

**Development of Autonomous Fire Resistant Mobile Robot for
Hazardous Environments**

Submitted in partial fulfillment of the requirements for the
award of

Bachelor of Engineering degree in Mechanical Engineering

by

SHAIK NOUMAN (37150174)

P.KISHORE (37150135)



DEPARTMENT OF MECHANICAL ENGINEERING

SCHOOL OF MECHANICAL ENGINEERING

SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY

(DEEMED TO BE UNIVERSITY)

**Accredited with Grade “A” by NAAC
JEPPIAAR NAGAR, RAJIV GANDHI SALAI,
CHENNAI - 600 119**

APRIL – 2021



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Jeppiaar Nagar, Rajiv Gandhi Salai, Chennai - 600 119

www.sathyabama.ac.in



DEPARTMENT OF MECHANICAL ENGINEERING BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **SHAIK NOUMAN(37150174), P KISHORE (37150135)** who carried out the project entitled **"Development of Autonomous Fire Resistant Mobile Robot for Hazardous Environments"** under our supervision from September 2020 to April 2021.

Internal Guide

Mr. R B DURAIRAJ, M.E., (Ph.D.,)

Head of the Department

Dr.G. ARUNKUMAR, M.E., Ph.D.,

Submitted for Viva voice Examination held on _____

Internal Examiner

External Examiner

DECLARATION

We **SHAIK NOUMAN (37150174), P KISHORE (37150135)** hereby declare that the Project Report entitled “**Development of Autonomous Fire Resistant Mobile Robot for Hazardous Environments**” done by me under the guidance of **Mr. DR.R B DURAIRAJ, M.E., (Ph.D.,)** is submitted in partial fulfilment of the requirements for the award of Bachelor of Engineering degree in Mechanical Engineering.

DATE:

SIGNATURE OF THE CANDIDATE

PLACE: CHENNAI

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I would like to express my sincere and deep sense of gratitude to my Project Guide **DR. R B. DURAIRAJ, M.E.,(Ph.D.,)** for his valuable guidance, suggestions and constant encouragement paved way for the successful completion of my project work.

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ABSTRACT

Owing to high temperatures or the presence of explosive devices, it has become more difficult for firefighting services to gain access to the scene of a fire, even though the fire is causing significant property destruction and human death. Fire-fighting robots can help extinguish a fire in such circumstances. The goal of the project is to create a robot that will enable us to monitor our preferred location. The robot's size makes it ideal for use as a covert agent. Many of the processes are controlled by the Arduino microcontroller. This project describes a smart firefighter robot with a fire sensor, ultrasonic sensor, and ZigBee connectivity for a defence surveillance device. The FIRE FIGHTING robot created as part of this project will step forward and backwards, as well as turn left and right. As a result, we can control a robot over a long distance without having to send a person anywhere near a fire. For fire detection, we used the flame sensing element. It is an extremely sensitive device that can sense even the tiniest of flames. To put out flames, the robot has a wireless sensor network built into it. The main aim of the project will be to design a Fire Fighting Robot toolkit which can replace the traditional Fire.

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CHAPTER 1:

INTRODUCTION

In recent years, robots, especially security robots, have played an increasingly important role. Robots have mainly been used in the automation of mass manufacturing sectors, where the same definable functions must be replicated over and over. However, the robots can be used for other purposes as well. As engineers, our mission was to develop and construct a test device that could autonomously detect the threat of explosion through a variety of flammable materials. Before approaching any questionable districts, we should send a robot to verify the state of the area so that military or army personnel do not have to risk their lives. In those zones, robots should be sent within.. Multiple sensors are used to identify different parameters, and an alarm may be sent out. It is possible to send serial data from an Arduino microcontroller using WSN technology. It's also capable of sensing flames and artefacts. As Electrical Engineers, our mission was to develop and construct a test device that could detect and extinguish a fire on its own. It also seeks to reduce air pollution. It is the Robot that can explore a model structure, spot a lit candle, and extinguish it using a blowing technique. The concept of a small autonomous Fire Fighting Robot is defined in our research paper. At our campus, we worked on the same project and delivered a synopsis of its basic construction and operation. The Fire Fighting Robot is built to look for a fire in a narrow floor plan with a house of unique proportions, extinguish the fire with the aid of a toy hovercraft's front fan, and then return to the house's front. The fire warning system that will be used has a low incidence of false alarms, and it is assumed that it will not overreact in non-fire situations.. This job is broken down into smaller tasks, each of which is performed as quickly as possible, such as self-starting the robot, navigation of the robot in each room step by step, locating the fire in a particular room, approaching the fire at a specified pace, extinguishing it, and eventually returning to the front of the building.

CHAPTER 2:

LITERATURE SURVEY

Kuo L. Su, “Automatic Fire Detection System Using Adaptive Fusion Algorithm for Fire Fighting Robot,”IEEE International Conference on System, Man and Cybernetics October 8-11, 2016, Taipei, Taiwan.

One of the latest hot topics of intelligent building science is the multisensory fire detection algorithm (MSFDA). For the intelligent house, we first develop a firefighting robot with an extinguisher. The chassis of the firefighting robot is made of aluminum. The robot's form is that of a cone. The width is 40 centimeters, and the height is about 80 centimeters. The firefighting robot has six structures, including a structure, an obstacle avoidance and driver system, a software creation system, a fire detection system, a remote supervise system, and others. The fire detection system in the firefighting robot was built using three flame sensors. The adaptive fusion approach is recommended for firefighting robot tire identification. We use computer simulation to develop the method so that it can diagnose fires properly. We create a fire warning system for the firefighting robot and use a sensor-based approach to configure the tyre detection and fighting process. Finally, we use a firefighting robot to incorporate the fire warning system. If a fire occurs, the robot will use the suggested approach by the fire detecting system to identify the fire source and travel to the fire source to extinguish the fire..

Jung-Hyun Park , Byung-Wook Kim, Dong-Jo Park and Moon-June Kim, “A System Architecture of Wireless Communication for Fire-Fighting Robot,” Proceedings of the 17th World Congress The International Federation of Automatic Control Seoul, Korea, July 6-11, 2017

The investigation of robust communication mechanisms between fire-fighting robots and remote operators. A wireless packet data transmission system and an analogue picture communication system make up the communication system. We used a commercial CDMA (Code Division Multiple Access) network architecture to create a secure data packet transmission scheme. After a connection protocol defined by the network service provider, serial data may be transmitted using CDMA modules.

To guide fire-fighting robots and report their status, wireless packet data transmission systems send and receive data packets. An analogue image communication system allows remote controllers to monitor a visual display of the robot's surroundings.

Abhilash Dhumatkar, Sumit Bhiogade, Shashank Rajpal, Datta Renge, Prof. V. Kale, “Automatic Fire Fighting Robot,” International Journal of Recent Research in Mathematics Computer Science and Information Technology Vol. 2, Issue 1, pp: (42-46), (April – September) 2015.

The Automated Fire Extinguisher Robot is a hardware-based model that is used to extinguish fires automatically in the event of a fire. A robot has been created with the ability to drive in the direction of the fire rate. Calcium silicate boards are used to coat the Robot shield, which can withstand exceptionally high temperatures. At a temperature of 300°C, the principle was designed and tested. The robot's temperature sensing capacity is modified by heating the Thermocouple ends to a cut-off temperature, above which the robot begins to react to the burn.. The robot can be used in relief operations during fires where servicemen have a limited ability to reach fire-prone areas, as well as during wartime to perform rescue functions. The most important advantage of this Robot is that it turns on automatically when it detects a fire in its immediate vicinity using a thermocouple and aims to extinguish it by driving in the direction of the fire. In the event that the Thermocouple fails, the temperature sensor serves as a buffer.

Shaik Sohel Pasha, Ch.Sathyanarayana, “Raspberry PI Based Wireless RF Controlled Fire Fighting with High Pressure Air Blower,” International Journal & Magazine of Engineering, Technology, Management and research Vol.3, Issue 11, November-2016.

This robot is a research model for the “Path Finder” device. An RF remote is used to operate this robot. Using 60RPM geared engines, which can be pushed forward and backward. In addition, this robot can make sharp turns to the left and right. The controller for this project is the BCM2835. This robot is fitted with a fire tracker, which detects a fire and transmits the information to the controller, as well as water sprinklers. When metal is sensed while the robot is running on a floor, the device emits a beep signal. This beep sound would be broadcast to a distant location. Simultaneously, the photos in the

environment The robot will be sent to a distant location. On the tv, the customer will watch footage of metal detector warnings and fire sensor activation. STT-433 MHz Transmitter, STR-433 MHz Receiver, HT12E RF Encoder, and HT12D RF Decoder are the RF modules used here. The RF Encoder links the three switches to the RF transmitter.

Simmi Dutta, Kameshwarsharma , Naman Gupta, Mohit Samyal,“A Fully Automated Fire Fighting Robot,” Global Journal of Advanced Engineering and Technologies Vol3, Issue2-2014.

The aim of this project is to develop, create, and test a robot that can put out building and basement fires and effectively replace a firefighter in high-risk scenarios. Firefighters would be able to use the robot to not only put out a fire remotely, but also to scout a burning building before calling in any firefighters. The use of this robot would improve the safety of firefighters, reducing the number of deaths caused by dangerous situations. An operator can use a wireless remote control to control the robot. The conditions would provide visual guidance to the operator.. While the robot design will be as robust as possible, the main goal of the project is a proof of concept

CHAPTER 3:

AIM AND SCOPE

In recent years, robots, especially security robots, have played an increasingly important role. Robots have mainly been used in the automation of mass manufacturing sectors, where the same definable functions must be replicated over and over.

However, the robots can be used for other purposes as well. As engineers, our mission was to develop and construct a test device that could autonomously detect the threat of an explosion in a variety of flammable materials..

Before approaching any doubtful districts, we should send a robot to verify the state of the area so that military or army personnel do not have to risk their lives. For this kind of region, robots with several sensors can be sent inside, which can sense different parameters and send out alerts.

It is possible to send serial data from an Arduino microcontroller using WSN technology. It's also capable of sensing flames and artefacts.

Owing to elevated temperatures or the presence of explosive materials, firefighting workers have recently found it difficult to reach the scene of a fire, even though the fire is causing serious property loss and human death.

Fire-fighting robots can be useful in such cases for extinguishing a fire. The goal of the project is to create a robot that will enable us to monitor the area where we have an advantage.

The robot's size also lends itself to being used as a secret agent robot. Many of the processes are regulated by an Arduino microcontroller.

This project describes a smart firefighter robot with a fire sensor, ultrasonic sensor, and ZigBee connectivity for a defense surveillance device.

CHAPTER 4:

MATERIALS AND EXPERIMENTAL METHOD

The aim of the project is to design and build an intelligent robot that uses gas sensors to detect harmful gas and smoke.

Bomb sensors are used to detect explosives in current firefighting robots, and temperature sensors are used to sense the temperature in a given location. There is no WUSN technology available here.

4.1 EXISTING SYSTEM

Existing System have limitation over range due to RF Control mechanism and also real time and efficient control is not possible due to Radio interference. In this system Basic Controller is used to Control the Robot and also does not have wireless sensor network

Thus, the existing system seems to be not an efficient one.

4.1.1 DISADVANTAGES IN EXISTING SYSTEM

Wireless sensor is not used here

This system is not efficient

4.2 PROPOSED SYSTEM

In this proposed system we using ultrasonic sensor to detect the objects .The fire sensor used to detect the fire in the environment. Here we are using wusn technology . In this proposed system we are using motor driver IC to control the speed of the motor. we can extinguished the fire with help of pump motor. All the project works on the principle of

EMBEDDED SYSTEM

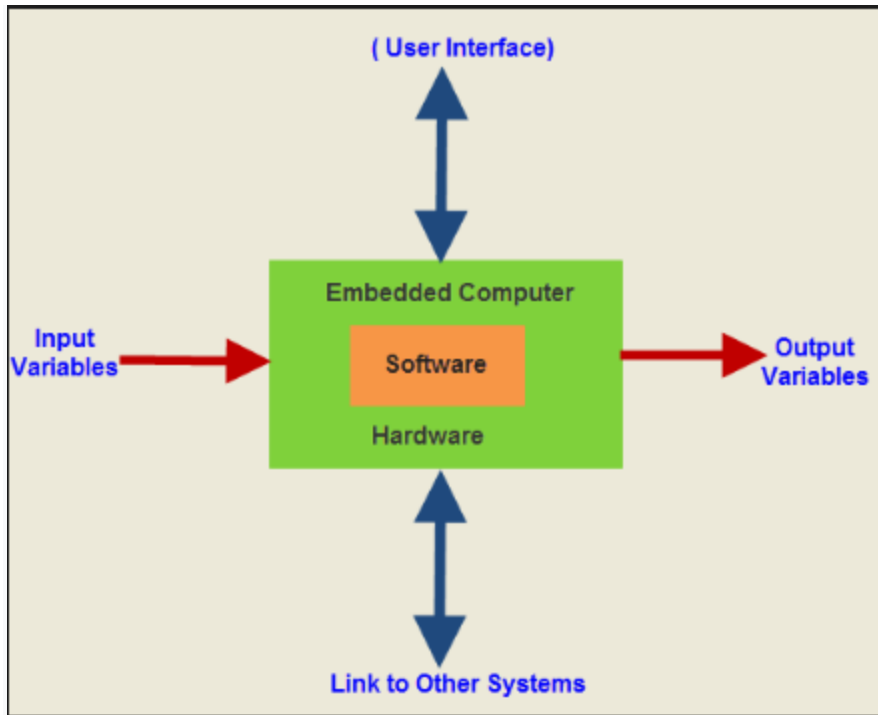
4.3 EMBEDDED SYSTEM:

An embedded system is a controller with a dedicated purpose inside a broader mechanical or electrical system that is programmed and controlled by a real-time operating system (RTOS), often with real-time computing constraints.

