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ADVANCED SECURITY SYSTEM IN MILITARY FOR IDENTIFICATION OF TRESPASSERS USING ULTRASONIC RADAR

Submitted in partial fulfillment of the requirements for the award of Bachelor
of Engineering degree in Electronics and Communication Engineering

by

FATHIMA BEGUM J (40130055)

MAHILA P (40130130)



**DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING
SCHOOL OF ELECTRICAL AND ELECTRONICS**

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

CATEGORY-1 UNIVERSITY BY UGC

**Accredited with Grade "A++" by NAAC | 12B status by UGC | Approved by AICTE
JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI - 600 119**

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **FATHIMA BEGUM J (40130055), MAHILA P (40130130)** who carried out the project entitled **"ADVANCED SECURITY SYSTEM IN MILITARY FOR IDENTIFICATION OF TRESPASSERS USING ULTRASONIC RADAR"** under my supervision from November 2023 to April 2024.

INTERNAL GUIDE

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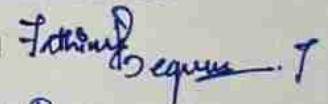
We Fathima Begum J (40130055), Mahila P (40130130) hereby declare that the Project Report entitled "ADVANCED SECURITY SYSTEM IN MILITARY FOR IDENTIFICATION OF TRESPASSERS USING ULTRASONIC RADAR" done by us under the guidance of Ms. G.I.Shamini,M.Tech.,(Ph.D)., Assistant Professor, is submitted in partial fulfillment of the requirements for the Project of award of Bachelor of Engineering degree in DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING.

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I convey my thanks to **Dr. N. M. NANDHITHA, M.E., Ph.D., Dean, School of Electrical and Electronics Engineering** and **Dr. T. RAVI, M.E., Ph.D., Head of the Department, Department of Electronics and Communication Engineering** for providing me necessary support during the progressive reviews.

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ABSTRACT

The "IoT-Based Advanced Military Security System," a novel solution presented in this project, combines the Internet of Things (IoT) with ultrasonic radar technology to improve perimeter security in military installations. In order to detect and identify possible trespassers in real time and improve the entire security infrastructure, the system integrates state-of-the-art hardware and software components. As part of the project's IoT component, ultrasonic sensors will be placed all over the military perimeter. These sensors will all have embedded IoT devices to enable smooth data flow and connectivity. Ultrasonic data is continuously collected by these sensors and sent to a centralized cloud-based platform for analysis. The cloud-based software uses machine learning and sophisticated signal processing algorithms to distinguish between authorized personnel and possible threats. It is the prime duty of every government to give more priority for border security and protection. It is very difficult to monitor miles of extended international borders with limited sources. So border security force divides the soldiers into team which protect the border in certain time interval but it is again difficult to monitor border 24*7. As technology increases new threats and risks arise towards national security. If there is some mechanism to secure and protect borders from illegal activities like illegal immigration of people from neighbouring countries like Pakistan, China and Bangladesh, smuggling of drugs and illegal trafficking then it can provide aid to the national security. Our borders extend thousands of miles and therefore our soldiers will not be able to provide complete security. The ordinary border patrol system suffers from intensive human involvement. Recently unmanned border patrol systems consist of high tech devices, like unmanned aerial vehicles, unattended ground sensors, and surveillance towers equipped with wireless cameras. Border patrol systems have recently achieved interest to address the concerns about national security. The major problem in protecting long stretches of borders is the need for large human involvement in patrolling the premises. Our border patrol system consists of security checkpoints and border troops.

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LIST OF ABBREVIATIONS

ABBREVIATION	EXPANSION
UART	Universal Asynchronous Receiver-Transmitter
USART	Universal Synchronous/ Asynchronous Receiver-Transmitter
GPIO	General Purpose Input/Output
MCU	Microcontroller Unit
HC	Host Controller
FIFO	First In-First Out
DOS	Disk Operating System
MOS	Military Occupation Code
SCI	Serial Communication Interface
ACIA	Asynchronous Communication Interface Adapter
SCCs	Serial Communication Controllers
FTDI	Future Technology Devices International Limited
PIR	Passive Infrared Sensor

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CHAPTER 1

INTRODUCTION

The operator should be aware of the relative size of the obstacles in comparison with the rescue robot and the direction of the robot to navigate the disaster area and avoid collisions with obstacles the ambiguities. We also estimate future robot paths using the control inputs. Then, we perform collision detection in the expected paths and their neighbors. It detects the Weapon with the support of Proximity Sensor and monitoring the obstacles with the support of the Ultrasonic Sensor. Traditional security systems have often relied on a combination of physical barriers, surveillance cameras, and human personnel. While effective to some extent, these methods are not immune to vulnerabilities, false alarms, and limitations in detecting covert trespassers. The proposed advanced security system seeks to overcome these challenges by integrating ultrasonic radar sensors within a sophisticated IoT network. In an era characterized by ever-evolving threats and challenges, military security remains paramount. Ensuring the integrity and safety of military installations is of utmost importance, and as technology continues to advance, it is essential to adapt and innovate security measures accordingly. One area of increasing concern is the identification of trespassers attempting unauthorized access to these highly secure environments. To address this concern, we present an advanced security system that harnesses the power of ultrasonic radar technology within the Internet of Things (IoT) domain. The operator should be aware of the relative size of the obstacles in comparison with the rescue robot and the direction of the robot to navigate the disaster area and avoid collisions with obstacles the ambiguities. We also estimate future robot paths using the control inputs. Then, we perform collision detection in the expected paths and their neighbors. It detects the Weapon with the support of Proximity Sensor and monitoring the obstacles with the support of the Ultrasonic Sensor. This introduction sets the stage for a discussion of the system's architecture, operation, and its potential to revolutionize military security by providing a more accurate, adaptable, and responsive means of identifying and distinguishing trespassers

from authorized individuals. It is an innovative solution designed to meet the ever-evolving security needs of military installations, emphasizing the importance of staying ahead in the realm of security technology. In an era characterized by ever-evolving threats and challenges, military security remains paramount. Ensuring the integrity and safety of military installations is of utmost importance, and as technology continues to advance, it is essential to adapt and innovate security measures accordingly. One area of increasing concern is the identification of trespassers attempting unauthorized access to these highly secure environments. To address this concern, we present an advanced security system that harnesses the power of ultrasonic radar technology within the Internet of Things (IoT) domain.

1.1 MOTIVATION:

1. IoT systems can process data from ultrasonic radar in real time, enabling rapid identification and response to potential trespassers, which is critical in military security.
2. The integration of ultrasonic radar with IoT enables military personnel to have a more detailed and real-time understanding of the security environment, including the precise location and movement of trespassers.
3. Military personnel can remotely monitor security systems and respond to threats from command centers, increasing operational efficiency and safety.
4. IoT systems are designed for interoperability, allowing military forces to work seamlessly with different devices, platforms, and technologies, enhancing overall security capabilities.
5. IoT technology allows military installations to create a comprehensive network of surveillance devices, including ultrasonic radar, which can seamlessly communicate and share data for enhanced security.

1.2 PROBLEM STATEMENT:

Design and implement an advanced security system for military applications, specifically focusing on the identification of trespassers, utilizing ultrasonic radar technology within the Internet of Things (IoT) domain.

1. Intrusion Detection:

Develop a robust ultrasonic radar system capable of accurately detecting and tracking intruders in real-time, even under adverse weather conditions and varying terrains.

2. IoT Integration:

Integrate the ultrasonic radar system into an IoT framework, enabling remote monitoring, control, and data transmission to a central command center, ensuring timely response to potential security breaches.

3. Data Processing and Analysis:

Implement sophisticated data processing algorithms to filter out false alarms, classify intruders, and provide actionable information to military personnel, reducing the burden of false positives and enhancing decision-making.

4. Security and Reliability:

Ensure the system's security by employing encryption, authentication, and access control mechanisms to protect the data and prevent unauthorized access. The system should also be highly reliable, with fail-safe mechanisms to be minimized.

5. Integration with Existing Infrastructure:

Ensure compatibility with existing military security infrastructure and protocols, allowing for a seamless integration into the overall security framework.

6. User-Friendly Interface:

Create an intuitive user interface for military personnel to configure, monitor, and control the system, with options for both on-site and remote management.

7. Cost-Effectiveness:

Strive for cost-effectiveness in the deployment and maintenance of the system, ensuring that it provides a high return on investment for the military. The successful development and implementation of this advanced security system will significantly enhance military site security, providing early detection of trespassers, reducing false alarms, and improving response times to potential threats.

1.3 OBJECTIVES:

Certainly, here are the summarized objectives for the advanced security system in the military for identifying trespassers using ultrasonic radar within the IoT domain:

1. Develop a highly accurate ultrasonic radar system for intruder detection.
2. Integrate the system into an IoT framework for remote monitoring and control.
3. Implement advanced data processing algorithms to reduce false alarms and provide actionable information.
4. Ensure the system's security and reliability with encryption and fail-safe mechanisms.
5. Design the system to be scalable for various military deployment scenarios.
6. Ensure seamless integration with existing military security infrastructure.
7. Make the system adaptable to diverse environmental conditions.
8. Create a user-friendly interface for easy system management.
9. Ensure compliance with relevant military and privacy regulations.
10. Maintain cost-effectiveness throughout the system's lifecycle

These objectives collectively aim to enhance military site security, improve response times, and minimize false alarms in the context of intruder detection using ultrasonic radar technology in the IoT domain.

1.4 METHODOLOGY:

Firstly, we define the problem of identifying trespassers in military installations while taking into account the unique requirements and constraints of military contexts. A comprehensive literature review is conducted to gather insights from existing research and technologies pertaining to ultrasonic radar, IoT, and military security systems, helping us identify gaps, challenges, and best practices. With a solid understanding of the problem and the state of the field, we move on to design the system architecture, which encompasses the integration of ultrasonic radar sensors, IoT devices, and data processing components. This includes selecting the most suitable hardware components, such as sensors and microcontrollers, and choosing the appropriate software platforms and programming languages for system development. We focus on

the seamless integration of ultrasonic radar sensors into the system, ensuring they are calibrated to function effectively in military-specific conditions.

1. Define Objectives and Scope:

Clearly define the objectives of the project, including the identification of trespassers using ultrasonic radar within military contexts. Specify the scope of the project, such as the military base or installation where the system will be deployed.

2. Hardware and Software Selection:

Select the appropriate hardware components, such as ultrasonic radar sensors, microcontrollers, and IoT devices. Choose software and programming languages for system development.

3. System Design:

Create a detailed system architecture, including component layout and connectivity. Develop schematic diagrams and flowcharts to illustrate the system's design.

This proposed methodology provides a structured approach to develop and implement an advanced security system in a military context using ultrasonic radar and IoT technologies. It covers various aspects from hardware and software selection to deployment and continuous improvement, ensuring a comprehensive and effective security solution. We establish a secure and scalable IoT network infrastructure to facilitate data transmission and remote monitoring, incorporating robust communication protocols and data encryption for security.

CHAPTER 2

LITERATURE SURVEY

TITLE: Optimization of Geographic Information Systems for Forest Fire Risk Assessment.

AUTHOR: Martina PETKOVIĆ; Ivan GARVANOV; Dragan KNEŽEVIĆ; Slavoljub ALEKSIĆ.

YEAR: 2020

CONTENT: Forest fires are natural disasters defined as uncontrolled and unrestrained movements of fire across forested areas. They pose a permanent hazard of forest and forested land loss. The increasingly more frequent forest fires are often of great magnitudes, threatening not only forests but also crops, residential areas, and human lives. Forest fire fighting involves three crucial stages: prevention, detection, and extinguishment. This paper discusses the preventive measures against forest fires as well as methods of forest monitoring as a means of preserving forest biodiversity. Using modern information technology, such as geographic information systems (GIS), can improve strategic and tactical planning and actions aimed at fire prevention.

TITLE: IoT–Fog Enabled Framework for Forest Fire Management System

AUTHOR: S Srividhya; Suresh Sankaranarayanan

YEAR: 2020

CONTENT: The Forest fires are one of the most critical catastrophes which has been initiated mostly by global warming. Due to environmental pollution, nature can make this threat even worse by destroying themselves and mankind. Forest management and wild life department are handling many problems such as rehabilitating wild animals, migration of animals to residential regions. The strength of the trees has drastically decreased which lead to unhealthy forest environment.

TITLE: Detection of Forest Fire using Convolutional Neural Networks

AUTHOR: A. Sheryl Oliver; U. Ashwanthika; R. Aswitha

YEAR: 2020

CONTENT: Forest fire is a dangerous condition when an uncontrolled, unexpected fire occurs in forests. It is extremely spontaneous and very difficult to control that damages millions of hectares of land and poses serious dangers not only to the ecosystem but also to humans. Hundreds of fires occur every year due to different reasons: seasonal dry spells, thunderstorms and volcanic ignition. Forest fires pose significant environmental issues, causing economic and environmental destruction and endangering human lives. For several nations a big issue is the occurrence of forest fires coupled with the inability of fire services to contain them effectively.

TITLE: IOT and image Processing based forest monitoring and counteracting system.

AUTHOR: Shivam Pareek; Shreya Shrivastava; Sonal Jhala; Juned A. Siddiqui; Savitanandan Patidar

YEAR: 2020

CONTENT: Security is the degree of protection, which separates the assets and potential threats. Security can be classified into different types; they are information technology security, physical security, potential security, monetary security etc. The design and development of robots now a day's focuses on unstructured and natural environments rather than for industrial environment. Robots are used for rescue security and surveillance. The skill of robot can be utilized where a human is not capable for doing it. For monitoring remote areas an intelligent robot can be designed with reliable economic communication.

TITLE: A Proposed Methodology to detect Forest Fire.

AUTHOR: Rekha Rani; Ashish Bagwari; Nikita Juyal; Vanshita Rajput.

YEAR: 2020

CONTENT: Forest Fire is one of the most dangerous phenomenon that could lead to the loss of flora and fauna. In this paper, we have proposed a model that can be used to detect forest fire. Due to this, we can save the life of human beings and animals as well. In the proposed model we use the Global system for mobile communication along with Global Positioning System to provide an accurate location of the incident and help the local authorities to control the forest fire and to minimize the destruction caused by it.

It is observed from the literature that surveillance systems are designed for detecting human/object movements, gas or flame in target areas. But they suffer from their inability to recognize between a known person and an unknown person. The proposed robotic system addresses this issue by recognizing the known person using image processing techniques. The system generates an alert message in case of dangerous events in areas under surveillance. This study explores the development of an AI-integrated ultrasonic radar system for improved trespasser identification in military security. By leveraging artificial intelligence, the system provides enhanced pattern recognition, distinguishing between animate and inanimate objects with high accuracy. The research presents the architecture of a machine learning model trained with a diverse dataset of ultrasonic signatures, enabling the identification of potential threats even in adverse weather conditions. The results indicate a significant reduction in false positives, optimizing the response time of security personnel.

CHAPTER 3

AIM AND SCOPE OF THE PRESENT INVESTIGATION

Current advanced security systems in military settings often rely on a blend of technologies including motion detectors, infrared cameras, and laser sensors to identify and track potential trespassers. These systems are designed to cover large perimeters and are capable of distinguishing between animals and humans to some extent. They typically involve integrated command centers where human operators assess threats and coordinate responses. The merits of these existing systems include their broad coverage and integration with a military base's comprehensive security protocol. They can provide constant surveillance and utilize a mix of technologies to adapt to various environmental conditions. However, their reliance on visual data can be a limitation, as they may be less effective in poor visibility conditions such as fog, heavy rain, or smoke.

