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KARNATAKA

A ProjectReportOn

"RoboRescue: Intelligent Robotics for Pioneering Fire Detection and Extinguishing Using Arduino"

Submitted in partial fulfillment of requirements for the award of degree

BACHELOR OF ENGINEERING
IN
ELECTRICAL AND ELECTRONICS ENGINEERING

Submitted by

ABDUL HANNAN	**(21EE001)**
BALAJIGOWDA D K	**(21EE006)**
HEMANTH A M	**(21EE019)**
HITHAISHI G M	**(21EE020)**

Under the guidance of

Mrs SOWMYA K R

B.E., M.Tech.,(Ph.D),MISTE
Assistant Professor,
Dept. of EEE SSIT,
Tumakuru – 572105

DEPARTMENT OF ELECTRICAL AND ELECTROMICS ENGINEERING

SRI SIDDHARTHA INSTITUTE OF TECHNOLOGY

(A Constituent College of Sri Siddhartha Academy of Higher Education, Approved by AICTE, Accredited by NBA, NAAC 'A+' Grade)
MARALUR, TUMAKURU-572105

2024-2025

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CERTIFICATE

This is to certify that the project entitled ***"RoboRescue: Intelligent Robotics for Pioneering Fire Detection and Extinguishing Using Arduino"*** *is a bonafide work carried out by* **ABDUL HANNAN, BALAJIGOWDA D K, HEMANTH A M , HITHAISHI G M** *in partial fulfillment for the award of degree of* ***Bachelor of Engineering*** *in* **Electrical and Electronics Engineering** *during the academic year* ***2024-25****.*

It is certified that all the corrections/suggestions indicated for internal assessment have been incorporated in the report. The project report has been approved as it satisfies the academic requirements in respect of project work prescribed for the degree of Bachelor of Engineering in Electrical and Electronics Engineering.

Signature of guide	Signature of HOD	Signature of Principal
Mrs. SOWMYA K R	**DR. N PRADEEP**	**DR. M S RAVIPRAKSHA**
B.E MTech (Ph.d)	B.E, MTech, Ph.d	B.E ,MTech,Ph.d,FIE
Assistant Professor	SSIT,TUMKUR	Principal,SSIT,TUMKUR
Dept.of EEE SSIT,TUMKUR		

External Examiners **Signature with Date**

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ACKNOWLEDGEMENT

At the outset we express our most sincere grateful thanks to holy sanctum of **"SRI SIDDHARTHA INSTITUTE OF TECHNOLOGY"**, the temple of learning, for giving us an opportunity to pursue the degree course in Electrical and Electronics Engineering thus help shaping our career.

We wish to express our sincere gratitude to **Dr. M. S. RAVIPRAKASHA** Principal, Sri Siddhartha Institute of Technology, for providing us an excellent academic environment, which has nurtured our practical skills, and for kindly obliging our requests and providing timely assistance.

We are highly grateful **Dr. N Pradeep,** Head of Department of Electrical and Electronics Engineering, for patronizing us throughoutthe project and for his encouragement and moral support.

We also wish to express our deep sense of gratitude to our project guide **SOWMYA K R,** Assistant Professor, Department of Electrical and Electronics Engineering, for his valuable suggestions, guidance, moral support and encouragement in completion of this project successfully. We have been fortunate for having hisprecious help.

Finally, we express our gratitude to all the teaching and non-teaching of the **Electrical and Electronics Engineering Department** staff for their timely support and suggestions.

We are also thankful to our parents for their moral support and constant guidance made our efforts fruitful. Last but not the least, our friends, without their constructive criticisms and suggestions we wouldn't have been able to complete successfully.

PROJECT ASSOCIATES

ABDUL HANNAN	(21EE001)
BALAJIGOWDA D K	(21EE006)
HEMANTH A M	(21EE019)
HITHAISHI G M	(21EE020)

DECLARATION

We hereby declare that this project work entitled ***"RoboRescue: Intelligent Robotics for Pioneering Fire Detection and Extinguishing Using Arduino"*** is an original and bonafide work carried out by us at **SRI SIDDHARTHA INSTITUTE OF TECHNOLOGY,** Tumakuru, in partial fulfillment of **BACHELOR OF ENGINEERING** in **Electrical and Electronics and Engineering**.

We also declare that, to the best of our knowledge and belief, The work reported herein does not form part of any other thesis or dissertation on the basis of which a degree or award was conferred on an earlier occasion by any student.

Date: Abdul Hannan (21EE001)

Place:

Balajigowda D K (21EE006)

Hemanth A M (21EE019)

Hithaishi G M (21EE020)

ABSTRACT

The increasing frequency of fire-related incidents in both industrial and residential environments has underscored the urgent need for advanced firefighting solutions that ensure rapid response, operational efficiency, and human safety. Traditional firefighting approaches, while effective in certain scenarios, are often constrained by human limitations, hazardous environments, and delayed reaction times. These limitations necessitate the development of intelligent robotic systems capable of operating in fire-prone areas with both manual and autonomous control capabilities. This research investigates the design and deployment of a firefighting robot that seamlessly integrates manual operation with automatic fire detection and suppression mechanisms.

This study explores the implementation of advanced control systems and sensor networks within the firefighting robot to enhance its operational flexibility and efficiency. The robot is equipped with flame, gas, and temperature sensors that continuously monitor environmental parameters, enabling the system to autonomously detect fire sources and initiate appropriate suppression actions. Additionally, the robot features a manual control interface, allowing human operators to navigate and control the system remotely in complex scenarios where human judgment is crucial. The integration of both modes allows for a hybrid approach, balancing automation with human oversight.

The firefighting robot performs several essential functions with enhanced precision and safety. In automatic mode, real-time data from onboard sensors is processed to detect fires, assess threat levels, and trigger extinguishing mechanisms without human intervention. In manual mode, operators can remotely maneuver the robot, especially in scenarios requiring strategic decisions or when the environment is not suitable for autonomous operation. This dual-mode functionality significantly improves the robot's versatility and effectiveness in dynamic and unpredictable fire emergencies.

The practical deployment of the dual-mode firefighting robot is a central aspect of this research. Key factors such as response time, sensor accuracy, mobility across terrains, and the reliability of automatic vs. manual switching mechanisms are critically analyzed. The study also evaluates the system’s ability to reduce human risk and its potential applications

CONTENTS

CHAPTER 1

INTRODUCTION

Firefighting robots equipped with both manual and automatic modes represent a significant advancement in disaster management and safety automation, leveraging intelligent systems to enhance firefighting capabilities. Unlike traditional firefighting methods that rely solely on human intervention, these robots are designed to operate in hazardous environments with minimal risk to human life, thanks to their dual control architecture. The integration of autonomous and manual functionalities allows the robot to adapt to varying fire scenarios effectively.

When configured for automatic mode, the robot utilizes a combination of sensors—such as flame detectors, temperature sensors, and gas sensors—to identify fire outbreaks with high precision. These sensors enable the robot to analyze environmental cues in real-time and initiate suppression mechanisms autonomously. On the other hand, the manual mode allows operators to remotely control the robot using a wireless interface, providing human oversight in complex or critical situations where judgment and strategy are essential.

The core advantage of this dual-mode system lies in its flexibility and real-time responsiveness. The autonomous mode ensures continuous monitoring and rapid response, reducing the delay typically associated with human-led interventions. As the robot navigates through fire-affected zones, it dynamically adapts its actions—detecting the fire source, adjusting its movement path, and deploying extinguishing agents as needed. Simultaneously, the manual mode allows seamless operator intervention whenever required, ensuring that control can be switched as per situational demands.

Furthermore, these robots provide a proactive and robust firefighting solution. They are not only capable of reacting to active fire hazards but also of patrolling high-risk zones to prevent disaster escalation. This dual capability significantly enhances safety and efficiency in environments such as industrial complexes, warehouses, and residential buildings. The integration of smart technology into firefighting systems thus contributes to faster incident response times,

1.1 LITERATURE REVIEW

1.2 PaperName: Development of Autonomous Firefighting Robots (2018)

Summary: This paper presents the design and implementation of autonomous firefighting robots capable of identifying and extinguishing fire without human intervention.

