TEXT AND IMAGE TRANSMISSION USING Li-Fi

A Project Report

Submitted in partial fulfilment of the requirements

for the award of the Degree of

BACHELOR OF TECHNOLOGY

IN

ELECTRONICS AND COMMUNICATION ENGINEERING

BY

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APPROVAL OF THE GUIDE

Recommended that the project entitled "TEXT AND IMAGE TRANSMISSION USING Li-Fi" presented by Akanksha Sinha (BTECH/15119/20) and Khushi Sinha (BTECH/15147/20) under my supervision and guidance be accepted as fulfilling this part of the requirements for the award of Degreeof Bachelor of Technology in Electronics and Communication Engineering. To the best of my knowledge, the content of this project did not form a basis for the award of any previous degree to anyone else.

Date: ____________

Dr. Priyadarshi Suraj
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DECLARATION CERTIFICATE

We certify that

a) The work contained in the project is original and has been done by us under the general supervision of our supervisor.
b) The work has not been submitted to any other Institute for any other degree or diploma.
c) We have followed the guidelines provided by the Institute in writing the project.
d) We have conformed to the norms and guidelines given in the Ethical Code of Conduct of the Institute.
e) Whenever we have used materials (data, theoretical analysis, and text) from other sources, we have given due credit to them by citing them in the text of the project and giving their details in the references.
f) Whenever we have quoted written materials from other sources, we have put them under quotation marks and given due credit to the sources by citing them and giving required details in the references.

Khushi Sinha (BTECH/15147/20)
Akanksha Sinha (BTECH/15119/20)

CERTIFICATE OF APPROVAL

This is to certify that the work embodied in this project entitled **“**TEXT AND IMAGE TRANSMISSION USING Li-Fi**”**, is carried out by Akanksha Sinha (BTECH/15119/20) and Khushi Sinha (BTECH/15147/20) has been approved for the degree of Bachelor of Technology in Electronics and Communication Engineering of Birla Institute of Technology, Mesra, Off-Campus Patna.

Date:

Place:

Internal Examiner **External Examiner**

(Chairman)
In-charge of Department

ABSTRACT

In this today's world, the widespread use of the internet, whether through wired or wireless networks, has become essential for optimizing various tasks. However, as the user base steadily grows on wireless networks, their demands also increase, leading to a proportional decrease in speed. In the current landscape, there is a growing need to explore alternative communication technologies, and Li-Fi technology has emerged as a promising alternative to conventional Wi-Fi. Li-Fi uses visible light, infrared, or ultraviolet light to transmit data. It offers high-speed data transfer providing an alternative to traditional Wi-Fi. Li-Fi can be described as an efficient and cost-effective optical counterpart to traditional Wi-Fi. At present, Wi-Fi and Bluetooth standout as the leading short-range wireless technologies. However, the radio wave spectrum faces notable limitations, encompassing issues like bandwidth usage, effectiveness, accessibility, and security.Li-Fi has the potential for faster data transfer rates and increased security.

The main purpose of this paper aims to enhance contemporary communications through advancement in wireless technology. This paper explores the feasibility and potential of Li-Fi for transmission of text and image.

ACKNOWLEDGEMENT

We would like to express our profound gratitude to our project guide, Dr. Priyadarshi Suraj for his guidance and support during our project work. We benefited greatly by working under his guidance. It was his effort for which we are able to develop a detailed insight on this subject and special interest to study further. His encouragement motivation and support has been invaluable throughout our studies at BIT, Mesra, Off-campus Patna.

Weconvey our sincere gratitude toDr. Ritesh Kumar Badhai, Incharge Dept. of ECE, BIT,Mesra, Off-campus Patna, for providing us various facilities needed to complete our project work. We would also like to thank all the faculty members of ECE department who have directly or indirectly helped during the course of the study. We would also like to thank all the staff (technical and non-technical) and our friends at BIT, Mesra, Off-campus Patna who have helped us greatly during the course.

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Our apologies and heartful gratitude to all who have assisted us yet have not been acknowledged by name.

Thank you.

DATE:

Khushi Sinha (BTECH/15147/20)
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OBJECTIVE

- This project aims at designing and implementing a prototype model for text and image transmission through Li-Fi technology.
- This model will transmit and receive text and image data using light as a carrier. To achieve this goal, we would be mainly using Arduino uno microcontroller, LED sources and photodiode for transmitting and receiving data respectively.
- The main objective of this project will be to provide a high speed data transmission using visible spectrum of light in day-to-day life achieving more efficient and cost effective network. Through Li-Fi based transmission, revolution in telecommunication industry can be brought and hence providing internet access to remote areas.

MOTIVATION

Li- Fi being an arising technology which uses light to transmit data, offering several advantages over traditional wireless communication styles. Exploring this slice- edge technology can be instigative and forward- looking. With the growing number of wireless bias, the radio frequency (RF) spectrum is getting decreasingly crowded. Visible light spectrum is less congested. Thus, this technology can be used alongside Wi-Fi to ameliorate speed of data transmission. Li-Fi has the implicit to give extremely high- speed data transfer rates, indeed surpassing the capabilities of Wi-Fi. This was a compelling provocation for us to design a prototype for perfecting data transmission effectiveness. Also, Li-Fi offers enhanced security because light signals can be contained within a physical space, reducing the threat of data interception. It can be used for transmitting data in colorful operations similar as smart homes, services, and metropolises. Li-Fi uses LED light bulbs for data transmission, which are energy-effective. Using this technology in day- to- day life can give numerous advantages.

