A Mini Project Report

on

# IR Wireless Underwater Communication

Submitted in partial fulfillment for the award of the degree of Bachelor of Technology

in **Electronics and Communication Engineering**

by

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Under the esteemed Guidance of

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# CERTIFICATE

This is to certify that the Mini Project titled "IR Wireless Underwater Communication" is a bonafide work carried over by Ms. Akshara Punreddy (21321A0409) in partial fulfillment of the requirements for the award of the degree Bachelor of Technology in Electronics and Communication Engineering from Bhoj Reddy Engineering College for Women, Hyderabad, affiliated to Jawaharlal Nehru Technological University Hyderabad (JNTUH) during the Third Year second semester of their B. Tech course (academic year 2023-2024).

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# ABSTRACT

Wireless communication is a vital component of underwater operations, including environmental monitoring, surveillance and exploration. However, traditional wireless communication methods such as acoustic or radio frequency suffer from limited range, low bandwidth and interference. Infrared technology has emerged as a promising solution for underwater wireless communication due to its ability to transmit high-bandwidth data over long distances with minimal interference.In this project, we provide an overview of the current state of the art in underwater wireless communication systems that utilize infrared technology. We discuss the various components of these systems, including the transmitters, receivers and signal processing techniques. Additionally, we explore the benefits and limitations of using infrared technology for underwater wireless communication and identify areas for future research.Underwater wireless communications system is comprising first and second communications modules which transmit and receive data utilizing infrared radiation. Each module has a transmitter/receiver which converts each received data. The infrared light detecting unit then provides a logic zero at its output when it receives a pulsed burst of infrared radiation for time period of approximately six hundred microseconds and a logic one when the unit fails to detect a pulsed burst of infrared radiation for a time period of six hundred microseconds. Wireless infrared (IR) communication system is meant to use free space propagation of light waves as a transmission medium in near infrared band. Message communication is implemented by using IR as a source that is established a light communication (link to transmit and receive data via infrared light). The outcome of this proposed work is to design and implementation an optical wireless system to transmit data over a certain distance. This system has many advantages such as is an inexpensive and the transmitter or receiver can be showed to another location with least distraction. This system is used for easy communication with transmitter and receiver in underground water. If they need any help means to transmit the signal using IR transmitter remote the signal transfer to IR receiver circuit. So thus they can easily identify the information.

# Chapter 1
# Introduction

## 1.1 Introduction

Wire less communication allows information to be transmitted between two devices without using wire or cable. The data is being transmitted and received using electromagnetic radiation, the electromagnetic spectrum orders electromagnetic energy according to wavelength or frequency, the electromagnetic spectrum ranged from energy waves having Extremely Low Frequency (ELF) to energy waves having much higher frequency, e.g. x-rays. Infrared is an electromagnetic radiation has a wavelength longer than that of visible light but shorter than radio waves and has wavelength between (750 nm-1mm) Infrared LEDS are classified into Near Infrared (NIR) and Far Infrared (FIR). In this project (NIR) is our interest, it is divided into two bands the long wave and short wave (NIR), So the used part of the infrared spectrum in laser communication system is divided into various bands based on the type of the light sources, transmitting/absorbing materials (fibres) and detectors.

IR communication system consists of three main parts transmitter circuit, medium propagation (IR) and receiver circuit. In this project, short distance transmission of signal is realized by the design and achievement of infrared communication link.

Underwater wireless communication is essential for a range of applications, including environmental monitoring, underwater exploration, and surveillance. However, the harsh underwater environment presents several challenges to wireless communication, including attenuation, multipath propagation, and interference. Traditional wireless communication methods such as acoustic or radio frequency suffer from limited range and low bandwidth. Therefore, there is a need for an effective and efficient method for underwater wireless communication.

Infrared technology has emerged as a promising solution for underwater wireless communication due to its ability to transmit high-bandwidth data over long distances with minimal interference. Infrared technology has been successfully used in various applications such as building automation, industrial control and medical devices. In recent years, researchers have focused on developing infrared-based systems for underwater wireless communication.

Although since recent several decades, artificial scattering agents are conditioned to recreate underwater optical communication channels under different water quality conditions, but the similarity between experimental water and natural water isn't reliable, like the similarity in frequency domain characteristics. An acoustic communication has been developed for the underwater wireless sensor network because of its relatively low attenuation, but the bandwidth of the underwater acoustic channel is restricted, Underwater sensors cannot share data with those ashore, as both use different wireless signals that only labour in their respective mediumsover conventional multi-chip systems. There is a cost and space advantage as extra chip costs and printed circuit board and connectors required to support multi-chip systems are eliminated. The other advantages include cheaper maintenance, decreased hardware design effort and decreased board density, which is relevant in portable control equipment.

The microcontroller unit is playing major role in this project work. Nowadays with the advancement of technology particularly in the field of micro-controllers, all the activities in our day-to-day living have become part of information technology and we find controllers in each and every application. Thus, the trend is directing towards micro-controller based project works. A micro-controller contains a CPU, clock circuitry, ROM, Ram and I/O circuitry on a single integrated circuit package. The Micro-controller is therefore, a self-contained device, which does not require a host of associated support chips for its operation as conventional microprocessors do. It offers several advantages over conventional multi-chip systems. There is a cost and space advantage as extra chip costs and printed circuit board and connectors required to support multi-chip systems are eliminated. The other advantages include cheaper maintenance, decreased hardware design effort and decreased board density, which is relevant in portable control equipment.

Micro-controllers functionality, however, has been tremendously increased in the recent years. Today, one gets micro-controllers, which are stand alone for applications in data acquisition system and control. With the help of analog-to-digital converts, provided at the input of micro-controller, enables them direct use in instrumentation. Another type of micro-controller has on-chip communication controller, which is designed for applications requiring local intelligence at remote nodes and communication capability among these distributed nodes. Advanced versions of the micro-controller in 16-bit configuration have been introduced for high performance requirements particularly in applications where good arithmetical capabilities are required. Particularly in the field of instrumentation and plat automation in industrial side, these controllers are playing major role.

The ATMEL arduino nano controller, the internal Architecture is similar to the 8031 core. The most popular and used architecture is Intel's 8031. Market acceptance of this particular family has driven many semiconductor manufacturers to develop something new based on this particular architecture. The 8031 contains variety of configurations; even after 25 years of existence, semiconductor manufacturers still come out with some kind of device using this 8031core.

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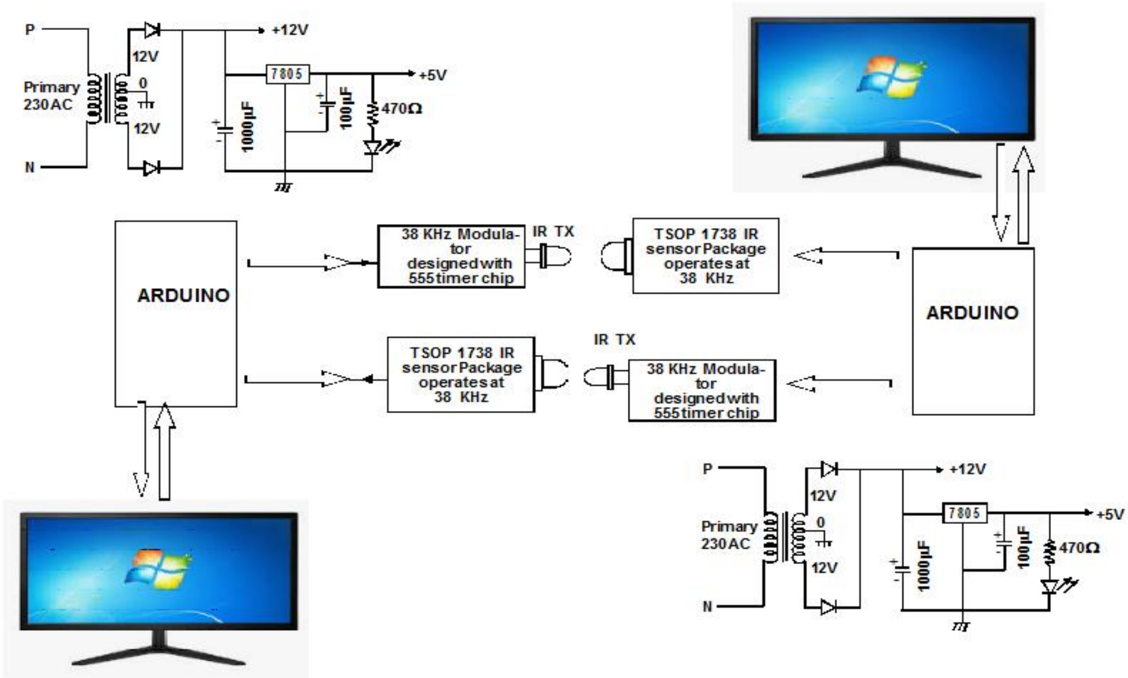



Figure 1.1: Block Diagram of IR Wireless Underwater Communication

## 1.2 Literature Survey

Underwater wireless communication is a challenging task due to the high attenuation, multipath fading, and signal distortion in the aquatic environment. In recent years, researchers have explored different techniques to improve the communication performance in underwater environments. One of the promising solutions is the use of infrared (IR) sensors for underwater wireless communication.

Several studies have been conducted to investigate the feasibility of using IR sensors for underwater wireless communication. In a study by Shrestha et al. (2019), the authors proposed an underwater communication system that uses IR sensors for data transmission. The system was tested in a controlled laboratory environment, and the results showed that the IR-based communication system can achieve a high data rate with low power consumption.

Similarly, in another study by Saha et al. (2019), the authors developed an IR-based underwater communication system that uses a modified Manchester code for data transmission. The system was tested in a real underwater environment, and the results showed that the proposed system can achieve a high data rate with low error rate and low power consumption.

In a different study by Li et al. (2020), the authors proposed an IR-based underwater wireless communication system that uses a time division multiple access (TDMA) scheme to allocate communication resources among different underwater nodes. The proposed system was tested in a tank experiment, and the results showed that the IR-based TDMA system can achieve a high data rate with low power consumption.