It's mostly used as part of a larger device that includes hardware and mechanical components. Many electronic devices are powered by embedded systems. Ninety-eight percent of all microprocessors are intended to be used as part of an embedded system. Low power consumption, compact scale, robust operating ranges, and low per-unit cost are some of the characteristics of typical embedded computers as opposed to general-purpose counterparts. This comes at the cost of scarce computing power, which makes programming and interacting with them even more challenging.

However, by creating intelligence mechanisms on top of the hardware, taking advantage of potential existing sensors and the presence of a network of embedded units, one can also optimise available resources at the device and network levels, as well as provide augmented capabilities well beyond what is currently available.

. For example, intelligent techniques can be designed to manage power.



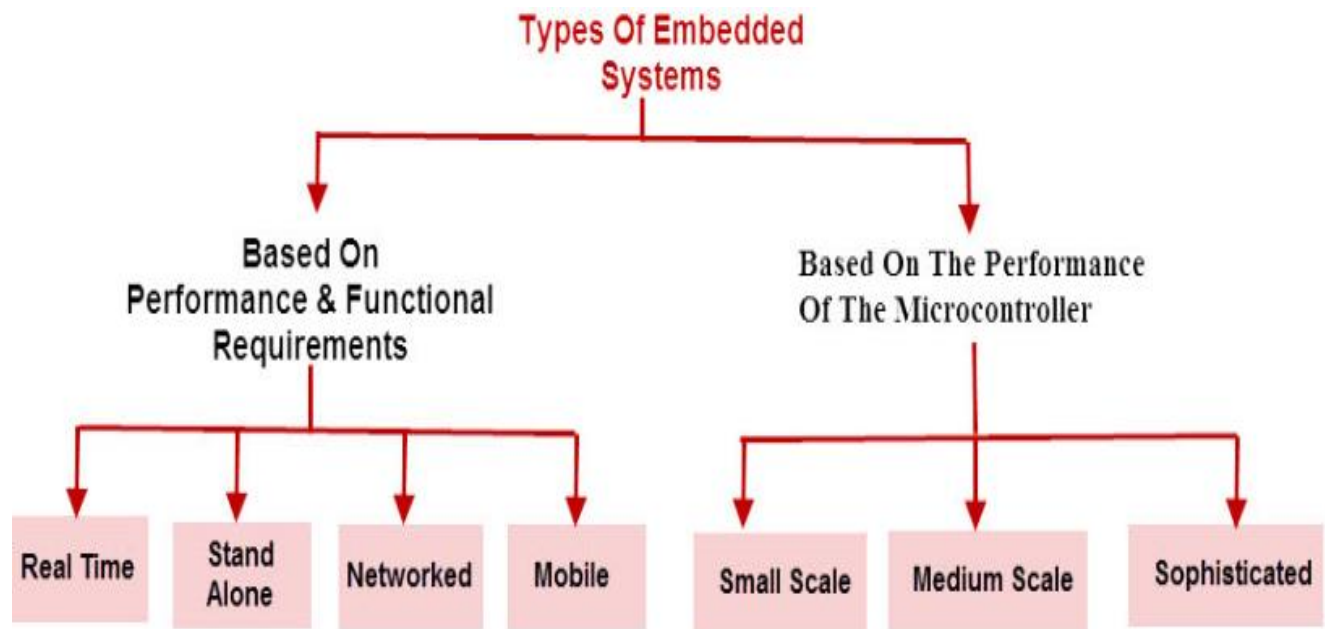
Electronic Voting Machine Embedded Computer Sub-Assembly

Consumer, agricultural, automobile, medical, commercial, and military applications all use embedded devices.

Telecommunications systems use a variety of embedded systems, ranging from network telephone switches to end-user cell phones. To route data in computer networking, dedicated routers and network bridges are used.

MP3 players, cell phones, video game controllers, GPS receivers, and printers are examples of consumer electronics. Embedded systems are used in household appliances such as microwave ovens, washing machines, and dishwashers to offer versatility, performance, and features.

4.3.1 CLASSIFICATIONS OF EMBDDED SYSTEMS:

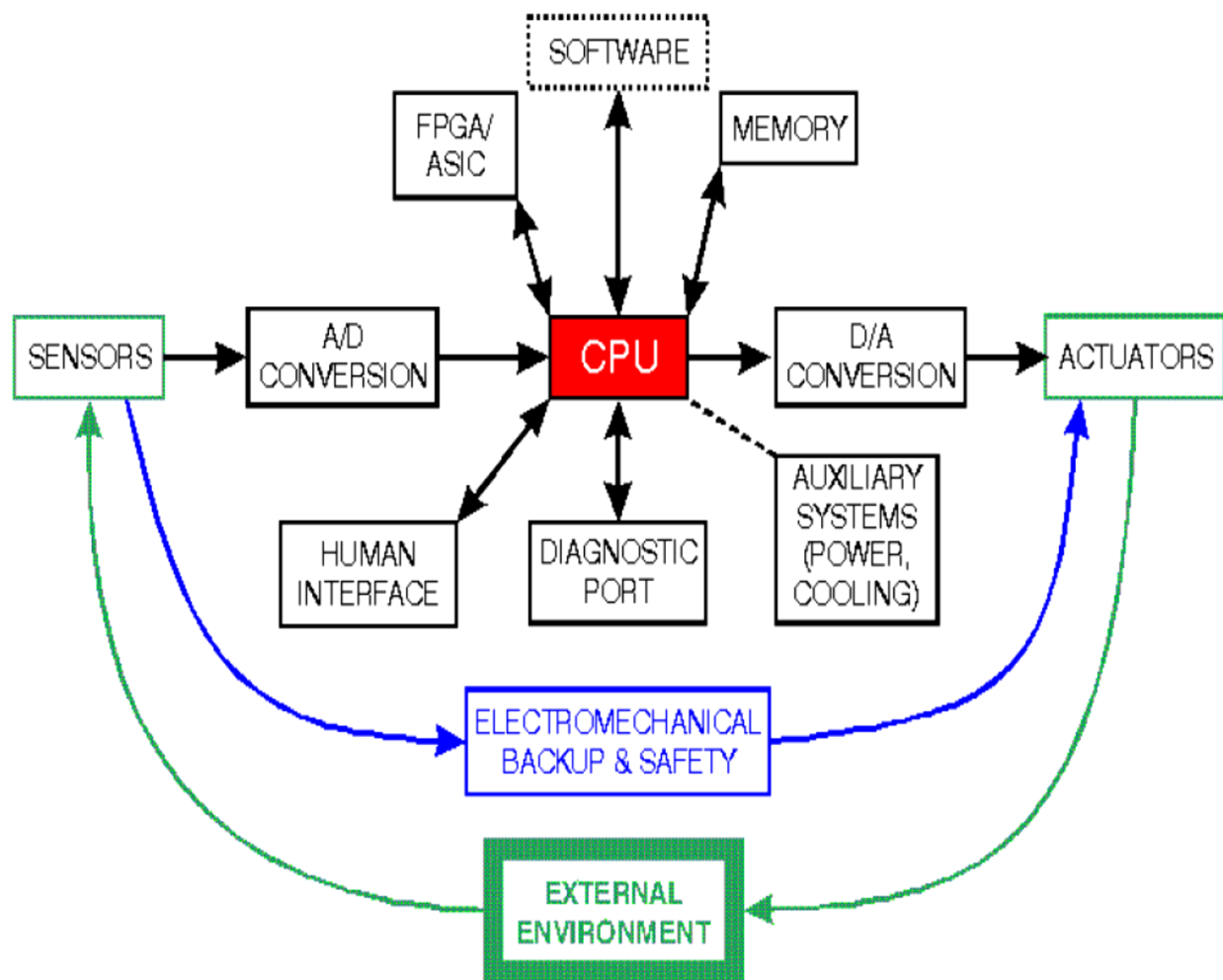


Advanced HVAC systems use networked thermostats to regulate temperature more precisely and effectively, which varies based on the time of day and season. Home automation employs both wired and wireless networking to monitor lighting, temperature, protection, audio/visual, and surveillance systems, among other things, both of which rely on embedded sensors for sensing and control.

such as traffic signs, factory controllers, and more advanced structures such as hybrid engines, MRI, and avionics Embedded systems can vary in size from tiny handheld devices like digital watches and MP3 players to massive fixed installations. The complexity ranges from simple (with a single microcontroller) to complex (with multiple microcontrollers).

4.3.2 Block diagram of an embedded system:

An embedded processor is normally located in a device. Embedded devices are used in many products that have a wireless display, such as microwaves, VCRs, and automobiles. An operating system is used in some embedded systems. Others are highly specialised, culminating in the implementation of the whole logic as a single application. This devices are built into a computer for a particular purpose other than general-purpose computing..



Block diagram of a typical embedded system

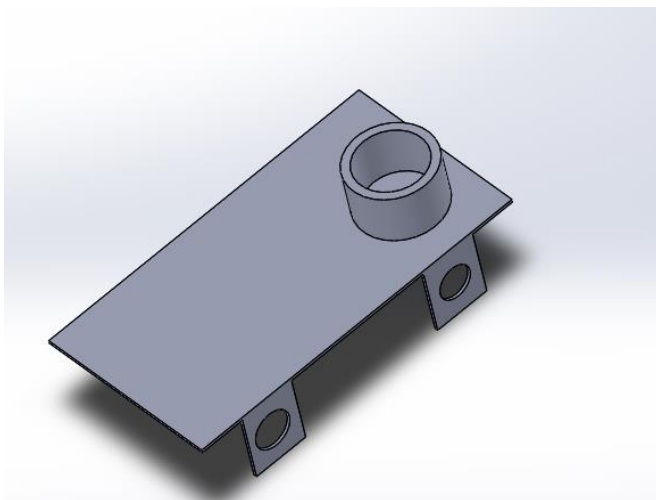
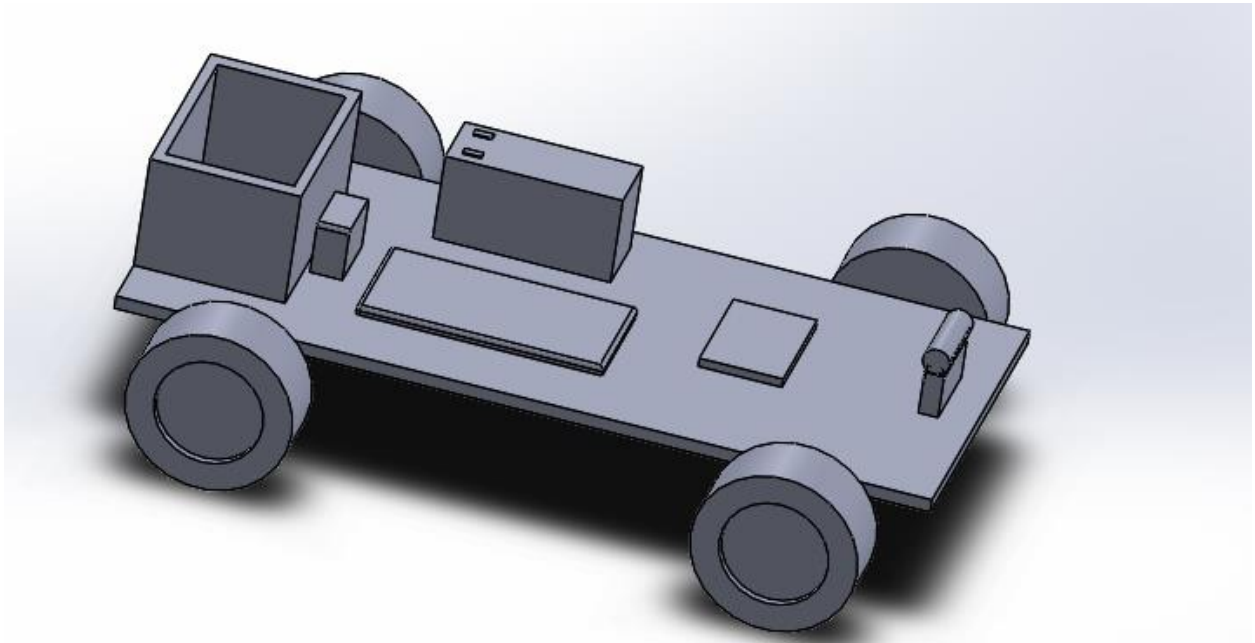
4.3.3 EMBEDDED SYSTEMS APPLICATIONS:

Motor control, cruise control, body safety, engine safety, assembly line automation, vehicle multimedia, car entertainment, E-com connectivity, mobiles, and other embedded systems in cars are only a few examples.