LITERATURE REVIEW

1. Abhiramasundarry dept. of ECE PITS, Shwetha dept. of ECE PITS Thanjavur (2018),*Real time embedded health monitoring system using Li-Fi*[1]-They usedlight-baseddata transmissionfor embedded healthmonitoringdevicesandothermedicalapplications. The information from the receiver, which includes a body temperature sensor, an ECG sensor, a SPO2 sensor, a pulse rate sensor, and other sensors, was retrieved using ARM. This gives us a chance to use Li-Fi for wearable technology like wrist watches, home-based patient monitoring systems, and radio-sensitive locations like hospitals.
2. Rahul R. Sharma, Akshay Sanganal, Sandhya Pat*Implementation of A Simple Li-Fi Based System*[2]- The main goal of this research is to transmit text, audio, and video data via Li-Fi technology. More complex transmitter is involved with PCB. This is employed to regulate and modify the LED's light intensity. Thus, this study turns out to be a more advanced version of the project we are working on right now, which just shows how text data can be transmitted. Additionally, RGB LEDs (red, green, and blue) are incorporated to improve the data transfer rate. The effectiveness of receiver design is increased by using a phototransistor rather than an LDR in most situations.
3. R. Bhavya and R. Lokesh M., *A Survey on Li-Fi Technology* (2016)[3]- Li-Fi's architecture was examined as a novel wireless technology that facilitates communication inside a specific network setting. The way Li-Fi technology operates allows us to communicate data through an LED, which is how it transfers data. The intensity ofthis LED changes so quickly that the human eye is unable to keep up with it. With a clear picture of a cleaner, greener, safer, and brighter future, this thought also encourages us to look forward to a better tomorrow. Their aim is quite similar to ours.
4. G Madhuri, K Anjali and R Sakthi Prabha *Transmission of data, audio and text signalusing Li-fi technology*[4]- A thorough illustration of image transmission is shown here. We see the use of transceivers that are linked to the two PCs that are in communication with one another. Using LEDs in the transmitter system has several benefits, such as being environmentally friendly, performing better, having a flexible design, and having a longer lifespan is discussed here.

1. INTRODUCTION

In the fleetly advancing geography of technology, where digitalization is pervasive and everything is connected through the internet, the demand for high- speed and effective communication has come more pivotal than ever. Presently, Wi-Fi and Bluetooth stand out as the primary short- range wireless technologies for communication. Still, as technology advances and the number of users increases, these networks frequently face challenges of load, leading to a failure in delivering the asked high data rates. In response to these challenges, a promising technology called Light-Fidelity has surfaced. Li-Fi harnesses visible light swells for data transfer and communication, offering an implicit result to the limitations of being wireless technologies. By using light as a medium for communication, it aims to give advanced speed, effectiveness, and sequestration compared to traditional Wi-Fi and Bluetooth. It involves the use of light emitting diodes (LEDs) to transmit data by fleetly modulating the intensity of light, a process that's too fast for the mortal eye to perceive. This technology offers advantages similar as advanced data transfer rates, enhanced security, and reduced hindrance, making it promising as the digital world continues to evolve, the disquisition and development of innovative results like Li-Fi play a pivotal part in meeting the growing demands for briskly and more dependable wireless communication.In less difficult terms, Li-Fi is like a high-tech way of exchanging information utilizing light instep of radio waves like Wi-Fi. The advantage is that light can't go through dividers, making it more secure from hacking, which is advantageous for places like healing centers, atomic control plants, and airplane where maintaining a strategic distance from electromagnetic obstructions is pivotal. Whereas it has a confinement on extend, it exceeds expectations in places where security and impedances evasion are best needs. Li-Fi usees the endless unmistakable light range, advertising nearly boundless capacity for information transmission. It works by sending light signals wirelessly to a collector, which at that point interprets the optical signals into the unique message. Basically, Li-Fi signals remain contained inside the physical space where the light is display, including an additional layer of security. The essential point of this venture centers around Obvious Light Communications (VLC). Our objective is to plan a customized analog circuit that consistently coordinating with an Arduino. The framework is outlined to transmit information utilizing unmistakable light LEDs from a transmitter and along these lines interpret this data with a collector.

1.1ARCHITECTURE OF Li-Fi SYSTEM

Li-Fi is enshrined as a potential future of data communication and provides a quick, low-cost optical alternative to Wi-Fi. Li-Fi uses the visible light spectrum for data transmission between 400 THz and 800 THz, with high-brightness white LEDs used as transmitters and silicon photodiodes for reception. The key components of a Li-Fi system are high-brightness white LEDs as the transmission source and silicon photodiodes optimized for visible light responsiveness as the receiving element. The LEDs are toggled to generate digital sequences of 1s and 0s, and data encodingis achieved by flicking the rate of flickering of the LEDs. Therefore, as light modulation transmitters, LEDs are excellent senders for data transmission.