Key Findings: Autonomous robots equipped with flame and temperature sensors can detect fires in real-time and suppress them efficiently, reducing the need for human firefighters in dangerous **environments.**

1.3 Paper Name: Design of a Remote-Controlled Firefighting Robot (2019)

Summary: The study explores the use of wireless technologies for manual operation of firefighting robots in inaccessible areas.

Key Findings: Remote-controlled robots enhance firefighter safety and allow human operators to navigate hazardous zones effectively while directing suppression mechanisms.

1.4 Paper Name: Hybrid Control System for Firefighting Robots (2020)

Summary: This research focuses on combining automatic and manual control systems in firefighting robots for improved adaptability.

Key Findings: Dual-mode systems provide the flexibility of autonomous operation in standard scenarios and manual control during complex decision-making situations.

1.5 Paper Name: Sensor Integration for Real-Time Fire Detection in Robots (2021)

Summary: The paper examines the use of multiple sensors—flame, gas, smoke, and temperature—for accurate and real-time fire detection.

Key Findings: Multi-sensor integration significantly improves detection reliability and helps the robot respond quickly to various fire-related conditions.

1.2 Problem Statement

Traditional firefighting methods, which rely heavily on human intervention and manual control, are increasingly proving inadequate in addressing the challenges posed by modern fire scenarios. These methods not only expose firefighters to life-threatening risks but also limit the speed and efficiency of response, particularly in environments that are difficult to access or too hazardous to enter. As fire incidents become more complex due to factors such as the presence of toxic materials, unstable structures, and rapidly spreading flames, there is a growing need for intelligent systems capable of operating autonomously in such conditions. However, integrating robotics into firefighting operations presents significant challenges, including ensuring accurate fire and obstacle detection, enabling autonomous navigation in smoke-obscured areas, and maintaining reliable communication and control in extreme environments. To address these limitations, there is an urgent demand for comprehensive firefighting solutions that incorporate robotic technologies while seamlessly integrating with existing emergency response systems. Such solutions must enhance operational efficiency and safety without requiring a complete transformation of current firefighting practices.

Moreover, the development of firefighting robots must focus on real-time decision-making, adaptability to different fire environments, and the ability to operate in both indoor and outdoor scenarios. Robust sensor fusion, thermal imaging, and AI-driven path planning are essential for effective fire detection and suppression. Additionally, these robots must be designed to withstand high temperatures, falling debris, and other physical hazards typically found in fire zones. Ensuring affordability and ease of deployment is also critical to encourage widespread adoption among fire departments with limited resources. Continuous testing, simulation, and refinement are necessary to meet safety standards and real-world demands. Ultimately, the goal is to create a reliable robotic firefighting system that not only supports but significantly strengthens human-led firefighting efforts.

1.3 MOTIVATION

Cultural property management is entrusted with the responsibility of protecting and preserving an institution's buildings, collections, operations and occupants. Constant at

tention is required to minimize adverse impact due to climate, pollution, theft, vandalism, insects, mold and fire. Because of the speed and totality of the destructive forces of fire, it constitutes one of the more serious threats. Vandalized or environmentally damaged structures can be repaired and stolen objects recovered. Items destroyed by fire, however, are gone forever. An uncontrolled fire can obliterate an entire room's contents within a few minutes and completely burn out a building in a couple of hours. Hence it has become very necessary to control and cease the fire to protect the Life and costlier things. For that we purposed to design and fabricate the fire-fighting robot.

Autonomous robots can act on their own, independent of any controller. The basic idea is to program the robot to respond in a certain way to outside stimuli. The very simple bump-and-go robot is a good illustration of how this works.

This sort of robot has a sensor to detect obstacles. When you turn the robot on, it zips along in a straight line. When it finally hits an obstacle, the impact is on sensors, i.e, sansors may get damaged. and programming logic, the robot is guided to turn right and move forward again, when the robot finds an obstacle in its way. In this way, the robot changes direction any time it encounters an obstacle. Advanced robots use more elaborate versions of this same idea. Roboticists create new programs and sensor systems ,to make robots more smarter and more perceptive. Today, robots can effectively navigate in a variety of environments.

1.4COMPONENTS OVERVIEW

This system uses the following components.

1.1.1 Microcontroller

Microcontroller can be described as a computer embedded on a rather small circuit board. To describe the function of a microcontroller more precisely it is a single chip that can perform various calculations and task and send/receive signals from other devices via the available pins. Precisely what tasks and communication with the world it does, is what is governed by what instructions we give to the Microcontroller. It is this job of telling the chip what to do, is what we refer to as programming on it.

However, the microcontroller by itself, cannot accomplish much, it needs several external inputs, power, for one, a steady clock signal, for another. Also, the job of programming it has to be accomplished by an external circuit. So typically, a microcontroller is used along with a circuit which provides these things to it; this combination is called a microcontroller board. The Arduino Uno that you have received is one such microcontroller board. The actual microcontroller at its heart is the chip called **Atmega328**. The advantages that Arduino offers over other microcontroller boards are largely in terms of reliability of the circuit hardware as well as the ease of programming and using it.

1.1.2 Power Supply

7805 is a voltage regulation IC which is used to supply 5V Direct current to the microcontroller

1.1.3 Motor Driver IC

L293D is a dual H-bridge motor driver integrated circuit (IC). They are use to control they the 4 motor used in project. There are 2 motor driver IC used in the project one to control front motor and other for rear motors.

1.1.4 Computer Interface

Finally, this project uses IDE compiler for interfacing the arduino with a PC. This interface is used to setup and compile the Arduino.

CHAPTER 2

SYSTEM DETAILS

As explained in the introduction chapter, the realization of complete potential of the sensors and the wired medium in information transfer is the major issue that the following thesis of the following project deals with.