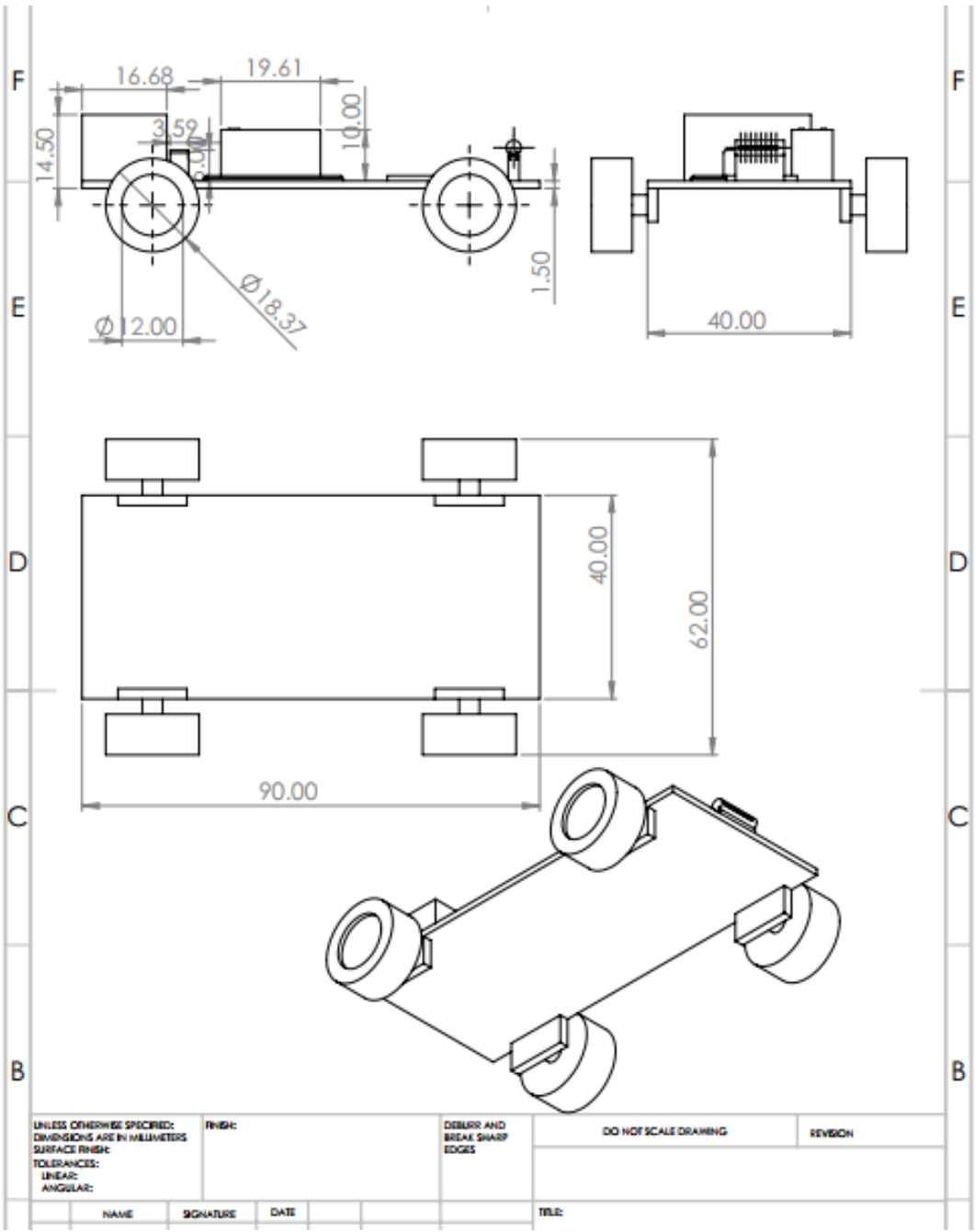
- Networking, handheld computing, and cellular communications are examples of embedded technologies in telecommunications.
- Banking, telecommunications, and surveillance systems are among the embedded devices in smart cards.
- Defense, networking, and aerospace are among the embedded systems in satellites and missiles.
- Image processing, networking networks, printers, network cards, monitors, and displays are examples of embedded systems of computer networking and peripherals.
- Set-top boxes, DVD players, and high-definition televisions are examples of embedded systems in digital consumer electronics.

4.4 DESIGN

4.4.1 CAD DESIGN OF THE ROBOT

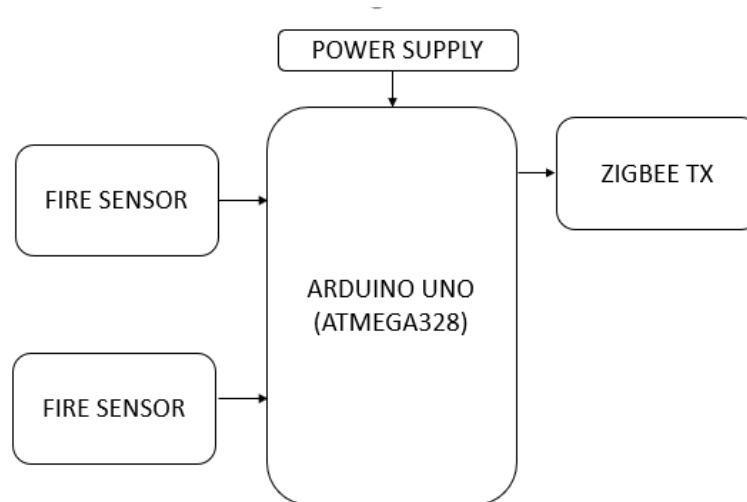


4.4.2 OUTLINE OF THE ROBOT

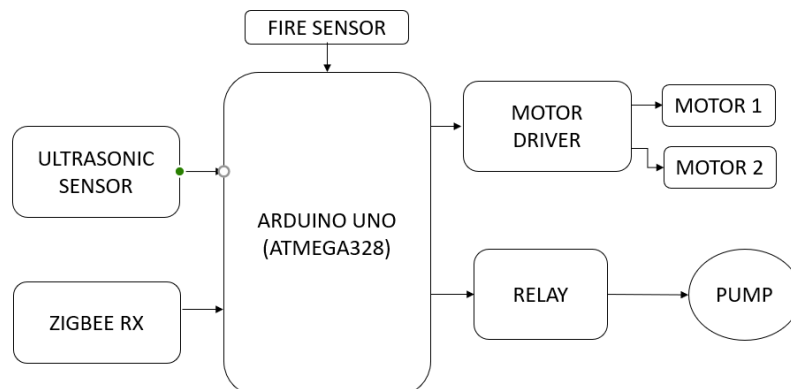


4.5 BLOCK DIAGRAM:

4.5.1 TRANSMITTER SECTION



4.5.2 VEHICLE SETUP RX SIDE



4.6 SOFTWARE REQUIREMENTS

- Embedded C
- Arduino IDE

4.7 HARDWARE REQUIREMENTS:

- Arduino UNO
- Fire sensor
- Ultrasonic sensor
- Motor driver IC
- Motor
- Zigbee TX,RX
- Relay
- Pump

4.6 SOFTWARES USED

4.6.1 ARDUINO IDE

Arduino is an open-source tool that can be used to create electronic projects. Arduino is made up of two parts: a physical programmable circuit board (also known as a microcontroller) and software (called an IDE) that runs on your cpu and is used to write and upload computer code to the physical board.

The Arduino platform has grown in popularity among people who are just getting started with electronics, and with good reason. Unlike other previous programmable circuit boards, the Arduino does not need a separate piece of hardware (known as a programmer) to load new code onto the board; instead, a USB cable is all that is needed. Furthermore, the Arduino IDE allows programming simpler by using a condensed version of C++. Finally, Arduino offers a regular form factor that separates the microcontroller's functions into a more manageable kit.

Artists, programmers, hobbyists, hackers, newbies, and anybody involved in making immersive objects or environments will benefit from the Arduino hardware and software. Buttons, LEDs, engines, microphones, GPS systems, the telephone, and even your smartphone or television can all be regulated by Arduino. Because of this simplicity, as well as the fact that the Arduino programme is free, the hardware boards are relatively inexpensive, and both the software and hardware are simple to understand, a vast group of users has contributed code and published instructions for a wide range of Arduino-based projects.

There are several different Arduino boards (described on the following page) that can be used for various purposes. While some Arduino boards vary from the one seen below, the majority of the components are the same:

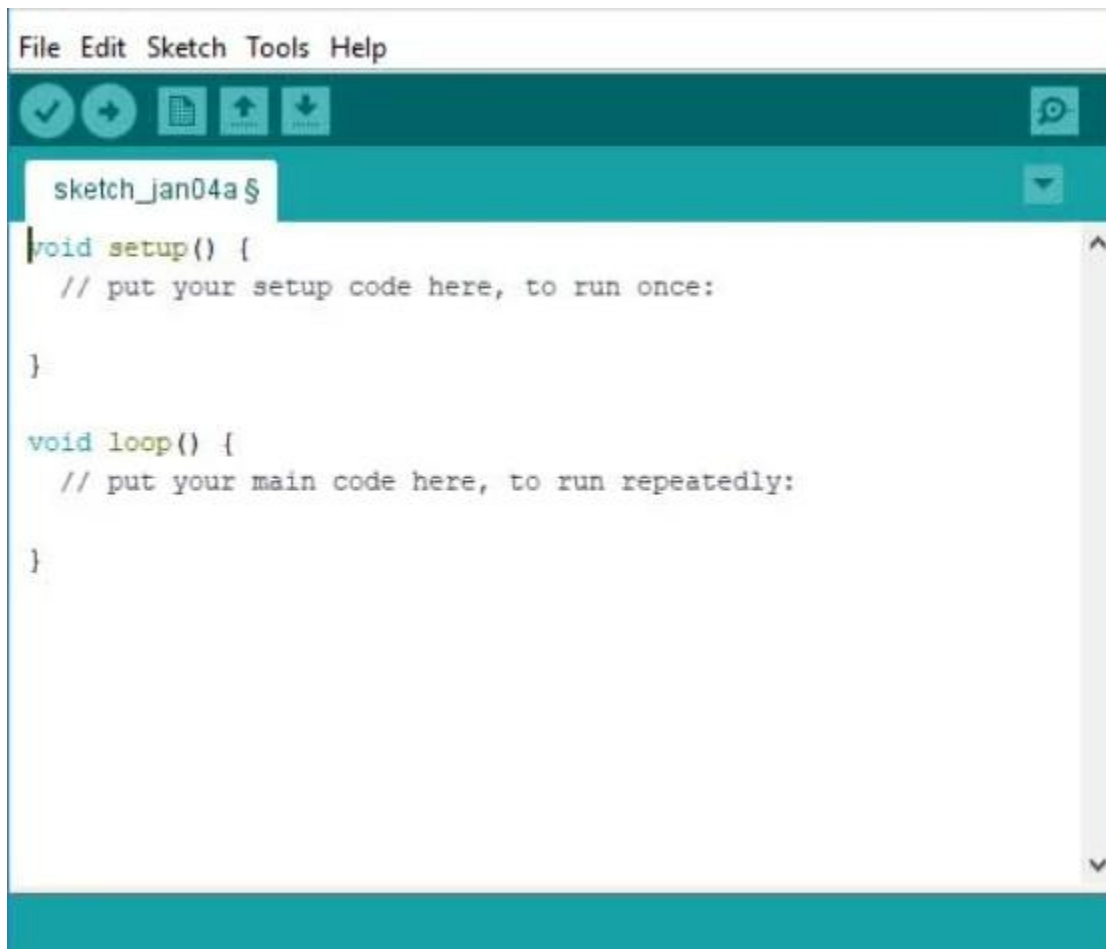


Sketches are programmes created with the Arduino Software (IDE). These sketches were created in a text editor and saved with the .ino file extension. Cutting/pasting, as well as searching/replacing text, are all possible in the editor. The message region shows errors and provides input when saving and exporting. The Arduino Program (IDE) outputs text to the console, which contains full error messages and other information. The designed board and serial port are shown in the window's bottom righthand corner. You can check and import programmes, make, open, and save drawings, and open the serial monitor using the toolbar buttons.

Although the Arduino IDE is extremely simple, it offers a nearly complete environment for most Arduino-based projects. The regular options are "File" (new, load, save, etc.), "Edit" (fonts, copy, paste, etc.), "Sketch" (for compiling and programming), "Tools" (useful options for checking projects), and "Help" in the top menu bar. The IDE's middle section is a basic text editor where you can type in your programme file. The output window at the bottom of the IDE is used to see the state of the compilation, how much memory has been used, any bugs encountered in the software, and a variety of other helpful messages.

Sketches are projects created using the Arduino that are written in a trimmed-down version of C++ (a variety of C++ features are not included). Since programming a microcontroller differs from programming a computer, Sketches are projects created

using the Arduino that are written in a trimmed-down version of C++ (a variety of C++ features are not included). Since programming a microcontroller differs from programming a computer, there are a number of device-specific libraries (e.g., changing pin modes, output data on pins, reading analog values, and timers). This sometimes confuses users who think Arduino is programmed in an “Arduino language.” However, the Arduino is, in fact, programmed in C++. It just uses unique libraries for the device.



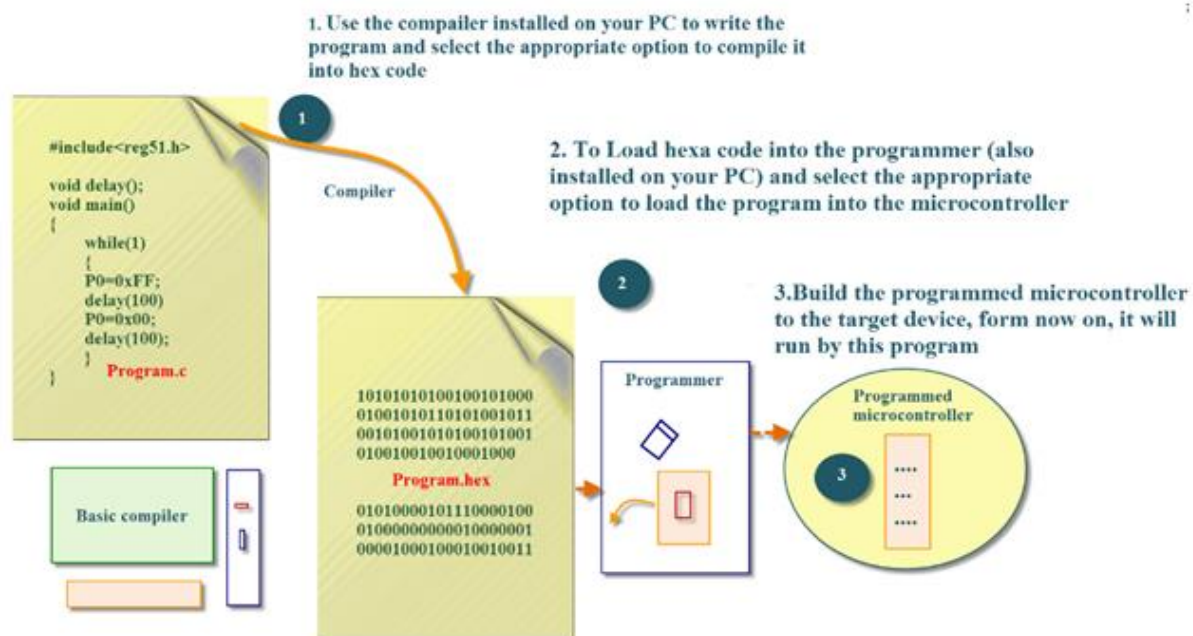
The Arduino IDE uses special code structuring rules to support the languages C and C++. The Wiring project includes a programme library that is included with the Arduino IDE that provides several standard input and output procedures. User-written code only needs two simple functions to start the sketch and the main programme loop, which are compiled and connected into an executable cyclic executive programme with the GNU toolchain, which is also included with the IDE distribution. The Arduino IDE makes use of the

program *avrdude* to convert the executable code into a text file in hexadecimal encoding that is loaded into the Arduino board by a loader program in the board's firmware.

