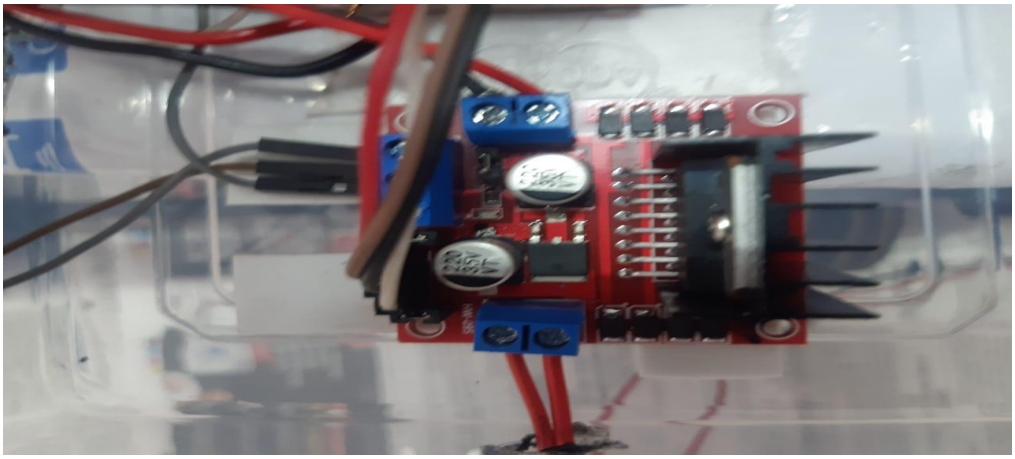


Fig 6.9 Motor driver 2 (submersible pump and spray motor)