2.1 BLOCK DIAGRAM

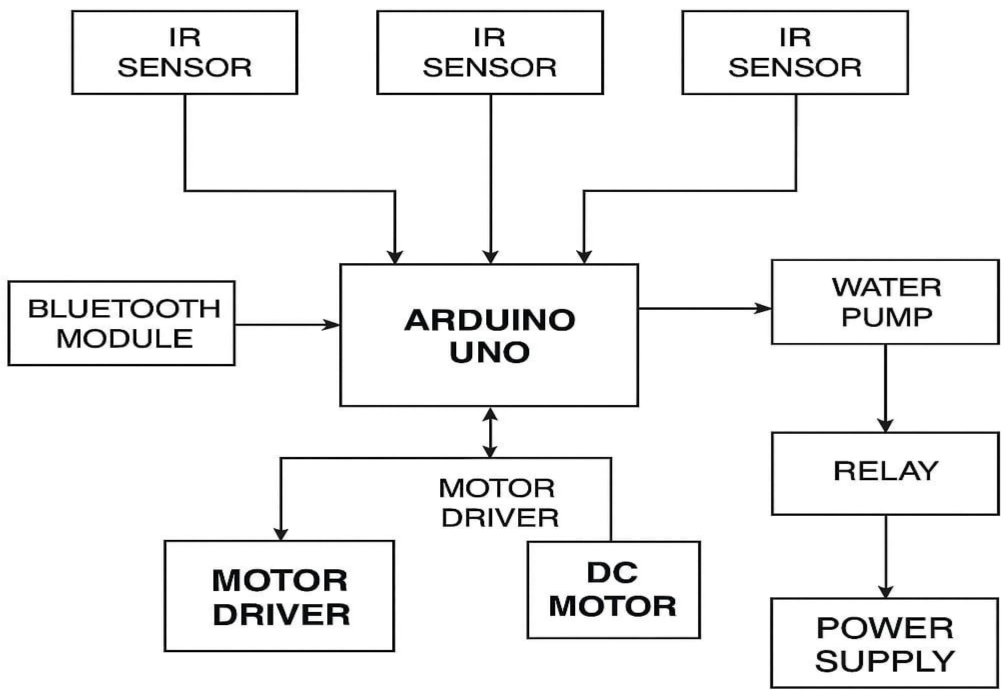

Fig 2.1 Block Diagram

2.2 CIRCUIT DIAGRAM OF THE SYSTEM

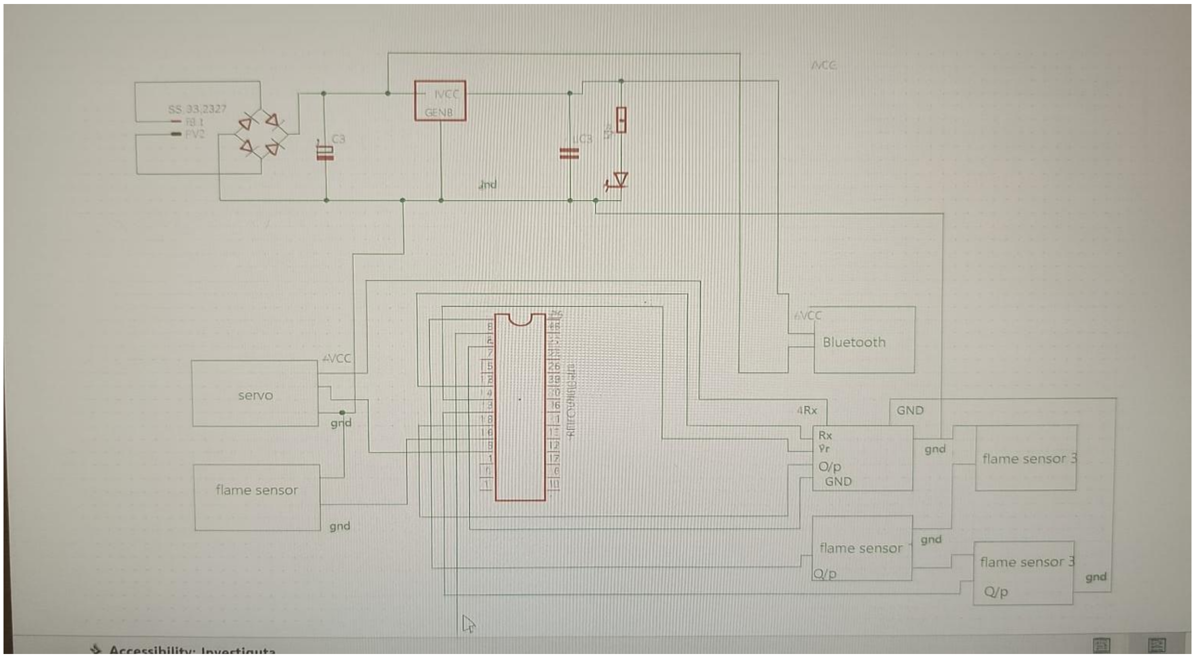

Fig 2.2: Circuit diagram of the system.

As you can see these sensors have an **IR Receiver (Photodiode)** which is used to detect the fire. How is this possible? When fire burns it emits a small amount of Infra-red light, this light will be received by the IR receiver on the sensor module. Then we use an Op- Amp to check for change in voltage across the IR Receiver, so that if a fire is detected the output pin will give 0V(LOW) and if the is no fire the output pin will be 5V(HIGH).So, we place three such sensors in three directions of the robot to sense on which direction the fire is burning. We detect the direction of the fire we can use the motors to move near the fire by driving our motors through the **L293D module**. When near a fire we have to put it out using water. Using a small container we can carry water

CHAPTER 3

SYSTEM REQUIREMENT SPECIFICATION

3.1 HARDWARE REQUIREMENTS

3.1.1 L293D Driver module

The Motor Driver is a module for motors that allows you to control the working speed and direction of two motors simultaneously .This Motor Driver is designed and developed based on L293D IC.L293D is a 16 Pin Motor Driver IC. This is designed to provide bidirectional drive currents at voltages from 5 V to 36 V.

Figure 3.1: L293D motor driver module

L293D is a dual H-bridge motor driver integrated circuit (IC). Motor drivers act as current amplifiers since they take a low-current control signal and provide a higher-current signal. This higher current signal is used to drive the motors.L293D contains two inbuilt H-bridge the corresponding motor. Logic 01 and 10 will rotate it in clockwise and anticlockwise directions, respectively.

Enable pins 1 and 9 (corresponding to the two motors) must be high for motors to start operating. When an enable input is high, the associated driver gets enabled. As a result, the outputs become active and work in phase with their inputs. Similarly, when the enable input is low, that driver is disabled, and their outputs are off and in the high-impedance state.

3.1.1.1 Features of L293D driver module

Hardware features

- can be used to run Two DC motors with the same IC.
- Speed and Direction control is possible
- Motor voltage Vcc2 (Vs): 4.5V to 36V
- Maximum Peak motor current: 1.2A
- Maximum Continuous Motor Current: 600mA
- Supply Voltage to Vcc1(vss): 4.5V to 7V
- Transition time: 300ns (at 5Vand 24V)
- Automatic Thermal shutdown is available
- Available in 16-pin DIP, TSSOP, SOIC packages

Applications

- Used to drive high current Motors using Digital Circuits
- Can be used to drive Stepper motors
- High current LED’s can be driven
- Relay Driver module (Latching Relay is possible)

3.1.1.2 Pin description

The L293D driver module has 16pins. They are as follows:

ENABLE:

When enable is pulled low, the module is disabled which means the module will not turn on and it fails to drive motors. When enable is left open or connected to 3.3V, the module is enabled i.e the module remains on and driving of motors also takes place.

VCC:

Supply voltage 3.3v to 5v

GND:

Ground pin.

INPUT & OUTPUT:

These two pins acts as an input and output interface for communication.

Pin No	Function	Name
1	Enable pin for Motor 1; active high	Enable 1,2
2	Input 1 for Motor 1	Input 1
3	Output 1 for Motor 1	Output 1
4	Ground (0V)	Ground
5	Ground (0V)	Ground
6	Output 2 for Motor 1	Output 2
7	Input 2 for Motor 1	Input 2
8	Supply voltage for Motors; 9-12V (up to 36V)	$V_{cc\ 2}$
9	Enable pin for Motor 2; active high	Enable 3,4
10	Input 1 for Motor 1	Input 3
11	Output 1 for Motor 1	Output 3
12	Ground (0V)	Ground
13	Ground (0V)	Ground
14	Output 2 for Motor 1	Output 4
15	Input2 for Motor 1	Input 4
16	Supply voltage; 5V (up to 36V)	$V_{cc\ 1}$

Table pin description table

3.1.2 Flame Sensor Module

A flame sensor module that consists of a flame sensor (IR receiver), resistor, capacitor, potentiometer, and comparator LM393 in an integrated circuit. It can detect infrared light with a wavelength ranging from 700nm to 1000nm.The far-infrared flame probe converts the light detected in the form of infrared light into current changes. Sensitivity is adjusted through the onboard variable resistor with a detection angle of 60 degrees.

Working voltage is between 3.3v and 5.2v DC, with a digital output to indicate the presence of a signal. Sensing is conditioned by an LM393 comparator.

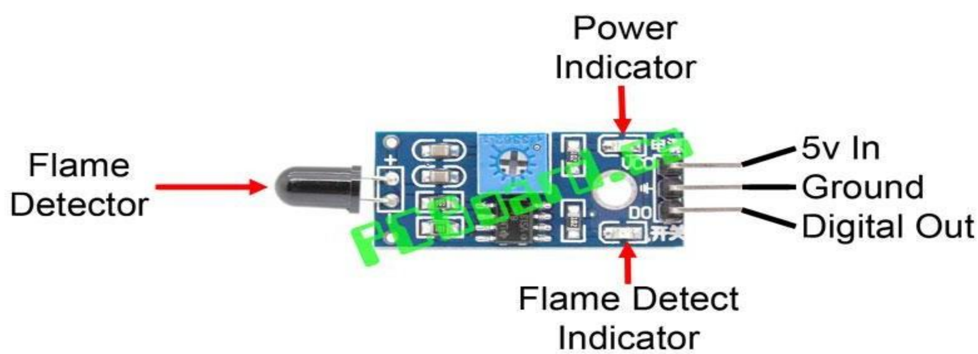

Figure 3.2: flame sensor module

3.1.2.1 Bluetooth module HC-05

For communication modules like the Bluetooth HC-05, there are typically two main types of pins used for interfacing: control pins and data pins.