3.1 SCOPE OF THE PROJECT:

1. Hardware Development and Integration.
2. IoT Network Architecture.
3. Sensor Technology and Data Collection.
4. Data Analytics and Machine Learning.
5. Security and Privacy Enhancement.
6. Military Applications and Deployment.
7. Energy Efficiency and Sustainability.
8. User Interface and Visualization.
9. Testing and Validation.
10. Cost Analysis and Budgeting.

3.2 PROPOSED ULTRASONIC RADAR SYSTEM:

The proposed ultrasonic radar system seeks to address the limitations of existing military security systems by incorporating ultrasonic sensors capable of operating in a

variety of environmental conditions, including complete darkness and obstructed weather. Ultrasonic radar uses high-frequency sound waves to detect objects and movement, creating detailed images of the environment that can be analyzed by advanced algorithms for threat identification.

3.3 MERITS OF THE PROPOSED SYSTEM:

1. **Enhanced Detection Capabilities:** The ultrasonic radar system can detect subtle movements and differentiate between types of intruders with greater accuracy, which is essential in a military context.
2. **Operational in Various Conditions:** Unlike cameras and infrared, ultrasonic waves are not affected by visual impairments due to weather or lack of light, ensuring reliable operation around the clock.
3. **Reduced False Alarms:** Advanced processing can reduce the number of false positives by accurately interpreting the data patterns, saving resources and time in threat assessment.
4. **Scalability:** The system can be scaled up to cover extensive perimeters or scaled down for more sensitive areas without significant changes to the technology or methodology.
5. **Integration with Autonomous Systems:** Ultrasonic radar can be integrated with autonomous response systems, including drones or automated lockdown protocols, for rapid response.
6. **Cost-Effectiveness:** Once installed, the maintenance and operation costs of ultrasonic systems can be lower compared to some high-end visual systems, especially since they require less human intervention.

3.4 BENEFITS OF PROPOSED SYSTEM:

Both local and global fire alert is provided

- The most important goals in this system is a quick and reliable detection of Weapon.
- Very low cost implementation

- The area of the forest is large, it is far away from urban area network coverage. It is a challenge for the communication between sensors and receivers to exchange data.

3.5 BLOCK DIAGRAM:

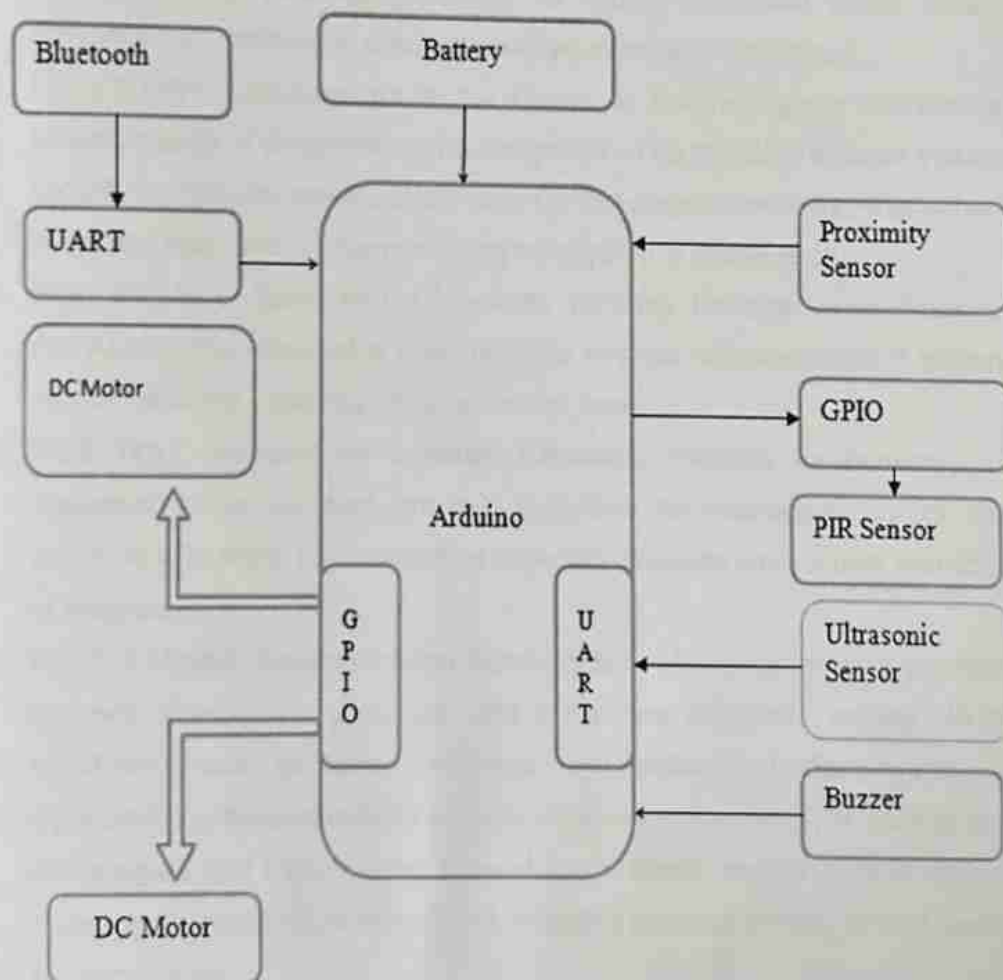


Fig 3.1 Block Diagram of Robotic Module

3.6 STANDARDS OF THE PROPOSED WORK:

In the military, advanced security systems for identifying trespassers using ultrasonic radar typically adhere to a combination of international standards and military specifications to ensure reliability, interoperability, and security. Some of the standards commonly followed include:

1. MIL-STD-810: Environmental Engineering Considerations and Laboratory Tests
- This standard provides guidelines for testing equipment under various environmental conditions, ensuring reliability in military applications.
2. MIL-STD-461: Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment - This standard ensures that the security system can operate effectively in electromagnetic environments without interfering with other systems or being susceptible to interference.
3. IEEE 802.15.4: Standard for Low-Rate Wireless Personal Area Networks (WPANs) - This standard is often used for wireless communication in military sensor networks, including ultrasonic radar systems.
4. IEEE 1451: Standard for a Smart Transducer Interface for Sensors and Actuators - This standard provides guidelines for interfacing sensors and actuators with digital communication networks, ensuring compatibility and ease of integration.
5. NATO STANAG (Standardization Agreements) - These agreements establish common procedures, protocols, and equipment standards among NATO member countries, facilitating interoperability in multinational military operations.
6. By adhering to these standards and specifications, military security systems can be designed and implemented to meet the stringent requirements of military applications, including identifying and mitigating potential security threats posed by trespassers.

3.7 CONSTRAINTS OF THE PROPOSED WORK:

1.Resource Limitations: The implementation of the IoT-Based Advanced Military Security System may be constrained by limited financial, human, and technological resources available for deployment and maintenance.

2.Environmental Factors: Environmental conditions, such as extreme weather and terrain variations, may pose challenges to the deployment and operation of hardware components, requiring robust design considerations.

3.Data Privacy Concerns: The collection, storage, and analysis of sensitive data raise concerns regarding data privacy and protection, necessitating adherence to strict privacy regulations and ethical guidelines.

4.Interference and False Alarms: Ultrasonic radar technology may be susceptible to interference from environmental factors, leading to false alarms or reduced detection accuracy, requiring mitigation strategies.

5.Operational Continuity: Maintaining uninterrupted operation and connectivity of the system, especially in remote or hostile environments, presents logistical challenges and requires contingency plans for system failures.

3.8 TRADE-OFFS OF THE PROPOSED WORK:

1. Cost vs. Capability: Balancing the cost of implementing and maintaining the system with its capability to provide comprehensive perimeter security entails trade-offs between budget constraints and desired security features.

2. Complexity vs. Usability: Increasing the complexity of the system with advanced technologies like machine learning and signal processing algorithms may improve security effectiveness but could also introduce usability challenges for operators, requiring training and support resources.

3. Coverage vs. Intrusiveness: Achieving extensive coverage of the military perimeter through the deployment of ultrasonic sensors must be balanced against the potential intrusiveness of the surveillance system on surrounding civilian populations and wildlife habitat.

4. Speed vs. Accuracy: Optimizing the system's detection speed to enable real-time threat identification may involve trade-offs with detection accuracy, as rapid processing may increase the risk of false positives or missed alerts.

5. Autonomy vs. Oversight: Introducing unmanned border patrol systems to reduce human involvement necessitates trade-offs between the autonomy of the system and the need for human oversight and decision-making in critical security situations.

CHAPTER 4

EXPERIMENTAL MATERIALS AND METHODS USED

4.1 HARDWARE REQUIREMENTS:

- Arduino UNO (ATMEGA 328)
- Node MCU
- Bluetooth
- DC Motor
- Ultrasonic Sensor
- PIR Sensor
- Proximity Sensor
- Battery
- UART (**Universal Asynchronous Receiver-Transmitter**)
- GPIO (**General Purpose Input/Output**)

4.2 SOFTWARE TOOLS:

- Arduino IDE
- Embedded C Programming Language

4.3 MODULES EXPLANATION:

4.3.1 ARDUINO (ATMega328) MICROCONTROLLERS

Arduino is a tool for making computers that can sense and control more of the physical world than your desktop computer. It's an open-source physical computing platform based on a simple microcontroller board, and a development environment for writing software for the board.

Arduino can be used to develop interactive objects, taking inputs from a variety of switches or sensors, and controlling a variety of lights, motors, and other physical outputs. Arduino projects can be stand-alone, or they can communicate with software running on your computer (e.g. Flash, Processing, Max MSP.) The boards can be

assembled by hand or purchased preassembled; the open-source IDE can be downloaded for free.

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

Why Arduino?

There are many other microcontrollers and microcontroller platforms available for physical computing. Parallax Basic Stamp, Netmedia's BX-24, Phidgets, MIT's Handyboard, and many others offer similar functionality. All of these tools take the messy details of microcontroller programming and wrap it up in an easy-to-use package. Arduino also simplifies the process of working with microcontrollers, but it offers some advantage for teachers, students, and interested amateurs over other systems:

- **Inexpensive** - Arduino boards are relatively inexpensive compared to other microcontroller platforms. The least expensive version of the Arduino module can be assembled by hand, and even the pre-assembled Arduino modules cost less than \$50
- **Cross-platform** - The Arduino software runs on Windows, Macintosh OSX, and Linux operating systems. Most microcontroller systems are limited to Windows.
- **Simple, clear programming environment** - The Arduino programming environment is easy-to-use for beginners, yet flexible enough for advanced users to take advantage of as well. For teachers, it's conveniently based on the Processing programming environment, so students learning to program in that environment will be familiar with the look and feel of Arduino
- **Open source and extensible software**- The Arduino software is published as open source tools, available for extension by experienced programmers. The language can be expanded through C++ libraries, and people wanting to understand the technical details can make the leap from Arduino to the AVR C

programming language on which it's based. Similarly, you can add AVR-C code directly into your Arduino programs if you want to.

- Open source and extensible hardware - The Arduino is based on Atmel's ATMEGA8 and ATMEGA168 microcontrollers. The plans for the modules are published under a Creative Commons license, so experienced circuit designers can make their own version of the module, extending it and improving it. Even relatively inexperienced users can build the breadboard version of the module in order to understand how it works and save money.
- The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega8U2 programmed as a USB-to-serial converter.
- "Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version
- 1.0 will be the reference versions of Arduino, moving forward. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform; for a comparison with previous versions.
- Microcontroller ATmega328
- Operating Voltage 5 V
- Input Voltage (recommended) 7-12 V
- Input Voltage (limits) 6-20 V
- Digital I/O Pins 14 (of which 6 provide PWM output)
- Analog Input Pins 6
- DC Current per I/O Pin 40 mA
- DC Current for 3.3V Pin 50 mA
- Flash Memory 32 KB of which 0.5 KB used by bootloader
- SRAM 2 KB

> EEPROM 1 KB

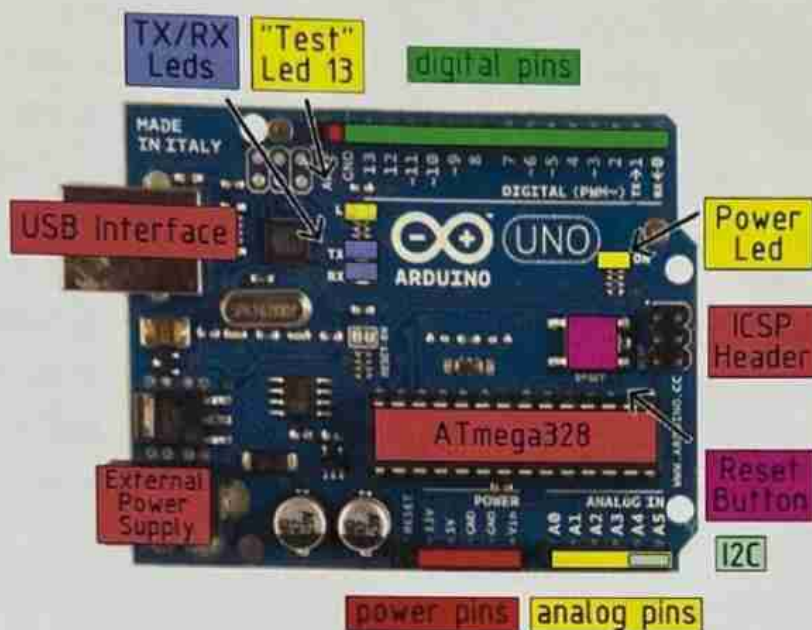


Fig 4.1 Arduino UNO

4.3.2 UART

A **universal asynchronous receiver/transmitter**, abbreviated **UART** is a piece of computer hardware that translates data between parallel and serial forms. UARTs are commonly used in conjunction with communication standards such as EIA, RS-232, RS-422 or RS-485. A UART is usually an individual (or part of an) integrated circuit used for serial communications over a computer or peripheral device serial port. UARTs are now commonly included in microcontrollers. A dual **UART**, or **DUART**, combines two UARTs into a single chip. An octal UART or **OCTART** combines eight UARTs into one package, an example being the NXP SCC2698. Many modern ICs now come with a UART that can also communicate synchronously; these devices are called **USARTs** (universal synchronous/asynchronous receiver/transmitter). The universal asynchronous receiver/transmitter (UART) takes bytes of data and transmits the

individual bits in a sequential fashion.^[1] At the destination, a second UART re-assembles the bits into complete bytes. Each UART contains a shift register, which is the fundamental method of conversion between serial and parallel forms. Serial transmission of digital information (bits) through a single wire or other medium is less costly than parallel transmission through multiple wires. The UART usually does not directly generate or receive the external signals used between different items of equipment. Separate interface devices are used to convert the logic level signals of the UART to and from the external signaling levels. External signals may be of many different forms. Examples of standards for voltage signaling are RS-232, RS-422 and RS-485 from the EIA. Historically, current (in current loops) was used in telegraph circuits. Some signaling schemes do not use electrical wires. Examples of such are optical fiber, IrDA (infrared), and (wireless) Bluetooth in its Serial Port Profile (SPP). Some signaling schemes use modulation of a carrier signal (with or without wires).