Moreover, in a recent study by Luo et al. (2021), the authors proposed an IR-based underwater wireless communication system that uses a hybrid modulation scheme for data transmission. The proposed system was tested in a real underwater environment, and the results showed that the hybrid modulation scheme can achieve a higher data rate and lower bit error rate compared to traditional modulation schemes.

Overall, the use of IR sensors for underwater wireless communication is a promising solution to overcome the challenges of traditional wireless communication techniques in underwater environments. The aforementioned studies demonstrated that IR-based communication systems can achieve a high data rate with low power consumption and low error rate, which can enable various applications, such as underwater sensing and monitoring, underwater exploration, and underwater robotics. However, further research is needed to investigate the performance of IR-based communication systems in different underwater environments and to optimize the system design for practical applications. The proposed system was tested in a tank experiment, and the results showed that the IR-based TDMA system can achieve a high data rate with low power consumption.

## 1.3 Aim of the Project

To design and implement a reliable infrared (IR) wireless communication system capable of transmitting data over short distances underwater. The project seeks to overcome challenges posed by water absorption and scattering of IR signals, while exploring

methods to enhance signal strength, minimize data loss, and optimize transmission efficiency for underwater applications such as remote sensing, underwater robotics, and environmental monitoring.

## 1.4 Objectives

- Study IR signal behaviour underwater.
- Design a prototype IR communication system.
- Optimize signal strength and reduce data loss.
- Ensure power-efficient communication.
- Address environmental interference factors.
- Test data transmission performance.
- Compare IR with other underwater communication methods.
- Explore potential applications in underwater systems.

## 1.5 Organization of the Report

Chapter 1 consists of an introduction to IR wireless underwater communication Chapter 2 consists of Introduction to embedded system. Chapter 3 consists ofIR wireless underwater communication. Chapter 4 Hardware description existing work, proposed work and results. Chapter 6 consists of advantages, disadvantages, and applications. Chapter 7 consists of Hardware details. Chapter 8 consists of Resul.t Chapter 9 conclusion of this project. Chapter 10 consists of references

## 1.6 Conclusion

The project work is designed and developed successfully. For the demonstration purpose, a prototype module is constructed; and the results are found to be satisfactory. The main objective is to overcome the present limitations and implement advanced technology for oceanographic research and cope up with the environmental effects on the performance of the underwater wireless communication systems to compete with the future challenges by the effective transmission of audio and video signals.

# Chapter2

## Introduction to Embedded System

### 2.1 Introduction

Embedded systems are specialized computing devices embedded in our daily environments, optimizing functionality for specific tasks while being largely invisible to users.

Each day, our lives become more dependent on 'embedded systems', digital information technology that is embedded in our environment. More than 98% of processors applied today are in embedded systems, and are no longer visible to the customer as 'computers' in the ordinary sense. An Embedded System is a special-purpose system in which the computer is completely encapsulated by or dedicated to the device or system it controls. Unlike a general-purpose computer, such as a personal computer, an embedded system performs one or a few pre-defined tasks, usually with very specific requirements. Since the system is dedicated to specific tasks, design engineers can optimize it, reducing the size and cost of the product. Embedded systems are often mass-produced, benefiting from economies of scale. The increasing use of PC hardware is one of the most important developments in high-end embedded systems in recent years. Hardware costs of high-end systems have dropped dramatically as a result of this trend, making feasible some projects which previously would not have been done because of the high cost of non-PC-based embedded hardware. But software choices for the embedded PC platform are not nearly as attractive as the hardware.

Typically, an embedded system is housed on a single microprocessor board with the programs stored in ROM. Virtually all appliances that have a digital interface -- watches, microwaves, VCRs, cars -- utilize embedded systems. Some embedded systems include an operating system, but many are so specialized that the entire logic can be implemented as a single program.

Physically, Embedded Systems range from portable devices such as digital watches and MP3 players, to large stationary installations like traffic lights, factory controllers, or the systems controlling nuclear power plants.

## 2.2 Features of Embedded Systems

The versatility of the embedded computer system lends itself to utility in all kinds of enterprises, from the simplification of deliverable products to a reduction in costs in their development and manufacture. Complex systems with rich functionality employ special operating systems that take into account major characteristics of embedded systems. Embedded operating systems have minimized footprint and may follow real-time operating system specifics.

The special computers system is usually less powerful than general-purpose systems, although some expectations do exist where embedded systems are very powerful and complicated. Usually a low power consumption CPU with a limited amount of memory is used in embedded systems. Many embedded systems use very small operating systems; most of these provide very limited operating system capabilities.

Since the embedded system is dedicated to specific tasks, design engineers can optimize it, reducing the size and cost of the product, or increasing the reliability and performance. Some embedded systems are mass-produced, benefiting from economies of scale. Some embedded systems have to operate in extreme environment conditions such as very high temperature & humidity.

For high volume systems such as portable music players or mobile phones, minimizing cost is usually the primary design consideration. Engineers typically select hardware that is just “good enough” to implement the necessary functions. For low volume or prototype embedded systems, general purpose computers may be adapted by limiting the programs or by replacing the operating system with a real-time operating system.

## 2.3 Conclusion

In this chapter features of the embedded system is explained.

# Chapter3
# IR wireless Underwater Communication

## 3.1 Introduction

In this chapter we will discuss about Existing/Proposed System, block diagram and methodology for IR Wireless Underwater communication.

## 3.2 Existing System

Underwater communication systems currently rely on a variety of methods, each with its own advantages and limitations depending on the application and environmental conditions. Below are the key types of existing underwater communication systems:

1. Acoustic Communication Systems (Sonar):

Most Widely Used: Acoustic systems are the most common method for underwater communication because sound waves travel much farther in water than electromagnetic waves.

Range and Bandwidth: They are capable of long-range communication, sometimes up to tens or even hundreds of kilometres. However, acoustic systems have a low bandwidth, typically in the range of a few kilobits per second (kbps).

Applications: Used in submarines, underwater sensor networks, remotely operated vehicles (ROVs), and oceanographic data collection.

Limitations: High latency, low data rate, and susceptibility to interference from ambient noise (marine life, ships, etc.).

2. Radio Frequency (RF) Communication Systems:

Limited Use: RF waves do not propagate well in water, especially seawater, due to the high conductivity that causes signal attenuation.

Range and Bandwidth: RF waves are limited to very short distances (a few meters), but they offer higher data rates compared to acoustic systems.

Applications: Short-range, high-speed data transfer in shallow water, such as between a diver's equipment or in certain underwater sensor networks.

Limitations: Rapid signal attenuation and very short range make it impractical for long-range communication.

3. Hybrid Systems:

Combination of Technologies: Some systems combine acoustic, RF, and optical communication to leverage the advantages of each method depending on the conditions and required application.

Applications: Multi-modal communication for underwater wireless sensor networks (UWSNs), where short-range high-speed data transfer can be paired with long-range, low-data-rate systems.

4. Magnetic Induction (MI) Communication

Niche Applications: MI uses low-frequency electromagnetic waves, which have better propagation characteristics in water than RF but are still limited in range.

Range and Bandwidth: Provides reliable communication over short distances (a few meters) with moderate data rates.

Applications: Suitable for use in confined environments such as pipelines, underwater exploration, or mine detection.

## 3.3 Proposed System

The proposed system as per the block diagram and circuit diagram is explained here, the devices used in the blocks are explained in a sequence. The description contains the functional operation of each and every block of the project is as followed.

The system consists of infrared transmitter and receiver for communication. It consists of two Arduino based circuits that have IR transmitter and receiver pairs as well as PC/laptop units for typing and displaying the messages. Whenever we want to send a message, we can type a message with the help of keyboard and the message taken as input of the Arduino nano then the electrical signal data is converted into the optical data then by the IR transmitter. It emits the light in infrared range of the electromagnetic spectrum. The data is transmitted from transmitter to receiver through the water as medium and it is converted from IR signal to electrical signal by using the TSOP1738 receiver.

The microcontroller is used at the receiver side to receive the data by the system bus and the output of the microcontroller is given to the PC/laptop to display. In the same way data can be transmitted from the other unit. Thus, the proposed system allows the efficient communication between the two units using IR wireless communication system.

The module designed here is a two way communication system mainly consists of data transmitting modules designed using IR transmitters and data receiving module designed using IR receiver TSOP 1738. The data transmitting module consisting of arduino nano controller, 555 timer and optical (IR Transmitter) sensor, generates digital data typed from laptop or PC and it is modulated with 38 KHz frequency generated by the timer IC. This modulated digital information is radiated in to air through optical sensor. The data receiving module consists of arduino nano controller, TSOP 1738 (IR Receiver) and PC or laptop that receives the digital data to display. The nano controller decodes this data and displays on the screen of laptop or PC.

## 3.4 Conclusion

IR wireless under water communication existing system and proposed system was explained in this chapter.

# Chapter4
# Hardware Description

## 4.1 Introduction

Infrared wireless underwater communication hardware utilizes specialize components to transmit data through light pulses, enabling efficient and reliable communication in aquatic environments where traditional radio frequency methods face limitations.

## 4.2 IR Transmitter & Receiver section

An IR LED (infrared light emitting diode) is a solid-state lighting (SSL) device that emits light in the infrared range of the electromagnetic radiation spectrum.

TSOP1738 is an IR receiver with an amplifier that acts as a switch and converter within a circuit. It has one input and output which only acts on the base of the input IR signal. The basic purpose of TSOP1738 is to convert the IR signal to electric signals.

The communication link is designed with optical sensors, for this purpose Infra-red LED's are utilized. The easiest way to remotely control a device within a visible range is via Infrared light. Infrared actually is normal light with a particular color. We humans can't see this color because its wavelength of 950nm which is below the visible spectrum. That's one of the reasons why IR is chosen for remote control purposes; we want to use it but were not interested in seeing it. Another reason is because IR LED's are quite easy to make, and therefore these are cost effective devices.