Control Pins:

- **EN (Enable):** This pin is used to switch between **Command Mode** and **Data Mode**. When pulled HIGH (usually >3.3V), the module enters Command Mode where AT commands can be used to configure it. When LOW, it is in normal data transmission mode.
- **STATE:** This pin gives the **connection status**. It becomes HIGH when the Bluetooth module is connected to another device and stays LOW otherwise. Useful for detecting whether the pairing is active.

Data Pins:

- **TXD (Transmit Data):** This pin sends serial data from the HC-05 to the microcontroller (e.g., Arduino or AVR).
- **RXD (Receive Data):** This pin receives serial data sent from the microcontroller. Since the module operates at **3.3V logic**, a voltage divider is usually used to step down 5V TX signals from Arduino.

Power Pins:

- **VCC:** Connects to **5V** power supply.
- **GND:** Ground connection.

Working Principle:

The HC-05 communicates over UART (Universal Asynchronous Receiver Transmitter) and sends/receives serial data wirelessly. It can be used in **Master or Slave** mode. The mode and pairing information can be set using **AT commands** when the module is in Command Mode.

Fig circuit diagram of 3.1.1.1 Bluetooth module HC-05

3.1.3 DC Motor:

Motors convert electrical energy into mechanical energy.A **DC motor** is an electric motor that runs on direct current (DC) electricity.

Fig dc motor

In any electric motor, operation is based on simple electromagnetism. A current-carrying conductor generates a magnetic field; when this is then placed in an external magnetic field, it will experience a force proportional to the current in the conductor, and to the strength of the external magnetic field. As you are well aware of from playing with magnets as a kid, opposite (North and South) polarities attract, while like polarities (North and North, South and South) repel. The internal configuration of a DC motor is designed to harness the magnetic interaction between a current-carrying conductor and an external magnetic field to generate rotational motion.

Direct current (DC) motors are widely used to generate motion in a variety of products. Permanent magnet DC (direct current) motors are enjoying increasing popularity in applications requiring compact size, high torque, high efficiency, and low power consumption.

In a brushed DC motor, the brushes make mechanical contact with a set of electrical contacts provided on a commutator secured to an armature, forming an electrical circuit between the DC electrical source and coil windings on the armature. As the armature rotates on an axis, the stationary brushes come into contact with different sections of the rotating commutator.

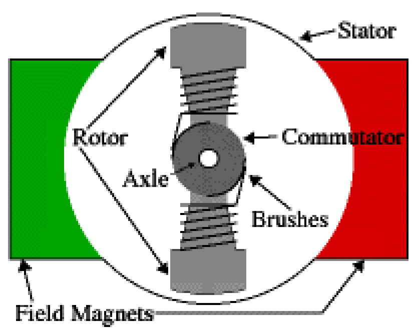

Fig internal architecture of dc motor

Permanent magnet DC motors utilize two or more brushes contacting a commutator which provides the direct current flow to the windings of the rotor, which in turn provide the desired magnetic repulsion/attraction with the permanent magnets

The brushes are conventionally located in brush boxes and utilize a U-shaped spring which biases the brush into contact with the commutator. Permanent magnet brushless dc motors are widely used in a variety of applications due to their simplicity of design, high efficiency, and low noise. These motors operate by electronic commutation of stator windings rather than the conventional mechanical commutation accomplished by the pressing engagement of brushes against a rotating commutator.

A brushless DC motor basically consists of a shaft, a rotor assembly equipped with one or more permanent magnets arranged on the shaft, and a stator assembly which incorporates a stator component and phase windings. Rotating magnetic fields are formed by the currents applied to the coils.

The rotator is formed of at least one permanent magnet surrounded by the stator, wherein the rotator rotates within the stator. Two bearings are mounted at an axial distance to each other on the shaft to support the rotor assembly and stator assembly relative to each other. To achieve electronic commutation, brushless dc motor designs usually include an electronic controller for controlling the excitation of the stator windings.

3.1.4 Water Pump

The water pump is operated at 5v which can be interfaced with Arduino

Fig 5v water pump

3.1.5 Servo Motor

A servo is a small DC motor with the following components added: some gear reduction, a position sensor on the motor shaft, and an electronic circuit that controls the motor's operation. In other words, a servo is to a DC motor what the Arduino is the ATmega microcontroller---components and housing that make the motor easy to use. This will become abundantly clear when we work with unadorned DC motors next week.

The gear reduction provided in a servo is large; the basic hobby servo has a 180:1 gear ratio. This means that the DC motor shaft must make 180 revolutions to produce 1 revolution of the servo shaft. This large gear ratio reduces the speed of the servo and proportionately increases its torque. What does this imply about small DC motors? Servo motors are typically used for angular positioning, such as in radio control airplanes. They have a movement range of 0 up to 180 degrees, but some extend up to 210 degrees. Typically, a potentiometer measures the position of the output shaft at all times so the controller can accurately place and maintain its position.

Fig servo motor

PPM uses 1 to 2ms out of a 20ms timeperiod to encode its information. The servo expects to see a pulse every 20milliseconds (.02 seconds). The length of the pulse will determine how far the motor turns. A 1.5 millisecond pulse will make the motor turn to the 90 degree position(often called the neutral position). If the pulse is shorter than 1.5 ms, then the motor

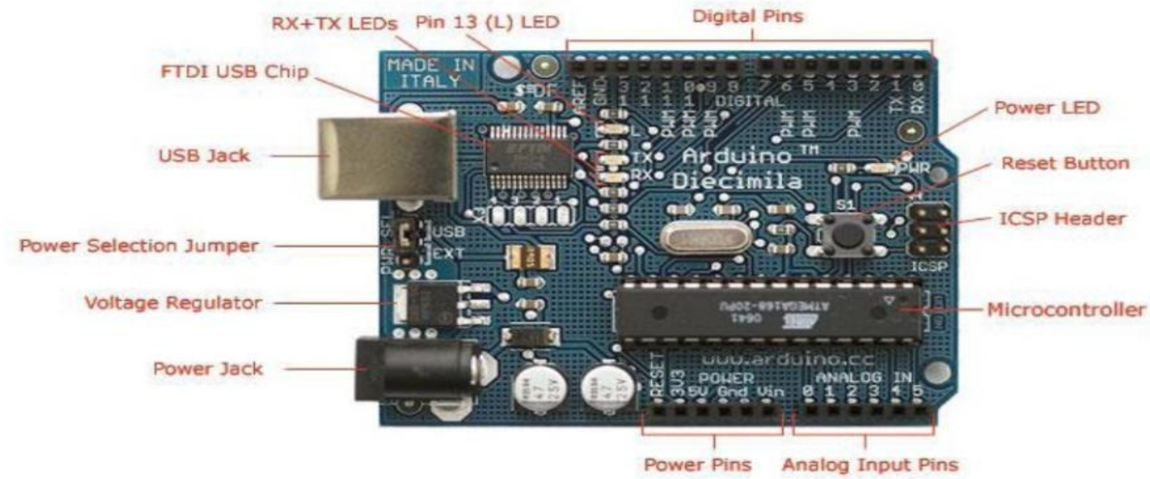

Figure 3.3: Arduino UNO board

The Atmel 8-bit AVR RISC-based microcontroller combines 32 KB ISP flash memory with read-while-write capabilities, 1 KB EEPROM, 2 KB SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible timer/counters with compare modes, internal and external interrupts, serial programmable USART, a byte-oriented 2-wire serial interface, SPI serial port, 6-channel 10-bit A/D converter (8-channels in TQFP and QFN/MLF packages), programmable watchdog timer with internal oscillator, and five software selectable power saving modes. The device operates between 1.8-5.5 volts. The device achieves throughputs approaching 1 MIPS.

3.1.6 Applications

Today the ATmega328 is commonly used in many projects and autonomous systems where a simple, low-powered, low-cost micro-controller is needed. Perhaps the most common implementation of this chip is on the popular Arduino development platform, namely the Arduino Uno and Arduino Nano models.