4.6.2 EMBEDDED C

Embedded C is the most commonly used programming language in the computing industry for building electronic devices. Embedded software is connected with each processor used in an electronic device.

Embedded C programming is important for the processor to execute complex tasks. We use a range of mobile gadgets in our everyday lives, such as a cell phone, a washing machine, a portable camera, and so on. All of these devices are controlled by a microcontroller that is programmed in embedded C.



The Embedded C code in the block diagram above is used to wink the LED attached to the microcontroller's Port0.

C coding is favoured over other languages in embedded machine programming. Because of the following factors:

- Easy to understand
- High Reliability
- Portability
- Scalability

A programming language is a set of one or more functions that are used to perform a specific task. A function is a collection of statements that are used to perform a specific task.

Application software, which offers features on a device, is common to the majority of customers. Embedded tech, on the other hand, is less apparent but no less complex. Embedded software, unlike application software, has set hardware specifications and features, and the addition of third-party hardware or software is strictly controlled.

Embedded software must contain the necessary device drivers at the time of manufacture, and device drivers are written specifically for the hardware. The programme is extremely reliant on the CPU and the specific chips used. Most embedded software engineers have a basic understanding of reading schematics and component data sheets to assess register and communication system use. Bit modulation and conversion of decimal, hexadecimal, and binary are both helpful.

While XML files and other output may be forwarded to a device for display, web applications are seldom used. SQL files, as well as file systems with directories, are usually not present.

A cross compiler, which runs on a computer but produces executable code for the target platform, is needed for software development. An in-circuit simulator, such as JTAG or SWD, is needed for debugging. The source code for the kernel (OS) is often available to software developers.

The storage memory and RAM sizes will differ greatly. Some systems have 16 KB of Flash and 4 KB of RAM and an 8 MHz CPU, while others will compete with modern computers. [eight] Because of the space constraints, more work is performed in C or

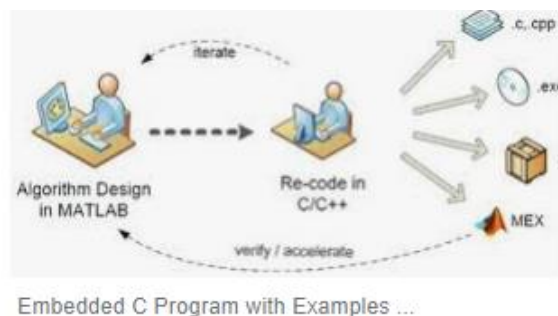
embedded C++ rather than C++. Languages that are interpreted, such as BASIC (while Java (Java ME Embedded 8.3[9] is available for e.g. ARM Cortex-M4, Cortex-M7 microcontrollers, and older ARM11 used in Raspberry Pi and Intel Galileo Gen. 2) are not commonly used; however, an implementation of the interpreted Python 3 language – MicroPython – is available specifically for microcontroller use, e.g. 32-bit ARM-based (such as BBC m3) microcontroller

It is important to interact between processors and between one processor and other components. I2C, SPI, serial ports, and USB are all standard protocols in addition to direct memory addressing.

.

Companies including InterNiche Technology and CMX Solutions provide closed source networking protocols for embedded systems. uIP, lwip, and other open-source protocols are examples.

- Using usual variables, this programme illustrates how to use structure within structure in C. In this software, the “student college detail” structure is declared within the “student detail” structure. Both structure variables are essential. Members of the “student college detail” structure are accessed using the 2 dot(.) operator, while members of the “student” structure are standard structure variables.
- A single dot(.) operator is used to enter the _detail” layout.



A keyword is a term that has a particular meaning for the compiler (a C Compiler for example, is a software that is used to convert programme written in C to Machine Code). For example, some of the keywords in the Keil's Cx51 Compiler (a common C compiler for 8051 based Microcontrollers) are as follows:

- bit
- sbit
- sfr
- small
- large

These are few of the many keywords associated with the Cx51 C Compiler along with the standard C Keywords

4.7 HARDWARE REQUIREMENTS

4.7.1 ARDUINO UNO:

The Arduino Uno is a microcontroller board that uses the ATmega328 microcontroller (datasheet). There are 14 optical input/output pins (six of which can be used as PWM outputs), six analogue inputs, a 16 MHz ceramic resonator, a USB link, a power port, an ICSP header, and a reset button on the board. It comes with everything you'll need to get started with the microcontroller; simply plug it into a device with a USB cable or power it with an AC-to-DC converter or battery. The Uno is unique in that it does not use the FTDI USB-to-serial driver chip used on previous boards. Instead, it uses a USB-to-serial adapter based on the Atmega16U2 (Atmega8U2 up to version R2). The 8U2 HWB line on revision 2 of the Uno board is pulled to ground by a resistor, making it simpler to bring into DFU mode. The board's third redesign has the following new features:

- 1.0 pinout: added SDA and SCL pins near the AREF pin, as well as two additional new pins near the RESET pin, the IOREF, which allow the shields to adjust to the voltage supplied by the board. Shields would be compliant with both the board and the future.

that use the AVR, which runs on 5V, and the Arduino Due, which runs on 3.3V. The second is an unconnected pin that will be used in the future.

- A more efficient RESET circuit.
- The Atmega 16U2 will take the place of the 8U2. The name "Uno" comes from the Italian word "uno," which means "one." It was chosen to commemorate the forthcoming release of Arduino 1.0. Going forward, the Uno and version 1.0 will be the reference versions of Arduino. The Uno is the most recent in a series of USB Arduino boards, and the platform's reference model; see the index of Arduino boards for a comparison with previous models.

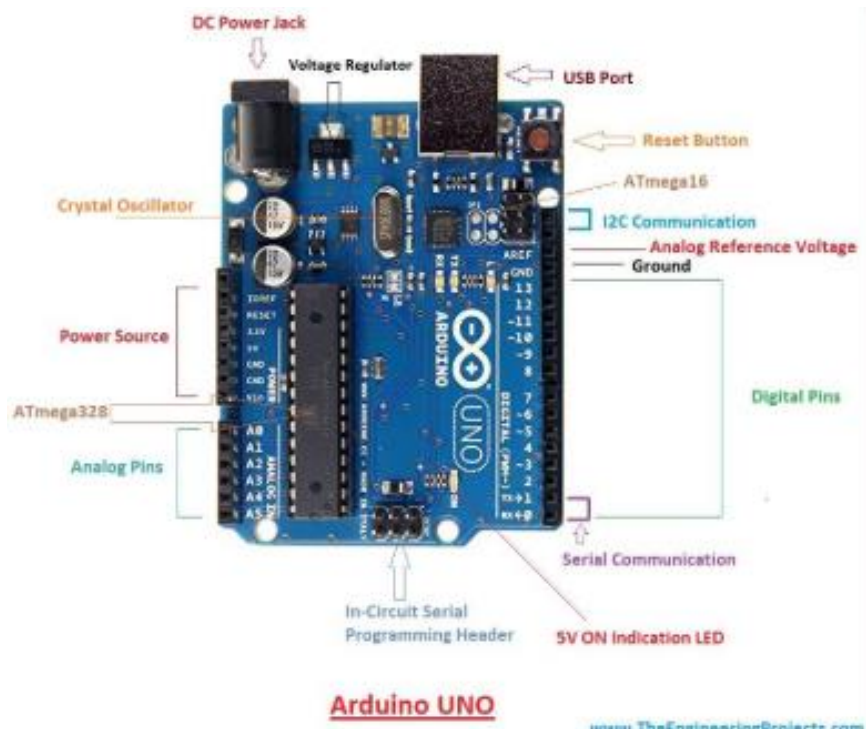
POWER:

When using an external power source, VIN is the reference voltage to the Arduino board (as opposed to 5 volts from the USB connection or other regulated power source). This pin may be used to supply voltage or to access voltage if it is supplied through the power socket.

- 5 volts. This pin receives a controlled 5V from the board's regulator. The board can be powered by the DC power jack (7 - 12V), the USB connector (5V), or the VIN pin on the board (7-12V). Using the 5V or 3.3V pins to supply voltage bypasses the regulator which may cause harm to your board. We don't recommend it.
- 3 volts The on-board regulator produces a 3.3 volt supply. The maximum existing pull is 50 milliamperes.

GND is a generic term that refers to a group of Pins that have been ground.

ARDUINO UNO:



Memory

The ATmega328 has 32 KB of memory (with 0.5 KB used for the bootloader). There's also 2 KB of SRAM and 1 KB of EEPROM on board (which can be read and written with the EEPROM library). Output and Input Using the pin Mode(), digital Write(), and digital Read() keys, any of the Uno's 14 digital pins can be used as an input or output. They are powered by 5 volts. Each pin can deliver or receive a maximum of 40 mA and has a 20-50 kOhm internal pull-up resistor (by default disconnected).

In addition, some pins have specialized functions:

- **Serial:** 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the ATmega8U2 USB-to-TTL Serial chip.
- **External Interrupts:** 2 and 3. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the attach Interrupt() function for details.
- **PWM:** 3, 5, 6, 9, 10, and 11. Provide 8-bit PWM output with the analog Write() function.
- **SPI:** 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK). These pins support SPI communication using the SPI library.
- **13 LEDs** A built-in LED is attached to digital pin 13 by a wire. The LED is turned on when the pin is HIGH, and it is turned off when the pin is LOW. The Uno has six analogue inputs, numbered A0 through A5, each with a resolution of 10 bits (i.e. 1024 different values). They scale from ground to 5 volts by default, but the AREF pin and the analogue Reference() feature can be used to adjust the upper end of their range. Few pins also have specialised functions, such as:
 - **TWI:** A4 (SDA) and A5 (SCL) pins. Using the Wire library, support TWI contact. On the board, there are a few more pins:
 - **AREF** (Arctic Research and Education Foundation). The analogue inputs have a reference voltage. Used in conjunction with analogue Reference
 - **Restart your computer.** To reset the microcontroller, set this line to LOW. Often used to apply a reset button to shields that are in the way of the board's reset button. Also see the ATmega328 port mapping and the Arduino pin mapping. The Atmega8, 168, and 328 all have the same routing. Communication is important. A cpu, another Arduino, or other microcontrollers can all be communicated with using the Arduino Uno.

On optical pins 0 (RX) and 1 (TX), the ATmega328 supports UART TTL (5V) serial communication (TX). This serial connectivity is channelled over USB by an ATmega16U2

on the board, which appears to software on the device as a virtual com port. The '16U2 firmware uses the standard USB COM drivers, and no external driver is needed.

On Windows, however, a.inf file is needed. A serial display is included in the Arduino programme, allowing basic textual data to be transmitted to and from the Arduino board. As data is transferred via the USB-to-serial chip and USB link to the device, the RX and TX LEDs on the board can glow (but not for serial communication on pins 0 and 1). Serial correspondence can be done on any of the Uno's digital pins using a Software Serial library. I2C (TWI) and SPI connectivity are both provided by the ATmega328. The Wire library is included with the Arduino programme to make using the I2C bus easier; see the documentation for more information. Using the SPI library for SPI correspondence..

Physical Characteristics

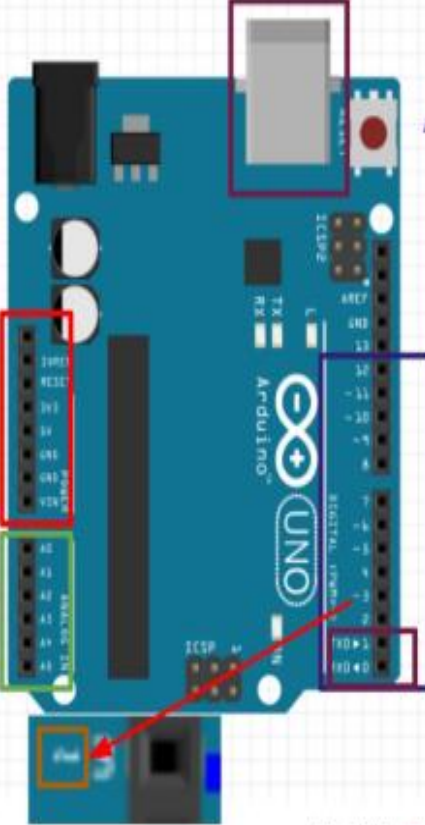
The USB connector and power jack stretch beyond the former dimension, making the Uno PCB's full length and width 2.7 and 2.1 inches, respectively. The board has four screw holes that allow it to be connected to a surface or case. The difference between optical pins 7 and 8 is 160 mil (0.16"), which is not an equal multiple of the other pins' 100 mil spacing.