In the IR transmitting block 555 timer IC is used to modulate infrared light, modulation is necessary to make infrared signal stand out above the noise. The modulation technique makes the IR light source to blink in a particular frequency, so that it can ignore everything else.

This timer IC will produce the pulse when a trigger signal is applied to it, here the trigger pulse can be obtained from the Microcontroller. The output of Microcontroller is fed to reset pin of timer IC; depending up on the resister and capacitor (timing components) connected externally to the timer IC, the pulse length is determined. Irrespective of trigger pulse, since the timer IC is configured as astable, depending up on the values of resistor and capacitor, it produces 38 KHz, which is used as IR signal transmitter.

The modulated signal obtained from output pin of timer IC is driving the IR LED through its drive transistor. In serial communication we usually speak of ‘marks’ and ‘spaces’. The ‘space’ is the default signal, which is the off state in the transmitter case. No light is emitted during the ‘space’ state. During the ‘mark’ state of the signal the IR light is pulsed on and off at a particular frequency.

Frequencies between 30 KHz and 60 KHz are commonly used in consumer electronics, but in this project work 38 KHz is produced to match with TSOP 1738 IR Receiver. At the receiver side a high level of the receiver’s output represents a ‘space’. A ‘mark’ is than automatically represented by a low level.

Many circuits are designed to be used as IR transmitters for remote operations and in this project work 555 timer IC is used with IR transmitter which consumes very less power. The data to be transmitted through IR LED is obtained from output pin of microcontroller, this digital data is fed to pin no.4 of 555 timer IC as a modulating signal. Since the timer IC is configured as Astable mode of operation, as it is delivering a perfect square pulse of 38 KHzcontinuously. The output of the timer IC is fed to infrared LED which is used as data transmitting LED. Since it is a commercial IR LED, the current flowing through the LED is restricted by connecting a current limiting resister of 47 ohms in series with this LED. Depending up on different ratings of IR LED’s, the current through the LED can vary from 50m amps to 500 milli amps. In order to get an acceptable control distance the LED currents have to be as high as possible. LED currents can be that high because the pulses driving the LED’s are very short, average power dissipation of the LED should not exceed the maximum value according to the data sheet provided by the manufacturer. Another important thing is that the maximum peak current applied to the LED should not exceed. Peak to peak amplitude value is also important that it should not exceed more than 1.5V.

To amplify the LED current, a simple transistor circuit can be used to drive the LED. A transistor with a suitable HFE and switching speed should be selected for this purpose. The current and voltage limiting resister values can simply be calculated using Ohm's law. Voltage drop across the LED should not exceed more than 1.2V.

The following figures shows that how the signal is modulated

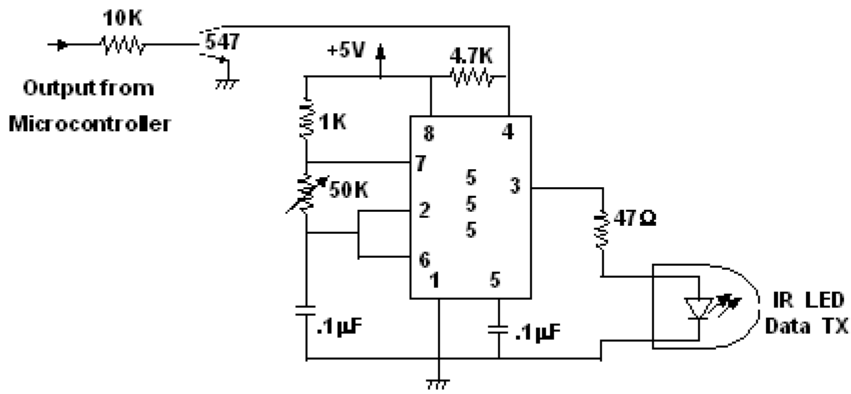



Fig 4.1: circuit diagram shows how the modulated IR signal is transmitted.

In the above circuit diagram the frequency can be set to 38 KHz approximately by varying the value of 50K variable resistor. The timing capacitor connected between pin No.2 to ground is a fixed value capacitor of 0.1Mf, this can be a metalized polyester capacitor and other wise if we use any ordinary capacitor, value may be differed due to the environmental conditions. When the circuit is energized initially, the discharge pin (pin no.7) is disconnected from ground and output pin is set high because the trigger pin is below 33% Vcc voltage. The capacitor C (.1MF), starts to charge through resisters 1K and 50K. The threshold pin (pin No.6) is used to detect when the voltage across the capacitor reaches 67% Vcc voltage approximately. When the voltage across the capacitor reaches 67%, the output pin is set low and the discharge pin is connected back to ground, after that the capacitor starts discharging through 50K variable resistor. Again when the voltage across the capacitor reaches 33%, the cycle repeats and creates a series of output pulses. An Astable circuit triggers from previous output pulse where as a mono-stable circuit requires an externally applied trigger. The output pin oscillates from high to low creating a series of output pulses. The duration the output pin stays high, t HIGH, is given below.

$$t\,HIGH = .693 \,.\, C \,.\, (R1 + R2)$$

The duration the output pin stays low, t LOW, is given below:

t LOW= 693.C . R2

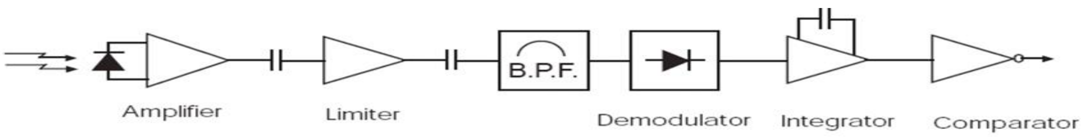



Fig 4.2 :The block diagram of IR receiver.

## 4.3 Arduino nano

The Arduino Nano is an open source bread board friendly microcontroller board based on the Microchip ATMEGA 328P microcontroller (MCU) and developed by Arduino.cc and initially released in 2008. It offers the same connectivity and specs of the Arduino Uno board in a smaller form factor.

The Arduino Nano is equipped with 30 male I/O headers, in a DIP-30-like configuration, which can be programmed using the Arduino Software integrated development environment (IDE), which is common to all Arduino boards and running both online and offline. The board can be powered through a type-B mini-USB cable or from a 9 V battery.

In 2008, the Arduino Nano was released. In 2019, Arduino released the Arduino Nano Every, a pin-equivalent evolution of the Nano. It features a ATmega4809 microcontroller (MCU) with three times the RAM.

### Technical Specifications:

- Microcontroller: Microchip ATmega328P
- Operating voltage: 5 volts
- Input voltage: 5 to 20 volts
- Digital I/O pins: 14 (6 optional PWM outputs)
- Analog input pins: 8
- DC per I/O pin: 40 mA
- DC for 3.3 V pin: 50 mA
- Flash memory: 32 KB, of which 2 KB is used by bootloader
- SRAM: 2 KB
- EEPROM: 1 KB
- Clock speed: 16 MHz
- Length: 45 mm
- Width: 18 mm
- Mass: 7 g
- USB: Mini-USB Type-B
- ICSP Header: Yes
- DC Power Jack: No

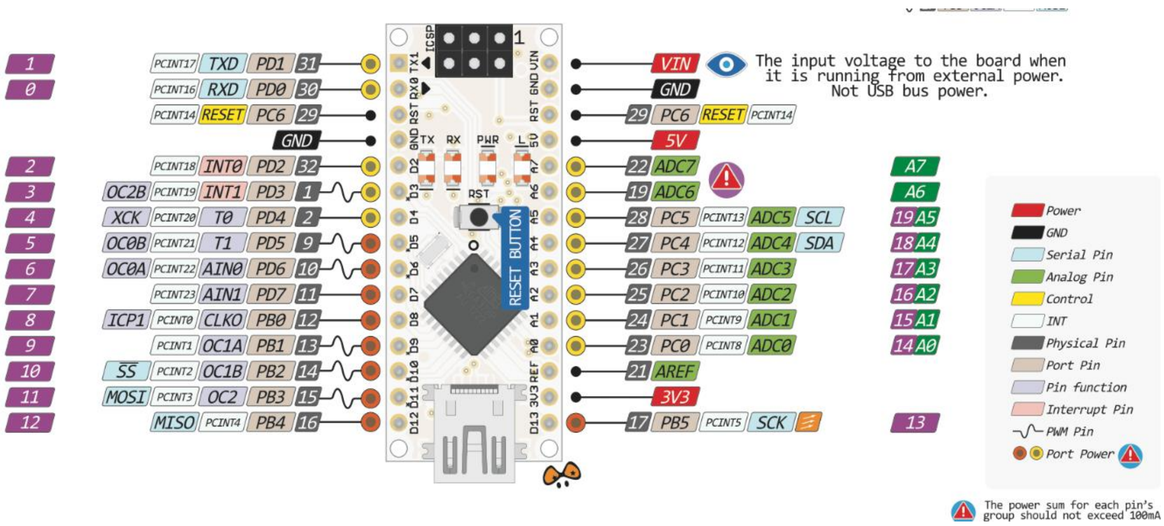



Fig 4.2: Arduino Nano Pins

The classic Nano is the oldest member of the Arduino Nano family boards. It is similar to the Arduino Duemilanove but made for the use of a breadboard and has no dedicated power jack. Successors of the classic Nano are for example the Nano 33 IoT featuring a WiFi module or the Nano 33 BLE Sense featuring Bluetooth Low Energy and several environment sensors.

## 4.4 Communication

The Arduino Nano has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega328 provides UART TTL serial (5V) communication, which is available on digital pins 0 (RX) and 1 (TX).

An FTDI FT232RL on the board channels this serial communication over USB and the FTDI drivers (included with the Arduino firmware) provide a virtual com port to software on the computer. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. The RX and TX LEDs on the board flash when data is being transmitted via the FTDI chip and the USB connection to the computer (but not for serial communication on pins 0 and 1). A Software Serial library allows for serial communication on any of the Nano's digital pins. The ATmega328 also supports I2C and SPI communication. The Arduino software includes the Wire library to simplify use of the I2C bus

Automatic (software) reset

Rather than requiring a physical press of the reset button before an upload, the Arduino Nano is designed in a way that allows it to be reset by software running on a connected computer. One of the hardware flow control lines (DTR) of the FT232RL is connected to the reset line of the ATmega328 via a 100 nano farad capacitor. When this line is asserted (taken low), the reset line drops long enough to reset the chip.