3.1.7 Features

- 28-pin AVR Microcontroller
- Flash Program Memory: 32 kbytes
- EEPROM Data Memory: 1 kbytes
- SRAM Data Memory: 2 kbytes
- I/O Pins: 23
- Timers: Two 8-bit / One 16-bit
- A/D Converter: 10-bit Six Channel
- RTC: Yes with Separate Oscillator
- MSSP: SPI and I²C Master and Slave Support
- USART: Yes
- External Oscillator: up to 20MHz

The Atmega328 is a very popular microcontroller chip produced by Atmel. It is an 8-bit microcontroller that has 32K of flash memory, 1K of EEPROM, and 2K of internal SRAM.

The Atmega328 is one of the microcontroller chips that are used with the popular Arduino Duemilanove boards. The Arduino Duemilanove board comes with either 1 of 2 microcontroller chips, the Atmega168 or the Atmega328. Of these 2, the Atmega328 is the upgraded, more advanced chip. Unlike the Atmega168 which has 16K of flash program memory and 512 bytes of internal SRAM, the Atmega328 has 32K of flash program memory and 2K of Internal SRAM.

The Atmega328 has 28 pins, It has 14 digital I/O pins, of which 6 can be used as PWM outputs and 6 analog input pins. These I/O pins account for 20 of the pins.

3.2 BASIC TERMINOLOGIES IN ARDUINO

3.2.1 Analog to Digital Converter (ADC)

- The process of Analog to digital conversion is shown in figure.
- The Arduino has 10 bits of Resolution when reading analog signals.
- 2^{10}=1024 increments.
- Influence also by how fast you sample.

3.2.2 Pulse Width Modulation (PWM)

- The Arduino has 8bit of resolution, when outputting a signal using PWM.
- The range of output voltage is from 0 to 5 Volts.
- 2^{8}=255 Increments
- Average of on/off(digital signals to make an average voltage),Duty cycle in 100% of 5Volts.

3. 8 LANGUAGE REFERENCES:

The Microcontroller on the board is programmed using the Arduino programming language (based on wiring) and the arduino development environment (based on processing).

3.8.1 Arduino programming language (APL) (based on wiring)

The Arduino programming language is an implementation of wiring, a similar physical computing platform, which is based on the Processing multimedia programming environment.

microcontroller boards to create all kinds of creative coding, interactive objects, spaces or physical experiences. The framework is thoughtfully created with designers and artists in mind to encourage a community where beginners through experts from around the world share ideas, knowledge and their collective experience. There are thousands of students, artists, designers, researchers, and hobbyists who use Wiring for learning, prototyping, and finished professional work production.

3.9 ARDUINO DEVELOPMENT ENVRONMENT

3.9.1 Processing

Processing is an open source programming language and environment for people who want to create images, animations, and interactions. Initially developed to serve as a software sketchbook and to teach fundamentals of computer programming within a visual context, there are tens of thousands of students, artists, designers, researchers, and hobbyists who use Processing for learning, prototyping, and production.

3.10 SOFTWARE REQUIREMENTS

3.10.1 Embedded C

Embedded C is a set of language extensions for the C Programming language by the C Standards committee to address commonality issues that exist between C extensions for different embedded systems. Historically, embedded C programming requires nonstandard extensions to the C language in order to support exotic features such as fixed-point arithmetic, multiple distinct memory banks, and basic I/O operations.

3.10.2 Difference between C and Embedded C

Though C and embedded C appear different and are used in different contexts, they have more similarities than the differences. Most of the constructs are same lies in their applications.

C is used for desktop computers, while embedded C is for microcontroller based applications. C takes more resources of a desktop PC like memory, OS, etc. while programming on desktop systems what embedded C cannot. Embedded C has to use the limited resources (RAM, ROM, I/O’s) on an embedded processor. Thus, program code must fit into the available program memory. If code exceeds the limit, the system is likely to crash.

Compilers for C (ANSI C) typically generate OS dependent executable files. Embedded C requires compilers to create files to be downloaded to the microcontrollers/microprocessors where it needs to run. Embedded compilers give access to all resources which is not provided in compilers for desktop computer applications.

Embedded systems often have the real-time constraints, which is usually not there with desktop computer applications.

Embedded systems often do not have a console, which is available in case of desktop applications.

The C programming language is perhaps the most popular programming language for programming embedded systems. C continues to be a very popular language for micro-controller developers/programmers due to the code efficiency and reduced overhead and development time. C offers low-level control and is considered more readable than assembly language which is a little difficult to understand. Assembly language requires more code writing, whereas C is easy to understand and requires less coding. Plus, using C increases portability, since C code can be compiled for different types of processors. We can program microcontrollers using Atmel Atmega328, AVR or PIC.

Here by developing the programs as per the electronic hardware using Atmel Atmega328 micro controller. For the operations like: blink led, increment decrement counters, token displays etc.

libraries available for use. The cold fact is, that in embedded systems, there rarely are many of the libraries that programmers have grown used to, but occasionally an embedded system might not have a complete standard library, if there is a standard library at all. Few embedded systems have capability for dynamic linking, so if standard library functions are to be available at all, they often need to be directly linked into the executable. Oftentimes, because of space concerns, it is not possible to link in an entire library file, and programmers are often forced to "brew their own" standard c library implementations if they want to use them at all. While some libraries are bulky and not well suited for use on microcontrollers, many development systems still include the standard libraries which are the most common for C programmers.

C remains a very popular language for micro-controller developers due to the code efficiency and reduced overhead and development time. C offers low-level control and is considered more readable than assembly. Many free C compilers are available for a wide variety of development platforms. The compilers are part of an IDEs with ICD support, breakpoints, single-stepping and an assembly window. The performance of C compilers has improved considerably in recent years, and they are claimed to be more or less as good as assembly, depending on who you ask. Most tools now offer options for customizing the compiler optimization. Additionally, using C increases portability, since C code can be compiled for different types of processors.

3.10.3 Software

The software used by the arduino is Arduino IDE. The Arduino IDE is a cross-platform application written in Java, and is derived from the IDE for the Processing programming language and the Wiring project. It is designed to introduce programming to artists and other newcomers unfamiliar with software development. It includes a code editor with features such as syntax highlighting, brace matching, and automatic indentation, and is also capable of compiling and uploading programs to the board with a single click. There is typically no need to edit make files or run programs on a command-line interface. Although building on command-line is possible if required with some

The Arduino IDE comes with a C/C++ library called "Wiring" (from the project of the same name), which makes many common input/output operations much easier. Arduino programs are written in C/C++, although users only need define two functions to make a runnable program:

- setup() – a function run once at the start of a program that can initialize settings
- loop() – a function called repeatedly until the board powers off

A typical first program for a microcontroller simply blinks a LED on and off. In the Arduino environment, the user might write a program like this:

```
#define LED_PIN 13
void setup (){
pinMode(LED_PIN, OUTPUT);// enable pin 13 for digital output
}
void loop (){
digitalWrite(LED_PIN, HIGH);// turn on the LED
delay(1000);// wait one second (1000 milliseconds)
```