### 6.1.5 Water tank and Submersible pump motor Assembly

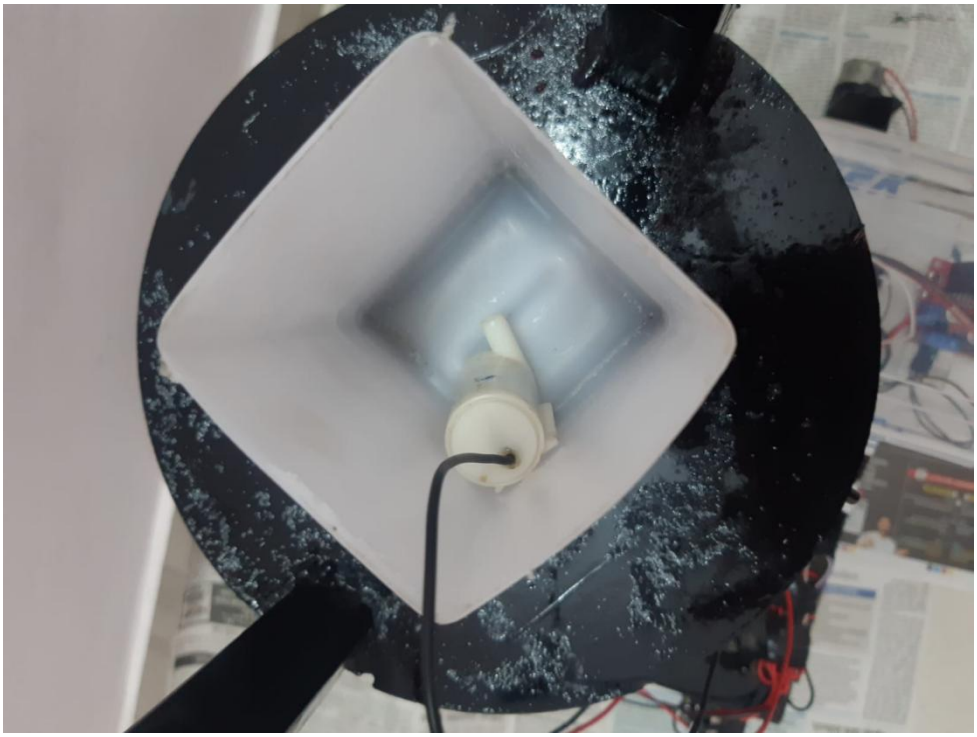


Fig 6.10 Water Tank and submersible pump motor

### 6.1.6 Complete project Assembly

Fig 6.11 Bottom square frame assembly

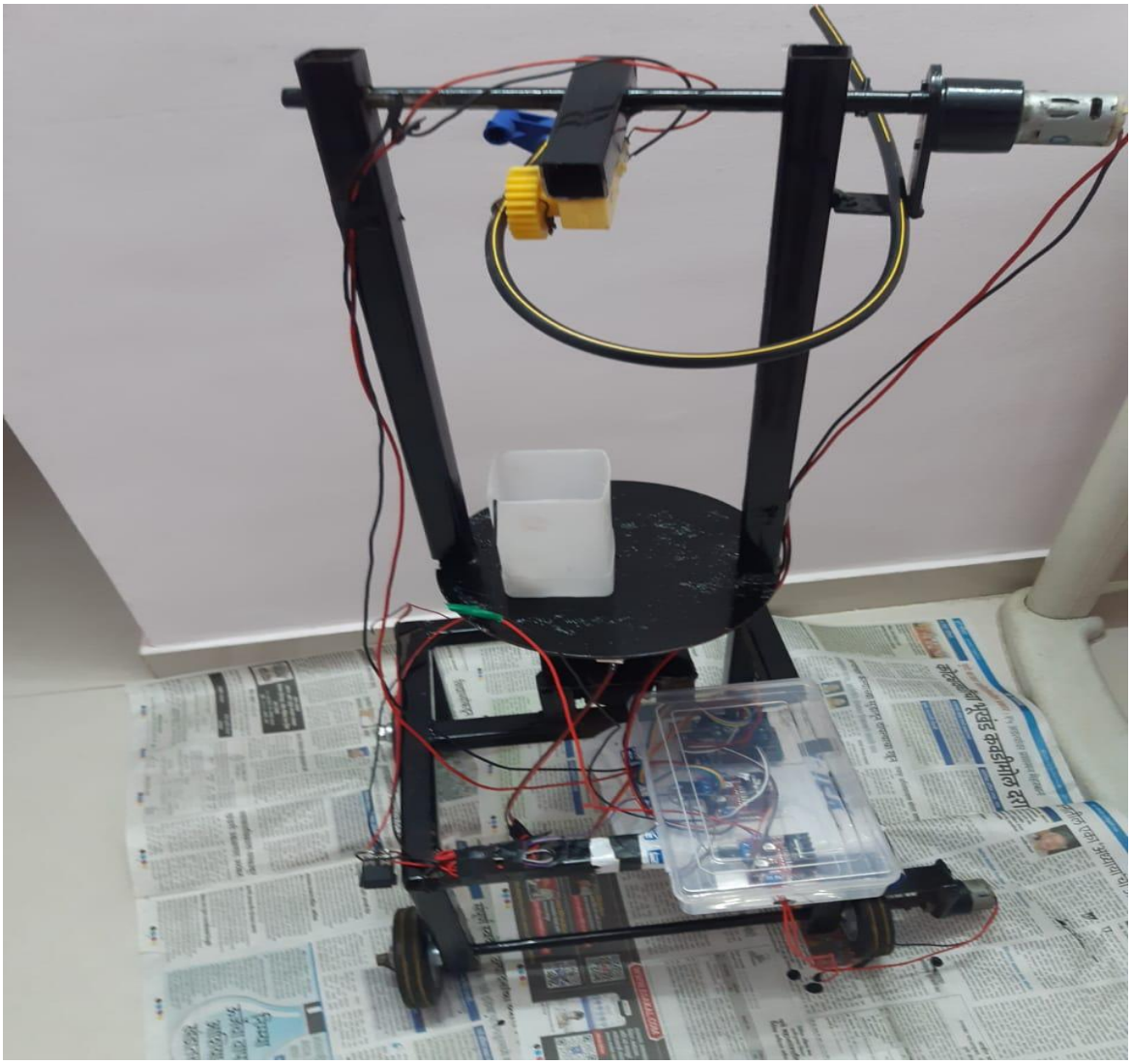


Fig 6.12 Complete project assembly 1

Fig 6.13 Complete project assembly 2

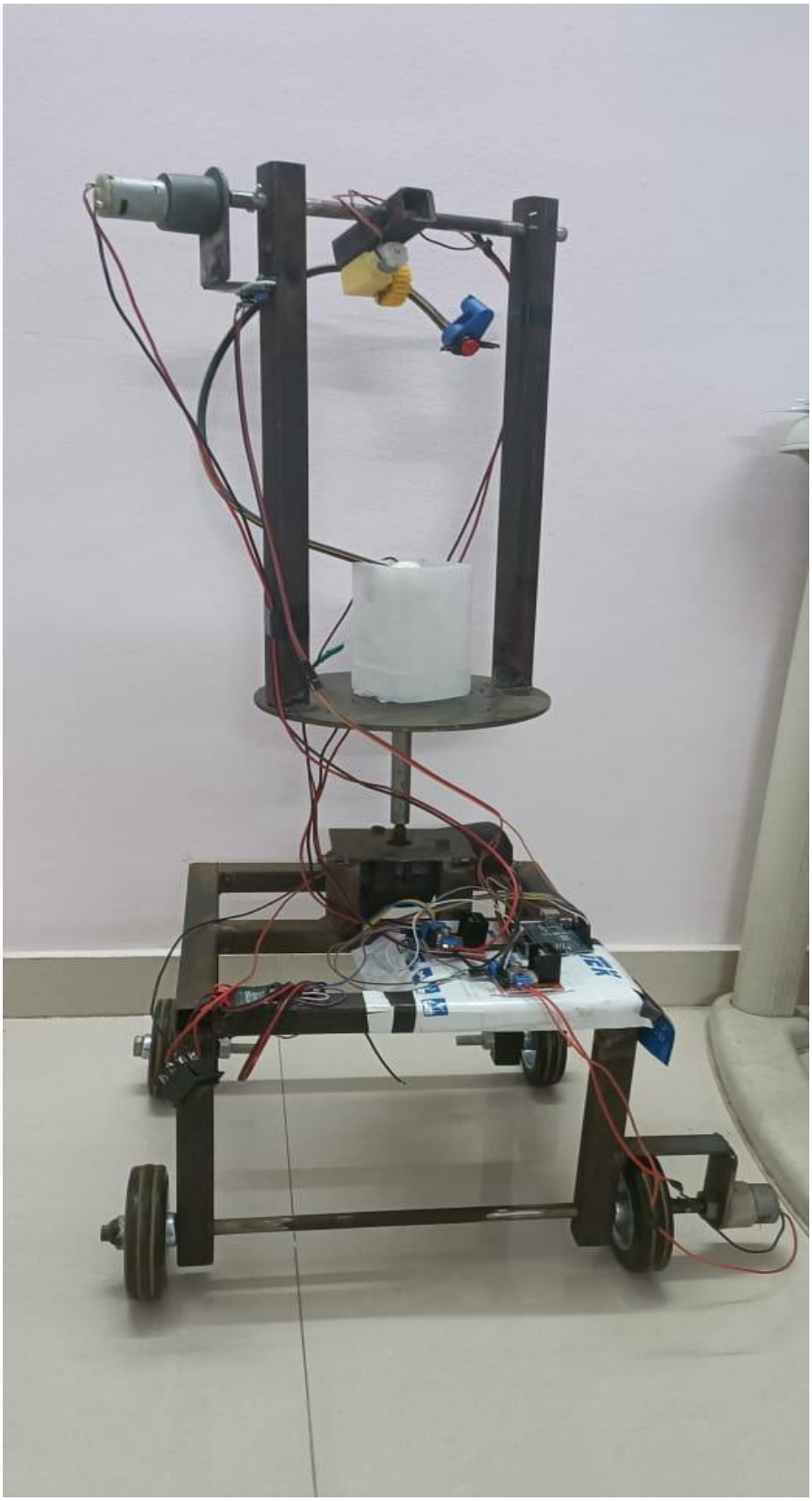


Fig 6.14 Complete project assembly 3

# CHAPTER - 7

## 7.1 CONCLUSION

Our project achieves our mission of providing quick responsive action towards any fire outbreak without any human involvement. This robot is cheap compared to other robots which also aligns with our goal to provide affordable safety equipment for all. Homes , Hospitals and Factories are safer with the installation of this robot. It is a modern way of fighting fire outbreaks

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# CHAPTER - 8

# RESEARCH PAPER

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# Arduino-Based Emergency Unmanned Fire Protection System