The rapid flickering that is imperceptible to human eyes results in a nearly constant LED output. High-speed LEDs and multiplexing methods may provide communication rates greater than 100 Mbps to VLC. VLC data rates can achieve 10 Gbps or higher with a lot of LEDs transmitting data in parallel at the same time through parallel data transmission. As a result of their speed, efficiency, and flexibility, Li-Fi is a powerful candidate for future wireless data communication. In this mini-project, I designed and demonstrated a simple Li-Fi system for text and image transmission using visible light. The aim of this project is not to demonstrate a system capable of transferring data at a high speed. This project can be used to send information using a one-to-one connection in one direction through the system.

The model allows for further exploration into the characteristics of visible light and LEDs integrated into the communication system.

1.2WORKING OF Li-Fi

Li-Fi technology is evolving to make data transfer briskly, more effective, and energy-effective. Li-Fi operates as a two- way network, offering a stoner experience similar to Wi-Fi. Looking ahead, as we advance into the future, the need for connectivity is anticipated to grow fleetly. In simpler terms, meeting the adding demands for connectivity requires networks with lesser spectral capacity. Li-Fi is presently delivering unequalled data bandwidth. Falling under the order of optic wireless dispatches, it encompasses infra- red, ultraviolet, and visible light. What makes Li- Fi unique is its capability to use the same light energy used for illumination for communication purposes as well. This paper describes a setup with two main corridor one is transmitter and other is receiver. Both sections include an Arduino, which is programmed using the Arduino Integrated Development Environment (IDE). In this the input is taken from a PC, and it's connected to an array of LED and an Arduino Uno microcontroller at the sender's end. At the receiver's end, a light- detecting resistor is employed to capture the incoming light from the LED. The affair is displayed on a TV (Liquid Crystal Display), showing the input given from the PC. When any data (textbook or image) is transferred from the PC, an immediate conversion to double occurs through the Arduino law executed within the microcontroller. The given input's corresponding double value is instantly showcased in the periodical examiner window of the Arduino IDE, furnishing a reference for implicit variations. coincidently, this double information undergoes rapid-fire transmission through the LED, achieving a high- speed data transfer through the LED's fluttering medium. For double value '1', the LED is illuminated, whereas it remains off for double value '0', effecting the transmission process. The fluttering, being at a gradually high speed, manifests as a bare flash of the LED to the mortal eye.

At the receiver end, a light- detecting diode captures and converts the transmitted light energy into electrical energy in double form. This double data is also subordinated to a rear process, rooting analog textbook information from the double law. The ultimate affair is displayed on a TV screen, showcasing the interpreted characters corresponding to the input given from the PC.

Figure 1.1 Li-Fi transmission

1.3WHY VISIBLE LIGHT COMMUNICATION

Visible Light Communication (VLC) is a technology that uses visible light to transmit data. It leverages the properties of light, generally through LEDs(Light Emitting Diodes), to enable communication. Then are some reasons why visible light communication is considered

Visible light has a much-advanced frequency than radio swells, which are generally used for wireless communication. This advanced frequency allows for the transmission of larger quantities of data, furnishing advanced bandwidth.

The visible light spectrum is vast and largely limited, furnishing a hugebandwidth for communication purposes. This is in discrepancy to the radio frequency diapason, which is getting decreasingly crowded with other wireless technologies.

Since visible light does not access through walls or other obstacles, VLC can offer a advanced position of security compared to some wireless technologies. It can be more delicate for unauthorized druggies to block signals.