PIN CONFIGURATION:

THE ARDUINO

MCU : Atmega 328
 Input voltage : 7V-12V
 Operating voltage : 5V
 CPU Speed : 16MHZ
 Analog In/Out : 6/0
 Digital IO/PWM : 14/6
 EEPROM : 1KB
 SRAM : 2KB
 Flash : 32KB
 UART : 1
 USB : Regular

Sensor's Power - 200 mA Max
 Analog In -
 Access with analogRead(pin#)
 returns mapped 0-5V => int 0-1023
 Digital In/Out -
 Set pin with pinMode(pin#, INPUT/OUTPUT)
 OUTPUT - 40 mA Max
 INPUT - return HIGH if > 3V else LOW
 PWM (Pulse Width Modulated) signal
 Access with analogWrite(pin#, Value)
 0 < Value < 255 maps to 0 - 100% Duty cycle
 Serial Communication Access Points



ARDUINO PIN	MICROCONTROLLER PIN
0	- PD0(RXD)
1	- PD1(TXD)
2	- PD2(INT0)
3	- PD3(INT1)
4	- PD4
5	- PD5
6	- PD6
7	- PD7
8	- PB0
9	- PB1
10	- PB2(SS ⁺)
11	- PB3(MOSI)
12	- PB4(MISO)
13	- PB5(SCK)
A0	- PC0
A1	- PC1
A2	- PC2
A3	- PC3
A4	- PC4(SDA)
A5	- PC5(SCL)

Pin out from: <http://circuit.net/arduino-boards-pin-mapping/1/>

USB Overcurrent Protection

A resettable poly fuse on the Arduino Uno prevents the computer's USB ports from shorts and overcurrent. Although most computers have their own built-in protection, the fuse adds another layer of security. The fuse would immediately sever the connection if more than 500 mA is added to the USB port before the short or overload is removed.

4.7.2 ULTRASONIC SENSOR

The ultrasonic distance sensor with ascii serial o/p is a fantastic device that allows for detecting and ranging over a wide range of distances. The sensor offers extremely accurate non-contact distance measurements ranging from around 2cm to 400cm. It is a useful sensor for distance measurement and mapping because of its small scale, higher range, and ease of use. The board can conveniently be connected to the rx pin

of a microcontroller



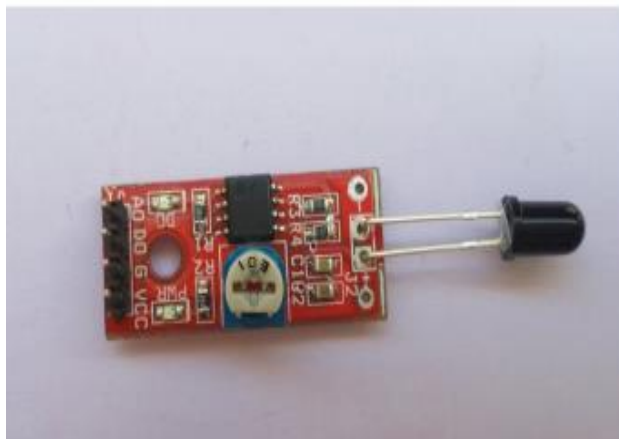
Every 50ms, the sensor sends out an ultrasonic burst and an ascii distance value that corresponds to the time it takes for the burst echo to return to the sensor. This sensor is ideal for a wide range of applications including measurements between moving and stationary subjects. Naturally, robotics applications are common, but this product can also be used in protection systems or as an infrared substitute if necessary. The “ECHO” ultrasonic sensor module can be used instead of an IR sensor for micro mouse applications since it is very stable. Trained PCB Layout Concept for Noise Reduction that is EMI/RFI Compliant

Features:

- Range: 2 cm to 400 cm
- Accurate and Stable range data
- Data loss in Error zone eliminated
- Modulation at 40 KHz
- Mounting holes provided on the circuit board
- Automatically Triggered at every 50 ms

4.7.3 FLAME SENSOR

The most sensitive sensor is one that measures flame wavelengths between 760 and 1100 nm in the infrared spectrum. Sensor that detects 60 degrees Two performance modes are available: On the thermal resistance, AO stands for analogue output, and is a real-time output voltage signal. DO: the output high and low signal levels are adjustable by potentiometer when the temperature exceeds a certain level. The Grove - Flame Sensor can detect fires and other light sources with wavelengths ranging from 760nm to 1100nm.



It uses a YG1006 sensor, which is a high-speed, high-sensitivity NPN silicon phototransistor. The sensor is vulnerable to infrared radiation due to its black epoxy.

The sensor is very important in the firefighting robot game; it can be used as a robot's eyes to identify the fire source..

Features

- Detects a flame or a light source of a wavelength in the range of 760nm-1100 nm
- Detection distance: 20cm (4.8V) ~ 100cm (1V)
- Detection angle about 60 degrees, it is sensitive to the flame spectrum.
- Comparator chip LM393 makes module readings stable.
- Adjustable detection range.
- Operating voltage 3.3V-5V

- Digital and Analog Output DO digital switch outputs (0 and 1) AO analog voltage output
- Power indicator and digital switch output indicator

4.7.4 DC MOTOR

For robotics applications, a simple to use, low-cost motor. Nut for securing the motor to the robot's body/chassis. Internally threaded hole on shaft for simple screw mounting of wheels. Any of a group of rotary electrical machines that transform direct current electrical energy into mechanical energy is known as a DC motor. The most popular forms depend on magnetic fields to generate forces. Almost all DC motors have an internal mechanism, either electromechanical or electronic, that changes the direction of current in a part of the motor on a regular basis.

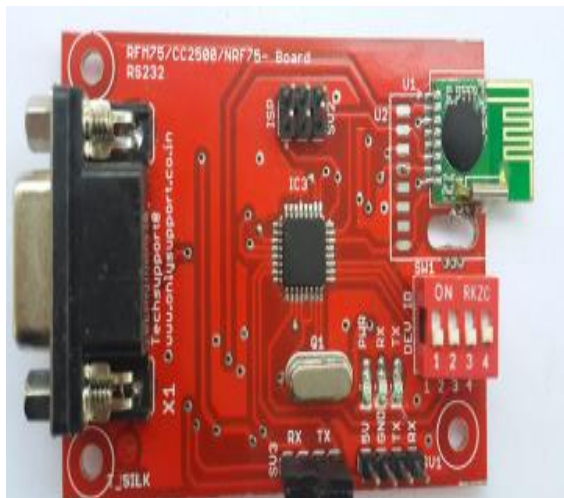
Since they could be operated by existing direct-current lighting power delivery systems, DC motors became the first type of motor to become widely adopted.



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.

4.7.5 ZIGBEE

- RFM75 data modem operates in half-duplex mode at 2.4 GHz, with automatic receive/transmit mode switching and LED hint.
- Receives and transmits serial data at RS232 level at a customizable baud rate of 9600/4800/38400/19200 bps for direct connection to a PC Serial port or other equipment.
- For applications that need two-way wireless data transfer, this platform can be used with other 2.4 Ghz Sensor embedded models (TTL, 30 metre range) or the RFM75 modem.
- It has a faster data rate and a wider transmission range.
- The contact protocol is entirely self-contained and open to the user interface. The module can be easily inserted into your current design to allow wireless communication.

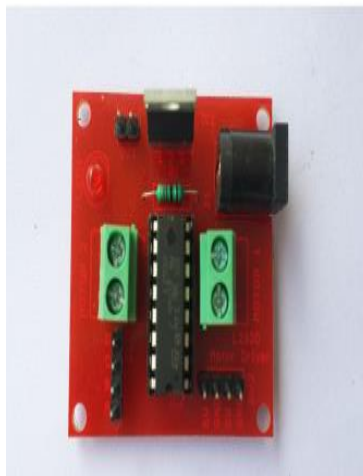


Features

- RS-232 direct interface
- TTL support
- Separate LED for RX,TX and power
- 30Mtr range
- 4 bit channel selection
- Programmable output power
- Variable payload length from 1 to 32bytes
- Automatic packet processing
- 6 data pipes for 1:6 star networks
- 4-pin SPI interface with maximum 8 MHz clock rate **7**
- 20-pin 4x4mm QFN package

4.7.6 L293D DRIVER

The L293D motor driver is designed to provide a simple and intuitive user interface for embedded applications. The L293D motor driver is mounted on a single-sided non-PTH PCB of excellent design. For quick access to the driver IC's pin functions, the pins of the L293D motor driver IC are attached to connectors..



With a supply voltage of up to 24V, the L293D is a Dual Full Bridge driver that can drive up to 1Amp per bridge. It can power two DC motors, relays, solenoids, and other devices. TTL compatibility is provided by the system. The current power of the L293D can be increased to 2 Amp by connecting two H bridges in parallel.

Features

- Easily compatible with any of the system
- Easy interfacing through FRC (Flat Ribbon Cable)
- External Power supply pin for Motors supported
- Onboard PWM (Pulse Width Modulation) selection switch
- 2pin Terminal Block (Phoenix Connectors) for easy Motors Connection

- Onboard H-Bridge base Motor Driver IC (L293D)

ELECTRICAL CHARACTERISTICS

- 600-mA Output Current Capability Per Driver
- Pulsed Current 1.2-A Per Driver
- Output Clamp Diodes for Inductive Transient Suppression
- Wide Supply Voltage Range 4.5 V to 36 V
- Separate Input-Logic Supply
- Thermal Shutdown
- Internal ESD Protection
- High-Noise-Immunity Inputs

4.7.7 WATER PUMP MOTOR

Water pumps do exactly as their name implies: they pump water. Customers will usually find a water pump to suit their car or to help them draw water from the ground in a self-dug well to be used in pressure tanks inside the area, whether it's in a vehicle, at a store, at home, or in a well. Vehicle water pumps monitor the flow of water into the cooling mechanism of a vehicle; when the seal on one breaks, the entire pump must be replaced..

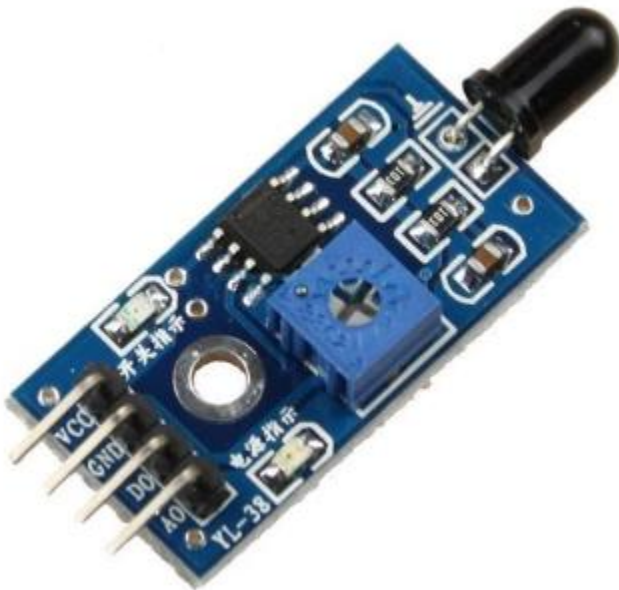


Pressure water pumps, which are usually found within a home or company, monitor water flow and maintain water pressure during the year. A pump motor is a DC motor that is used to drive liquids. A DC motor transforms electrical power from direct current to mechanical power. When a current carrying conductor is put in a magnetic field, it feels torque and has a propensity to travel. This is how a DC or direct current motor operates. This is referred to as "motoring movement." Pumps use energy to conduct mechanical work by transferring fluid and are powered by a motion (usually reciprocating or rotary). Pumps use a variety of energy sources, including manual and electric power.

4.8 FIRE SENSOR:

A flame detector is a sensor that detects and responds to the appearance of a flame or heat, making it possible to identify flames. Sound an alert, deactivating a fuel line (such as a propane or natural gas line), and activating a fire control system are all possible responses to a perceived blaze, depending on the installation.

4.8.1 FIRE SENSOR



When used in applications such as industrial furnaces, their role is to provide confirmation that the furnace is working properly; in these cases they take no direct action beyond notifying the operator or control system. A flame detector can often respond faster and more accurately than a smoke or heat detector due to the mechanisms it uses to detect the flame

4.9 OPTICAL FLAME DETECTORS:

4.9.1 Ultraviolet detector

UV detectors operate by measuring UV radiation that is released at the time of ignition. Though capable of detecting fires and explosions in 3–4 milliseconds, a 2–3 second time interval is often included to reduce false alerts caused by other UV sources such as lightning, arc welding, radiation, and sunlight. To reduce the effects of natural background radiation, UV detectors usually run at wavelengths less than 300 nm. Oily pollutants can quickly blind the solar blind UV wavelength band.

4.9.2 Near IR array

Visual flame detectors, also known as near infrared (IR) array flame detectors (0.7 to 1.1 m), use flame recognition devices to validate fire by measuring near IR radiation using a charge-coupled unit (CCD). A near infrared (IR) sensor can be used to track flame phenomenon without being hindered by water or water vapour. At this wavelength, pyroelectric sensors can be surprisingly inexpensive. Multiple channel or pixel array sensors that track flames in the near infrared band are arguably the most accurate fire detection technology available. A fire's light emission creates an impression of the blaze at a certain moment. It is possible to use digital image processing to.

4.9.3 Infrared

Flame detectors that use infrared (IR) or wideband infrared (1.1 m and higher) scan the infrared spectral band for complex patterns emitted by hot gases. A sophisticated fire-fighting thermal imaging camera (TIC), a kind of thermographic camera, detects these. Other hot surfaces and background thermal radiation in the environment can cause false alarms. Water on the detector's mirror, as well as exposure to direct sunlight, can significantly limit the detector's accuracy. 4.3 to 4.4 m is a unique frequency spectrum. This is a CO₂ resonant frequency. As a hydrocarbon (such as wood or fossil fuels like oil and natural gas) is burned, a lot of heat and CO₂ is emitted. CO₂ emission is very hot. This level is known as "solar blindness," but sunshine reduces susceptibility. The detector is made less vulnerable to false alarms caused by heat radiation, such as that caused by hot equipment, by observing the flicker frequency of a fire (1 to 20 Hz).

The fact that nearly all radiation can be absorbed by water or water vapor is a major disadvantage; this is especially true for infrared flame detection in the 4.3 to 4.4 μm range. Water or ice absorbs almost entirely at a wavelength of around 3.5 μm and greater. As a result, infrared sensors for outdoor use are highly unresponsive to flames. The most serious issue is our ignorance; some infrared detectors have a self-adjusting (automatic) detector slot.