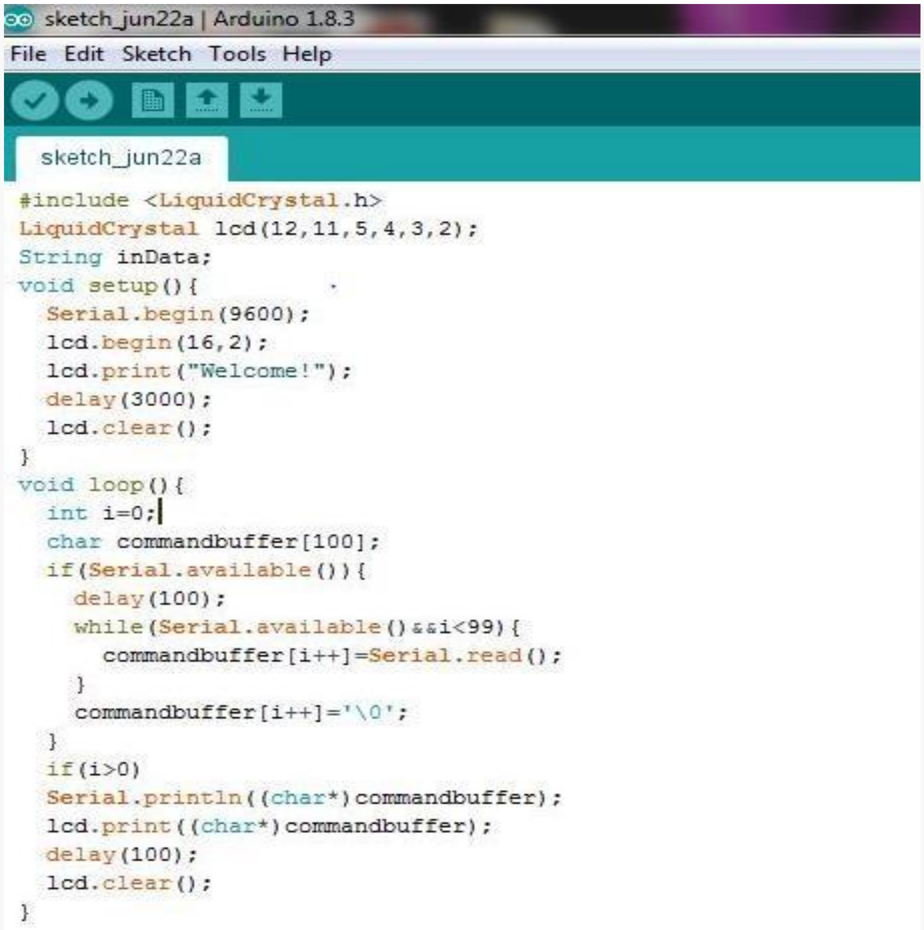

Figure 3.6: A Screenshot of Arduino IDE

For the above code to work correctly, the positive side of the LED must be connected to pin 13 and the negative side of the LED must be connected to ground. The above code would not be seen by a standard C++ compiler as a valid program, so when the user clicks the "Upload to I/O board" button in the IDE, a copy of the code is written to a temporary file with an extra include header at the top and a very simple main() function at the bottom, to make it a valid C++ program.

The Arduino IDE uses the GNU tool chain and AVR Libc to compile programs, and uses AVR dude to upload programs to the board.

For educational purposes there is third party graphical development environment called Mini blog available under a different open source license.

PROGRAM COMPILING

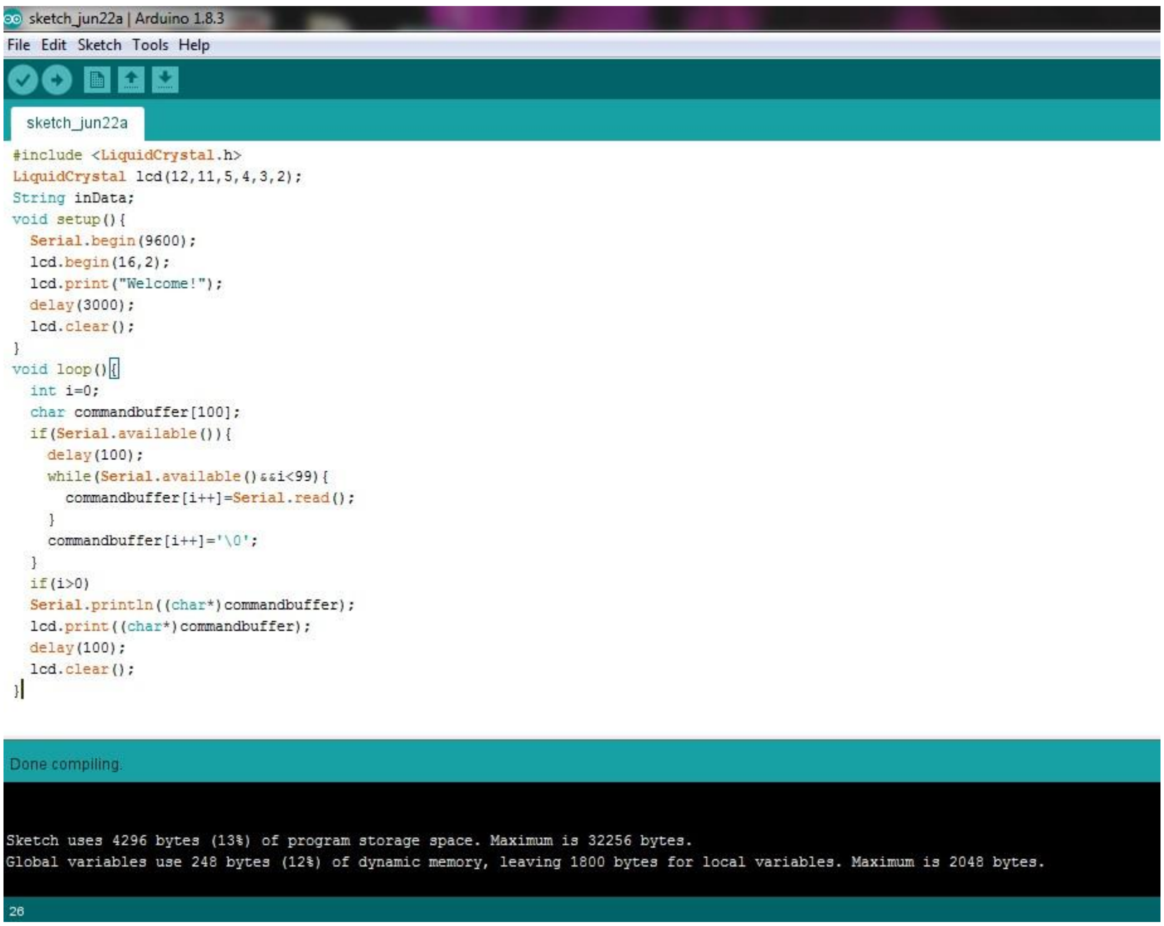

Figure 3.7: Program compiling using arduino IDE.