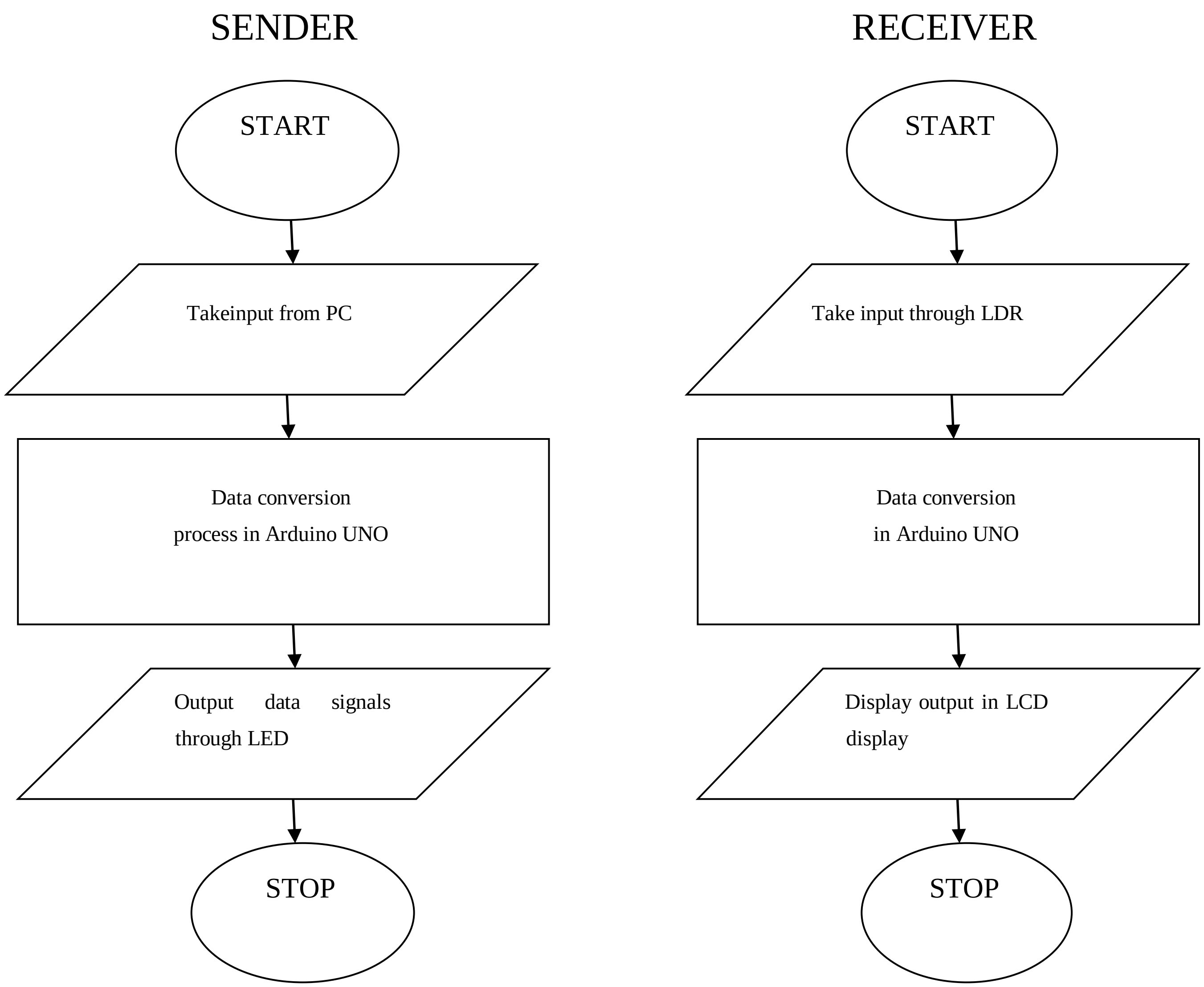
LEDs, generally used for VLC, are energy-effective compared to traditional light sources. By integrating communication capabilities into lighting systems, VLC can contribute to energy savings and environmental sustainability.

Visible light communication is less susceptible to hindrance from other electronic bias because visible light does not access accoutrements as much as radio swells. This can affect in further dependable and hindrance-free communication.

VLC systems can be used for inner positioning and position- grounded services. By using the visible light emitted by LEDs, it's possible to determine the position of a device within a given space with high delicacy.

Unlike some wireless technologies that use radio swells, visible light communication doesn't pose health enterprises related to electromagnetic radiation. It's considered a safer volition in surroundings where minimizing exposure to electromagnetic fields is a precedence.

2. METHODOLOGY



In this project, we will build a prototype model based on Li-Fi technology for text and image transmission.

Following are the steps which we will be following: -

Text transmission using Li-Fi has two sections transmitter/sender and receiver.

1. Text or image input is given to the processor from the PC.
2. The processor processes the data received.
3. The entered input data is converted from digitalto binary bits using an Arduino microcontroller which is present on the transmitter side.

4. This data is transmitted to the receiver side in the form of blinking of LED. When LED is in On state it is detected as 1 and when LED is in Off state it is detected as 0.
5. On the receiver side this On-Off blinking pattern is detected by the LDR and input is taken through LDR.
6. The received data is then sent to the Arduino UNO which is present on the receiver side which then converts this received data into desired format.
7. Final output is displayed on the LCD display present in the receiver side.