Character framing:

The right-most (least significant) data bit is always transmitted first. If parity is present, the parity bit comes after the data bits but before the stop bit(s).

Bit number	1	2	3	4	5	6	7	8	9	10	11
	Start bit	5–8 data bits								Stop bit(s)	
	Start	Data 0	Data 1	Data 2	Data 3	Data 4	Data 5	Data 6	Data 7	Stop	

The idle, no data state is high-voltage, or powered. This is a historic legacy from telegraphy, in which the line is held high to show that the line and transmitter are not damaged. Each character is sent as a logic low start bit, a configurable number of data bits (usually 8, but users can choose 5 to 8 or 9 bits depending on which UART is in use), an optional parity bit if the number of bits per character chosen is not 9 bits, and one or more logic high stop bits.

The start bit signals the receiver that a new character is coming. The next five to nine bits, depending on the code set employed, represent the character. If a parity bit is used, it would be placed after all of the data bits. The next one or two bits are always in the **mark** (logic high, i.e., '1') condition and called the stop bit(s). They signal the receiver that the character is completed. Since the start bit is logic low (0) and the stop bit is logic high (1) there are always at least two guaranteed signal changes between characters.

If the line is held in the logic low condition for longer than a character time, this is a break condition that can be detected by the UART.

Receiver:

All operations of the UART hardware are controlled by a clock signal which runs at a multiple of the data rate, typically 8 times the bit rate. The receiver tests the state of the incoming signal on each clock pulse, looking for the beginning of the start bit. If the apparent start bit lasts at least one-half of the bit time, it is valid and signals the start of a new character. If not, it is considered a spurious pulse and is ignored. After waiting a further bit time, the state of the line is again sampled and the resulting level clocked into a shift register. After the required number of bit periods for the character length (5 to 8 bits, typically) have elapsed, the contents of the shift register are made available (in parallel fashion) to the receiving system. The UART will set a flag indicating new data is available, and may also generate a processor interrupt to request that the host processor transfers the received data.

Communicating UARTs usually have no shared timing system apart from the communication signal. Typically, UARTs resynchronize their internal clocks on each change of the data line that is not considered a spurious pulse. Obtaining timing

information in this manner, they reliably receive when the transmitter is sending at a slightly different speed than it should. Simplistic UARTs do not do this, instead they resynchronize on the falling edge of the start bit only, and then read the center of each expected data bit, and this system works if the broadcast data rate is accurate enough to allow the stop bits to be sampled reliably.

It is a standard feature for a UART to store the most recent character while receiving the next. This "double buffering" gives a receiving computer an entire character transmission time to fetch a received character. Many UARTs have a small first-in, first-out FIFO buffer memory between the receiver shift register and the host system interface. This allows the host processor even more time to handle an interrupt from the UART and prevents loss of received data at high rates.

Transmitter:

Transmission operation is simpler since it is under the control of the transmitting system. As soon as data is deposited in the shift register after completion of the previous character, the UART hardware generates a start bit, shifts the required number of data bits out to the line, generates and appends the parity bit (if used), and appends the stop bits. Since transmission of a single character may take a long time relative to CPU speeds, the UART will maintain a flag showing busy status so that the host system does not deposit a new character for transmission until the previous one has been completed; this may also be done with an interrupt. Since full-duplex operation requires characters to be sent and received at the same time, UARTs use two different shift registers for transmitted and received characters.

Application:

Transmitting and receiving UARTs must be set for the same bit speed, character length, parity, and stop bits for proper operation. The receiving UART may detect some mismatched settings and set a "framing error" flag bit for the host system; in exceptional cases the receiving UART will produce an erratic stream of mutilated characters and transfer them to the host system.

Typical serial ports used with personal computers connected to modems use eight data bits, no parity, and one stop bit; for this configuration the number of ASCII characters per second equals the bit rate divided by 10.

Some very low-cost home computers or embedded systems dispense with a UART and use the CPU to sample the state of an input port or directly manipulate an output port for data transmission. While very CPU-intensive (since the CPU timing is critical), the UART chip can thus be omitted, saving money and space. The technique is known as bit-banging.

Synchronous transmission:

USART chips have both synchronous and asynchronous modes. In *synchronous* transmission, the clock data is recovered separately from the data stream and no start/stop bits are used. This improves the efficiency of transmission on suitable channels since more of the bits sent are usable data and not character framing. An asynchronous transmission sends no characters over the interconnection when the transmitting device has nothing to send; but a synchronous interface must send "pad" characters to maintain synchronization between the receiver and transmitter. The usual filler is the ASCII "SYN" character. This may be done automatically by the transmitting device. USART were often used to create data streams compatible with the synchronous telephonic data channels. The standard method would multiplex synchronous data from many terminals to a telephonic data line such as E1 (Europe) or T1 (US).

HISTORY:

Some early telegraph schemes used variable-length pulses (as in Morse code) and rotating clockwork mechanisms to transmit alphabetic characters. The first UART-like devices (with fixed-length pulses) were rotating mechanical switches (*commutators*). Various character codes using 5, 6, 7, or 8 data bits became common in teleprinters and later as computer peripherals. Gordon Bell designed the UART for the PDP series of computers. The teletypewriter made an excellent general-purpose I/O device for a small computer. To reduce costs, including wiring and back-plane costs,

these computers also pioneered flow control using XON and XOFF characters rather than hardware wires.

Western Digital made the first single-chip UART WD1402A around 1971; this was an early example of a medium scale integrated circuit. Another popular chip was a SCN2651 from the Signetics2650 family.

An example of an early 1980s UART was the National Semiconductor 8250. In the 1990s, newer UARTs were developed with on-chip buffers. This allowed higher transmission speed without data loss and without requiring such frequent attention from the computer. For example, the popular National Semiconductor 16550 has a 16 byte FIFO, and spawned many variants, including the *16C550*, *16C650*, *16C750*, and *16C850*.

Depending on the manufacturer, different terms are used to identify devices that perform the UART functions. Intel called their 8251 device a "Programmable Communication Interface". MOS Technology 6551 was known under the name "Asynchronous Communications Interface Adapter" (ACIA). The term "Serial Communications Interface" (SCI) was first used at Motorola around 1975 to refer to their start-stop asynchronous serial interface device, which others were calling a UART. Zilog manufactured a number of Serial Communication Controllers or SCCs.

After the RS-232 COM port was removed from most IBM PC compatible computers in the 2000s, an external USB-to-UART serial adapter cable was used to compensate for the loss. A major supplier of these chips is FTDI.

STRUCTURE:

A UART usually contains the following components:

- A clock generator, usually a multiple of the bit rate to allow sampling in the middle of a bit period.
- Input and output shift registers
- Transmit/receive control

- Read/Write control logic
- Transmit/receive buffers (optional)
- Parallel data bus buffer (optional)
- First-in, First-out (FIFO) buffer memory (optional)

SPECIAL RECEIVER CONDITIONS:

Overflow error:

An "overflow error" occurs when the receiver cannot process the character that just came in before the next one arrives. Various devices have different amounts of buffer space to hold received characters. The CPU must service the UART in order to remove characters from the input buffer. If the CPU does not service the UART quickly enough and the buffer becomes full, an Overflow Error will occur, and incoming characters will be lost.

Underrun error:

An "underrun error" occurs when the UART transmitter has completed sending a character and the transmit buffer is empty. In asynchronous modes this is treated as an indication that no data remains to be transmitted, rather than an error, since additional stop bits can be appended. This error indication is commonly found in USARTs, since an underrun is more serious in synchronous systems.

Framing error:

A "framing error" occurs when the designated "start" and "stop" bits are not found. As the "start" bit is used to identify the beginning of an incoming character, it acts as a reference for the remaining bits. If the data line is not in the expected state (hi/lo) when the "stop" bit is expected, a *Framing Error* will occur.

Parity error:

A Parity Error occurs when the parity of the number of 1 bits disagrees with that specified by the parity bit. Use of a parity bit is optional, so this error will only occur if parity-checking has been enabled.

Break condition:

A "break condition" occurs when the receiver input is at the "space" level for longer than some duration of time, typically, for more than a character time. This is not necessarily an error, but appears to the receiver as a character of all zero bits with a framing error. The term "break" derives from current loop signaling, which was the traditional signaling used for teletypewriters. The "spacing" condition of a current loop line is indicated by no current flowing, and a very long period of no current flowing is often caused by a break or other fault in the line.

Some equipment will deliberately transmit the "space" level for longer than a character as an attention signal. When signaling rates are mismatched, no meaningful characters can be sent, but a long "break" signal can be a useful way to get the attention of a mismatched receiver to do something (such as resetting itself). Unix-like systems can use the long "break" level as a request to change the signaling rate, to support dial-in access at multiple signaling rates.

UART in Modems:

Modems for personal computers that plug into a motherboard slot must also include the UART function on the card. The original 8250 UART chip shipped with the IBM personal computer had a one character buffer for the receiver and the transmitter each, which meant that communications software performed poorly at speeds above 9600 bits/second, especially if operating under a multitasking system or if handling interrupts from disk controllers. High-speed modems used UARTs that were compatible with the original chip but which included additional FIFO buffers, giving software additional time to respond to incoming data.

A look at the performance requirements at high bit rates shows why the 16, 32, 64 or 128 byte FIFO is a necessity. The Microsoft specification for a DOS system requires that interrupts not be disabled for more than 1 millisecond at a time. Some hard disk drives and video controllers violate this specification. 9600 bit/s will deliver a character approximately every millisecond, so a 1byte FIFO should be sufficient at this rate on a DOS system which meets the maximum interrupt disable timing. Rates above this may receive a new character before the old one has been fetched, and thus the old character

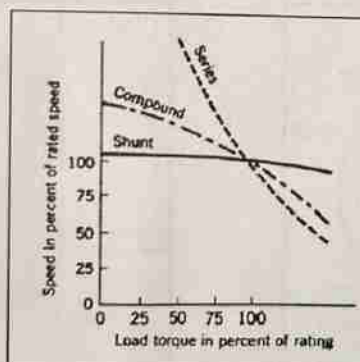
will be lost. This is referred to as an overrun error and results in one or more lost characters.

A 16byte FIFO allows up to 16 characters to be received before the computer has to service the interrupt. This increases the maximum bit rate the computer can process reliably from 9600 to 153,000 bit/s if it has a 1 millisecond interrupt dead time. A 32 byte FIFO increases the maximum rate to over 300,000 bit/s. A second benefit to having a FIFO is that the computer only has to service about 8 to 12% as many interrupts, allowing more CPU time for updating the screen, or doing other chores. Thus the computer's responses will improve as well.

4.3.3 DC MOTORS

A. General Information

A DC motor is used to drive a mechanical load. In this lab, a separately excited DC generator provides the load. The load on the motor is adjusted by varying the generator field current. By increasing the field current of the DC generator, the load on the DC motor increases and thus the armature current increases. In general, DC motors are characterized by their torque-speed curves as shown in Figure 9.1. Since the measuring equipment for shaft torque is not available in the lab it is necessary to use alternative means of characterizing the DC motor. One alternative is to plot shaft speed



versus armature current since torque is directly proportional to the armature current ($T = K_a \phi_a I_a$) with a constant field current supplied to the motor. Shaft speed is also a function of the field current in a DC motor while maintaining a constant armature voltage

($E_a = K_a \phi_d \omega$) as field current is directly proportional to the direct axis flux produced in the machine.

The stator of the dc motor has poles, which are excited by dc current to produce magnetic fields. In the neutral zone, in the middle between the poles, commutating poles are placed to reduce sparking of the commutator. The commutating poles are supplied by dc current. Compensating windings are mounted on the main poles. These short-circuited windings damp rotor oscillations. The poles are mounted on an iron core that provides a closed magnetic circuit. The motor housing supports the iron core, the brushes and the bearings. The rotor has a ring-shaped laminated iron core with slots. Coils with several turns are placed in the slots. The distance between the two legs of the coil is about 180 electric degrees. The coils are connected in series through the commutator segments. The ends of each coil are connected to a commutator segment. The commutator consists of insulated copper segments mounted on an insulated tube. Two brushes are pressed to the commutator to permit current flow. The brushes are placed in the neutral zone, where the magnetic field is close to zero, to reduce arcing. The rotor has a ring-shaped laminated iron core with slots. The commutator consists of insulated copper segments mounted on an

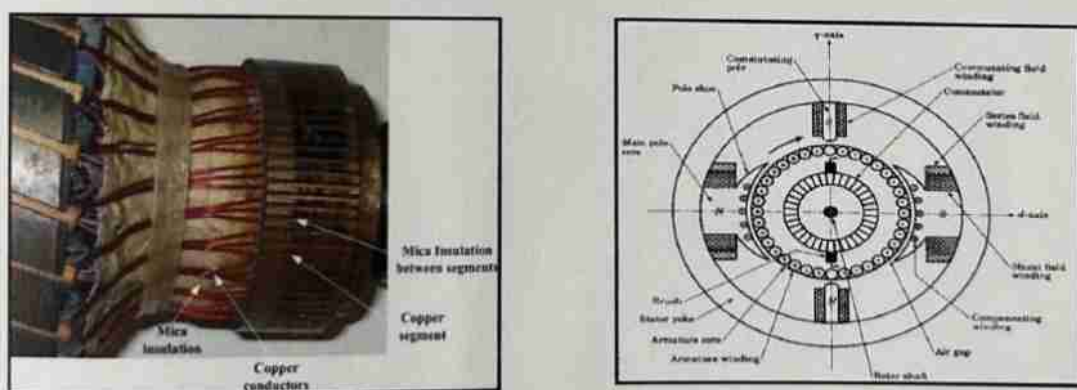


Fig 4.2 DC motor

insulated tube. Two brushes are pressed to the commutator to permit current flow. The brushes are placed in the neutral zone, where the magnetic field is close to zero, to reduce arcing. The commutator switches the current from one rotor coil to the adjacent coil, the switching requires the interruption of the coil current. The sudden interruption

of an inductive current generates high voltages. The high voltage produces flashover and arcing between the commutator segment and the brush.