Atharva Choudhari[1], Dwarkesh Virkhare[2], Sarvesh Kaledhonkar[3], Prof. Mr. D.S. Patil[4]
*Mechanical Engineering Department, Pune Vidyarthi Griha's College of Engineering and Technology and G.K. Pate (Wani) Institute of Management, Pune*

***Abstract:*** ***The safety of a person's home, workplace, factory, and other structures is crucial. We create a fire-fighting robot that can be operated via a semiautomatic control. The highest source is the destructive damage that electrical energy causes. It is because our security system can't alert us to unusual or harmful situations. Additionally, it is challenging for the user to identify minor burns caused by electrical appliances. When using an automatic water cannon, the user might take some extra time to do things like locate a water source. Small charred areas and locations that are difficult for users to access, even with automatic water cannons, might make a fire difficult to detect. In order to control the water cannon for the intelligent building, a "semiautomatic water Canon (movable) for fire extinguishing using Arduino" was designed. This robot is able to sense the fire flames in the region where a fire is occurring and will automatically spray water in that direction.***

***Keywords: Semiautomatic water cannon, Arduino***

## I. INTRODUCTION

Rescue and firefighting operations are thought to be particularly risky undertakings. Rescue and evacuation of injured firemen and bystanders from hazardous buildings are dangerous. Because they frequently lack prior understanding of the infrastructure of dangerous buildings, firemen can face significant obstacles when trying to enter the building, activate the automatic water cannon, and identify civilians. A lot of firemen have been hurt while doing their tasks, such as using automatic water cannons and rescuing individuals, because they are exposed to major threats on the job, including flames, heat, and high levels of CO or CO2. The safety of a person's home, workplace, factory, and other structures is crucial. We create a fire-fighting robot that can be operated via a remote control. The highest source is the destructive damage that electrical energy causes. It's because our security system can't alert us to unusual or harmful situations. Additionally, it was challenging for the user to identify the minor burns caused by electrical appliances. When using an automatic water cannon, the user might take some extra time to do things like locate a water source. Small charred areas and locations that are difficult for users to access, even with automatic water cannons, might make a fire difficult to detect. In order to control the water canon for the intelligent building, "automated water Canon (movable) for fire extinguishing" was designed. This robot will move to the region where a fire is occurring and will automatically spray water in that direction.

### *A. Problem Statement*

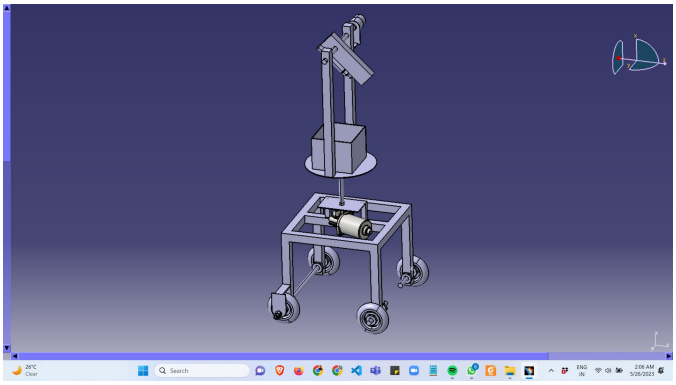
Rescue and firefighting efforts are regarded as extremely hazardous tasks. Rescuing and evacuating injured firemen and regular citizens from hazardous buildings is risky. Because they frequently lack prior understanding of the infrastructure of hazardous buildings, firefighters can encounter significant difficulties entering these structures to utilize automatic water cannons and identify civilians. On the job, firefighters are exposed to dangerous hazards like fires, heat, high levels of CO or CO2, as well as physical and emotional stress. Many firefighters have suffered injuries while doing routine tasks like using automatic water cannons and rescuing bystanders.