2.1. BLOCK DIAGRAM

Transmitter Section

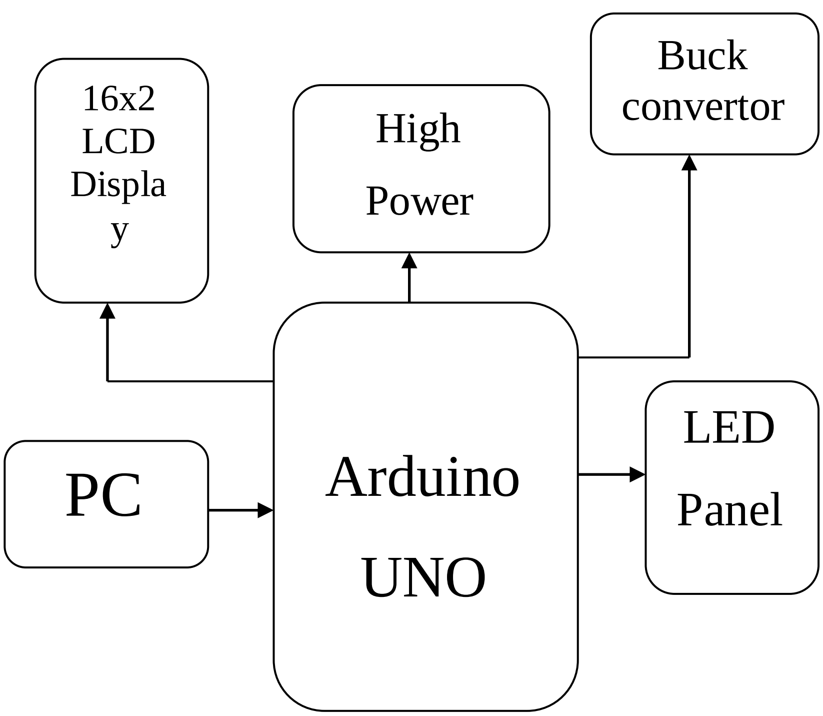


Figure 2.1 Block diagram of sender side

Receiver Section

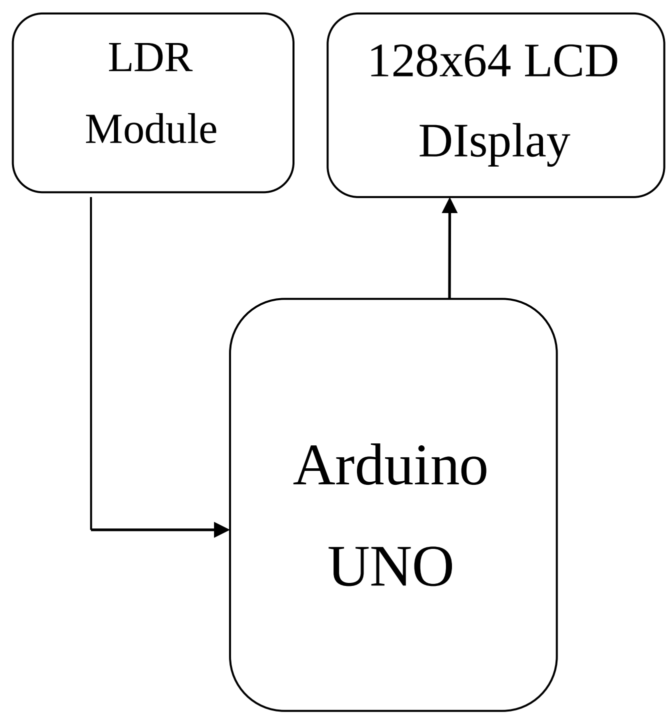


Figure 2.2 Block diagram of receiver side

3. HARDWARE DESCRIPTION

3.1 Power supply system:

The power supply is a complex apparatus created to convert the high voltage AC of the primary power supply into a low voltage regulated DC supply that is proper for operating digital circuits and other high-quality electronic equipment. Power supplies can be divided into several separate components since each one of them has a single-purpose component within the overall structure. One such component is the Direct Current power supply, also recognized as a “regulated D.C power supply”. It is crucial in the case since this part ensures that the output voltage remains constant no matter what happens to the AC mains input, meaning that it is unresponsive to external instabilities or changes in the load required. The controlled D.C. power supply is a dependable power supply since it produces a fixed and stabilized voltage that is needed to meet the requests of advanced circuits and progressed electronic gadgets.

3.2 Arduino UNO:

Arduino is an open-source electronics platform and programming language that offers easy-to-use hardware and software for creating interactive projects. The device accommodates users of all experiences as a simple board that accepts input from several sensors and sends signals to light and other devices. Its primary benefit is that anyone with basic knowledge of electronics and C programming can use it, making it an open-source device for everyone. The hardware of the Arduino consists of a board called the Arduino Board, which is the software, the Arduino Integrated Development Environment, used for coding the board.The platform can be further expanded beyond the core board to include a wide range of external hardware modules, such as sensor modules, motors, lights, and more. There are various models of the Arduino board, each with unique characteristics to fit certain requirements. The most popular ones are the Arduino UNO, Arduino MEGA, ArduinoMINI, Arduino DUE, Arduino YUN and Arduino Lily pad.The first model is chosen the most frequently. The hardware name comes from the Italian one meaning per the release of the Arduino Software (IDE) version 1.0.

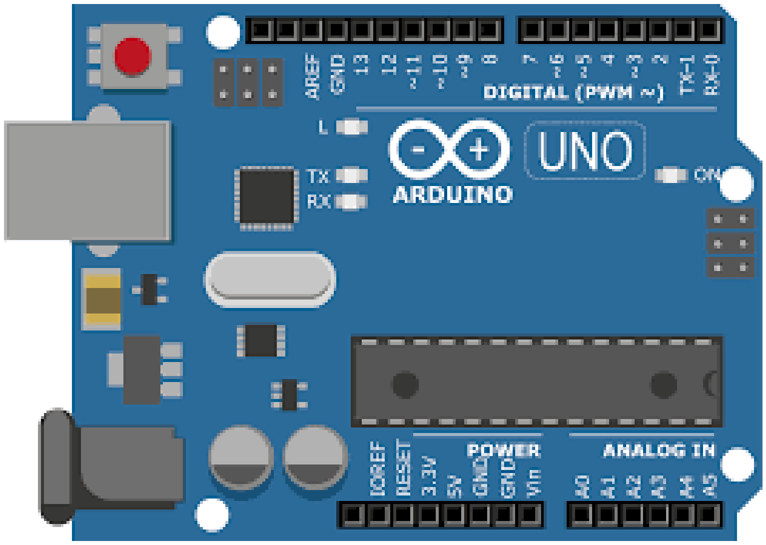


Figure3.1 Arduino Uno

3.3 16 x 2 LCD Display:

A LCD (Liquid Crystal Display) is a flat-panel display technology extensively used in electronic gadget. It's composed of liquid chargers held between layers of glass or plastic. When an electric field is applied, the liquid chargers change exposure, modulating light and creating images. crucial features include colorful display types (TN, IPS, VA), judgments, color reduplication, and operations in bias like observers, TVs, laptops, smartphones, and bedded systems. crucial features include colorful display types (TN, IPS, VA), judgments, colour reduplication, and operations in bias like observers, TVs, laptops, smartphones, and bedded systems. In a 16 x 2 LCD, 16 characters are shown at one time or per line, and there are two lines. Each character in this LCD is displayed in a 5x7 pixel matrix. The 16 x 2 intelligent alphanumeric dot matrix display can show 224 distinct characters and symbols.