C. DC Motor Operation

In a dc motor, the stator poles are supplied by dc excitation current, which produces a dc magnetic field. The rotor is supplied by dc current through the brushes, commutator and coils. The interaction of the magnetic field and rotor current generates a force that drives the motor. The magnetic field lines enter into the rotor from the north pole (N) and exit toward the south pole (S). The poles generate a magnetic field that is perpendicular to the current carrying conductors. The interaction between the field and the current produces a Lorentz force; the force is perpendicular to both the magnetic field and conductor. The generated force turns the rotor until the coil reaches the neutral point between the poles. At this point, the magnetic field becomes practically zero together with the force. However, inertia drives the motor beyond the neutral zone where the direction of the magnetic field reverses. To avoid the reversal of the force direction, the commutator changes the current direction, which maintains the counterclockwise rotation. Before reaching the neutral zone, the current enters in seg

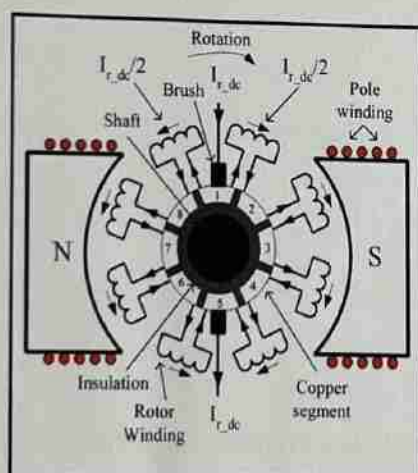
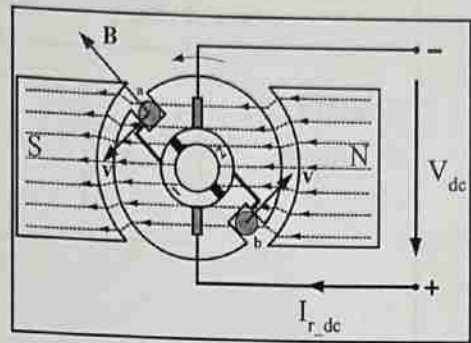
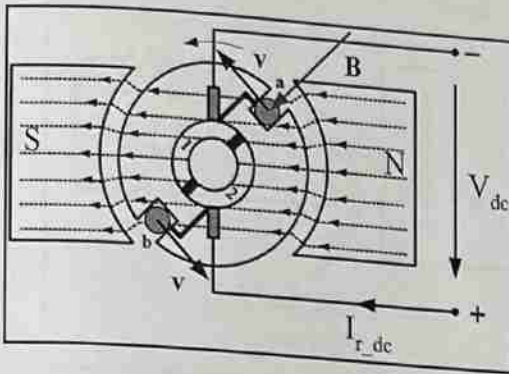


Fig 4.3 DC Motor Operation

from segment 2. Therefore, current enters the coil end at slot a and exits from slot b during this stage. After passing the neutral zone, the current enters segment 2 and exits from segment 1, this reverses the current direction through the rotor coil, when the coil passes the neutral zone.



D. DC Motor Equivalent circuit

The following figures show the equivalent circuit of a separately excited dc motor. Equivalent circuit is similar to the generator only the current directions are different. The operation equations are:

Armature voltage equation

$$V_{dc} = E_{am} + I_{am} R_a + V_{brush}$$

The induced voltage and motor speed vs angular frequency

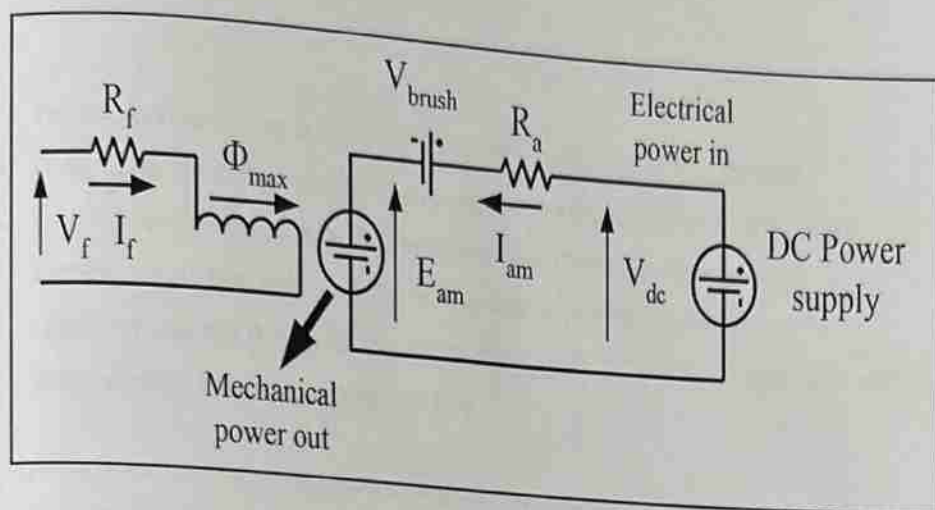
$$E_{am} = K_m I_f \omega \quad \omega = 2\pi n_m$$

The combination of the equations results in

$$K_m I_f \omega = E_{am} = V_{dc} - I_{am} R_m$$

The current is calculated from this equation. The output power and torque are:

$$P_{out} = E_{am} I_{am} \quad T = \frac{P_{out}}{\omega} = K_m I_{am} I_f$$



Generally, even the simplest robot requires a motor to rotate a wheel or performs particular action. Since motors require more current than the microcontroller pin can typically generate, you need some type of a switch (Transistors, MOSFET, Relay etc.,) which can accept a small current, amplify it and generate a larger current, which further drives a motor. This entire process is done by what is known as a **motor driver**.

Motor driver is basically a current amplifier which takes a low-current signal from the microcontroller and gives out a proportionally higher current signal which can control and drive a motor. In most cases, a transistor can act as a switch and perform this task which drives the motor in a single direction.

Turning a motor ON and OFF requires only one switch to control a single motor in a single direction. What if you want your motor to reverse its direction? The simple answer is to reverse its polarity. This can be achieved by using four switches that are arranged in an intelligent manner such that the circuit not only drives the motor, but also controls its direction. Out of many, one of the most common and clever design is a H-bridge circuit where transistors are arranged in a shape that resembles the English alphabet "H".

As you can see in the image, the circuit has four switches A, B, C and D. Turning these switches ON and OFF can drive a motor in different ways.

1. Turning on Switches **A** and **D** makes the motor rotate clockwise
2. Turning on Switches **B** and **C** makes the motor rotate anti-clockwise
3. Turning on Switches **A** and **B** will stop the motor (Brakes)
4. Turning off all the switches gives the motor a free wheel drive
5. Lastly turning on **A & C** at the same time or **B & D** at the same time shorts your entire circuit. So, do not attempt this.

H-bridges can be built from scratch using relays, mosfets, field effect transistors (FET), bi-polar junction transistors (BJT), etc. But if your current requirement is not too high and all you need is a single package which does the job of driving a small DC motor in two directions, then all you need is a L293D IC. This single inexpensive package can interface not one, but two DC motors. L293, L293B and few other versions also does the same job, but pick the L293D version as this one has an inbuilt fly back diode which protects the driving transistors from voltage spikes that occur when the motor coil is turned off.

Introduction to L293D IC

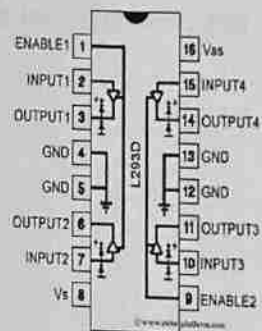
L293D IC generally comes as a standard 16-pin DIP (dual-in line package). This motor driver IC can simultaneously control two small motors in either direction; forward and reverse with just 4 microcontroller pins (if you do not use enable pins). Some of the features (and drawbacks) of this IC are:

1. Output current capability is limited to 600mA per channel with peak output current limited to 1.2A (non-repetitive). This means you cannot drive bigger motors with this IC. However, most small motors used in hobby robotics should work. If you are unsure whether the IC can handle a particular motor, connect the IC to its circuit and run the motor with your finger on the IC. If it gets really hot, then beware... Also note the words "non-repetitive"; if the current output repeatedly reaches 1.2A, it might destroy the drive transistors.

2. Supply voltage can be as large as 36 Volts. This means you do not have to worry much about voltage regulation.
3. L293D has an enable facility which helps you enable the IC output pins. If an enable pin is set to logic high, then state of the inputs match the state of the outputs. If you pull this low, then the outputs will be turned off regardless of the input states
4. The datasheet also mentions an "over temperature protection" built into the IC. This means an internal sensor senses its internal temperature and stops driving the motors if the temperature crosses a set point.

L293D Connections:

The circuit shown to the right is the most basic implementation of L293D IC. There are 16 pins sticking out of this IC and we have to understand the functionality of each pin before implementing this in a circuit.



1. Pin1 and Pin9 are "Enable" pins. They should be connected to +5V for the drivers to function. If they pulled low (GND), then the outputs will be turned off regardless of the input states, stopping the motors. If you have two spare pins in your microcontroller, connect these pins to the microcontroller, or just connect them to regulated positive 5 Volts.
2. Pin4, Pin5, Pin12 and Pin13 are ground pins which should ideally be connected to microcontroller's ground.
3. Pin2, Pin7, Pin10 and Pin15 are logic input pins. These are control pins which should be connected to microcontroller pins. Pin2 and Pin7 control the first motor (left); Pin10 and Pin15 control the second motor(right).
4. Pin3, Pin6, Pin11, and Pin14 are output pins. Tie Pin3 and Pin6 to the first motor, Pin11 and Pin14 to second motor
5. Pin16 powers the IC and it should be connected to **regulated** +5Volts

6. Pin8 powers the two motors and should be connected to positive lead of a secondary battery. As per the datasheet, supply voltage can be as high as 36 Volts

4.3.4 ULTRASONIC RADAR:

Bats are wonderful creatures. Blind from the eyes and yet a vision so precise that could distinguish between a moth and a broken leaf even when flying at full speed. No doubt the vision is sharper than ours and is much beyond human capabilities of seeing, but is certainly not beyond our understanding. **Ultrasonic ranging** is the technique used by bats and many other creatures of the animal kingdom for navigational purposes. In a bid to imitate the ways of nature to obtain an edge over everything, we humans have not only understood it but have successfully imitated some of these manifestations and harnessed their potential to the greatest extent.



Fig 4.4 Ultrasonic sensor

Ultrasonic sensing:

Ultrasonic sensing is one of the best ways to sense proximity and detect levels with high reliability. Our technical support gets emails all of the time about how our sensors work and what environments our sensors work (or don't work) in. This guide was created as an introduction to ultrasonic sensing, it's principles, and how ultrasonic sensors work in your applications. At a top level, you need to know what an ultrasonic sensor is...

What is an ultrasonic sensor?

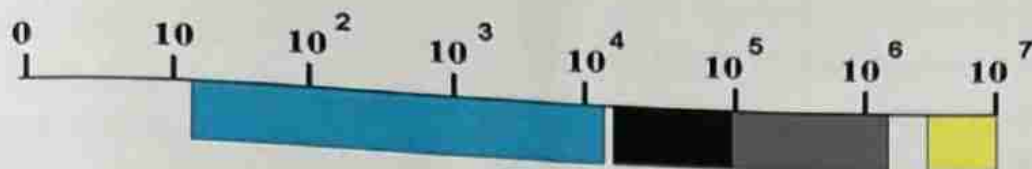
An ultrasonic sensor is an instrument that measures the distance to an object using ultrasonic sound waves. An ultrasonic sensor uses a transducer to send and receive ultrasonic pulses that relay back information about an object's proximity. High-frequency sound waves reflect from boundaries to produce distinct echo patterns

How Ultrasonic Sensors Work?

Ultrasonic sensors work by sending out a sound wave at a frequency above the range of human hearing. The transducer of the sensor acts as a microphone to receive and send the ultrasonic sound. Our ultrasonic sensors, like many others, use a single transducer to send a pulse and to receive the echo. The sensor determines the distance to a target by

measuring time lapses between the sending and receiving of the ultrasonic pulse. The working principle of this module is simple. It sends an ultrasonic pulse out at 40kHz which travels through the air and if there is an obstacle or object, it will bounce back to the sensor. By calculating the travel time and the speed of sound, the distance can be calculated. Ultrasonic sensors are a great solution for the detection of clear objects. For liquid level measurement, applications that use infrared sensors, for instance, struggle with this particular use case because of target translucence. 28 For presence detection, ultrasonic sensors detect objects regardless of the color, surface, or material (unless the material is very soft like wool, as it would absorb sound.) To detect transparent and other items where optical technologies may fail, ultrasonic sensors are a reliable choice.

The Frequency Ranges of the Sound



Human hearing



16Hz - 18kHz

Conventional power ultrasound



20kHz - 100kHz

Extended range for sonochemistry



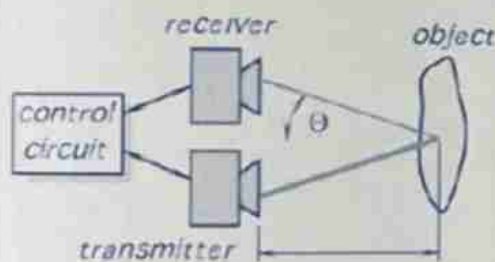
20kHz - 2MHz

Diagnostic ultrasound



5MHz - 10MHz

When ultrasonic waves are incident on an object, diffused reflection of the energy takes place over a wide solid angle which might be as high as 180 degrees. Thus some fraction of the incident energy is reflected back to the transducer in the form of echoes and is detected. The distance to the object (L) can then be calculated through the speed of ultrasonic waves (v) in the medium by the relation



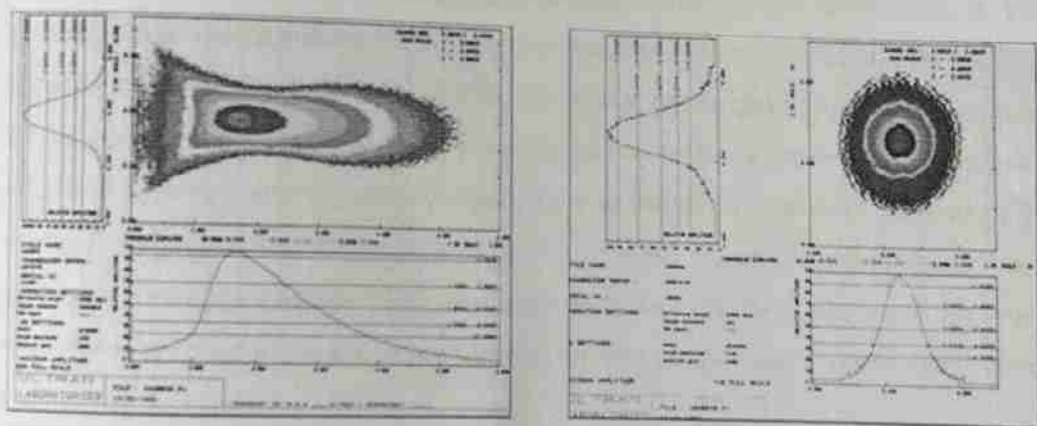
$$L = \frac{v t \cos \theta}{2}$$

Where ' t ' is the time taken by the wave to reach back to the sensor and ' θ ' is the angle between the horizontal and the path taken as shown in the figure. If the object is in motion, instruments based on Doppler shift are used. Get all the details about internal structure and working of an ultrasound sensor at [Insight-How Ultrasonic Sensors Work](#).

Generating Ultrasonic Waves

For the generation of such mechanical waves, movement of some surface like a

diaphragm is required which can then induce the motion to the medium in front of it in the form of compression and rarefaction. Piezoelectric materials operating in the motor mode and magnetostrictive materials have been widely employed in the generation of ultrasonic waves at frequency ranges of 1-20 MHz and 20-40 kHz respectively. The sensors employ piezoelectric ceramic transducers which flex when an electric signal is applied to them. These are connected to an electronic oscillator whose output generates the oscillating voltages at the required frequency. Materials like Lead Zirconate Titanate are popular piezoelectric materials used in medical ultrasound imaging. For best results, the frequency of the applied oscillations must be equal to the natural frequency of the ceramic, which produces oscillations readily through resonance. It offers maximum sensitivity and efficiency when operated at resonance. Piezoelectricity being a reversible phenomenon produces electrical voltages when ultrasonic waves reflect back from the target and impinge upon the ceramic structure. In this way, a transducer may work both as a transmitter and a receiver in pulsed mode. When continuous measurement of distances is required, separate transducers may be used for transmission and reception.