This setup has other implications. When the Nano is connected to a computer running Mac OS X or Linux, it resets each time a connection is made to it from software (via USB). For the following half-second or so, the bootloader is running on the Nano. While it is programmed to ignore malformed data (i.e. anything besides an upload of new code), it will intercept the first few bytes of data sent to the board after a connection is opened.

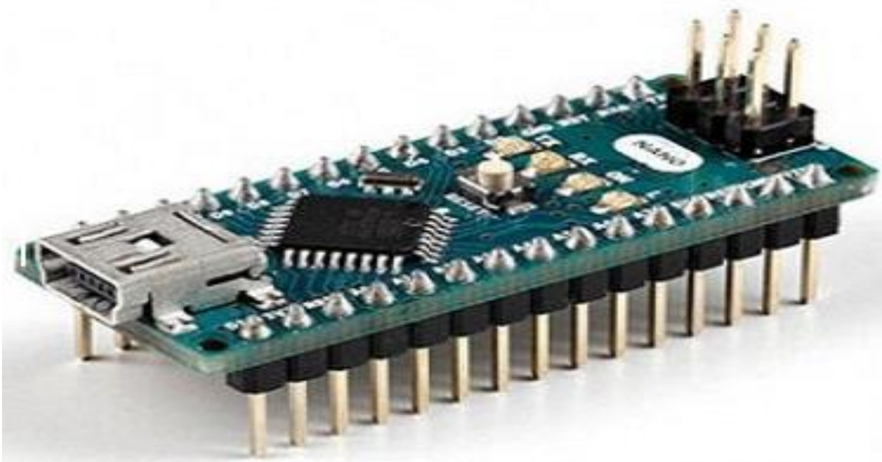


Fig 4.3 : Arduino-nano-board

## 4.5 Brief Description about IR Sensors

The applications and advantages of infrared sensors are plenty; mostly these devices are utilized for various types of security systems by implementing proximity detection theme. Other important applications are for counting objects, or counting revolutions of a rotating object. In any concept, the proximity detection package contains two devices, namely infrared light emitting diode (IR LED) and infrared light/signal detector (IR sensor). The IR LED is always ON, meaning that this device is constantly emitting light and the sensor is detecting this light. The sensors can be interfaced with trigger circuit to generate logic high/low pulses depending up on the interruptions created by any object. This design of the circuit is suitable many applications. However this design is more power consuming and is not optimized for high ranges, in this design, range can be from 1 to 10 cm, depending on the ambient light conditions.

## 4.6 Object detection using IR light

The solution proposed doesn't contain any special components, like photo-diodes, phototransistors, or IR receiver ICs, only a couple if IR led's, an Op amp, a transistor and a couple of resistors. In need, as the title says, a standard IR led is used for the purpose of detection. Due to that fact, the circuit is extremely simple, and any novice electronics hobbyist can easily understand and build it. To prove the concept practically, as shown in the figure, we required 2 simple IR LED's, and they must be arranged side by side to pick-up the reflected IR light. For detecting the reflected IR light, a very simple technique is used by using another IR-LED, to detect the IR light that was emitted from another led of the same type.

This is an electrical property of Light Emitting Diodes (LED's), which is the fact that a led produces a voltage difference across its leads when it is subjected to light. As per the following figure, the infrared signal delivered from one LED hits the object and it is reflected, another infrared LED detects the reflected signal. The signal strength depends up on the current that is passing through the infrared LED; signal strength can be defined as radiating power, which is measured in mill watts. The range is depends up on the signal strength.

This IR detection system works by using one LED to emit infrared light and another LED to detect the reflected light. When the emitted IR light hits an object, it bounces back to the second LED, which generates a small voltage in response. This voltage is amplified by the Op-amp, allowing the circuit to detect the object. The range of detection depends on the strength of the emitted IR light, which can be adjusted by changing the current flowing through the transmitting LED. This simple setup is easy to build and useful for proximity sensing applications.

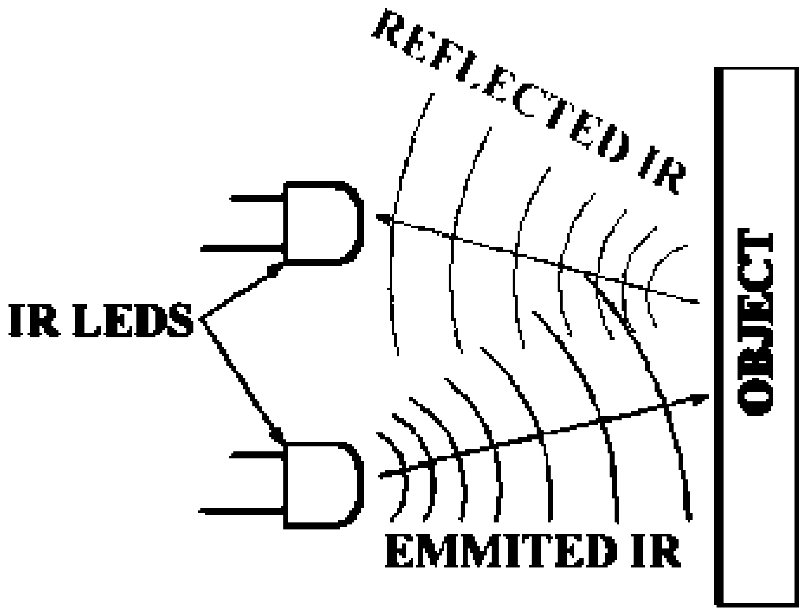



Fig 4.5: IR LEDS

## 4.7 Basics of IR transmitter

Infra red transmitter emits IR rays in planar wave front manner. Even though infrared rays spread in all directions, it propagates along straight line in forward direction. IR rays have the characteristics of producing secondary wavelets when it collides with any obstacles in its path. This property of IR is discussed here.

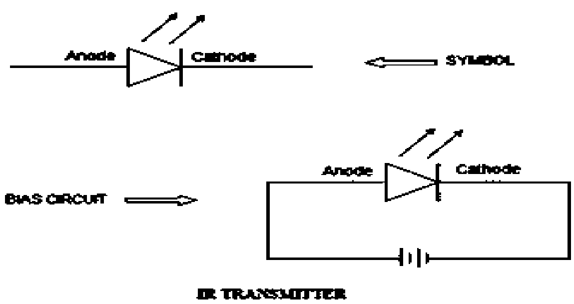


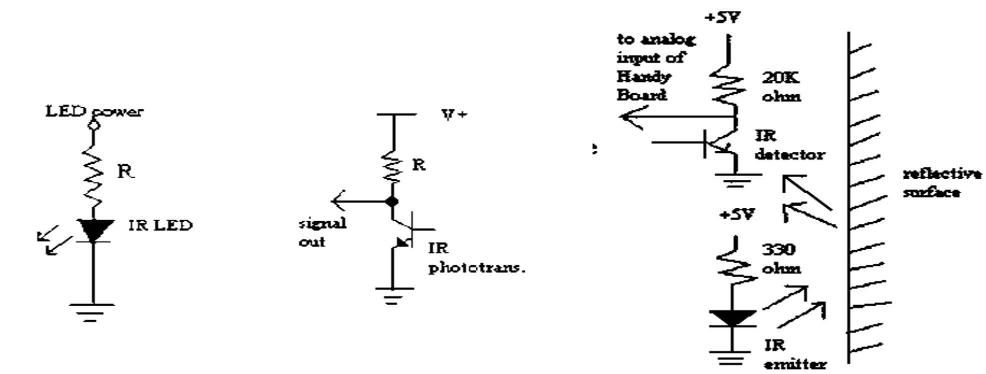

Fig 4.7.1: IR Transmitter

## Basics of IR receiver

Infrared photo receiver is a two terminal PN junction device, which operates in a reverse bias. It has a small transparent window, which allows light to strike the PN junction. A photodiode is a type of photo detector capable of converting light into either current or voltage, depending upon the mode of operation. Most photodiodes will look similar to a light emitting diode. They will have two leads, or wires, coming from the bottom. The shorter end of the two is the cathode, while the longer end is the anode. A photodiode consists of PN junction or PIN structure. When a photon of sufficient energy strikes the diode, it excites an electron thereby creating a mobile electron and a positively charged electron hole. If the absorption occurs in the junction's depletion region, or one diffusion length away from it, these carriers are swept from the junction by the built-in field of the depletion region. Thus holes move toward the anode, and electrons toward the cathode, and a photocurrent is produced.

Fig 4.7.2: IR emitter & IR phototransistor

Use of Infrared Detectors Basics




An IR emitter An IR phototransistor Circuit diagram of a infrared reflectance sensor.

IR reflectance sensors contain a matched infrared transmitter and infrared receiver pair. These devices work by measuring the amount of light that is reflected into the receiver. Because the receiver also responds to ambient light, the device works best when well shielded from ambient light, and when the distance between the sensor and the reflective surface is small (less than 5mm). IR reflectance sensors are often used to detect white and black surfaces. White surfaces generally reflect well, while black surfaces reflect poorly. One of such applications is the line follower of a robot.