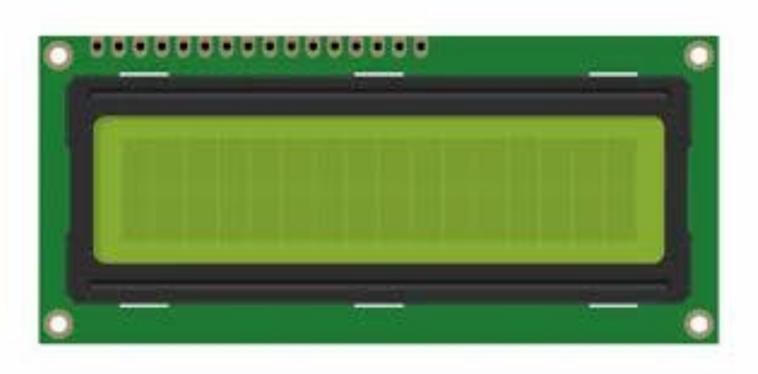


Figure3.2 16 x 2 LCD display

3.4 Jumper wire:

Jumper wires are crucial electronic components that enable you to create temporary electrical connections between various spaces on a breadboard grid or between electronic parts in a circuit. They are critical components when prototyping, and they allow for rapid and versatile assembly without having to use solder. Jumper wires come in three types: male-to-male, male-to-female, and female-to-female, each catering to its unique need to be connected. Furthermore, since they are color-coded, they can easily be sorted and come in diverse lengths. Jumper wires are used to prototype, test, and change electronic circuits during the design phase because they are flexible, reusable, and easy to use. Due to its simplicity, optimal practicality, and adaptability, the jumper wire is well-known in the electronic field due to our scope of work.

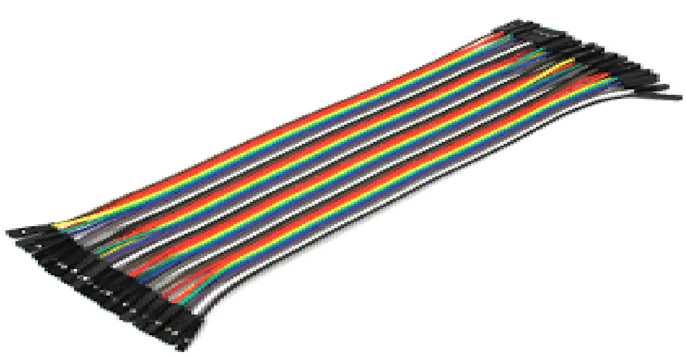


Figure 3.3 Jumper Wire

3.5 Resistor:

A resistor is an indispensable electrical component built to hinder the flow of electrical current in a circuit; it provides resistance and is measured in ohms. Represented by a rectangle with two terminals in circuit diagrams, resistors are essential for controlling current and voltage levels in a circuit. Most resistors are colour-coded to indicate their resistance, tolerance, and sometimes a temperature coefficient. These components abide by Ohm's Law, which defines the current passing through a conductor is directly proportional to the voltage across the conductor and inversely proportional to the resistance by the conductor. Resistors can be classified as fixed and variables, with fixed resistors maintaining constant and adjustable resistance in variable resistors. Resistors are widely applied in electronic goods and heavily influence the behaviour of circuits.

Figure 3.4 Resistors

3.6 LED:

An LED (Light Emitting Diode) is a semiconductor device. Whenelectric current passes through it, LED emits light. LEDs are efficient, durable, and are compact in size, hence widely used in various applications. They operate on the principle of electroluminescence, where the movement of electrons across a semiconductor material produces photons, resulting in visible light. There are various colours available in LEDs. They have many applications such as lighting, displays, indicators, and automotive lighting. Compare to traditional light sources, they offer energy efficiency, longer lifespan, and fast switching capabilities. Hence, they are a popular choice in modern electronics and illumination systems.

Figure 3.5 LED

3.7 Potentiometer:

A potentiometer is an electrical component whose function is to manually adjust the resistance in a circuit. A resistive element made of a material like carbon or a conductive plastic and a sliding contact, called a wiper that can move along its length are present in it.When a potentiometer is connected to a circuit, it acts as a variable voltage divider. The amount of resistance between the wiper and the two ends of the resistive element can be changed by adjusting the position of the wiper. This change in resistance changes the output voltage across the ends of the potentiometer. The common uses of potentiometers arein a wide range of electronic devices for tasks such ascontrolling volume in audio equipment, controlling the brightness of light in LCD, or adjusting the speed of a motor. They come in various types, including rotary potentiometers (where the adjustment is made by rotating a knob) and linear potentiometers (where the adjustment is made by sliding a lever or button). In this project, we are using potentiometer to adjust brightness of LCD display.