Since salt absorbs water, a salt film is also toxic. Water vapor, cloud, or light rain, on the other hand, blinds the sensor without the user's awareness. The reason is analogous to what a firefighter does when approaching a hot fire: he uses a water vapor screen to cover himself from the intense infrared heat radiation. Water vapor, cloud, or light rain would then "shield" the monitor, stopping it from seeing the flames. However, visible light can pass through the water vapor filter, as shown by the fact that a person can still see the flames through the water vapor screen. The usual response time of an IR detector is 3–5 seconds.

4.9.4 Infrared thermal cameras

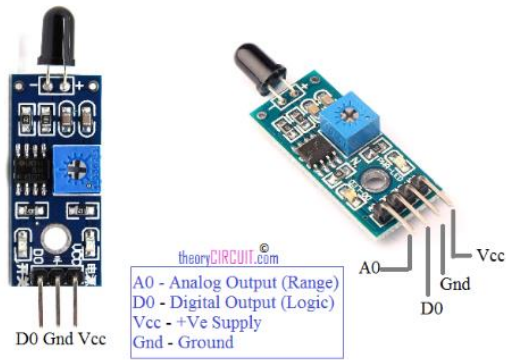
MWIR infrared (IR) cameras can sense heat and, with the aid of complex algorithms, can detect hotspots within a scene as well as flames for fire detection and prevention. This cameras can work both inside and outside and can be used in total darkness.

4.9.5 UV/IR

These detectors are sensitive to both UV and IR wavelengths, and detect flame by comparing the threshold signal of both ranges. This helps minimize false alarms.

4.9.6 IR/IR flame detection

Flame detectors with dual infrared ranges (IR/IR) equate the threshold signal in two infrared ranges. Typically, one sensor measures 4.4 μm carbon dioxide (CO_2) and the other measures a reference frequency. For hydrocarbon fuels, measuring CO_2 emissions is acceptable; for non-carbon dependent fuels, such as hydrogen, measuring broadband water bands is appropriate.



4.9.7 UV/IR flame detectors are used in:

- Hydrogen stations.
- Gas-fueled cookers
- Industrial heating and drying systems
- Domestic heating systems
- Industrial gas turbines

CHAPTER 5

RESULTS AND DISCUSSIONS

5.1 ANALYSIS

- The analysis is the numerical simulation of any particular physical event using the Finite Element Method (FEM). Engineers use it to minimise the number of actual samples and tests, as well as refine parts during the design process, in order to create better goods faster.
- Mathematics is needed to fully comprehend and measure any physical phenomenon, such as structural or fluid behavior, thermal transport, wave propagation, and so on. Partial Differential Equations are used to explain the majority of these systems (pdes). Numerical techniques have been developed over the last few decades to allow a machine to solve these problems, and one of the most well-known is
- Differential equations can be used to explain not just natural processes but also physical phenomena in engineering mechanics. These partial differential equations (pdes) are difficult equations that must be solved in order to calculate related structural quantities (such as stresses (), strains (), and so on) in order to predict the behavior of the investigated variable under a given load. It's important to remember that FEA only provides an approximate solution to the problem and is merely a numerical method for obtaining the real solution to these partial differential equations. Simply put, FEA is a numerical method for predicting how a part or assembly will behave under certain conditions.
- It acts as the base for advanced simulation applications, aiding engineers in detecting blind points, places of tension, and other structural shortcomings. The outcomes of a simulation using the FEA method are normally represented by a color scale that represents the pressure distribution over the target, for example.
- FEA can be traced back to Euler's work as early as the 16th century, depending on one's point of view. The first mathematical papers on Finite Element Analysis, however, can be found in Schellbach's (1851) and Courant's (1943) works.

- FEA was independently developed by engineers in different companies and industries to address structural mechanics problems related to aerospace and civil engineering. The development for real life applications started around the mid-1950s as papers by Turner, Clough, Martin and Topp [1956], Argyris [1957] and Babuska and Aziz [1972] show. The books by Zienkiewicz [1971] and Strang and Fix [1973] also laid the foundations for future developments in FEA.

5.1.1 GEOMETRIC MODELLING

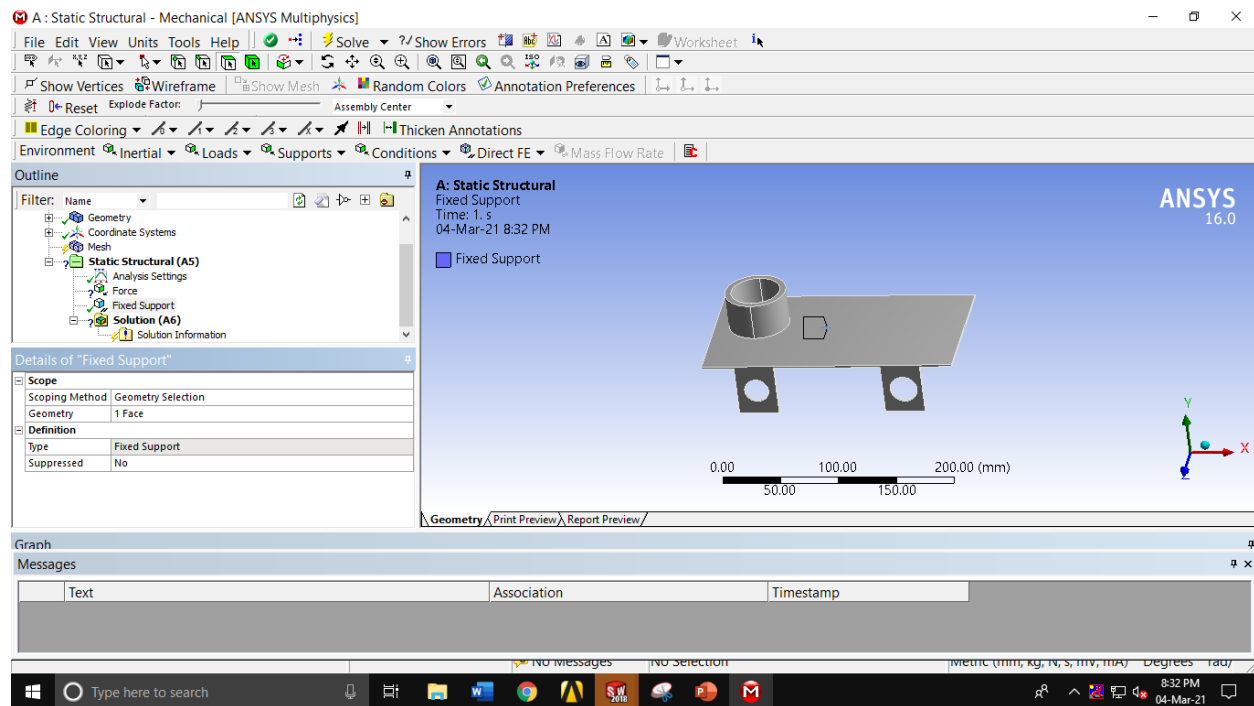
- Geometry simulation in the ANSYS Workbench framework is highly automated, and users may configure it according to the form of research or application they're operating on. The parametric, feature-based The ANSYS Design Modeler program can be used to construct parametric geometry from scratch or to study CAD geometry that already exists. It has automatic simplification, clean-up, maintenance, and defeaturing solutions.
- Simulation also necessitates modelling capability not found in traditional computer-aided design (CAD) operations. As a result, these features are either missing from CAD programs or applied in an inefficient manner for simulation..
- ANSYS Design Modeler offers simulation-specific modelling functions such as parametric geometry development, concept model formation, CAD geometry adjustment, automatic cleanup and repair, and other custom methods for fluid flow, structural, and other analyses..

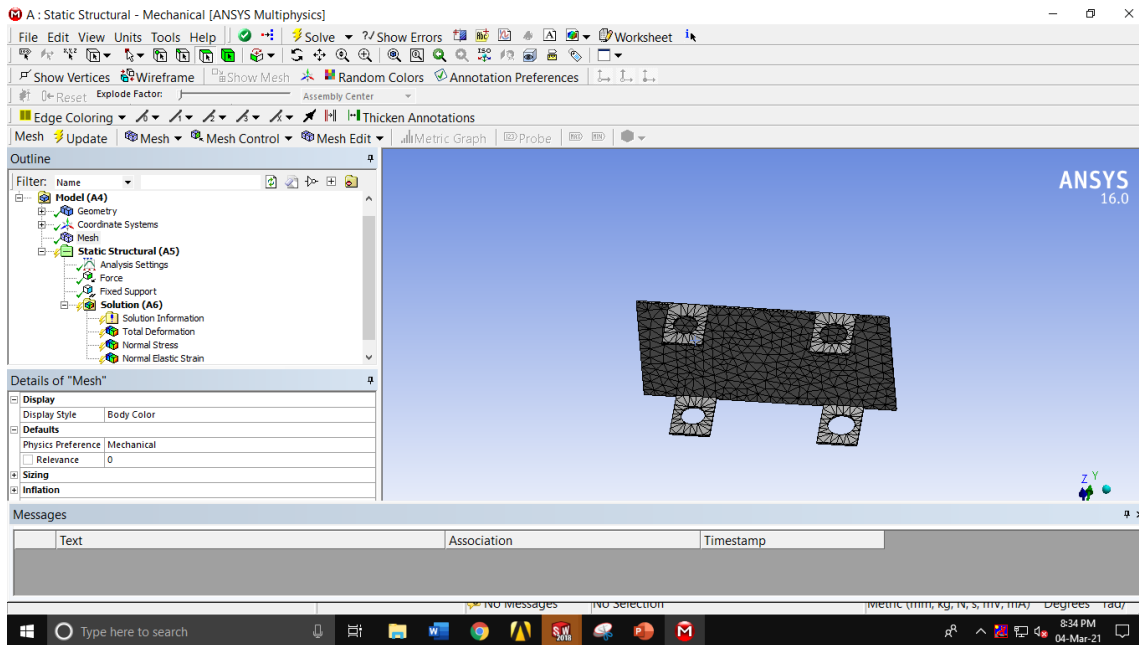
5.1.2 MATHEMATICAL MODELLING

- ANSYS FLUENT combines the ability to model dynamic geometries with a wide variety of mathematical simulations for transport processes (such as heat transfer and chemical reactions). Laminar non-Newtonian flows in process equipment; conjugate heat transfer in turbomachinery are examples of ANSYS FLUENT applications.

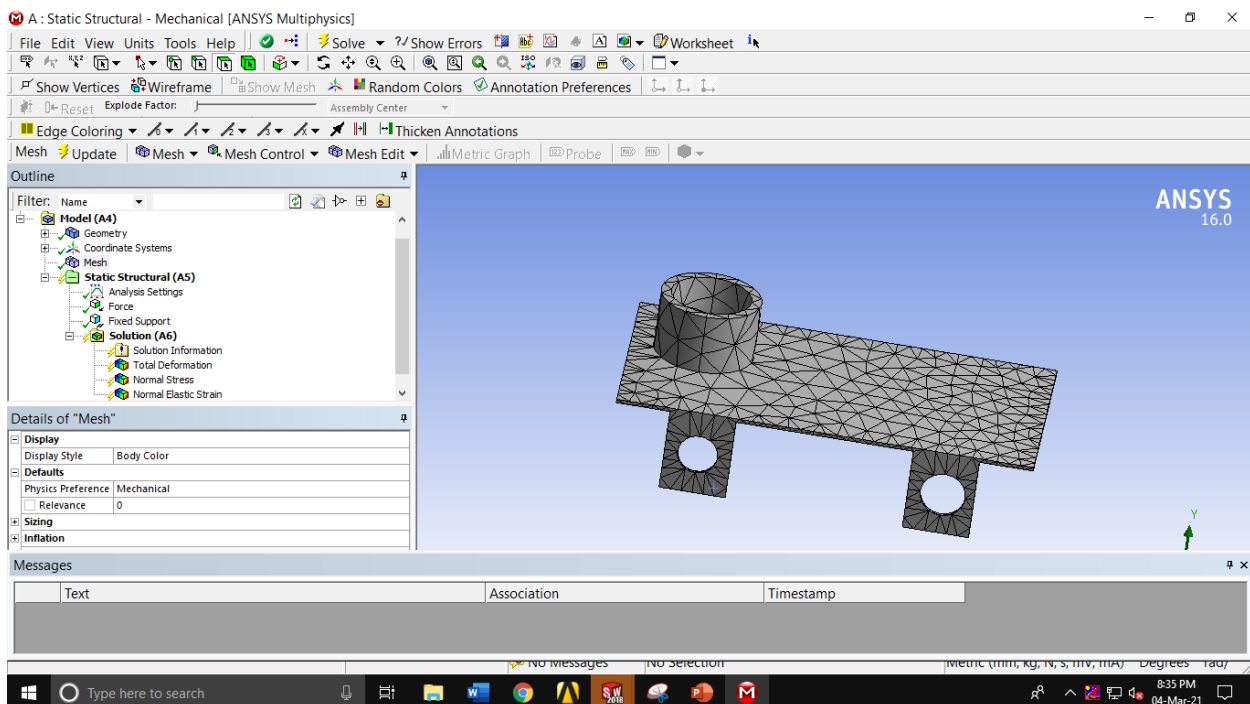
- and multiphase flows in bubble columns and fluidized beds; pulverized coal combustion in service boilers; external aerodynamics; movement by compressors, motors, and fans; and external aerodynamics. The turbulence models presented cover a wide variety of applications and take into account the effects of other physical processes like buoyancy and compressibility. Using expanded wall functions and zonal models, special attention has been paid to issues of near-wall precision.
- We prefer geometric modelling over mathematical modelling because we can get finite elemental analysis and finite elemental volume at a particular point of any metals and this cannot be obtained for mathematical modelling. The geometric modelling helps in generation of balanced system architecture that concurrently incorporate representations of system behavior, structure, and physical layout