The parameters on which the performance of an ultrasonic sensor is measured include bandwidth, attenuation, dynamic range and resolution like grayscale, axial and lateral resolution. Other parameters are Nominal Frequency, Peak Frequency, Bandwidth center Frequency, Pulse Width, sensitivity and Signal to Noise Ratio (SNR).

Importance of Ultrasonic Sensors:

There are a variety of sensors based on other physical transduction principles like the optical range finding sensors and the microwave based devices too. Then why should one use ultrasonic transducers in the first place, given that the speed of sound is very slow than the speed of electromagnetic waves? The answer lies in the question itself. Because the EM waves based devices are too fast. Being slower than the EM waves, the time taken by ultrasonic waves is much longer than that taken by the latter and hence its measurement can be done more easily and less expensively. Because these are based on sound waves rather than EM waves, these would work in places where the latter would

For example, in the case of clear object detection and measurement of liquid levels or high glare environments, light based sensors would suffer greatly because of the transmittance of the target or the translucence of the propagating media. Ultrasonic devices being based upon sound propagation would remain practically unaffected. These also function well in wet environments where optical beams may suffer from refraction from the water droplets in the environment. On account of range and accuracy, the ultrasonic sensors may lie in between two EM wave based sensors, the Infrared rangefinders on the lower end and the LIDARs on the upper end. Not as accurate or long distance as the LIDARs, the Ultrasonic rangefinders fare better than the IR rangefinders which are highly susceptible to ambient conditions and require recalibration when environment changes. Further these devices offer advantage in medical imaging as compared to MRI or X-Ray scans due to inexpensiveness and portability. No harmful effects of ultrasonic waves at the intensity levels used have been detected in contrast to X-rays or radioactivity based methods and is particularly suited for imaging soft tissues.

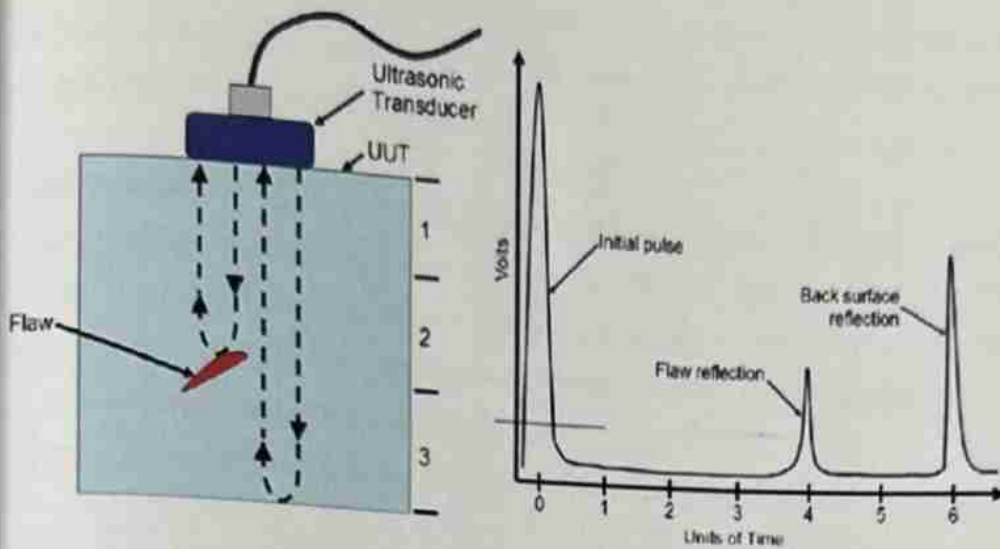
Applications:

The applications of ultrasonic sensors can be classified on the basis of the property that they exploit. These can be summarized as:

Research has been going on to overcome the problems of ultrasonic sensors, particularly in medical imaging where it is known as ultrasound. The artifacts of

ultrasonic sensors like Acoustic shadowing and Acoustic Enhancement are being exploited to characterize tissues which allow the differentiation between solid and cystic tissues. The industry too has reaped the benefits from ultrasonic sensors in applications like plastic welding, jewelry cleaning, remote sensing and telemetry, assisted parking systems etc. Robotics has been known to use ultrasonic rangefinders as a favorite tool for distance ranging and mapping.

Domain	Parameter	Applications
Time	Time-of-Flight, Velocity	Density, Thickness, Flaw Detection, Anisotropy, Robotics, Remote Sensing etc.
Attenuation	Fluctuations in reflected and Transmitted Signals	Defect characterization, microstructures, interface analysis
Frequency	Ultrasonic Spectroscopy	Microstructure, grain size, porosity, phase analysis.
Image	Time-of-Flight, velocity, attenuation mapping in Raster C-Scan or SARs	Surface and internal Defect imaging, density, velocity, 2D and 3D imaging.



Future:

Non-Destructive testing and flaw detection uses ultrasonic waves in various modes like the Longitudinal (L-wave) mode and the Shear (S-wave) mode to detect flaws in materials. With the advances in Science, new materials offering increased performance at lower voltages like the capacitive micromachined ultrasonic transducers (CMUTs) are being developed which are expected to have higher bandwidth and greater potential for integration with electronic circuits.

These devices provide non-invasive measures for the detection of problems in all kinds of materials, be it a living tissue or non-living manufactured goods. With a healthy history of being able to detect many problems which otherwise left the doctors dazed and the problem untreated, ultrasonic sensors do offer a lot of promise even in the coming times. The environmental and psychological effects of exposure to EM-radiation being rigorously being put under the scanner, ultrasonic applications are expected to thrive and offer a substantial alternative to the contemporary technologies.

4.3.5 PROXIMITY SENSOR:

OBJECTIVE:

Increasing automation of complex production systems necessitates the use of components which are capable of acquiring and transmitting information relating to the production process. Sensors fulfill these requirements and have therefore in the last

few years become increasingly important components in measuring and in open and closed loop technology. Sensors provide information to a controller in the form of individual process variables.

Proximity sensors are the most basic data acquisition devices in automation. They measure / detect physical input such as temperature, pressure, force, length, and proximity of an object. Transducers are typically a sensorial system capable of signal processing, equipped with electronic instrumentation. Position sensors give a "yes" or "no" response according to the place of the object.

The aim of this experiment is to illustrate the aspects of different types of proximity sensors, their properties, and to compare them. For this, a setup table containing Magnetic, Inductive, Capacitive, and Optical sensors is used. A positioning slide coupled with a vernier caliper is used to measure switching distances.

- The term "Proximity Sensor" encompasses a wide range of sensors designed for non-contact detection, distinguishing them from sensors like limit switches that rely on physical contact with objects. Proximity Sensors play a crucial role in converting information regarding the movement or presence of an object into an electrical signal. There are three main detection systems responsible for this conversion:
- Eddy Current Detection: This system operates by utilizing eddy currents induced in metallic objects through electromagnetic induction. These currents are harnessed to detect the proximity of objects.
- Electrical Capacity Detection: This approach focuses on detecting changes in electrical capacity as an object approaches the sensor. It's especially useful for sensing various types of objects.
- Magnetic and Reed Switch Detection: The third system employs magnets and

reed switches to identify the presence or movement of objects. This method is valuable for proximity detection in different scenarios.

They usually convert some physical data into a voltage difference for further processing by a Computer, PLC or I/O Card. The advantages of proximity sensors are:

- They determine the geometrical positions automatically and sensitively.
- They do not need of a direct contact with the workpiece.
- They do not have movable parts that can wear out.
- They are usually equipped with electronic circuits for failure protection.
- They have various types that can be used under different situations.
- They provide the secure working of the process.
- They are used for the system failure analysis.

4.3.6 GPIO (General Purpose Input/Output):

- GPIO, which stands for General Purpose Input/Output, is a powerful and versatile tool in the world of electronics. It serves as a standard interface, bridging the gap between microcontrollers and a wide array of electronic devices. This little acronym, GPIO, holds immense potential and offers boundless opportunities for innovation.
- Think about it: with GPIO, you can seamlessly connect microcontrollers to sensors, diodes, displays, and System-on-Chip modules, among many other devices. It's the bridge that enables
- These components to communicate and work together, opening the door to a world of possibilities.
- But that's not all. Let's take a closer look at Estimote Location Beacons, Specifically Hardware Revision F2.3 and later. These beacons are equipped with GPIO, making them even more versatile and powerful. GPIO on Estimote

Beacons allows for various applications, including providing external power supply, remote control of connected devices, broadcasting contextual data, and defining contents for custom Bluetooth data packets. This not only enhances their capabilities but also paves the way for innovative and customized solutions in a wide range of scenarios.

- And the support for GPIO doesn't stop there. In fact, it's integrated seamlessly into the latest versions of the Estimote app and SDK. This means that the power and versatility of GPIO are easily accessible, putting the control at your fingertips.

When it comes to using GPIO, you have three main modes to choose from:

Input: GPIO can be configured to receive data from external devices, such as sensors, and process that information within your microcontroller.

Output: Conversely, GPIO can also be set up to control external devices, sending signals and commands to them as needed.

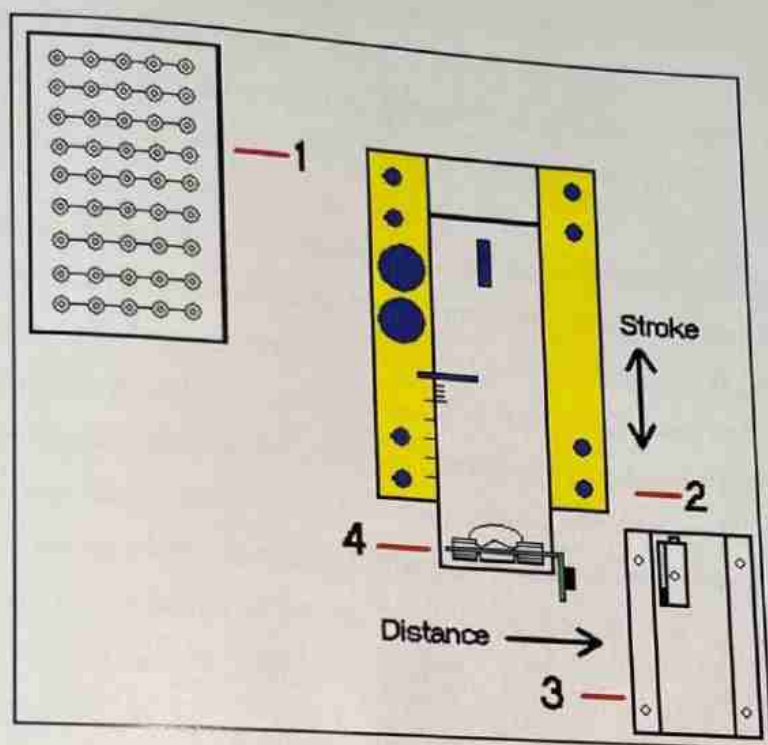
Switching characteristics of a contacting magnetic proximity sensor:

The objective of the experiment is to learn about the switching characteristics of a contact based magnetic proximity sensor (Reed contact) as a function of position and orientation of a magnet.

SETUP:

Mount the distribution plate (1), the positioning slide (2), and the magnetic Reed sensor (3, Designation 167056) on the assembly board. Mount the magnetic sensor laterally offset by 5 cm to the center of the positioning slide. Plug in the electrical power supply and connect the sensor to the distribution plate. Note that the red color represents (+24V), the blue (0 V or natural) and the black is the sensorial output (either +24V or 0,

ON/OFF). Mount the test object (Magnet 1) on the positioning slide. Adjust the distance from 0 to +18 mm with 2 mm increments and at a constant distance adjust the stroke from -50 to +50 mm manually to detect on/off positions. Enter the response points into the data sheet provided in the following pages. Repeat the same procedure with the test object 2 (Magnet 2).



4.3.7 BUZZER:

Buzzer typically consists of one of two key components: electromechanical or piezoelectric. When electric current is applied, these components spring to life, vibrating and oscillating with a vigor that belies their unassuming nature. This vibration, in turn, generates audible sound waves, filling the air with that familiar buzzing or beeping sound. The versatility of buzzers knows no bounds. They're commonly employed in various domains, from the everyday household appliances that gently remind us that the toast is ready, to the high-tech security systems that protect our

homes and businesses. Their use extends to industries like healthcare, where they ensure the timely delivery of medication, and in industrial settings, where they alert workers to potential hazards. These simple devices are the unsung heroes of modern life.

4.3.8 BATTERY:

The 9V battery is not just a simple power source; it's a versatile energy solution that has played a significant role in powering various devices. Its history traces back to the early days of transistor radios, where it made its debut. This unassuming power pack comes in the form of a rectangular prism, making it easy to spot, and it relies on a pair of snap connectors located at its peak to deliver power efficiently.

One of the most fascinating aspects of the 9V battery is its ubiquity. Numerous battery manufacturers, both large and small, have contributed to its availability, ensuring that it can be found virtually everywhere. This wide production spectrum offers consumers a variety of choices to suit their specific needs. But what truly sets the 9V battery apart is the diverse range of chemistries it come in. In the world of primary (non-rechargeable) 9V batteries, you have options like Alkaline, Carbon-Zinc (Heavy Duty), and Lithium, each with its unique characteristics and applications. On the other hand, secondary (rechargeable) 9V batteries open up even more possibilities with nickel-cadmium (NiCd), nickel-metal hydride (NiMH), and lithium-ion chemistries.

The magic lies in the fact that the performance and suitability of the 9V battery can vary significantly based on the chosen chemistry. This means that some chemistries shine in specific applications, while others may not be as well-suited. Whether it's long-lasting power, high performance, or eco-friendliness, the 9V battery has an option for every need.

4.3.9 NODE MCU:

The Nodemcu (Node Microcontroller Unit) is an open-source software and hardware development environment built around an inexpensive system-on-a-chip (SoC) called the ESP8266. The ESP8266, designed and manufactured by Espressif Systems, contains the crucial elements of a computer: CPU, RAM, networking (WiFi), and even a modern operating system and SDK. That makes it an excellent choice for Internet of Things (IoT) projects of all kinds.

However, as a chip, the ESP8266 is also hard to access and use. You must solder wires, with the appropriate analog voltage on the chip. You also have to program it in low-level machine instructions that can be interpreted by the chip hardware. This level of integration is not a problem using the ESP8266 as an embedded controller chip in mass-produced electronics.

But, what about Arduino? The Arduino project created an open-source hardware design and software SDK for their versatile IoT controller. Similar to NodeMCU, the Arduino hardware is a microcontroller board with a USB connector, LED lights, and standard data pins. It also defines standard interfaces to interact with sensors or other boards. But unlike NodeMCU, the Arduino board can have different types of CPU chips (typically an ARM or Intel x86 chip) with memory chips, and a variety of programming environments. There is an Arduino reference design for the ESP8266 chip as well. However, the flexibility of Arduino also means significant variations across different vendors. For example, most Arduino boards do not have WiFi cap.

4.3.10 PIR MOTION SENSOR:

A PIR detector is a motion detector that senses the heat emitted by a living body. These are often fitted to security lights so that they will switch on automatically if approached. They are very effective in enhancing home security systems.