Figure 3.6 Potentiometer

3.8 Transistor:

A transistor is a fundamental semiconductor device which is used in electronic circuits for amplification, switching, and signal modulation. It consists of three layers of semiconductor material which are the emitter, the base, and the collector. There are countless uses of transistors in electronic devices and circuits, like simple amplifiers, switches and they are also used in complex digital circuits in computers and microprocessors. They serve as the building blocks of modern electronic circuits. To put it simply a transistor is a tiny device that is used to regulate or control the flow of electronic impulses.

Figure 3.7 Transistor

3.9 Push Button:

A push button is also known as a push switch. It is a simple electromechanical device which is used to control the flow of electricity in a circuit. It's main work is to make or break electrical contact between two terminals when the button present in it is pushed. There are various applications in which push buttons are used, which are, simple on/off controls in consumer electronics, more complex functions in industrial equipment and machinery. Most often they are used to perform specific tasks in electronic circuits in combination with other components, such as relays or microcontrollers. In this project, we are using two push buttons to enable either text transmission or image transmission.

Figure 3.8 Push Button

3.10Breadboard:

A breadboard is a fundamental tool in electronics used for prototyping and testing circuits. It provides a platform for quick and temporary assembly of electronic components without the need for soldering. Key features include a grid of holes for inserting components, interconnected rows and columns for easy circuit connections, and power supply rails for voltage sources. Breadboards are reusable, allowing components and wires to be easily repositioned. They serve as a valuable tool for engineers, hobbyists, and students during the early stages of circuit design, enabling rapid experimentation and modification.

Figure 3.9 Breadboard

4. **SOFTWARE DESCRIPTION**

4.1 ARDUINO UNO SOFTWARE

4.1.1 ARDUINO IDE

The Arduino integrated development environment is a sophisticated cross-platform application implemented in Java. Originating from the IDE developed for the Processing programming language and the Wiring projects, this software is engineered with the educational application in mind. The intent to introduce even unsophisticated newcomers to the area of programming explains the software availability to artists unskilled in the nuances and details of software engineering. The essential feature of the IDE is the interface ensuring easy use of the robust code editor. Perfectly manageable, the editor is equipped with several essential functions, including indentation, syntax highlight, brace matching, among others. For the benefit of even less sophisticated users interested in programming, a single mouse click installs the program on the Arduino board after compilation. Arduino ESP32. With this suite, users develop applications with an Arduino board that adopts ESP32 microcontroller, programs the hexadecimal code to the microcontroller, saved in persistent memory, and launched once the processor turns on. Arduino programming is done using the C or C++ language, which is made pleasant by Wiring, a software library developed from the original Wiring project . Wiring enriches the programing art as it simplifies most common Input and Output operations, which is advantageous as it makes the programming environment user-friendly. Ultimately, facilitates a learner with a platform to develop programming skills quickly and confidently.

Figure 4.1 Arduino ide

4.2 CoolTerm Software

CoolTerm is a simple serial port terminal application (no terminal emulation) that is geared towards hobbyists and professionals with a need to exchange data with hardware connected to serial ports such as servo controllers, robotic kits, GPS receivers, microcontrollers, etc. We use this to transfer our binary number string generated from ASCII code of text and image to our arduino. It's available for multiple platforms including Windows, macOS, and Linux. Overall, CoolTerm is a versatile and powerful tool for serial communication, offering a range of features essential for working with serial devices in various applications such as embedded systems development, electronics prototyping, and hardware testing.