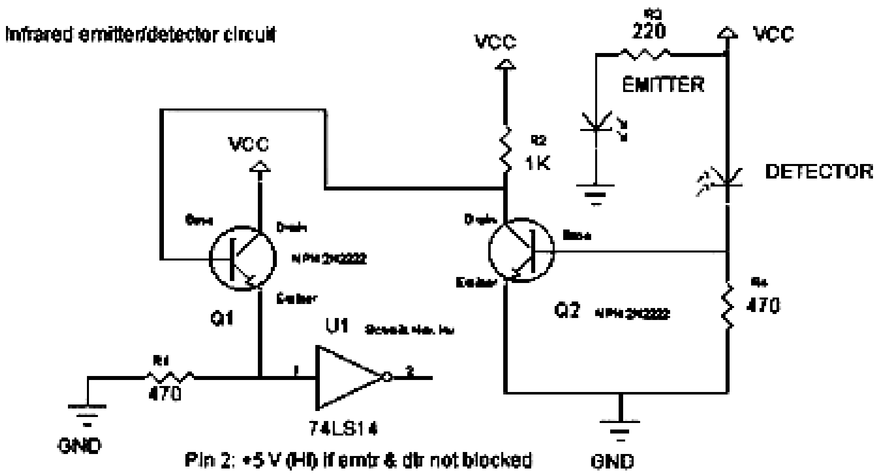



Fig 4.7.3: Schematic Diagram for a Single Pair of Infrared Transmitter and Receiver

## 4.8 Infrared Radiation

Infrared radiation is electromagnetic radiation whose wavelength is longer than that of visible light, but shorter than that of terahertz radiation and microwaves. The name means "below red" (from the Latin*infra*, "below"), red being the color of visible light with the longest wavelength. Infrared radiation has wavelengths between about 750 nm and 1 mm, spanning three orders of magnitude. Humans at normal body temperature can radiate at a wavelength of 10 micrometers. Infrared imaging is used extensively for both military and civilian purposes. Military applications include target acquisition, surveillance, night vision, and homing and tracking. Non-military uses include thermal efficiency analysis, remote temperature sensing, short-ranged wireless communication, spectroscopy, and weather forecasting. Infrared astronomy uses sensor-equipped telescopes to penetrate dusty regions of space, such as molecular clouds; detect cool objects such as planets, and to view highly red-shifted objects from the early days of the universe.

## 4.9 Description about 555 Timer

The single 555 Timer chip in its basic form is a Bipolar 8-pin mini Dual-in-line Package (DIP) device consisting of some 25 transistors, 2 diodes and about 16 resistors arranged to form two comparators, a flip-flop and a high current output stage as shown below. As well as the 555 Timer there is also available the NE556 Timer Oscillator which combines TWO individual 555's within a single 14-pin DIP package and low power CMOS versions of the single 555 timer such as the 7555 and LMC555 which use MOSFET transistors instead.

A simplified "block diagram" representing the internal circuitry of the **555 timer** is given below with a brief explanation of each of its connecting pins to help provide a clearer understanding of how it works. Operating Modes: The 555 timer has two basic operational modes: one shot and astable. In the one-shot mode, the 555 acts like a monostable multivibrator. A monostable is said to have a single stable state--that is the off state. Whenever it is triggered by an input pulse, the monostable switches to its temporary state

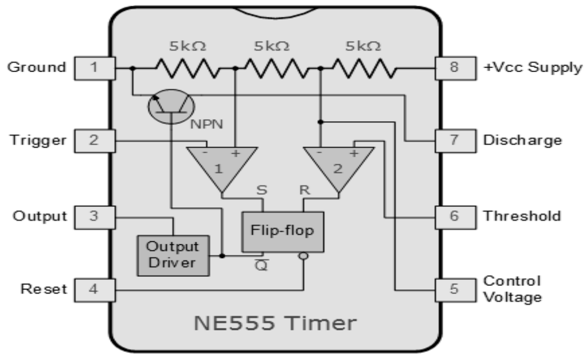



Fig 4.9: 555 Timer Oscillator Block Diagram

## 4.10 Power Source Description

The power supplies are designed to convert high voltage AC mains electricity to a suitable low voltage supply for electronics circuits and other devices. A RPS (Regulated Power Supply) is the Power Supply with Rectification, Filtering and Regulation being done on the AC mains to get a Regulated power supply for Microcontroller and for the other devices being interfaced to it.

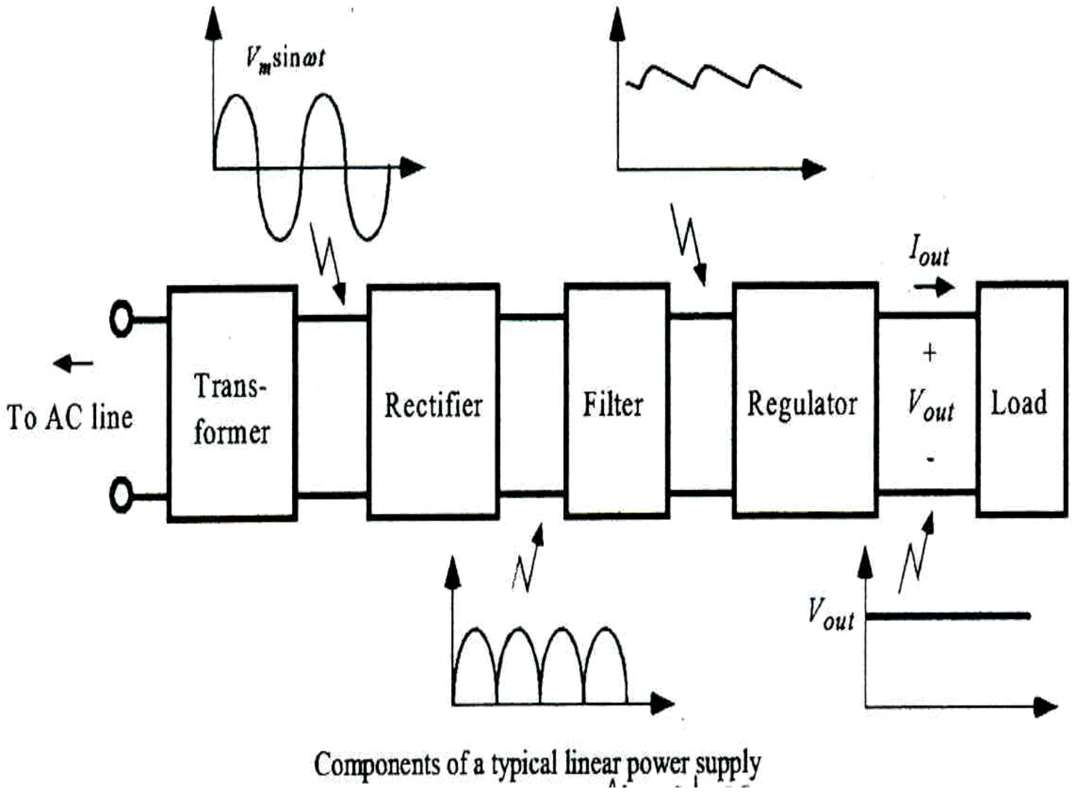



Fig 4.10.1: Block Diagram of the Power Supply

## Transformer

A transformer is an electrical device which is used to convert electrical power from one Electrical circuit to another without change in frequency. Transformers convert AC electricity from one voltage to another with little loss of power. Transformers work only with AC and this is one of the reasons why mains electricity is AC. Step-up transformers increase in output voltage, step-down transformers decrease in output voltage. Most power supplies use a step-down transformer to reduce the dangerously high mains voltage to a safer low voltage. The input coil is called the primary and the output coil is called the secondary.

There is no electrical connection between the two coils; instead they are linked by an alternating magnetic field created in the soft-iron core of the transformer. The two lines in the middle of the circuit symbol represent the core.Transformers waste very little power so the power out is (almost) equal to the power in. Note that as voltage is stepped down current is stepped up. The ratio of the number of turns on each coil, called the turn's ratio, determines the ratio of the voltages. A step-down transformer has a large number of turns on its primary (input) coil which is connected to the high voltage mains supply, and a small number of turns on its secondary (output) coil to give a low output voltage.

Figure 4.9.2: An Electrical Transformer

## Rectifier

We came to know that full wave bridge rectifier as more advantages than the other two rectifiers. So, in our project we are using full wave rectifier circuit.

## Capacitor Filter:

We have seen that the ripple content in the rectified output of half wave rectifier is **121%** or that of full-wave or bridge rectifier or bridge rectifier is **48%** such high percentages of ripples is not acceptable for most of the applications.

**Regulator:** Voltage regulator ICs is available with fixed (typically 5, 12 and 15V) or variable output voltages. The maximum current they can pass also rates them. Negative voltage regulators are available, mainly for use in dual supplies.

Most regulators include some automatic protection from excessive current ('overload protection') and overheating ('thermal protection'). Many of the fixed voltage regulators ICs have 3 leads and look like power transistors, such as the 7805 +5V 1A regulator shown on the right. The LM7805 is simple to use. You simply connect the positive lead of your unregulated DC power supply (anything from 9VDC to 24VDC) to the Input pin, connect the negative lead to the Common pin and then when you turn on the power, you get a 5 volt supply from the output pin.

LM7805 is simple to use. You simply connect the positive lead of your unregulated DC power supply (anything from 9VDC to 24VDC) to the Input pin, connect the negative lead to the Common pin and then when you turn on the power, you get a 5 volt supply from the output pin.


Figure 4.10.3: A Three Terminal Voltage Regulator

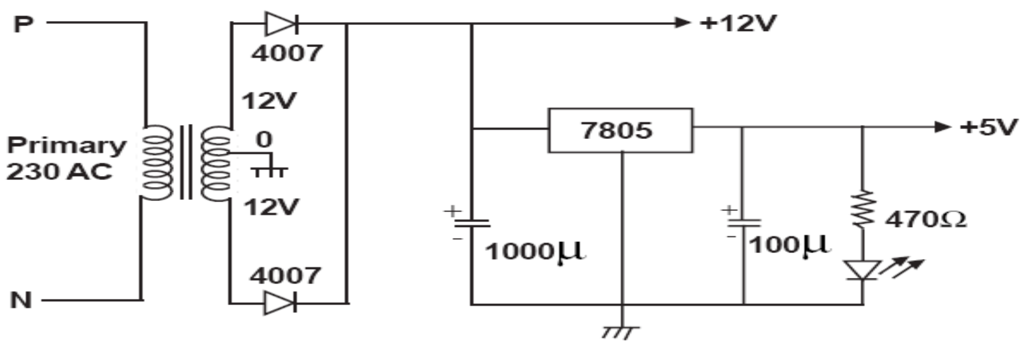



Figure 4.10.4:Circuit of power supply

## 4.11 Conclusion

In this chapter the hardware description of the IR wireless underwater communication is explained.