SELECTING BOARD

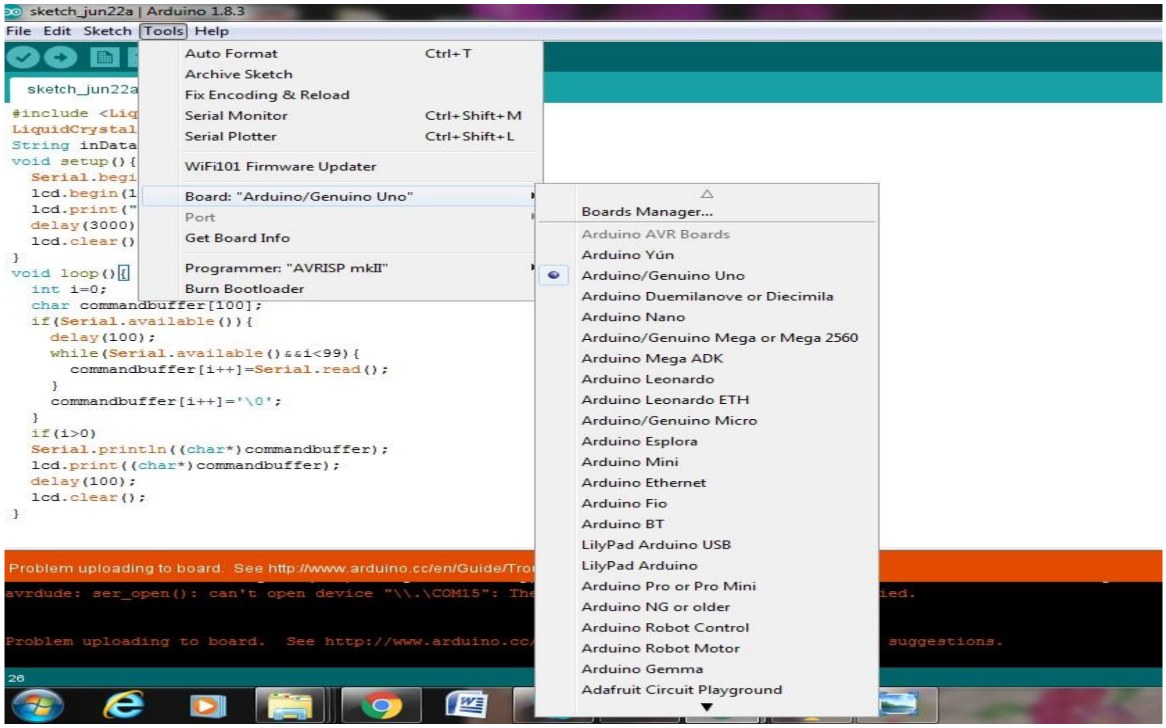

Figure 3.8: Selecting the board from Tools menu

SELECTING PORT

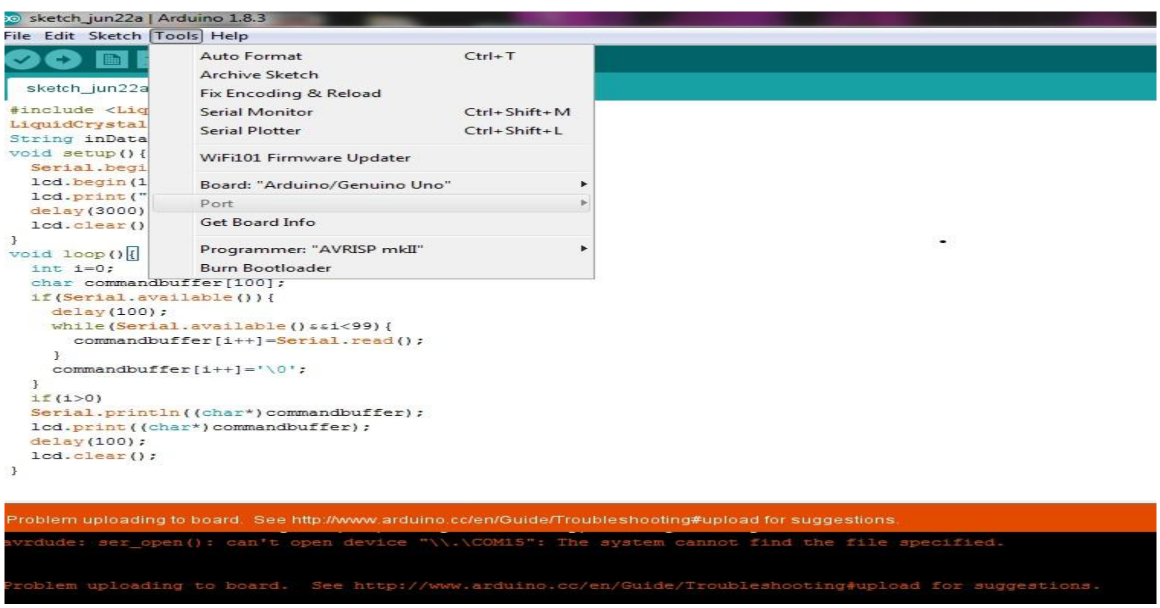

Figure 3.9: Selecting the port

UPLOADING PROGRAM

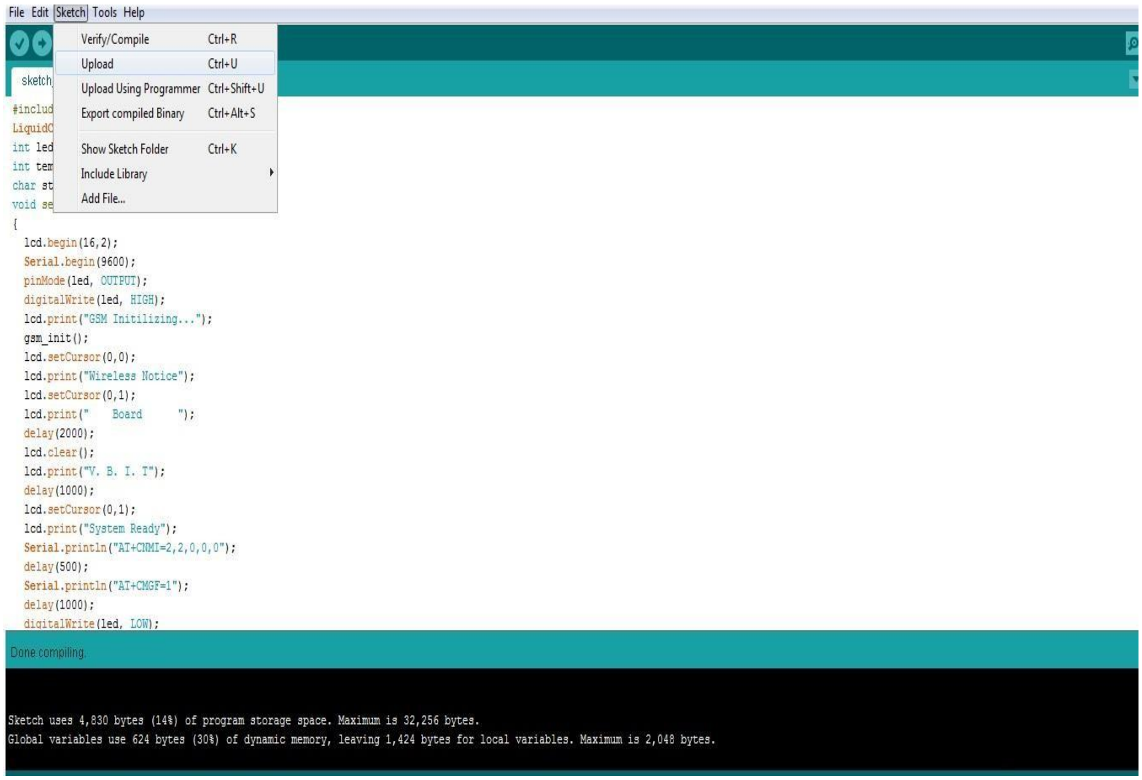

Figure 3.10: Uploading program to the arduino.

3.10.4 Language Reference

Arduino programs can be divided in three main parts: structure, values (variables and constants), and functions.

Available data types in ARDUINO IDE are

- void
- boolean
- char **(0 – 255)**
- byte - **8 bit data (0 – 255)**
- int - **16-bit data (32,767 - -32,7)**

CHAPTER 4
SYSTEM MODELLING AND DESIGN

4.1 FUNCTIONAL DESCRIPTION

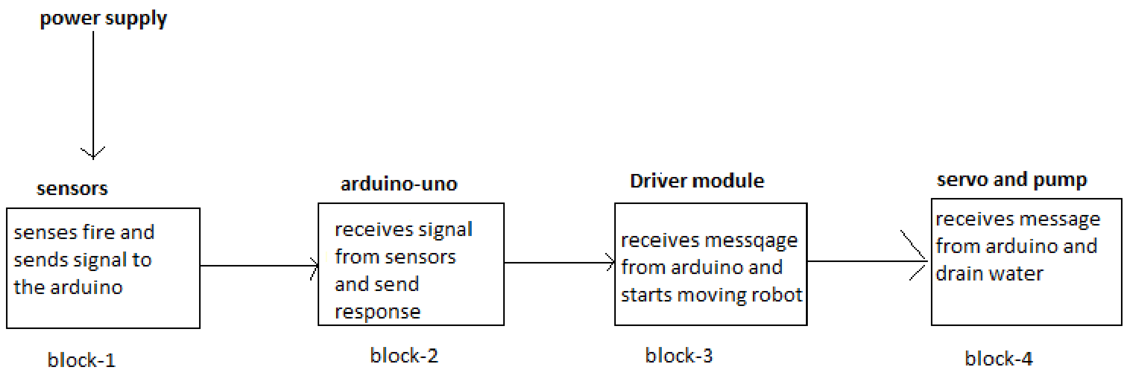

Fig 4.1: Functional description diagram

The constituent parts involved in the process are

- sensors
- Arduino with Atmel Atmega328 microcontroller
- L293 driver module
- Servo with pump

First block portrays to be sensors which receives, verifies and forwards the message to the Microcontroller. Micro is the second block. Micro processes the message and sends to the driver module. Driver module behaving as the third constituent part and servo pump acts as fourth part which extinguishes the fire