The sensor is passive because, instead of emitting a beam of light or microwave energy that must be interrupted by a passing person in order to "sense" that person, the PIR is simply sensitive to the infrared energy emitted by every living thing. When an intruder

walks into the detector's field of vision, the detector "sees" a sharp increase in infrared energy.

A PIR sensor light is designed to turn on when a person approaches, but will not react to a person standing still. The lights are designed this way. A moving person exhibits a sudden change in infrared energy, but a slower change is emitted by a motionless body. Slower changes are also caused by gradual fluctuations in the temperature of the environment. If the light were sensitive to these slower changes, it would react to the sidewalk cooling off at night, instead of the motion of a burglar.

If you have a PIR light, you may notice that it is more sensitive on cold days than on warm days. This is because the difference in temperature between the ambient air and the human body is greater on cold days, making the rise in temperature easier for the sensor

to detect. This has drawbacks, though; if the sensor is too sensitive, it will pick up things you don't want it to such as the movement of small animals.

Passive infrared sensor is an electronic device, which measures infrared light radiating from objects in its field of view. PIRs are often used in the construction of PIR-based motion detectors. Apparent motion is detected when an infrared source with one temperature, such as a human, passes in front of an infrared source with another temperature, such as a wall.

All objects emit what is known as black body radiation. This energy is invisible to the human eye but can be detected by electronic devices designed for such a purpose. The term 'Passive' in this instance means the PIR does not emit energy of any type but merely accepts incoming infrared radiation.

Infrared radiation enters through the front of the sensor, known as the sensor face. At the core of a PIR is a solid state sensor or set of sensors, made from approximately 1/4 inches square of natural or artificial pyroelectric materials, usually in the form of a thin film, out of gallium nitride (GaN), caesium nitrate (CsNO_3), polyvinyl fluorides,

derivatives of phenylpyrazine, and cobalt phthalocyanine. (See pyroelectric crystals.) Lithium tantalate (LiTaO_3) is a crystal exhibiting both piezoelectric and pyroelectric properties.

The sensor is often manufactured as part of an integrated circuit and may consist of one (1), two (2) or four (4) 'pixels' of equal areas of the pyroelectric material. Pairs of the sensor pixels may be wired as opposite inputs to a differential amplifier. In such a configuration, the PIR measurements cancel each other so that the average temperature of the field of view is removed from the electrical signal; an increase of IR energy across the entire sensor is self-cancelling and will not trigger the device. This allows the device to resist false indications of change in the event of being exposed to flashes of light or field-wide illumination. (Continuous bright light could still saturate the sensor materials and render the sensor unable to register further information.)

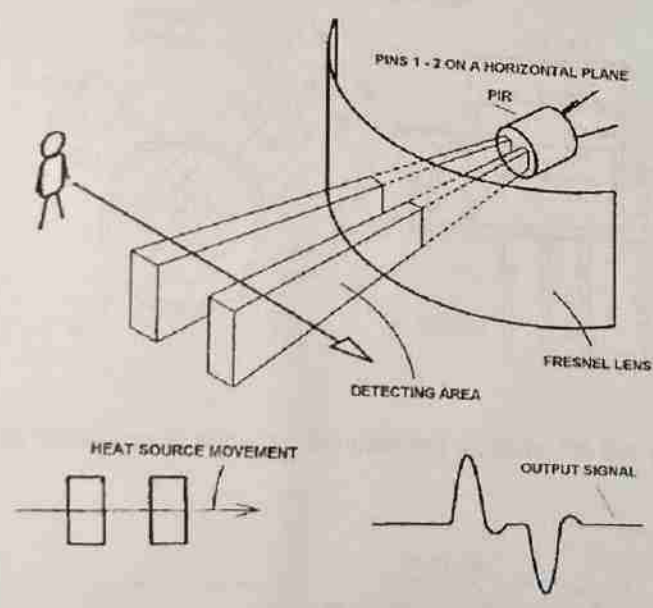
At the same time, this differential arrangement minimizes common-mode interference; this allows the device to resist triggering due to nearby electric fields. However, a differential pair of sensors cannot measure temperature in that configuration and therefore this configuration is specialized for motion detectors.

In a PIR-based motion detector, the PIR sensor is typically mounted on a printed circuit board, which also contains the necessary electronics required to interpret the signals from the chip. The complete circuit is contained in a housing, which is then mounted in a location where the sensor can view the area to be monitored. Infrared energy is able to reach the sensor through the window because the plastic used is transparent to infrared radiation (but only translucent to visible light). This plastic sheet prevents the introduction of dust and insects, which could obscure the sensor's field of view.

PIR sensors allow you to sense motion, almost always used to detect whether a human has moved in or out of the sensors range. They are small, inexpensive, low-power, easy to use and don't wear out. For that reason they are commonly found in appliances and gadgets used in homes or businesses. They are often referred to as PIR, "Passive Infrared", "Pyroelectric", or "IR motion" sensors. PIR sensors are more complicated than

many of the other sensors explained in these tutorials (like photocells, FSRs and tilt switches) because there are multiple variables that affect the sensors input and output. To begin explaining how a basic sensor works, we'll use this rather nice diagram (if anyone knows where it originates plz let me know).

The PIR sensor itself has two slots in it, each slot is made of a special material that is sensitive to IR. The lens used here is not really doing much and so we see that the two slots can 'see' out past some distance (basically the sensitivity of the sensor). When the sensor is idle, both slots detect the same amount of IR, the ambient amount radiated from the room or walls or outdoors. When a warm body like a human or animal passes by, it first intercepts one half of the PIR sensor, which causes a positive differential change between the two halves. When the warm body leaves the sensing area, the reverse happens, whereby the sensor generates a negative differential change. These change pulses are what is detected.



The PIR Sensor:

The PIR sensor itself is housed in a hermetically sealed metal can to improve noise/temperature/humidity immunity. There is a window made of IR-transmissive material typically coated silicon since that is very easy to come by) that protects the sensing element. Behind the window are the two balanced sensor

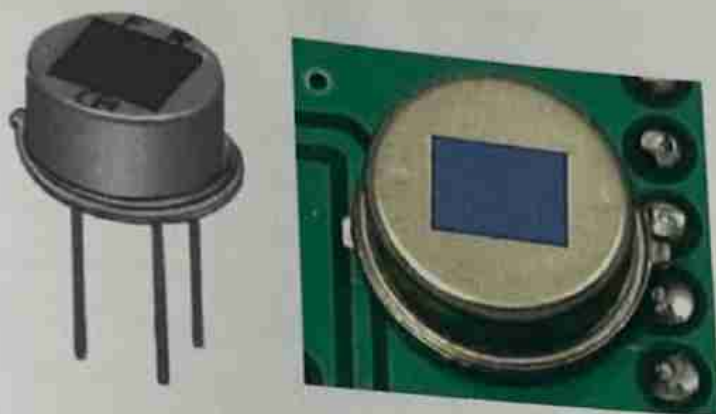
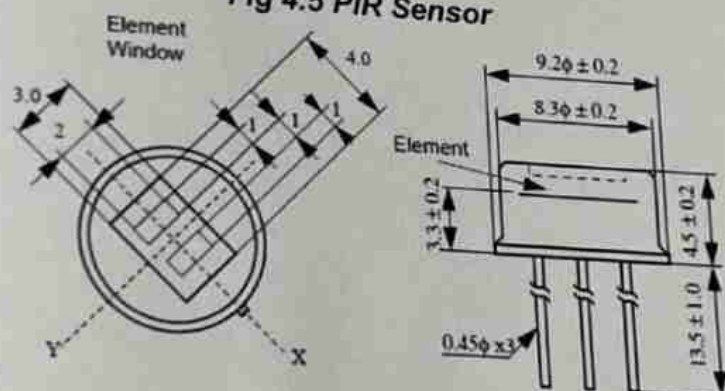
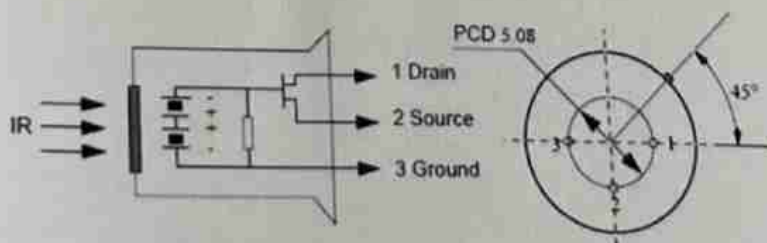


Fig 4.5 PIR Sensor



You can see above the diagram showing the element window, the two pieces of sensing material

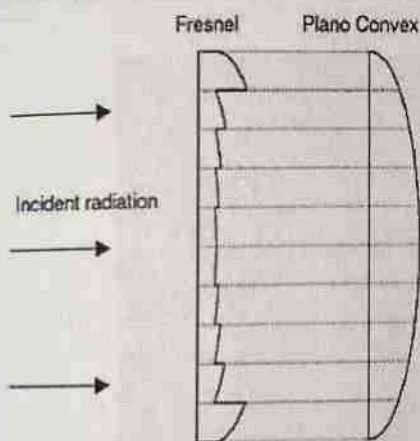


This image shows the internal schematic. There is actually a JFET inside (a type of transistor) which is very low-noise and buffers the extremely high impedance of the

sensors into something a low-cost chip (like the BIS0001) can sense.

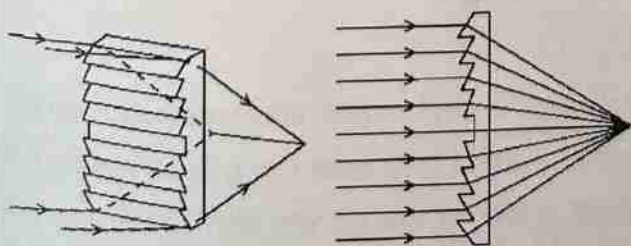
Lenses:

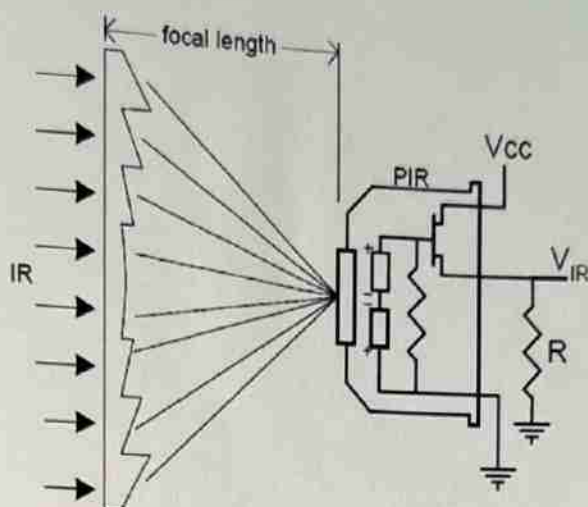
PIR sensors are rather generic and for the most part vary only in price and sensitivity. Most of the real magic happens with the optics. This is a pretty good idea for manufacturing: the PIR sensor and circuitry is fixed and costs a few dollars. The lens costs only a few cents and can change the breadth, range, sensing pattern, very easily. In the diagram up top, the lens is just a piece of plastic, but that means that the detection area is just two rectangles. Usually we'd like to have a detection area that is much larger. To do that, we use a simple lens (<http://adafru.it/aKq>) such as those found in a camera. they condenses a large area (such as a landscape) into a small one (on film or a CCD sensor). For reasons that will be apparent soon, we would like to make the PIR lenses small and thin and moldable from cheap plastic, even though it may add distortion. For this reason the sensors are actually Fresnel



lenses.

The Fresnel lens condenses light, providing a larger range of IR to the sensor.





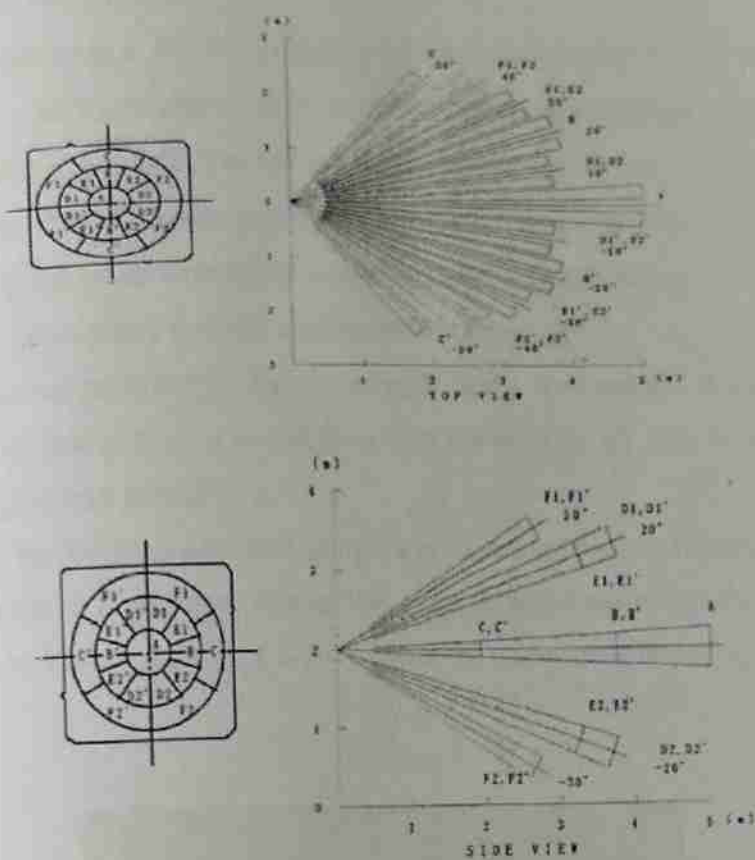
OK, so now we have a much larger range. However, remember that we actually have two sensors, and more importantly we don't want two really big sensing-area rectangles, but rather a scattering of multiple small areas. So what we do is split up the lens into multiple section, each section of which is a Fresnel lens.



Fig 4.6 Fresnel

This macro shot shows the different Fresnel lenses in each facet!

The different faceting and sub-lenses create a range of detection areas, interleaved with each other. That's why the lens centers in the facets above are 'Inconsistent' - every other one points to a different half of the PIR sensing element.



Here is another image, more qualitative but not as quantitative. (Note that the sensor in the Adafruit shop is 110° not 90°)

Ceiling Mount

Top View



Side View

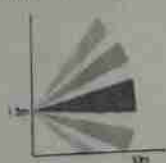


Wall Mount

Top View



Side View



Connecting to a PIR Sensor:

Most PIR modules have a 3-pin connection at the side or bottom. The pinout may vary between modules so triple-check the pinout! It's often silkscreened on right next to the connection (at least, ours is!) One pin will be ground, another will be signal and the final one will be power. Power is usually 3-5VDC input but may be as high as 12V. Sometimes larger modules don't have direct output and instead just operate a relay in which case there is ground, power and the two switch connections.

The output of some relays may be 'open collector' - that means it requires a pullup resistor. If you're not getting a variable output be sure to try attaching a 10K pullup between the signal and power pins.

An easy way of prototyping with PIR sensors is to connect it to a breadboard since the connection port is 0.1" spacing. Some PIRs come with header on them already, the one's from adafruit have a straight 3-pin header on them for connecting a cable.



Fig 4.7 Connecting way of PIR Sensor

For our PIR's the red cable is + voltage power, black cable is - ground power and yellow is the signal out. Just make sure you plug the cable in as shown above! If you get it backwards you won't damage the PIR but it won't work.