GEOMETRICAL MODELING





GEOMETRICAL MODELING



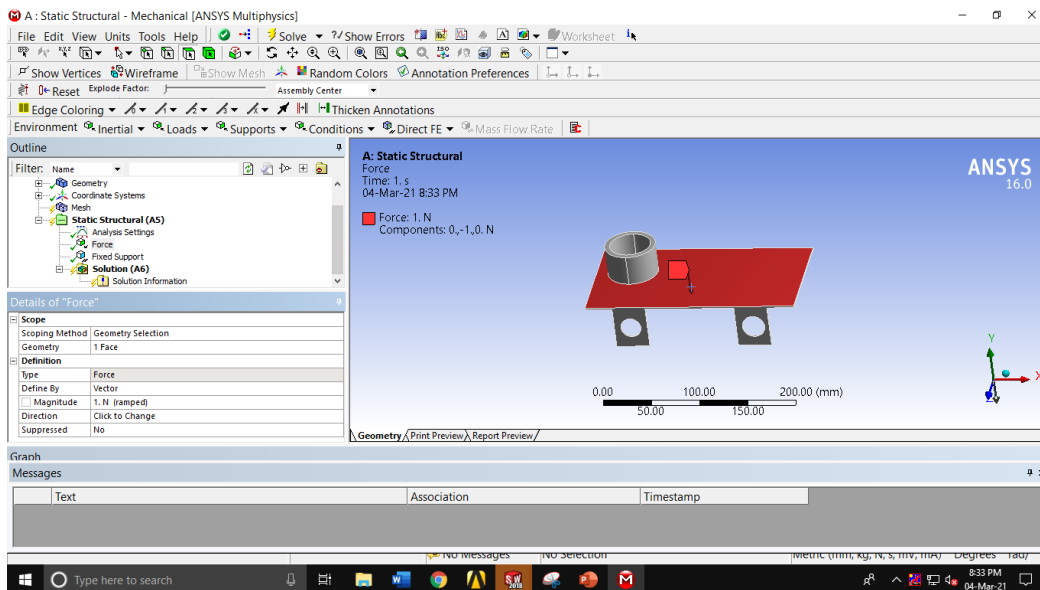
5.2 BOUNDARY CONDITIONS

Force, strain, and temperature are the three major forms of loading present in FEA. These can be used on points, surfaces, borders, nodes, and components, or they can be implemented remotely from the future. The way the model is constrained has a big impact on the outcomes, so it's important to think about it. Models that are above or under constrained 34

will provide tension that is so off that it is useless to the engineer. We may have large assemblies of modules all attached to each other with communication elements in a perfect universe, but this is out of most people's budgets and resources. We should, therefore, make the most of the computing hardware we have, which requires an understanding of how to use it properly.

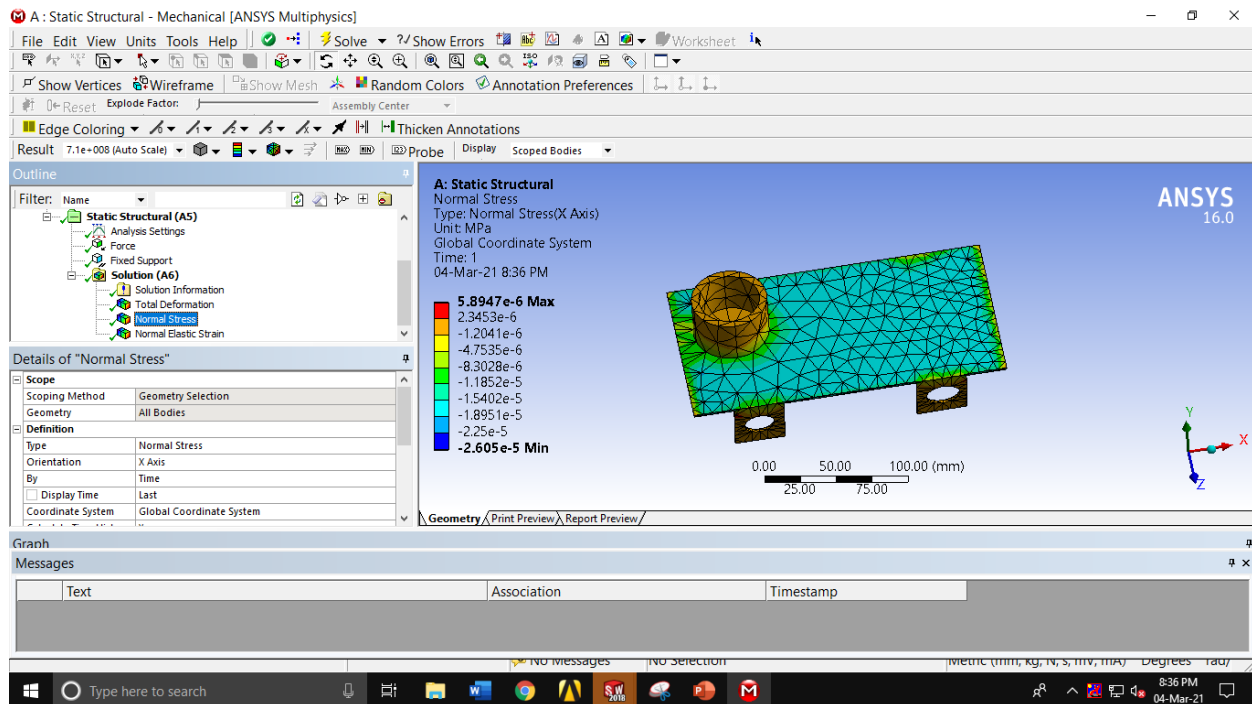
5.3 ANALYSIS FOR FORCE

An analysis that yields the respective forces acting at either point of any individual, or part of a member, of a system, based on dynamic equilibrium relationships in a plane rigid body subject to external forces within this plane and internal forces related to its motion in this plane.



5.4 ANALYSIS FOR STRESS

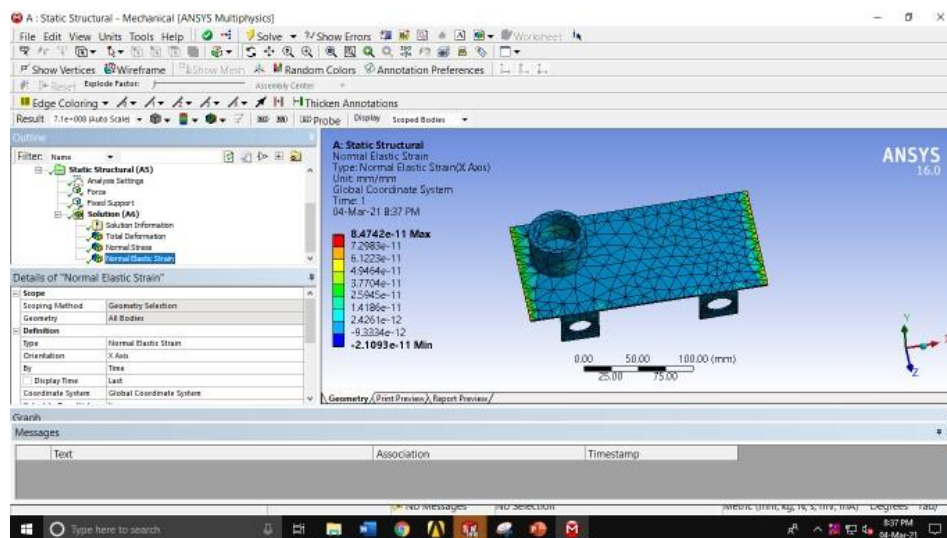
Stress-strain analysis (also known as stress analysis) is a field of engineering that utilises a range of techniques to assess the stresses and strains of materials and systems that have been exposed to forces. Stress analysis is also used in the repair of these systems, as well as in the investigation of structural defects..



5.5 ANALYSIS FOR STRAIN

Indirect stress or strain analysis is a flexible tool for determining whether a product or part is likely to fail or has already failed. Externally added stress or residual (molded-in) pressures will both cause failure. A component may fail prematurely due to both external stress and molded-in strain (or a combination of both). Failures caused by faulty construction or unnecessary service forces are easier to spot. Residual tensions and pressures, on the other hand, are a whole different story. Bad molding techniques can create residual strain almost anywhere, at any time. Photo elastic inspection will identify frozen-in strains, causing fault to be identified, and the process will expose the act.

Strain



5.6 ANALYSIS FOR DEFORMATION

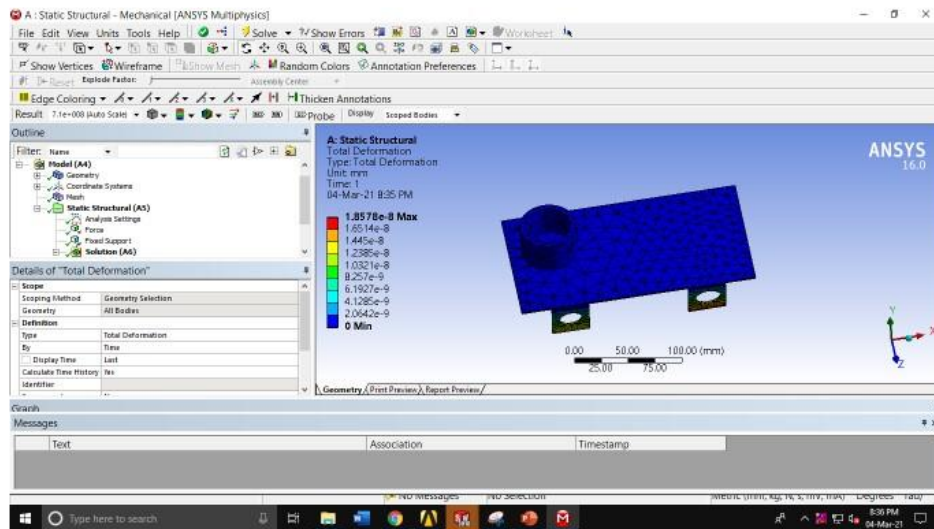
The review of all solid mechanics problems begins with a deformation analysis. Solid mechanics equations are normally written by watching a volume of fluid as it travels, rotates, and deforms. In contrast to the Eulerian formulation used in many other areas of physics, such as fluid flow analysis, this is known as a Lagrangian formulation. The flux into and out of a fixed-in-space control volume is at the heart of an Eulerian formulation.

1. Two related variants of Lagrangian formulations are widely used in finite element analysis: In the *total Lagrangian* formulation, the equations are based on the original configuration of the body
2. In the *updated Lagrangian* formulation, the equations are based on the current configuration of the body

These two formulations are mathematically similar in the sense that they can be converted into each other using a set of transformations. When it comes to the computational utility of finite element formulations, however, the formulations vary.

The theory's development suggests that solid matter can be viewed as a continuum. The length dimension is considerably greater than the molecular scale, resulting in homogeneous properties that are small enough to be rendered infinitesimal mathematically..

Deformation



5.7 BOUNDARY CONDITION

Property	value
Density	7850 kgm ⁻³
Isotropic secant coefficient of thermal expansion	
Coefficient of thermal expansion	1.2E -0.5 c ⁻¹
Reference temperature	22C
Isotropic elasticity	
Derived from	young's modulus
Young's modulus	2E + 11 pa
Poisson's ratio	0.3
Bulk modulus	1.6667E + 11 pa
Shear modulus	7.6923E + 10 pa

Alternating stress mean stress

Interpolation	log – log
Scale	1
Offset	0 pa
Strain life parameters	
Display curve type	strain life
Strength coefficient	9.2E +08 pa
Strength exponent	-0.106
Ductility coefficient	0.213
Ductility exponent	-0.47
Cyclic strength coefficient	1E + 09 pa
Cyclic strain hardening exponent	0.2

DEFORMATION -MM	STRESS-mpa	STRAIN
1.8578	5.89	8.47

5.8 CODING FOR THE PROJECT

The Arduino IDE is a free and open-source tool for creating electronic projects. Arduino is made up of a physical programmable circuit board (also known as a microcontroller) and software, known as an IDE (Integrated Development Environment), that runs on your device and is used to write and upload computer code to the physical board.