# Chapter 5

# Software Description

## 5.1 Introduction

The software for infrared wireless underwater communication manages data encoding, modulation, and signal processing, ensuring robust transmission and reception of information in challenging aquatic conditions.

## 5.2 Creating project in Arduino 1.7.11 version

Ardunio IDE Installation:

In this we will get know of the process of installation of Arduino IDE and connecting Arduino uno to Arduino IDE.

**Step 1** − First we must have our Arduino board (we can choose our favorite board) and a USB cable. In case we use Adriana UNO, Arduino Duemilanove, Nano, Arduino Mega 2560, or Diecimila, we will need a standard USB cable (A plug to B plug), t In case we use Arduino Nano, we will need an A to Mini-B cable..

**Step 2** − Download Arduino IDE Software. We can get different versions of Arduino IDE from the Download page on the Arduino Official website. We must select wer software, which is compatible with wer operating system (Windows, IOS, or Linux).

After wear file download is complete, unzip the file.

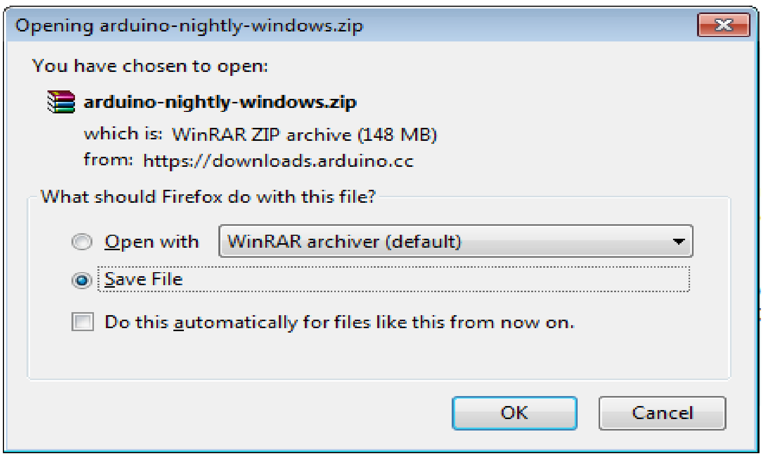



Figure 5.1: Download Interface of Arduino IDE

**Step 3** − Power up our board.

The Arduino Uno, Mega, Duemilanove and Arduino Nano automatically draw power from either, the USB connection to the computer or an external power supply. If we are using an Arduino Diecimila, we have to make sure that the board is configured to draw power from the USB connection. The power source is selected with a jumper, a small piece of plastic that fits onto two of the three pins between the USB and power jacks.

Check that it is on the two pins closest to the USB port.

Connect the Arduino board to wer computer using the USB cable. The green power LED

(labeled PWR) should glow.

**Step 4** − Launch Arduino IDE.

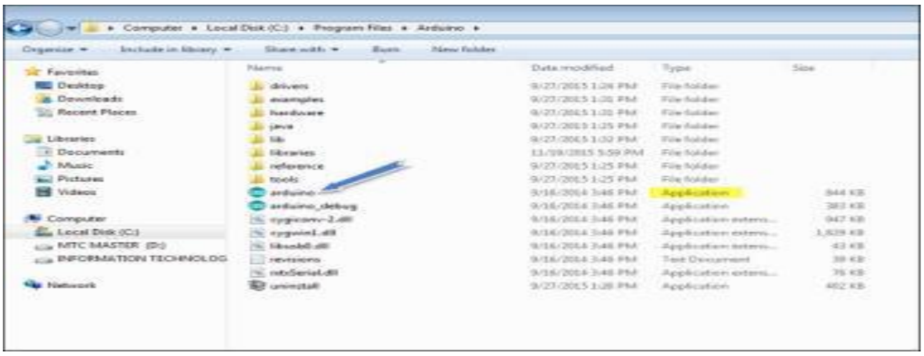


Figure 5.2: Launching Ardunio IDE

After our Arduino IDE software is downloaded, we need to unzip the folder. Inside the folder, we can find the application icon with an infinity label (application.exe).

Double click the icon to start the IDE.

**Step 5** − Open our first project.

Once the software starts, we have two options

* Create a new project

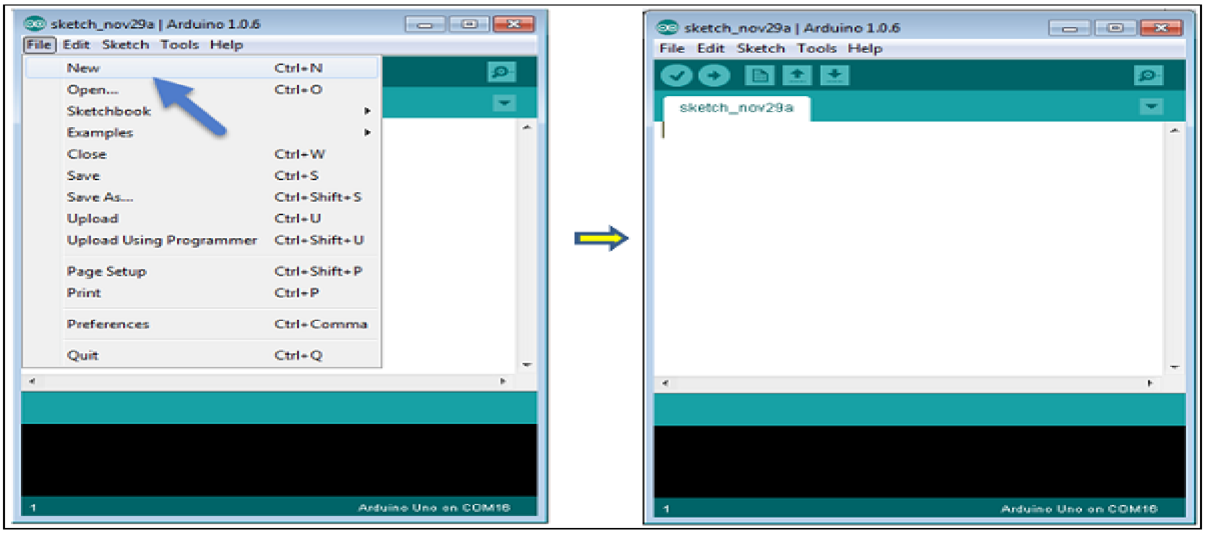



Fig 5.3 Interface of Setup

* Open an existing project example.

To create a new project, select File → New.

.

**Step 6** − Select our Arduino board.

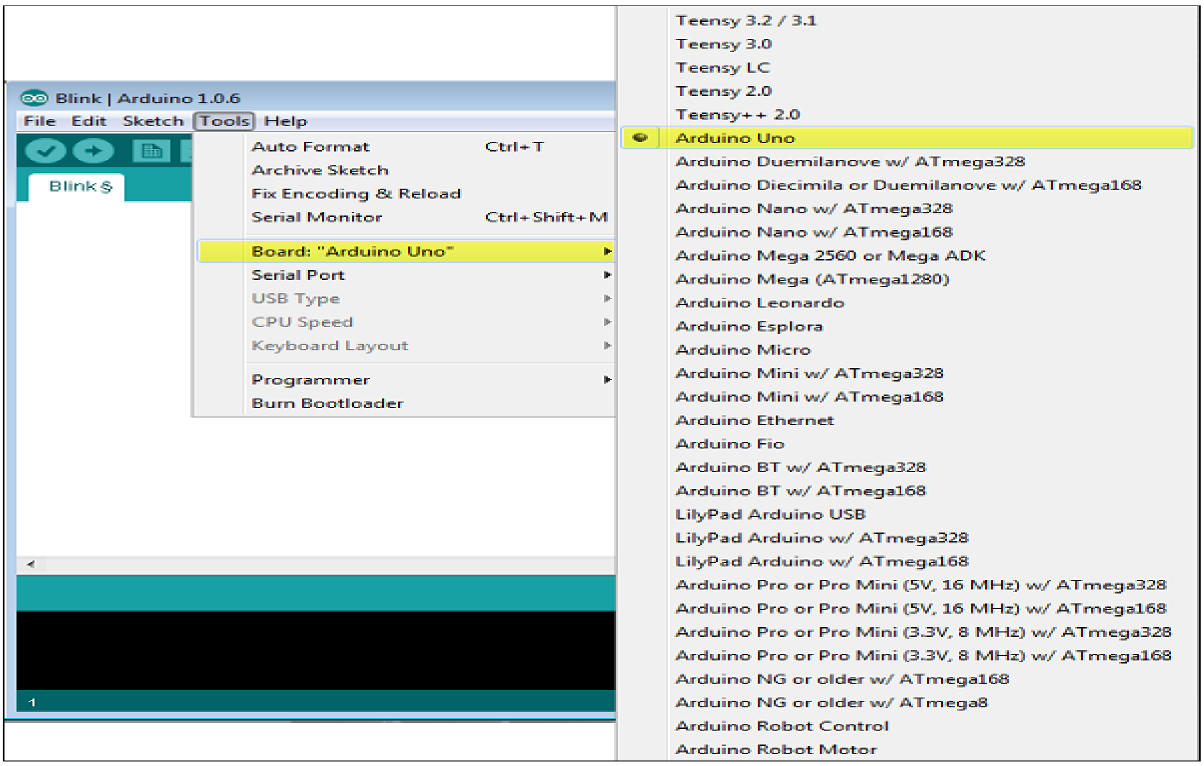



Fig 5.4: Interface of Selecting Board-Arduino Uno

To avoid any error while uploading wear program to the board, we must select the correct Arduino board name, which matches with the board connected to computer.

Go to Tools → Board and select wear board.

Here, we have selected Arduino Uno board according to our tutorial, but we must select

the name matching the board that we are using.