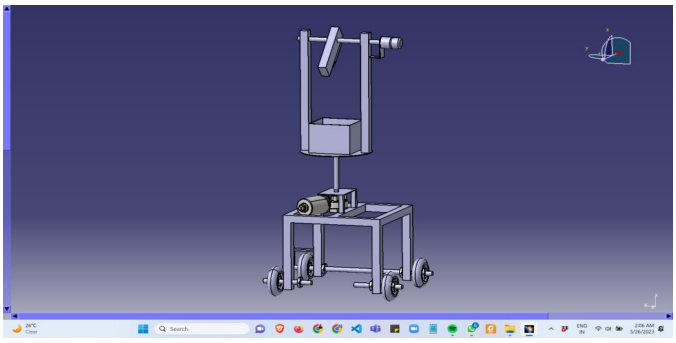
### *B. Project Components*

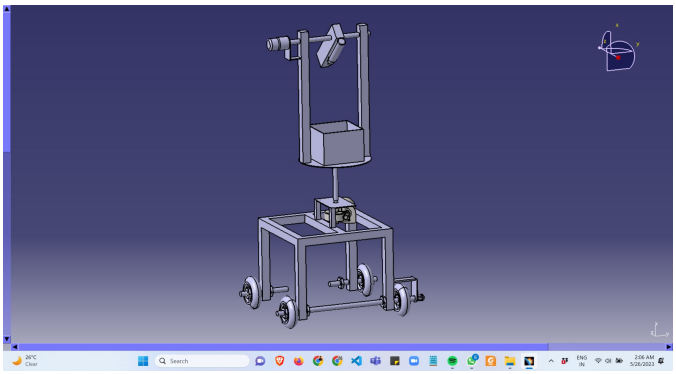
*1)* Two motors are employed in the system, along with a strong sprayer motor and pipe system. The second motors are utilized to control the nozzle direction movement. (JOHNSON'S MOTOR)
*2)* The sprayer mechanism is designed to create 360-degree water spray coverage while operating with 2 degrees of freedom. (SPRAYER MOTOR)
*3)* To send movement orders for this project, utilize a remote. The user commands are received by the system's receiver circuit, which also controls the pump motor to start and stop the spray. (ARDUINO).
*4)* Arduino UNO.
*5)* Battery
*6)* Water storage tank
*7)* Nozzle

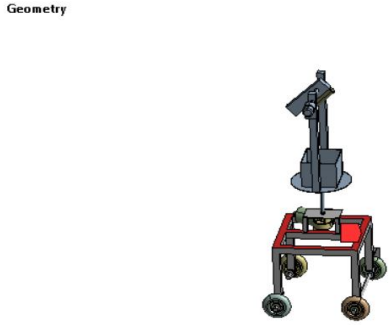
## II. CAD DESIGN

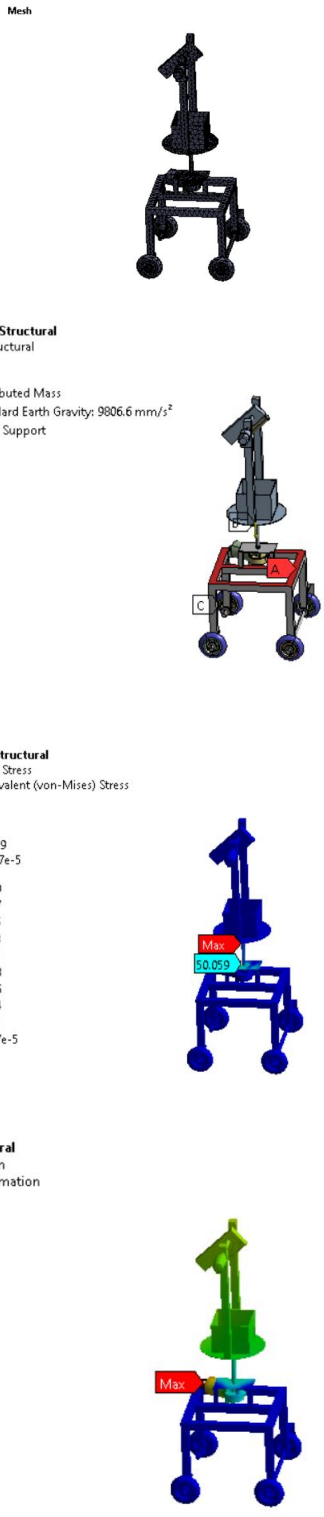






### *A. Ansys Design Analysis*






## III. CONCLUSIONS

Our project achieves our mission of providing quick responsive action towards any fire outbreak without any human involvement. This robot is cheap compared to other robots which also alignes with our goal to provide affordable safety equipment for all. Homes , Hospitals and Factories are safer with the installation of this robot. It is a modern way of fighting fire outbreaks.