The Arduino platform has grown in popularity among people who are just getting started with electronics, and with good reason. Unlike other previous programmable circuit boards, the Arduino does not need a separate piece of hardware (known as a programmer) to load new code onto the board; instead, a USB cable is all that is needed. Furthermore, the Arduino IDE makes use of a simp

5.8.1 Code

```
long duration;

int distance;

int motor1 =7;

int motor2 =8;

int motor3 =9

int motor4 =10;

int fire =11;

int water =12;

int buzzer =6;

void setup(){

    Serial.begin(9600);

    pinMode(motor1,OUTPUT);
```

```

pinMode(motor2,OUTPUT);

pinMode(motor3,OUTPUT);

pinMode(motor4,OUTPUT);

pinMode(water,OUTPUT);

pinMode(buzzer, OUTPUT);

pinMode(fire, INPUT);

pinMode(trigPin,OUTPUT);

pinMode(echoPin,INPUT);
}

void loop()

{

digitalWrite(trigPin,LOW);

delayMicroseconds(2);

digitalWrite(trigPin,HIGH);

delayMicroseconds(10);

digitalWrite(trigPin,LOW);


duration=pulseIn(echoPin,HIGH);

distance=(duration*0.034/2);

Serial.print("Distance : ");

Serial.print(distance);

Serial.println(" cm ");

delay(1000);

```

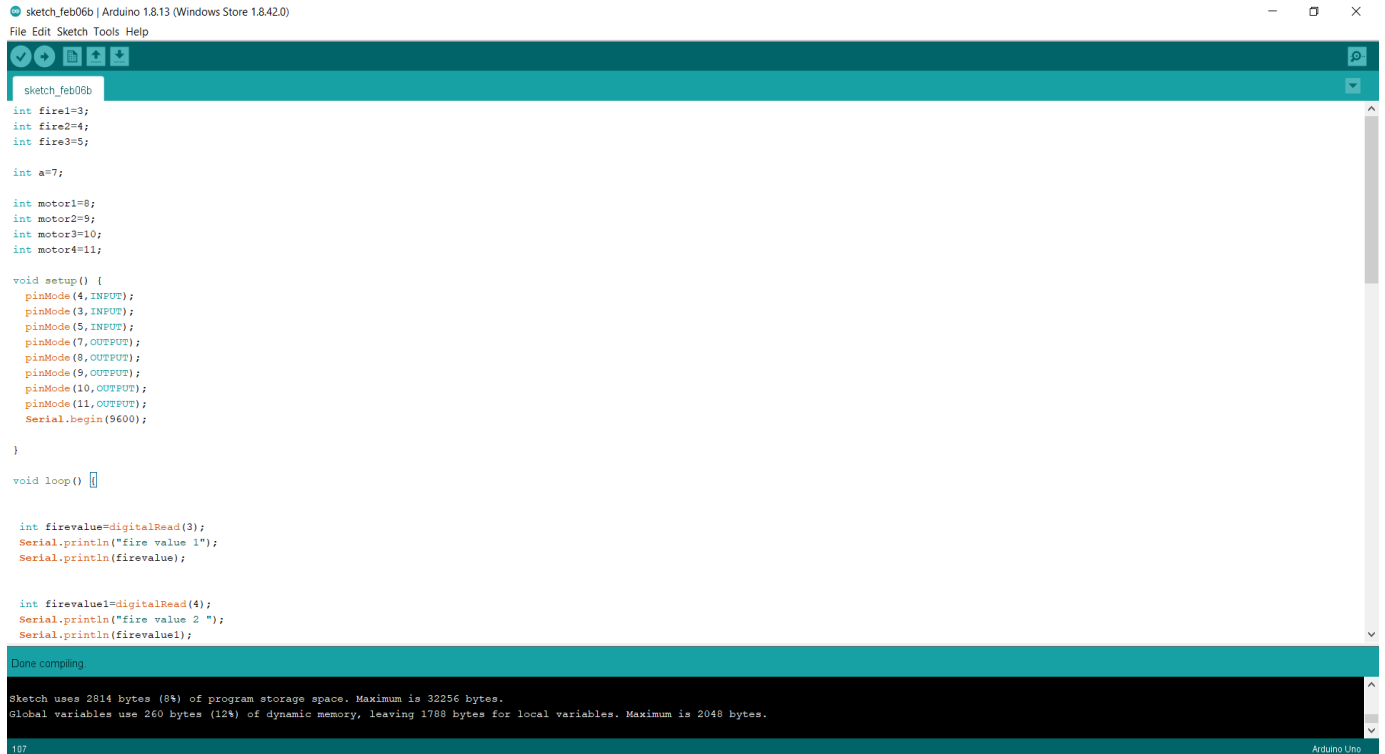
```
if(serial.available()>0)
{
String a=Serial.readString();
if(a=='forward')
{
digitalWrite(motor1, HIGH);
digitalWrite(motor2, LOW);
digitalWrite(motor3, HIGH);
digitalWrite(motor4, LOW);
}
if(a=='reverse')
{
digitalWrite(motor1, LOW);
digitalWrite(motor2, HIGH);
digitalWrite(motor3, LOW);
digitalWrite(motor4, HIGH);
}

if(a=='right')
{
digitalWrite(motor1, HIGH);
digitalWrite(motor2, LOW);
```

```
digitalWrite(motor3, LOW);  
digitalWrite(motor4, LOW);  
}  
if(a=='left')  
{  
digitalWrite(motor1, LOW);  
digitalWrite(motor2, LOW);  
digitalWrite(motor3, HIGH);  
digitalWrite(motor4, LOW);  
  
}  
  
if(a=='stop' || distance<10)  
{  
digitalWrite(motor1, LOW);  
digitalWrite(motor2, LOW);  
digitalWrite(motor3, LOW);  
digitalWrite(motor4, LOW);  
  
}  
if(a=='on')  
{  
digitalWrite(water, HIGH);
```

```
}  
  
if(a=='off')  
{  
    digitalWrite(water, LOW);  
}  
}  
  
  
int b=digitalRead(fire);  
  
if(b==0)  
{  
    digitalWrite(buzzer, HIGH);  
    delay(1000);  
    digitalWrite(buzzer, LOW);  
    delay(1000);  
  
}
```

5.8.2 CODE COMPILATION IN ARDUINO IDE



```
sketch_feb06b | Arduino 1.8.13 (Windows Store 1.8.42.0)
File Edit Sketch Tools Help

sketch_feb06b
int fire1=3;
int fire2=4;
int fire3=5;

int a=7;

int motor1=8;
int motor2=9;
int motor3=10;
int motor4=11;

void setup() {
  pinMode(4,INPUT);
  pinMode(3,INPUT);
  pinMode(5,INPUT);
  pinMode(7,OUTPUT);
  pinMode(8,OUTPUT);
  pinMode(9,OUTPUT);
  pinMode(10,OUTPUT);
  pinMode(11,OUTPUT);
  Serial.begin(9600);
}

void loop() {

  int firevalue=digitalRead(3);
  Serial.println("fire value 1");
  Serial.println(firevalue);

  int firevalue1=digitalRead(4);
  Serial.println("fire value 2 ");
  Serial.println(firevalue1);
}

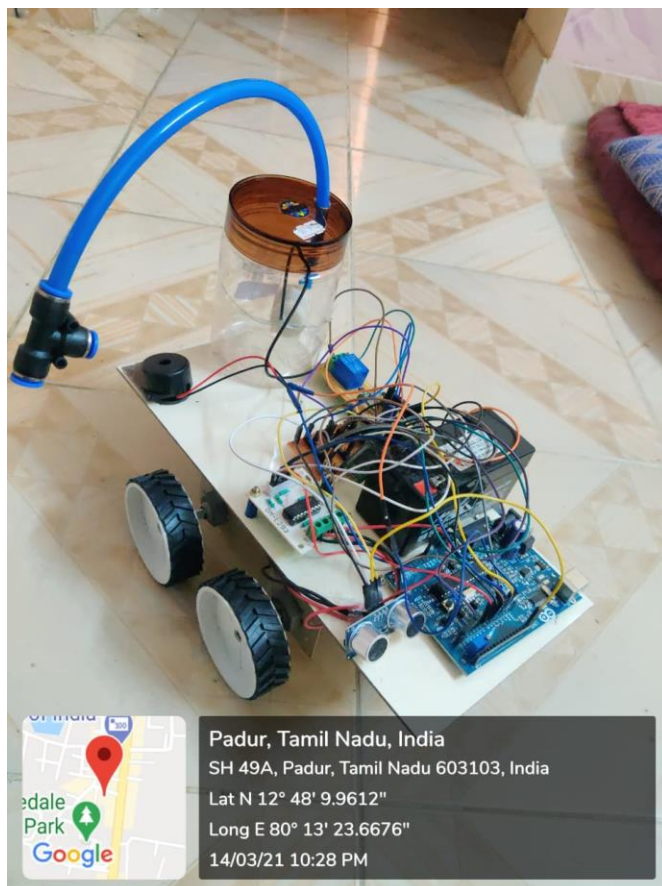
Done compiling

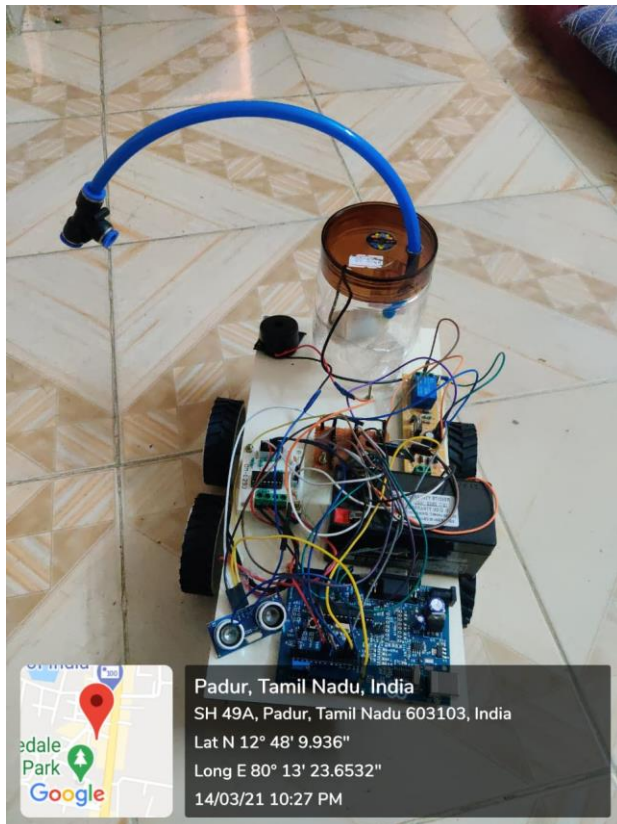
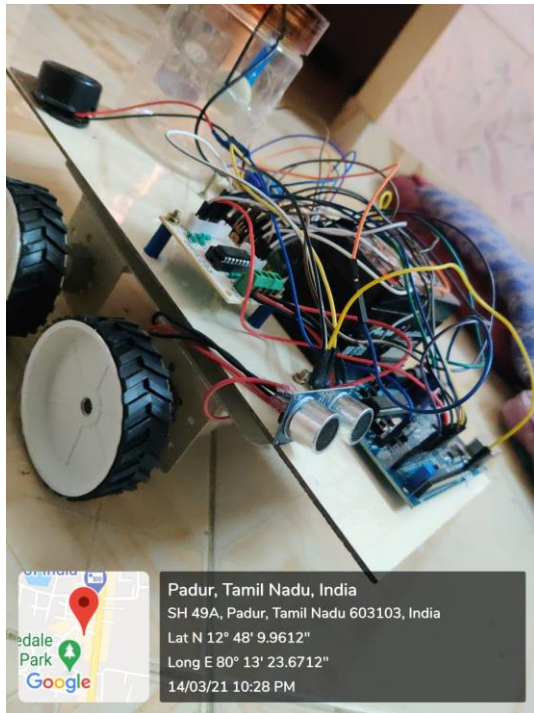
Sketch uses 2814 bytes (8%) of program storage space. Maximum is 32256 bytes.
Global variables use 260 bytes (12%) of dynamic memory, leaving 1788 bytes for local variables. Maximum is 2048 bytes.

107 Arduino Uno
```

Compilation done

5.9 Robot photos





CHAPTER 6

SUMMARY AND CONCLUSION

6.1 SUMMARY

Every fire and emergency response field needs to be concerned with this scheme. Owing to elevated temperatures or the presence of explosive materials, firefighting services have recently found it difficult to reach the scene of a fire, even though the fire is causing significant property destruction and human death.

Fire-fighting robots can be useful in such situations for extinguishing a fire. The goal of the project is to create a robot that will enable us to monitor the area where we have an advantage.

The robot's size also lends itself to being used as a secret agent robot. Many of the processes are regulated by an Arduino microcontroller. According to the findings, the robot can detect obstacles using its UV sensor and detect fire using its fire sensor, all of which are located in the robot's front portion. We can control the robot using a cell phone with a wireless transmitter. When the fire sensor senses a fire, an alarm is sounded, and we use the pump to pump water out of the fire. According to the prototype, it will go up to 20 meters and will be powered by a 12 volt battery.

6.2 REFERENCES

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6.3 CONCLUSION:

This paper has presented a unique vision of the concepts which are used in this particular field. It aims to promote technology innovation to achieve a reliable and efficient outcome from the various instruments. Experimental work has been carried out carefully. The result shows that higher efficiency is indeed achieved using the embedded system. With a common digitalized platform, these latest instruments will enable increased flexibility in control, operation, and expansion; allow for embedded intelligence, essentially foster the resilience of the instruments; and eventually benefit the customers with improved services, reliability and increased convenience



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Development of Autonomous Fire Resistant Mobile Robot for Hazardous Environments
Submitted in partial fulfillment of the requirements for the award of Bachelor of
Engineering **degree in Mechanical Engineering** by SHAIK NOUMAN (37150174)
P.KISHORE (37150135) / DEPARTMENT OF MECHANICAL ENGINEERING **SCHOOL OF
MECHANICAL ENGINEERING SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY
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RAJIV GANDHI SALAI,** CHENNAI - 600 119 APRIL – 2021 / DEPARTMENT OF
MECHANICAL ENGINEERING BONAFIDE CERTIFICATE This is to certify that this Project
Report is the bonafide work of SHAIK NOUMAN(37150174), P KISHORE (37150135) who
carried out the project entitled "Development of Autonomous Fire Resistant Mobile
Robot for Hazardous Environments" under our supervision from September 2020 to
April 2021. Internal Guide Mr. R B DURAIRAJ, M.E., (Ph.D.,) Head of the Department Dr.G.
ARUNKUMAR, M.E., Ph.D.,

_ Submitted for Viva voice Examination held on _____ Internal Examiner External
Examiner DECLARATION We SHAIK NOUMAN (37150174), P KISHORE (37150135)
hereby declare that the Project Report entitled "Development of Autonomous Fire
Resistant Mobile Robot for Hazardous Environments" done by me under the guidance
of Mr. DR.R B DURAIRAJ, M.E., (Ph.D.,) is submitted in partial fulfillment of the
requirements for the award of Bachelor of Engineering degree in Mechanical
Engineering. DATE: SIGNATURE OF THE CANDIDATE PLACE: CHENNAI
ACKNOWLEDGEMENT I am pleased to acknowledge **my sincere thanks to** Board of
Management of SATHYABAMA for their kind encouragement in doing this project and
for completing it successfully.

I am grateful to them. I convey **my sincere thanks to** Dr.S. Prakash, M.E., Ph.D., Dean,