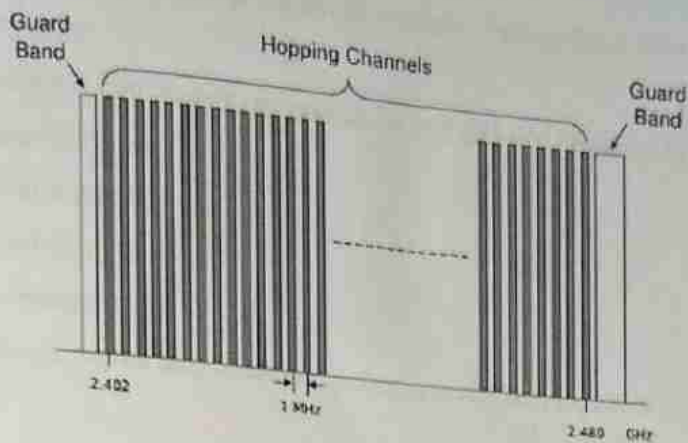
4.3.11 HC-05 Bluetooth module:

Bluetooth is a way of communication which makes the world wonder about it. Bluetooth is now provided in everything which is designed for some type of communication. It is available from smartphones to self-driving vehicles systems. It has interesting history and working system, which proves how versatile it is. It is managed by the Bluetooth Special Interest Group, which set the standards, advance the Bluetooth capabilities.



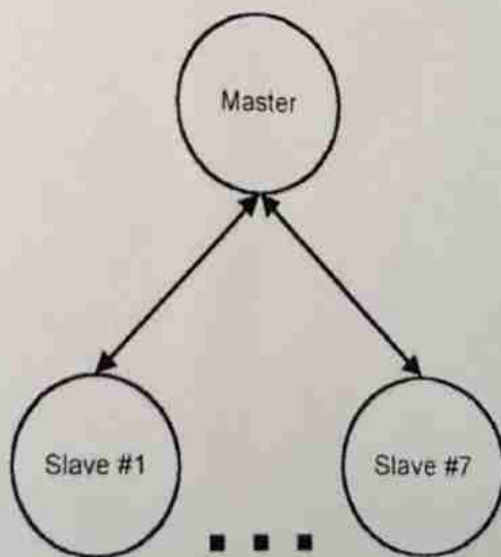
Fig 4.8 HC-05 Bluetooth Module

Bluetooth operates in the standard Industrial, Scientific and Medical (ISM) short range frequency band of 2.4 GHz. Specifically, it operated in the 2400–2483.5 MHz frequency band, which includes guard bands as well. It uses something called Frequency Hopping Spread Spectrum (FHSS), which is basically a multiple access method in which data packets are divided based on frequency over 79 designated Bluetooth channels. Each channel has a bandwidth of 1 MHz. The newer Bluetooth 4.0 standard, however, uses 2 MHz steps and thus has 40 designated channels. It uses a variation of FHSS called Adaptive Frequency-hopping spread spectrum (AFH), which theoretically skips channels with interference and results in better communication.



Bluetooth is essentially a protocol with a master-slave architecture, which means that one master device can communicate with up to 7 devices. This was and is a huge advantage to earlier wired communication protocols which could work only with a 1 to 1 configuration. Essentially creating a new standard called Personal Area Networks (PANs), Bluetooth brought about far more effective ad-hoc networks and allows communication without traditional host based networking.

Pin Configuration of HC-05 Bluetooth Module:



There are 6 pins available at the output of module. Facing back side, from left to right these are as follows:

1. EN Used for AT commands. In normal usage it is not required to be connected.
2. VCC Power supply +5V
3. GND Power supply ground
4. TxD Transmitting pin
5. RxD Receiving Pin
6. STATE Gives digital output showing status whether module is connected or not.

4.4 SKETCHES:

Programs written using Arduino Software (IDE) are called sketches. These sketches are written in the text editor and are saved with the file extension .ino. The editor has features for cutting/pasting and for searching/replacing text. The message area gives feedback while saving and exporting and also displays errors. The console displays text output by the Arduino Software (IDE), including complete error messages and other information. The bottom right hand corner of the window displays the configured board and serial port. The toolbar buttons allow you to verify and upload programs, create, open, and save sketches, and open the serial monitor.

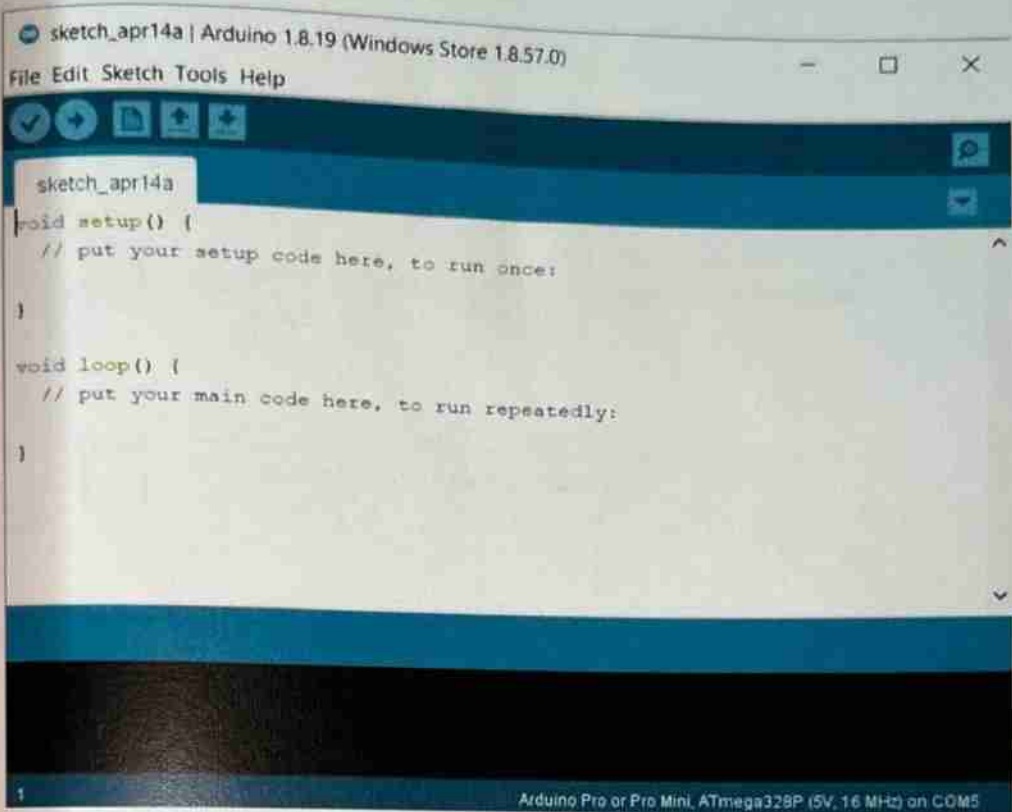


Fig 4.9 Arduino IDE Sketch Window

The Arduino IDE supports the languages C and C++ using special rules of code structuring. The Arduino IDE supplies a software library from the Wiring project, which provides many common input and output procedures. User-written code only requires two basic functions, for starting the sketch and the main program loop, that are compiled and linked with a program stub `main()` into an executable cyclic executive program with the GNU toolchain, also included with the IDE distribution. The Arduino IDE employs the program `avr-dude` 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.

	<i>Verify</i> Checks your code for errors compiling it.
	<i>Upload</i> Compiles your code and uploads it to the configured board.
	<i>New</i> Creates a new sketch.
	<i>Open</i> Presents a menu of all the sketches in your sketchbook. Clicking one will open it within the current window overwriting its content.
	<i>Save</i> Saves your sketch.
	<i>Serial Monitor</i> Opens the serial monitor .

6 Buttons of Menu bar

Fig 4.10 6 Buttons of Menu Bar

UPLOADING:

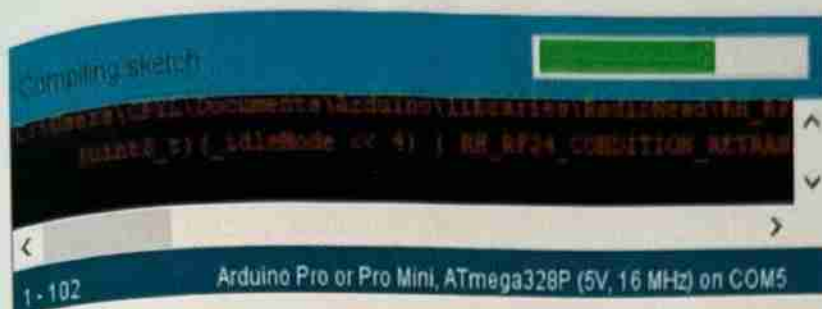
Before uploading your sketch, you need to select the correct items from the Tools > Board and Tools > Port menus. Once you've selected the correct serial port and board, press the upload button in the toolbar or select the Upload item from the Sketch menu. Current Arduino boards will reset automatically and begin the upload. With older boards (pre-Diecimila) that lack auto-reset, you'll need to press the reset button on the board just before starting the upload. On most boards, you'll see the RX and TX LEDs blink as the sketch is uploaded. The Arduino Software (IDE) will display a message when the upload is complete, or show an error.

LIBRARIES:

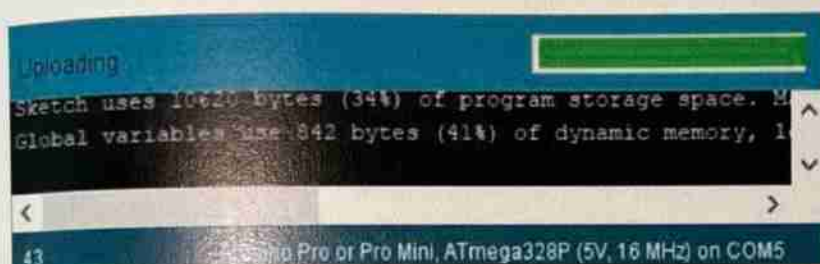
Libraries provide extra functionality for use in sketches, e.g. working with hardware or manipulating data. To use a library in a sketch, select it from the Sketch > Import Library menu. This will insert one or more `#include` statements at the top of the sketch and compile the library with your sketch. Because libraries are uploaded to the board with your sketch, they increase the amount of space it takes up. If a sketch no longer needs a library, simply delete its `#include` statements from the top of your code.

UPLOADING CODE:

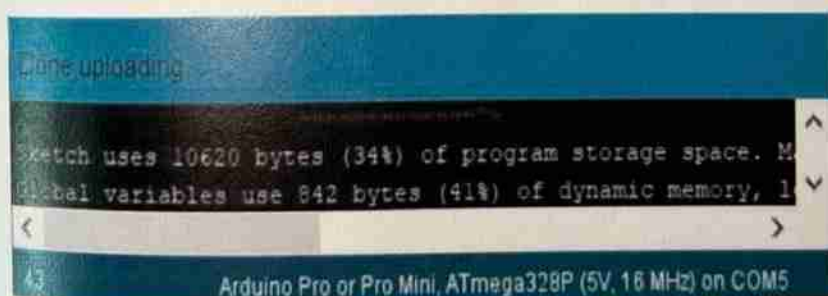
Both the transmitter and receiver codes are uploaded in two different Arduino Pro Mini microcontrollers using Arduino.



Compiling Sketch



Uploading



Done Uploading

Fig 4.11 Uploading sketch

CHAPTER 5

RESULTS AND DISCUSSION

The robotics is a progressive sector in the current era of electronics. In the future, most of the jobs done by the humans may be replaced by the robots. Here in this project the robot is able to solve certain problems which human cannot solve. Since the Indian government is also spending more amounts for robots which can help in military applications, the proposed robot is having high importance. In the future the robot can be used for bigger purposes. It is concluded that surveillance system using Raspberry pi capable of capturing video/image and transmitting through emails. Also this paper contains detailed information for controlling a robotic vehicle guided via internet. All this techniques can be used in any conditions and areas where safety is important and mandatory for secure place to live. It can monitor the areas and secures a place from the adversaries which can be done by surveillance robot all the times with great accuracy and high precision.

5.1 PROTEUS SOFTWARE:

The Proteus Design Suite is a proprietary software tool suite used primarily for electronic design automation. The software is used mainly by electronic design engineers and technicians to create schematics and electronic prints for manufacturing printed circuit boards. The Proteus Design Suite is a Windows application for schematic capture, simulation, and PCB (Printed Circuit Board) layout design. It can be purchased in many configurations, depending on the size of designs being produced and the requirements for microcontroller simulation. All PCB Design products include an auto router and basic mixed mode SPICE simulation capabilities.

5.2 SCHEMATIC CAPTURE:

Schematic capture stands as a cornerstone within the Proteus Design Suite, serving a multifaceted role pivotal to both design simulation and the initiation phase of PCB layout endeavors. Its versatility extends across all product configurations, underlining its fundamental importance in facilitating seamless transitions from conceptualization to practical implementation. By integrating simulation capabilities with the initial design phase, Proteus empowers designers to iterate and refine their concepts with precision, ultimately enhancing efficiency and efficacy in the development of complex PCB projects.