## IV. ACKNOWLEDGEMENT

We take this profound opportunity to express our gratitude and deep regard to Prof. D.S. Patil, and Prof. Dr. M.M. Bhoomkar, HOD Mechanical, PVG Pune for their exemplary guidance, monitoring, and constant encouragement throughout the project work.
We are thankful to Prof. Dr. M.M. Bhoomkar, Head of the Mechanical Engineering Department for his valuable support. We are thankful to Prof. D.S. Patil, for his valuable guidance throughout the project. for his valuable guidance. We take the opportunity to express our gratitude towards all those who have been involved in our project work

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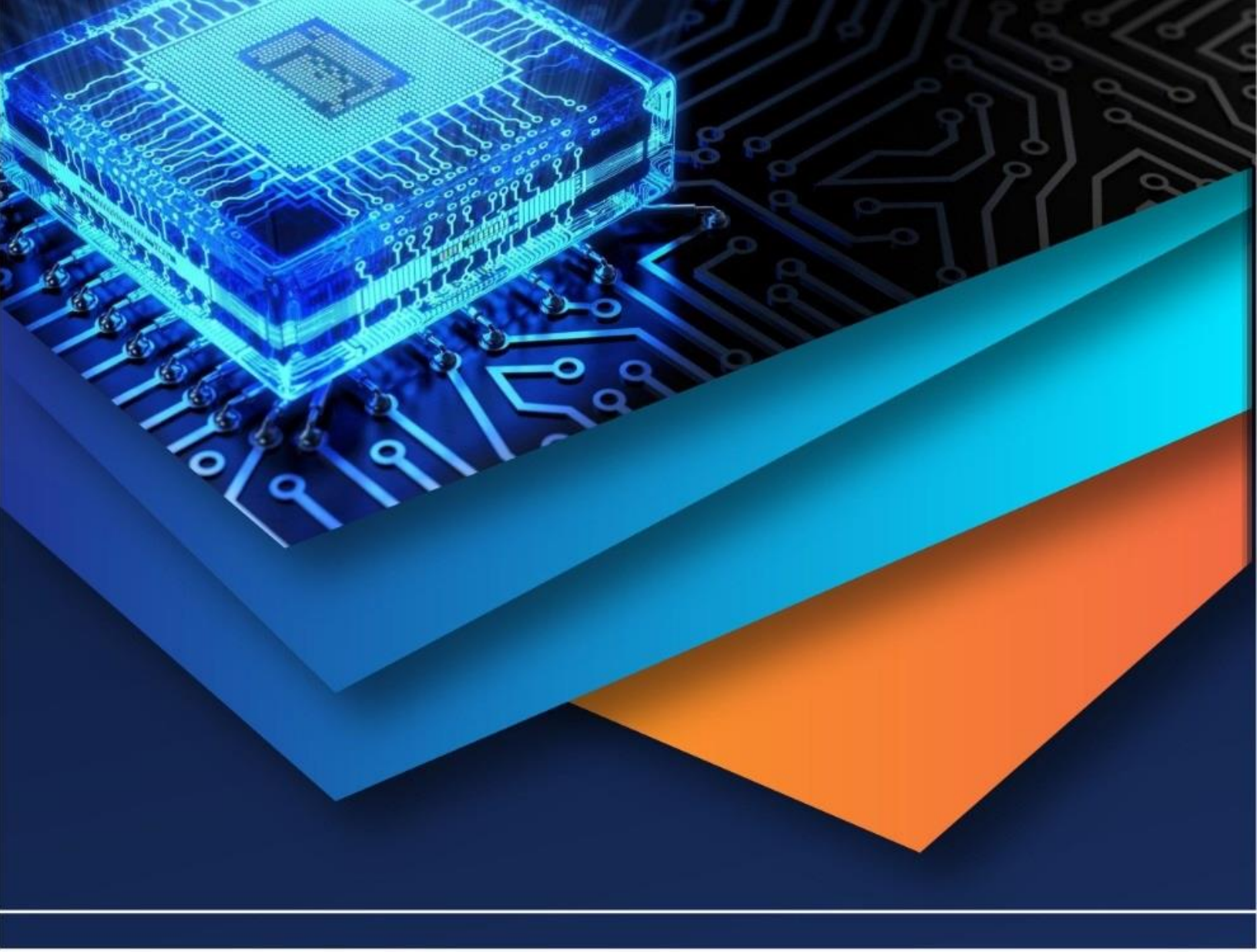

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