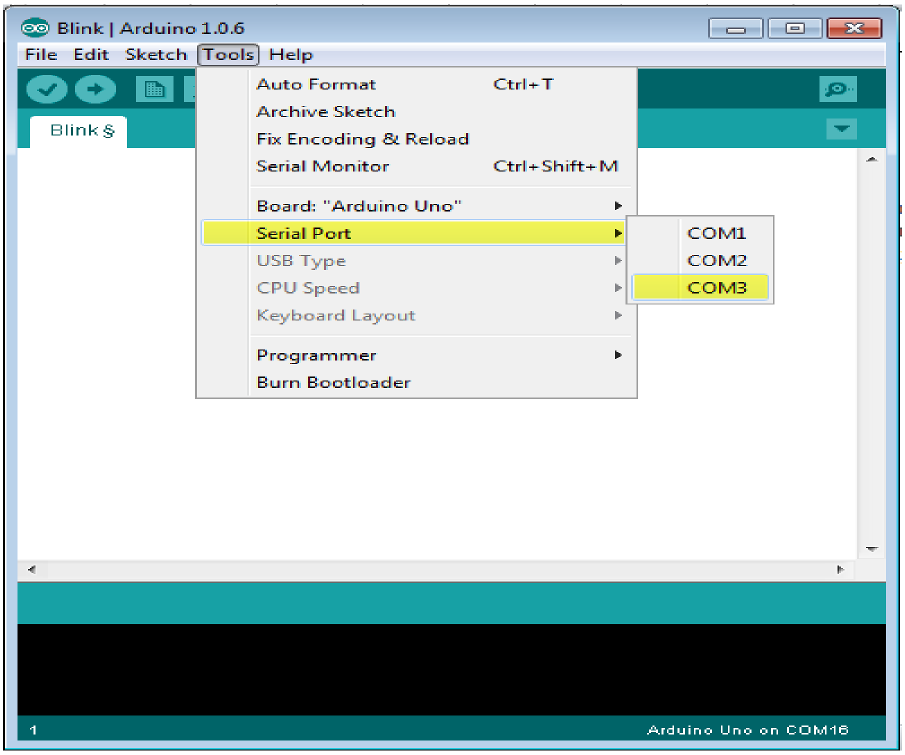



Fig 5.5: Interface of Serial port

**Step 7** – Select Serial Port

Select the serial device of the Arduino board. Go to Tools → Serial Port menu. This is likely to be COM3 or higher (COM1 and COM2 are usually reserved for hardware serial ports). To find out, we can disconnect wer Arduino board and re-open the menu, the entry that disappears should be of the Arduino board. Reconnect the board and select that serial port.

**Step 8** − Upload the program to wer board.

Before explaining how we can upload our program to the board, we must demonstrate the function of each symbol appearing in the Arduino IDE toolbar.

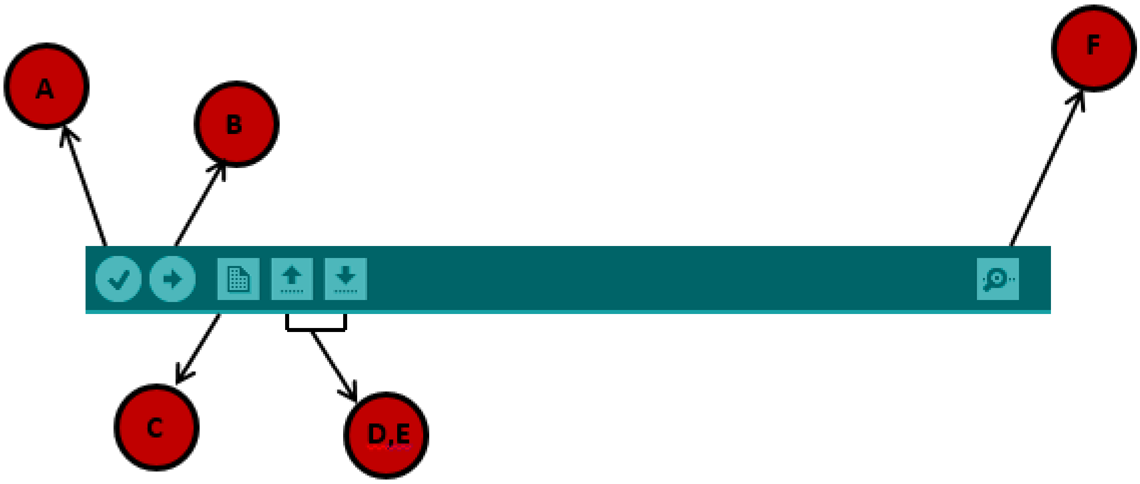



Fig 5.5: Navigation tools

A – Used to check if there is any compilation error.

B – Used to upload a program to the Arduino board.

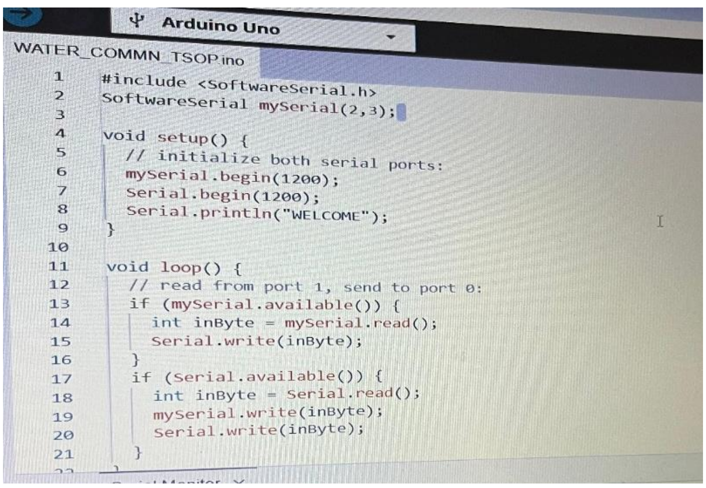
C – Shortcut used to create a new sketch.

D – Used to directly open one of the example sketch.

E – Used to save wer sketch.

F – Serial monitor used to receive serial data from the board and send the serial data to the board serial port.

**Step 9:** The following is the code



```
#include <SoftwareSerial.h>
SoftwareSerial mySerial(2,3);

void setup() {
  // initialize both serial ports:
  mySerial.begin(1200);
  Serial.begin(1200);
  Serial.println("WELCOME");
}

void loop() {
  // read from port 1, send to port 0:
  if (mySerial.available()) {
    int inByte = mySerial.read();
    Serial.write(inByte);
  }
  if (Serial.available()) {
    int inByte = Serial.read();
    mySerial.write(inByte);
    Serial.write(inByte);
  }
```

Fig 5.7: Software Code

**Step 10:**Set the Baud Rate to 1200 baud

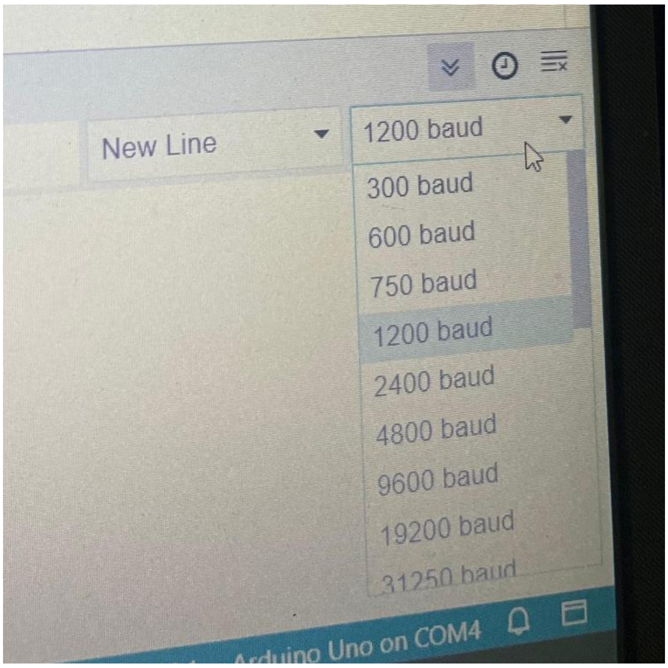



Fig 5.8: Setting Baud Rate

**Step 12:** After a successful setup you will see the “Welcome” output section.

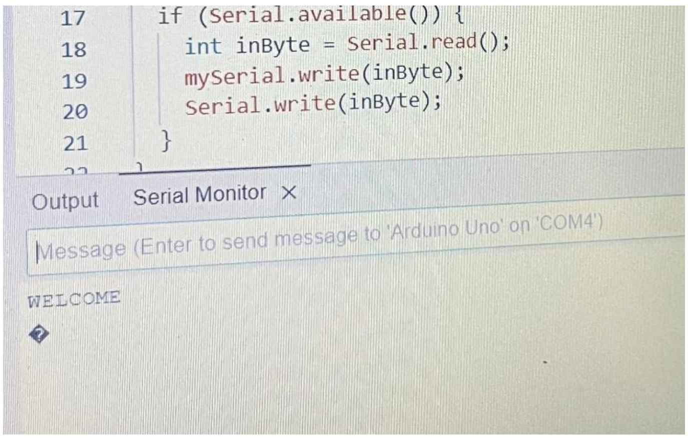



Fig 5.9: Successful setup Message

## 5.3 Conclusion

In this chapter the software description of the IR wireless underwater communication is explained.

# Chapter 6

# Advantages Disadvantages and Applications

## 6.1 Introduction

Infrared (IR) wireless underwater communication provides high-speed data transmission but faces challenges such as limited range and signal attenuation due to water properties.

## 6.2 Advantages

**Simplicity:** One of the advantages of infrared communication is the simplicity of its general operating principle. The technology is relatively easier to implement than other wireless communication technologies.

**Power Efficiency:** The LED used in blasting IR beams has low power requirements. Furthermore, the entire IrDA transmitter can be operated with small and non-rechargeable batteries. These batteries can last for months. The technology is suitable for low-power use-case scenarios, such as in the case of small and portable devices.