SIMULATION:

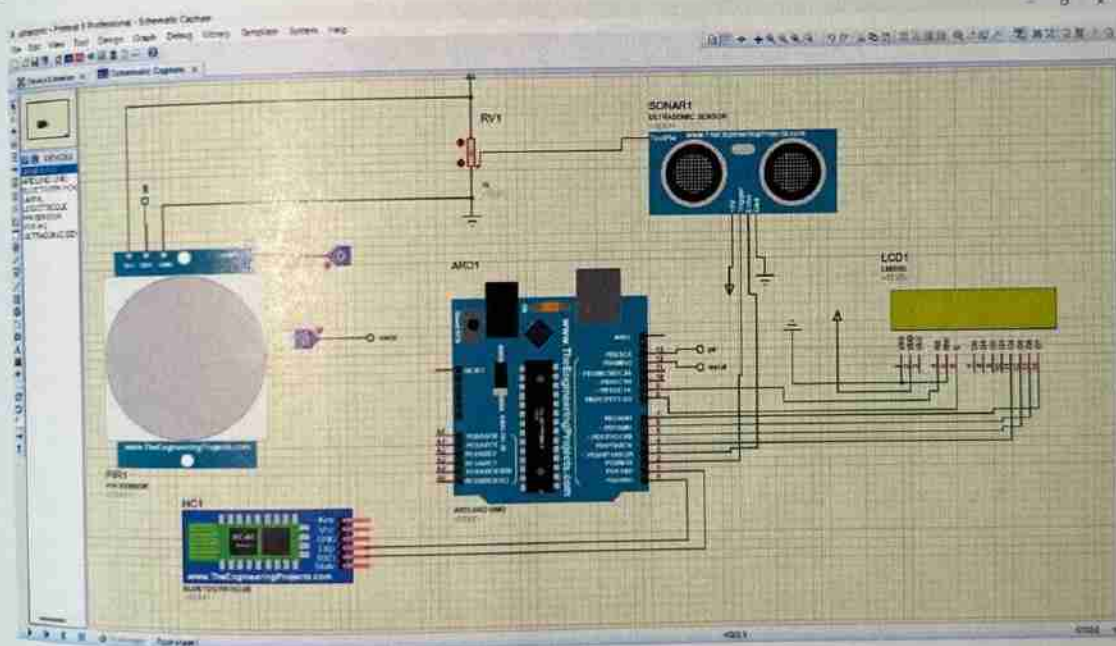


Fig 5.1 Layout of the Circuit

APPLICATION USED :

- BLE Terminal

<https://play.google.com/store/apps/details?id=project.bluetoothterminal>

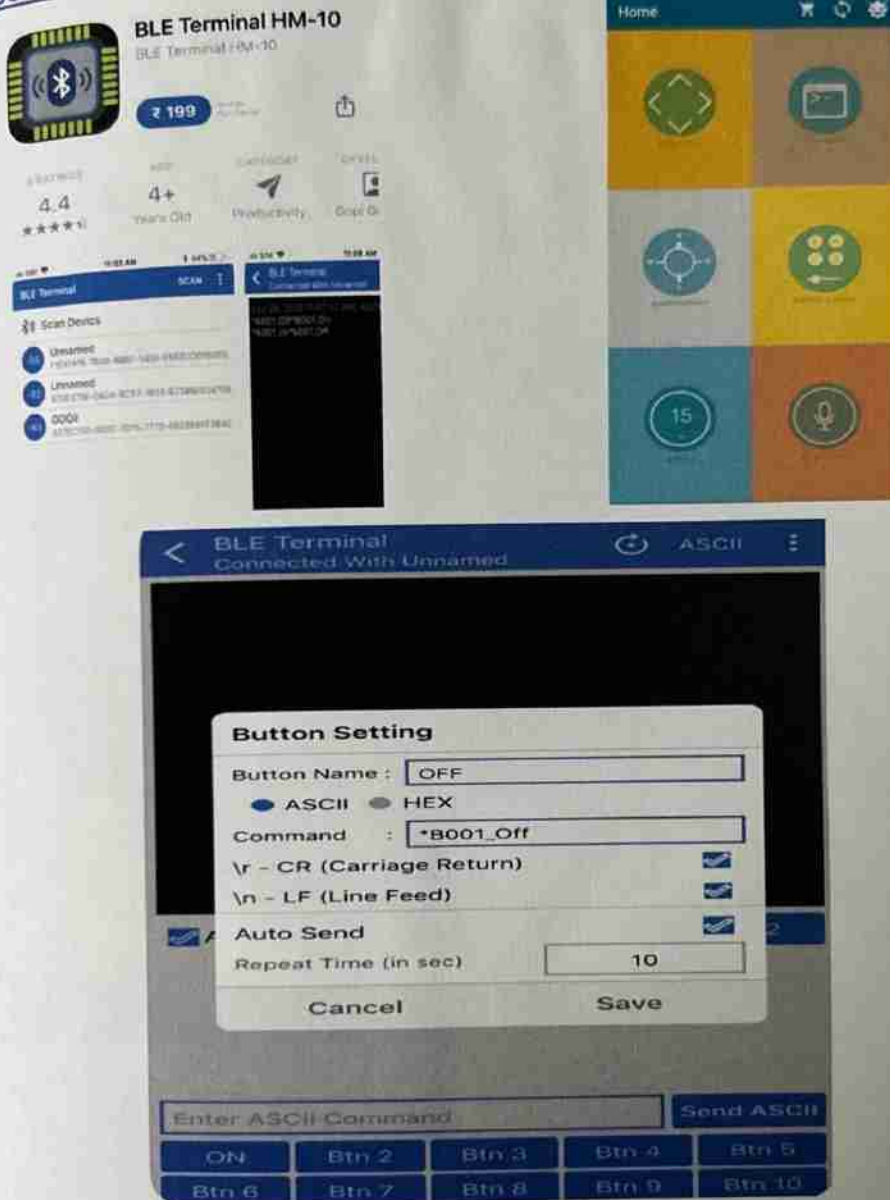


Fig 5.2 Design of the Proposed Application

HARDWARE CONNECTION OF ROBOTIC MODULE:

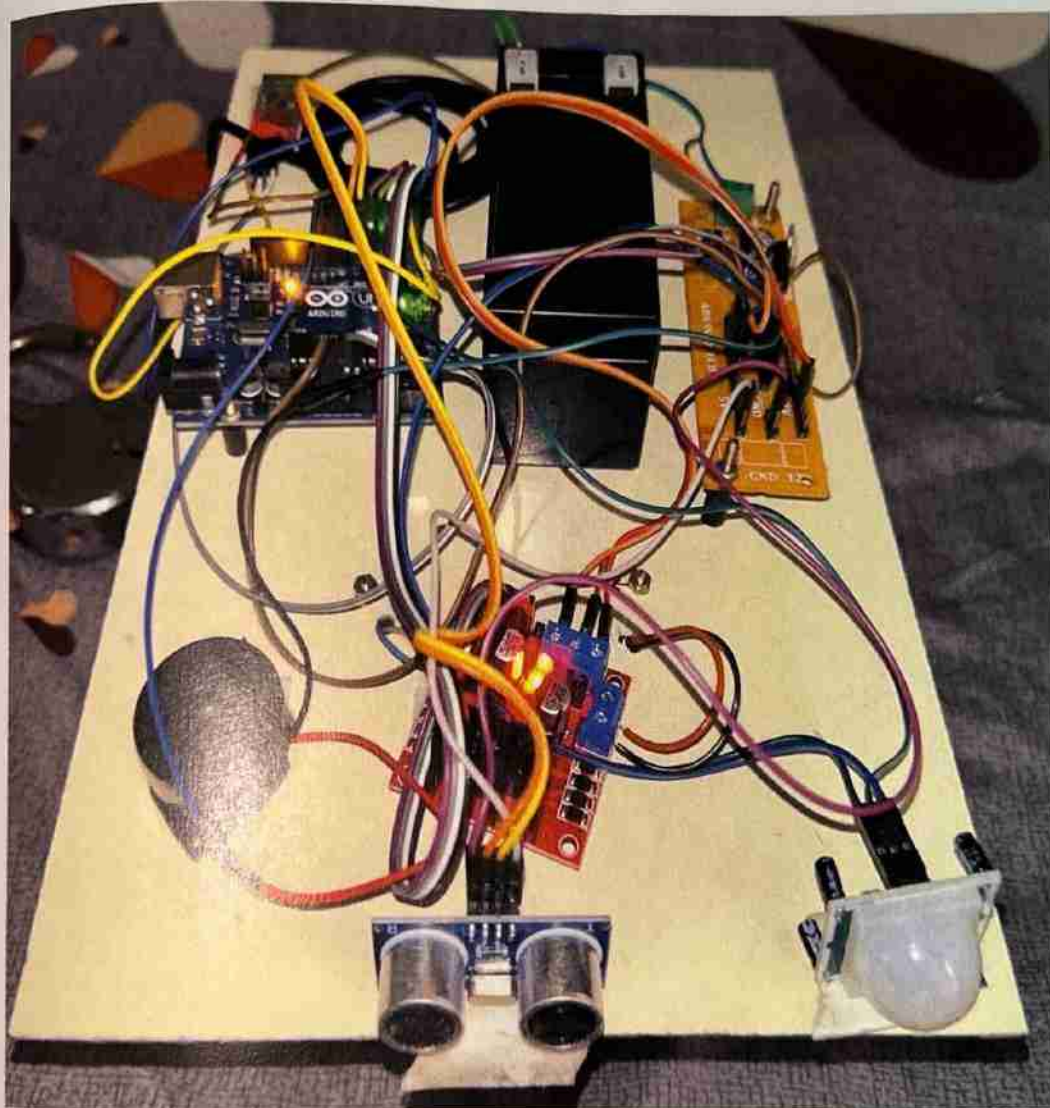


Fig 5.3 Hardware Connection

HARDWARE OUTPUT:

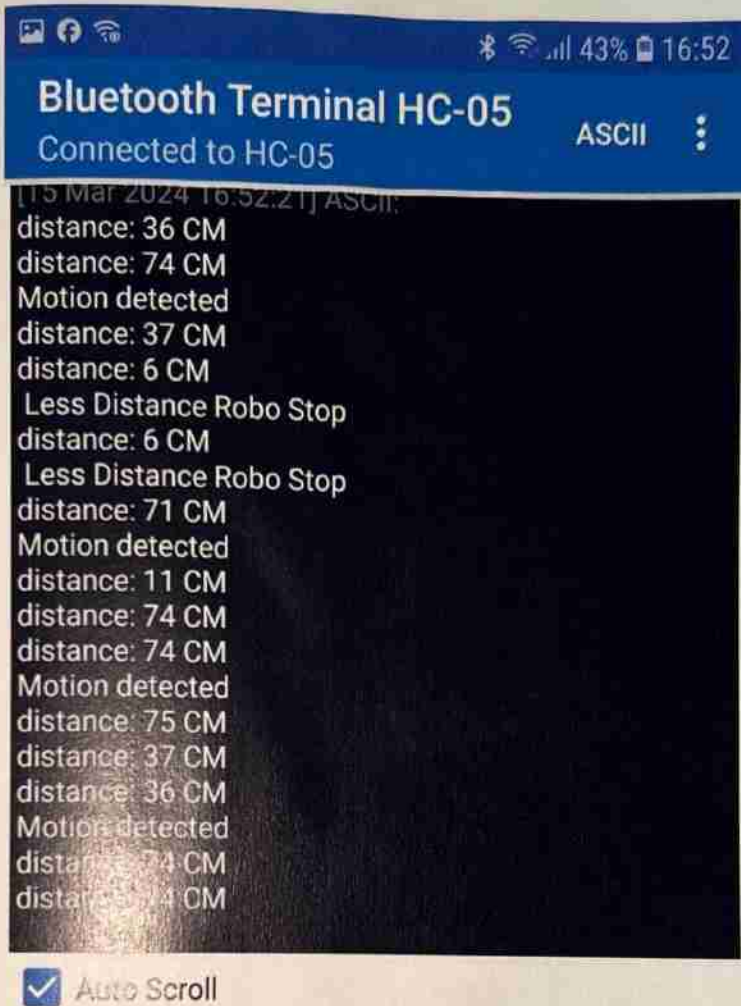


Fig 5.4 Hardware Output

CHAPTER 6

CONCLUSION AND FUTURE SCOPE

In this paper, the framework for making a robot for surveillance purpose is proposed. It overcomes the problem of limited range surveillance by using the concept of IOT. We can control the robot with the help of laptop/mobile manually. Automatic monitoring can also be done. Our proposed robot is small in size thus maneuvering into area where human access is impossible. Wireless technology is one of the most integral technologies in the electronics field. This technology is used to serve our project as a supreme part of surveillance act. This provides highly efficient and a cost effective robot that replaces human work and reduces human labor and performing monitoring works in a well effective manner. Implementing an advanced security system in the military for identifying trespassers using ultrasonic sensors offers several benefits. Firstly, it provides real-time detection and alerts for unauthorized individuals, enhancing perimeter security. Secondly, it reduces false alarms by accurately distinguishing between humans and other objects. Additionally, the system's adaptability to various terrains and weather conditions enhances its reliability. Overall, integrating ultrasonic sensors into military security protocols significantly strengthens defense capabilities against potential threat.

6.2 FUTURE SCOPE:

- Better sensor technology.
- Integration of AI and machine learning.
- A higher level of energy economy.
- Integration across domains with additional security technologies.
- Utilizing sophisticated data analytics to anticipate threats.
- Tightened cybersecurity safeguards.
- The deployment's scalability and flexibility.
- Response systems with autonomy.
- International cooperation for consistent procedures and exchange of threat intelligence.

6.3 APPLICATIONS:

1. Base Security:

Monitor perimeters for unauthorized entry.

2. Patrol Assistance:

Aid patrols in spotting threats.

3. Border Surveillance:

Detect illegal border crossings.

4. Infrastructure Protection:

Secure critical sites from intrusion.

5. Outpost Security:

Guard remote bases from trespassers.

6.4 ADVANTAGES:

- Detects trespassers early, allowing for timely response.
- Provides precise location of intruders, aiding in quick intervention.
- Operates day and night, ensuring continuous surveillance.
- Advanced algorithms minimize false alarms, ensuring efficient use of resources.
- Provides data logs for analysis and improvement of security protocols over time.

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APPENDICES:

```
char i;

int d;
int t;
int triggerpin=6;
int echopin=7;

int pirpin= 8;    // PIR Sensor
int metalpin= 9;  // Metal Sensor
int buzzer= 10;   // buzzer

void setup() {
  pinMode(2, OUTPUT);
  pinMode(3, OUTPUT);
  pinMode(4, OUTPUT);
  pinMode(5, OUTPUT);
  pinMode(triggerpin, OUTPUT);
  pinMode(echopin, INPUT);
  pinMode(pirpin, INPUT);
  pinMode(metalpin, INPUT);
  pinMode(buzzer, OUTPUT);
  Serial.begin(9600);
}

void loop() {
  while(Serial.available()>0)
  {
    i=Serial.read();
    Serial.println(i);
    if(i=='F')
    {
      Serial.println("Moving Forward");
    }
  }
}
```

```
digitalWrite(2, HIGH);  
digitalWrite(3, LOW);  
digitalWrite(4, HIGH);  
digitalWrite(5, LOW);
```

```
}  
if(i=='B')
```

```
{  
    Serial.println("Moving Reverse");  
    digitalWrite(2, LOW);  
    digitalWrite(3, HIGH);  
    digitalWrite(4, LOW);  
    digitalWrite(5, HIGH);
```

```
}
```

```
if(i=='L')           // Load
```

```
{  
    Serial.println("Moving Left");  
    digitalWrite(2, LOW);  
    digitalWrite(3, LOW);  
    digitalWrite(4, HIGH);  
    digitalWrite(5, LOW);
```

```
}
```

```
if(i=='R')
```

```
{  
    Serial.println("Moving Right");  
    digitalWrite(2, HIGH);  
    digitalWrite(3, LOW);  
    digitalWrite(4, LOW);  
    digitalWrite(5, LOW);
```

```
}
```

```
if(i=='S')
```

```
{  
    Serial.println("Stop");  
    digitalWrite(2, LOW);  
    digitalWrite(3, LOW);  
    digitalWrite(4, LOW);  
    digitalWrite(5, LOW);
```

```
}
```

```
}
```

```
digitalWrite(triggerpin, LOW);  
//delay(50);  
digitalWrite(triggerpin, HIGH);  
//delay(50);  
digitalWrite(triggerpin, LOW);  
t=pulseIn(echopin, HIGH);
```

```

d=t*0.034/2;
// Serial.print(d);

Serial.print("distance: ");
Serial.print(d);
Serial.println(" CM");
delay(1000);
if(d<10)
{
  Serial.println(" Less Distance Robo Stop");
  digitalWrite(2, LOW);
  digitalWrite(3, LOW);
  digitalWrite(4, LOW);
  digitalWrite(5, LOW);

}

if (digitalRead(pirpin) == HIGH)
{
  Serial.println("Motion detected");
  digitalWrite(10, HIGH); // turn on the buzzer
  delay(500);
  digitalWrite(10, LOW);
}

if (digitalRead(metalpin) == LOW)
{
  Serial.println("metal Sensor detected");
  digitalWrite(10, HIGH); // turn on the LED
  delay(500);
  digitalWrite(10, LOW);
}
}

```