CHAPTER 5: IMPLEMENTATION AND TESTING

1.1 MICROCONTROLLER – FLAME SENSOR INTERFACING

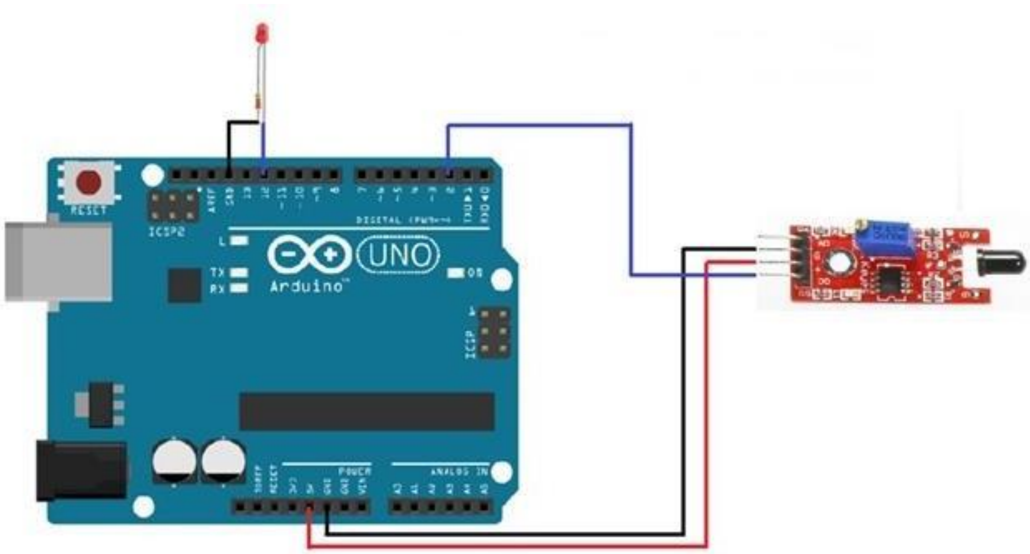

Fig 5.1: Microcontroller –flame sensor interfacing

Fig 5.1 The flame sensor is used to detect the fire or other light sources which are in the range of wavelength from 760nm to 1100nm. The module consists of an IR sensor, potentiometer, OP-Amp circuitry and a led indicator. When a flame will be detected, the module will turn on its red led. This module is sensitive to flame but it can also detect ordinary light. The detection point is 60 degrees. The sensitivity of this sensor is adjustable and it also has a stable performance.

It has both outputs, analog and digital. The analog output gives us a real time voltage output signal on thermal resistance while the digital output allows us to set a threshold via a potentiometer. In our tutorial we are going to use both of these outputs one by one and see how the sensor works.We can use the flame sensor to make an alarm when detecting the fire, for safety purpose in many projects and in

1.2 PROGRAMMING OVERVIEW

About Arduino Uno R3 Programming To programing Arduino Uno, you need the open source Arduino IDE software that the card manufacturer company wrote. The Arduino IDE Program is a software program written in Java language, used to program Arduino cards and to download Arduino cards to Arduino cards.download the program that I downloaded from the firm's site (https://www.arduino.cc/) with this program. It has an editor that uses the Processing / Wiring language, the commands that resemble the C language in some places, and the supporting utilities for the projects (Library - library). Along with this, another company's editor (IDE) has been developed since Arduino includes open source software. A bootloader (boot loader) has already been installed on ATmega328 on Arduino Uno. With this bootloader we can develop software without the need for an external programmer to program Arduino. The programming work can easily be performed by making the necessary settings and definitions in the IDE program

1.3 INITIALIZATION AND WORKING OF MODULE:

The initial stage of the project is the part of Finding fire, fire sensor LM393 The fire sensor detects fire at a certain distance. It does not receive data from areas outside of the determined area. It was decided to use two Reducing motors in order to realize the motion system. Both of these Reducing engines can move forward and backward. According to the obstacle state, if the motor is to be turned, one of the motors is given a reverse current by the processor and the axial rotation is provided and the obstacle less driving is provided. Thus, every obstacle was easily overcome in the environment where the system is located

CHAPTER 6: ADVANTAGES AND APPLICATIONS

5.1 ADVANTAGES

- Prevention from dangerous incidents.
- Minimization of o ecological consequences
- financial loss can be prevented.
- a threat to a human life can be minimized.
- No supervision is required to control robot

5.2 DISADVANTAGES

- It is applicable only for shorter distances
- Doesn’t predict nor interfere with operator’s thoughts.
- Cannot force directly the operator to work.

5.3 APPLICATIONS

- Can be used in extinguishing fire where probability of explosion is high. For eg. Hotel kitchens, LPG/CNG gas stores, etc.
- Can be used in Server rooms for immediate action in case of fire
- Can be used in extinguishing fire where probability of explosion is high. For eg. Hotel kitchens, LPG/CNG gas stores, etc.
- Every working environment requiring permanent operator's attention, At power plant control rooms
- Can be used in serach and rescue operation
- Can Used in domestic cold storage places

CONCLUSION

The prototype of the fire fighter robot was efficiently designed. This prototype has facilities to be integrated with many sensors making it move forward. The toolkit detects the infrared light emitted by the fire with photo diode and sends signal to controller. We intend to extend this work to provide a keypad programmed to allow manipulation of robot to move desired direction with help of motor driver module and extinguish the flames using water tank which is rotated at 180 degress with help of servo in order for faster result. This future work will also explore to the use of a long distance sensor with suitable hardware to get more better and faster results addition to the characters.

FUTURE SCOPE

The project has been motivated by the desire to design a system that can detect fires and take appropriate action, without any human intervention. The development of sensor networks and the maturity of robotics suggests that we can use mobile agents for tasks that involve perception of an external stimulus and reacting to the stimulus, even when the reaction involves a significant amount of mechanical actions. This provides us the opportunity to pass on to robots tasks that traditionally humans had to do but were inherently life- threatening. Fire-fighting is an obvious candidate for such automation. Given the number of lives lost regularly in fire- fighting, the system we envision is crying for adoption. Our experience suggests that designing a fire-fighting system with sensors and robots is within the reach of the current sensor network and mobile agent technologies. Furthermore, we believe that the techniques developed in this work will carry over to other areas involving sensing and reacting to stimulus, where we desire to replace the human with an automated mobile agent.

However, there has been research on many of these pieces in different contexts, e.g. coordination among mobile agents, techniques for detecting and avoiding obsta cles, on-thefly communication between humans and mobile agents, etc. It will be both interesting and challenging to put all this together into a practical, autonomous fire-fighting service.

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

PROFILE OF THE GUIDE

Mrs SOWMYA K R B.E., M.Tech.,(Ph.D.),MISTE

Assistant Professor in Department of Electrical and Electronics Engineering

Sri Siddhartha Institute of Technology, Tumakuru-572105, Karnataka, INDIA

Cell: 8105491845

E-mail: sowmyakr@ssit.edu.in

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Profile of Student-1

ABDUL HANNAN Studying BE in Department of Electrical and Electronics Engineering, Sri Siddhartha Institute of Technology,Tumakuru

USN: 21EE001

Contact No: 8951872328

Email Id: hannanabd60@gmail.com

Profile of Student-2

BALAJIGOWDA DK Studying BE in Department of Electrical and Electronics Engineering, Sri Siddhartha Institute of Technology,Tumakuru

USN: 21EE006

Contact No: 9980901094

Email Id: balajigowdadk@gmail.com

Profile of Student-3

HEMANTH A M Studying BE in Department of Electrical and Electronics Engineering, Sri Siddhartha Institute of Technology,Tumakuru

USN: 21EE019

Contact No: 9380157419

Email Id: hemantham666@gmail.com

Profile of Student-4

HITHAISHI G M Studying BE in Department of Electrical and Electronics Engineering, Sri Siddhartha Institute of Technology,Tumakuru

USN: 21EE020

Contact No: 9513879029

Email Id: hithaishigm007@gmail.com

TECHNODEA CERTIFICATE :

Abdul Hannan (21EE001)

Balajigowda D K (21EE006)

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