**Economy:** Underwater communication systems are useful for commercial purposes; particularly in industries such as oil and gas. The ocean is full of a lot of resources, and these systems are used in carrying out exploration of these resources. In the oil and gas industry, for example, AUVs are used in making maps of the seafloor before operations. This will keep these oil and gas practitioners well in formed in setting up their pipelines, and to her infrastructure. This ensures their infrastructure is set up, without posing any harm to the environment.

**Security:** Underwater Communication systems are instrumental in ensuring the security of a nation. It is used by the military, to conduct underwater surveillance, as well as to detect intrusion. As rival states might plan as a bot age through the water; having a communication system in the body of waters will alert the nation to the danger. Also, as drug traffickers now deploy autonomous submarines for their operations; having strong communication systems will help to detect and keep them off. So, this system can be easy and fast communication with underground water.

## 6.3 Disadvantages

Infrared (IR) wireless underwater communication offers some key advantages, but it also comes with several disadvantages that limit its practical use in various underwater environments. Here are the main disadvantages:

**1. Limited Range**

Absorption by Water: IR signals are heavily absorbed by water, especially seawater. This limits the effective range of communication to a few meters (typically 10-20 meters in clear water), which is far less than acoustic systems.

Reduced Penetration in Murky Water: In turbid or murky water, the range is even shorter due to increased scattering by suspended particles.

**2. Line-of-Sight (LoS) Dependency**

Direct Path Required: IR communication requires a clear, unobstructed line of sight between the transmitter and receiver. Any obstacles, such as rocks, marine life, or debris, can block or degrade the signal.

Alignment Challenges: Maintaining alignment between the IR transmitter and receiver can be difficult in dynamic underwater environments, where currents or moving objects may cause misalignment

## 6.4 Applications:

Infrared (IR) wireless underwater communication is a promising technology with several potential applications due to its ability to transmit data in aquatic environments Here are a few key applications:

1. Environmental Monitoring: IR communication can be used for underwater sensor networks that monitor water quality, marine life, pollution levels, or temperature changes in oceans, lakes, and rivers.

2. Marine Biology Research: IR-based underwater communication can assist in tracking and collecting data from aquatic species, aiding research in fish migration, behavior analysis, and habitat studies.
3. Underwater Vehicles (ROVs/AUVs): Remotely Operated Vehicles (ROVs) and Autonomous Underwater Vehicles (AUVs) can use IR signals to communicate between each other or with a base station for underwater exploration, maintenance, and repairs in deep-sea environments.
4. Underwater Robotics: IR wireless communication helps in coordinating underwater robots used for mapping seabeds, pipeline inspections, and other oceanic engineering tasks
5. Underwater Security Systems: IR systems can be used for wireless communication in underwater surveillance or monitoring systems, guarding marine installations, harbors, or military equipment against threats.
6. Submarine Communication: IR technology offers a way to establish short-range, high-speed communication between submarines or submarines and underwater stations.
7. Underwater Data Centers: In futuristic concepts of submerged data centers, IR could facilitate inter-server communication within water-cooled environments.
8. Aquatic Entertainment and Augmented Reality: IR can be used in interactive underwater theme parks or AR experiences for divers by transmitting real-time data to diving helmets or gear.

Since IR has limited range due to absorption by water, these applications often involve short-range, high-data-rate communication systems.

## 6.5 Conclusion

In this chapter the advantages, disadvantages and applications of the IR wireless underwater communication was explained.

# Chapter 7

## Hardware Details

## 7.1 Introduction

The hardware for IR wireless underwater communication typically includes IR transmitters, photodetectors, signal processors, and optical filters designed to operate efficiently in underwater environments.

The IC's and other important components used in this project work, procured from the Hyderabad Electronics Market. The details or data sheets of the IC's are downloaded from the Internet.

The following are the IC's and other important components used in this project work

- Arduino Nano controller Board
- IR Transmitter
- 555 Timer Chip
- TSOP 1738 IR Receiver
- BC547 NPN Transistor
- 7805 Voltage Regulator

The required PCB'S (Printed Circuit boards) for the project work fabricated by SUN RISE CIRCUITS, Kushaiguda Industrial Estate, Hyderabad. Kushaiguda Industrial Estate is very famous for fabricating the Industrial grade PCB's.

## 7.2 Conclusion

In this chapter the hardware details of the IR wireless underwater communication system is explained.

# Chapter 8

## Result

This project is focusing on transmitting light signal from the transmitter ending to the receiver ending using the infrared light radiation equipment in underwater, this design is called the underwater wireless communication system. The designing in this project devoted on the development of the conventional infrared radiation communicating by increasing the transmission distance and the effective signal coverage region, likewise, this system has unique advantages such as minimal effort with low-cost, high-speed communication and almost no limitations of bandwidth range.

Our system not only enables communication through under water channels but also provides information by transmitting the message. With this system, communication can be established without the need for expensive infrastructure, making it an ideal solution for various applications, including marine research, underwater exploration, and submarine operations.

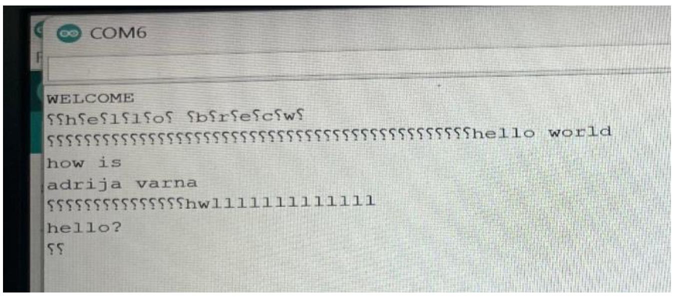



Fig 8.1: Input at Transmitter

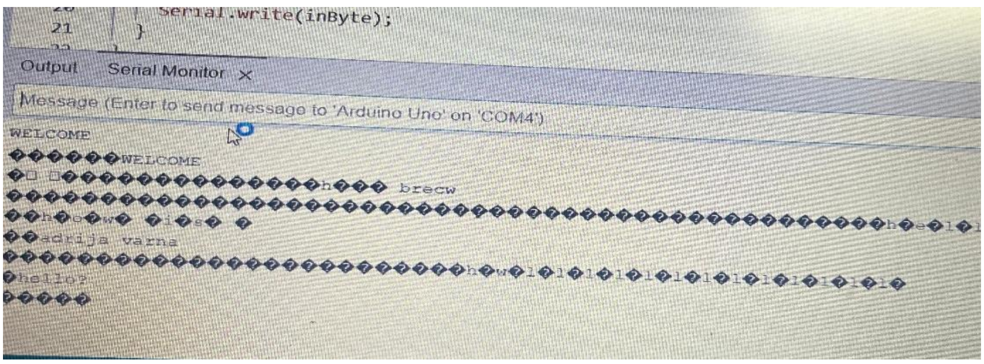



Fig 8.2: Output at Receiver

In an IR (Infrared) underwater wireless communication system, when an input such as "hello world" is sent and the same "hello world" is received as the output, it demonstrates the successful transmission of data through water using infrared light. The process starts with the input being converted into binary data. For example, the phrase "hello world" is encoded in binary form using a standard encoding scheme like ASCII. In this scheme, each character has a corresponding binary representation, such as "h" as 01101000, "e" as 01100101, "l" as 01101100, "o" as 01101111, and so on, including the space as 00100000. The entire string is converted into a sequence of binary numbers.

After encoding, the binary data is modulated onto the IR light signal. During this process, each binary bit (0 or 1) is represented by different characteristics of the light. For example, a pulse of infrared light may represent a "1," while the absence or a low-intensity light pulse represents a "0." These light pulses are then transmitted underwater from the IR source.

One of the main challenges of underwater communication is the attenuation and scattering of infrared light by water, which can interfere with the signal. Factors like water clarity and distance between the transmitter and receiver affect how well the light pulses travel. In clear water and short distances, the light pulses are transmitted with less interference, ensuring the data is transferred effectively.

On the receiving side, the IR detector captures the incoming light pulses and converts them back into their original binary form. The system then demodulates the signal, reversing the modulation process to retrieve the binary data. Using the same encoding method as before, the binary sequence is decoded back into readable characters. In this case, the binary sequence for "hello world" is decoded back into the original text.

The successful transmission and reception of "hello world" as the output, after sending it as input, indicates that the IR communication system accurately transmitted the data through water without significant signal loss or distortion. This outcome highlights the feasibility of using IR technology for underwater wireless communication over short distances and with small data transmissions, demonstrating the system's effectiveness in handling more complex messages.

# Chapter 9
# Conclusion and Future Scope

## 9.1 Conclusion:

The project work is designed and developed successfully. For the demonstration purpose, a prototype module is constructed; and the results are found to be satisfactory. The main objective is to overcome the present limitations and implement advanced technology for oceanographic research and cope up with the environmental effects on the performance of the underwater wireless communication systems to compete with the future challenges by the effective transmission of audio and video signals. An improvement in submerged correspondence framework is required because of expanded correspondence depends on acoustic signs and notwithstanding the generous progression in this field, acoustic correspondence is unable to give adequate data transmission low inertness. number of automated vehicles in space and submerged. Conventional submerged Optical submerged correspondence gives incredible potential to enlarge customary acoustic correspondence because of its high information rates, low dormancy, less force utilization and littler bundling. Likewise, this innovation can profit definitively from the advancement made in the earthly optical remote correspondence. We propose another strategy by adding heartbeats to the FDM technique which is predominantly utilized in submerged wire-less information correspondence. Rather than the regular optical remote transmission, we use information correspondence module.

## 9.2 Future Scope:

The future of IR wireless underwater communication holds significant potential, particularly with advancements in increasing data transfer rates, range, and energy efficiency. Improvements in modulation techniques and hybrid communication systems, combining IR with acoustic or RF technologies, will enhance its applications in underwater sensor networks, marine research, and autonomous vehicles. As smart underwater networks and swarm robotics grow, IR technology will play a crucial role in enabling efficient, real-time communication in challenging aquatic environments, contributing to environmental monitoring, security, and ocean exploration.

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