4.3 CODE:

4.3.1 Transmitter Side Code:

```
#include<LiquidCrystal.h>
#include<SoftwareSerial.h>

LiquidCrystallcd(4, 5, 6, 7, 8, 9);
SoftwareSerialGSerial(11,12);

intarr_count=0,i;
unsignedchararr[1027];
charcmd_arr2[100];
intrec_flag1=0;
intrec_flag2=0;
intbuttonPin1=10;
intbuttonPin2=3;
intbuttonState = 0;
voidserial_get_command()
{
  inti;
  intcmd_count=0;
  charinchar=0;
  charcmd_arr[30];
  if(Serial.available()>0)
  {
    inchar = Serial.read();
    if(inchar == '{')
    {
```

```
  arr[0]=128;arr[1]=64;
  arr_count=2;
  while(inchar != '}')
  {
    if(Serial.available()>0)
    {
      inchar = Serial.read();
      if(inchar=='x' || inchar=='X')
      {
        while(Serial.available()==0);
        cmd_arr[2]=Serial.read();
        while(Serial.available()==0);
        cmd_arr[3]=Serial.read();
        cmd_arr[0]='0';cmd_arr[1]='x';cmd_arr[4]='\0';
        uint8_tintVal;
        sscanf(cmd_arr, "%x", &intVal);
        arr[arr_count++]=intVal;
        arr[arr_count]='\0';
      }
    }
  }
  if(inchar == '}')
  {
    Serial.print(F("Count : "));Serial.println(arr_count);
    for(i=0;i<arr_count;i++)
    {
     Serial.print(arr[i]);
    }
    lcd.clear();lcd.print(F("Received : "));lcd.print(arr_count);
    rec_flag1=1;
  }
  else
  {
    Serial.println("<EE04>");
  }
  // cmd_count=7 for command <xxyyyy>
}

if(inchar == '<')
{
  cmd_count=0;
  while(inchar != '>' &&cmd_count<200)
  {
    if(Serial.available()>0)
    {
```

```
        inchar = Serial.read();
        cmd_arr2[cmd_count++] = inchar;
        cmd_arr2[cmd_count] = '\0';
      }
    }
    if(inchar == '>')
    {
      rec_flag2=1;
      cmd_arr2[cmd_count-1] = '\0';
      Serial.print(F("Text Received : "));Serial.println(cmd_arr2);
      lcd.clear();lcd.print(F("Rec. Text: "));lcd.print(cmd_count-1);
    }
    else
    {
      Serial.println(F("<EE04>"));
    }
    // cmd_count=7 for command <xxyyyy>
  }


 }
}
voidsetup()
{
 Serial.begin(57600);
 Serial.println("Program Started");
 pinMode(buttonPin1, INPUT);digitalWrite(buttonPin1, HIGH);
 pinMode(buttonPin2, INPUT);digitalWrite(buttonPin2, HIGH);
 GSerial.begin(400);
 lcd.begin(16, 2);
 lcd.print(F("LiFi Tx..."));
 delay(4000);
 lcd.clear();
}
voidloop()
{
 serial_get_command();
 if(rec_flag1==1)
 {
   buttonState = digitalRead(buttonPin1);
   if(buttonState == LOW)
   {
    lcd.setCursor(0, 1);lcd.print(F("Sending Image..."));
    delay(1000);
    GSerial.print(F("<"));
```

```
    for(i=0;i<arr_count;i++)
    {
     GSerial.write(arr[i]);
     buttonState = digitalRead(buttonPin1);
     if(buttonState == LOW)
     {
       i=2000;
     }
    }
    GSerial.print(F(">"));
    delay(1000);
    lcd.setCursor(0, 1);lcd.print(F("                "));
   }
  }

  if(rec_flag2==1)
  {
   buttonState = digitalRead(buttonPin2);
   if(buttonState == LOW)
   {
    lcd.setCursor(0, 1);lcd.print(F("Sending Text... "));
    delay(1000);
    GSerial.print(F("{"));
    GSerial.print(cmd_arr2);
    GSerial.print(F("}"));
    delay(1000);
    lcd.setCursor(0, 1);lcd.print(F("                "));
   }
  }
}
```

4.3.2 Receiver Side Code:

```
#include<openGLCD.h>
#include<include/openGLCD_GLCDv3.h>// GLCDv3compatibilty mode
#include"fonts/allFonts.h"
#include<SoftwareSerial.h>
SoftwareSerialGSerial(2,3);

unsignedcharcmd_arr[1050];
charcmd_arr2[100];
intcmd_count=0;
charinchar;

voidDrawBitmap2(Image_tbitmap, uint8_tx, uint8_ty, uint8_tcolor);
```

```
voidserial_get_command()
{
 charinchar=0;

 if(GSerial.available()>0)
 {
   inchar = GSerial.read();
   if(inchar == '<')
   {
     GLCD.ClearScreen();
     GLCD.print("Receiving...Image");
     cmd_count=0;
     while(inchar != '>' &&cmd_count<1050)
     {
       if(GSerial.available()>0)
       {
         inchar = GSerial.read();
         cmd_arr[cmd_count++] = inchar;
         cmd_arr[cmd_count] = '\0';
       }
     }
     if(inchar == '>')
     {
       GLCD.ClearScreen();
       GLCD.print("Received...Image");
       delay(2000);
       //GLCD.print("Received : ");GLCD.print(cmd_arr);
       //Serial.print("Cmdreceived : ");Serial.print(cmd_arr);Serial.print("cmd value : ");Serial.println(cmd_count);
       DrawBitmap2(cmd_arr, 0,0,BLACK);
       delay(5000);
     }
     else
     {
       Serial.println("<EE04>");
     }
     // cmd_count=7 for command <xxyyyy>
   }
  if(inchar == '{')
  {
     GLCD.ClearScreen();
     GLCD.print("Receiving...Text");
     cmd_count=0;
     while(inchar != '}' &&cmd_count<1050)
     {
```

```
        if(GSerial.available()>0)
        {
          inchar = GSerial.read();
          cmd_arr2[cmd_count++] = inchar;
          //Serial.print(cmd_arr2);
          cmd_arr2[cmd_count] = '\0';
        }
      }
      if(inchar == '}')
      {
        cmd_arr2[cmd_count-1] = '\0';
        GLCD.ClearScreen();
        GLCD.print("Received...Text");
        //Serial.print("Cmdreceived : ");Serial.print(cmd_arr2);Serial.print("cmd value : ");Serial.println(cmd_count);
        delay(1000);
        GLCD.ClearScreen();
        GLCD.print(cmd_arr2);
        //GLCD.print("Received : ");GLCD.print(cmd_arr);
        //Serial.print("Cmdreceived : ");Serial.print(cmd_arr2);Serial.print("cmd value : ");Serial.println(cmd_count);
        delay(5000);
      }
      else
      {
        Serial.println("<EE04>");
      }
      // cmd_count=7 for command <xxyyyy>
    }
  }
 }

voidDrawBitmap2(Image_tbitmap, uint8_tx, uint8_ty, uint8_tcolor)
{
uint8_t width, height;
uint8_ti, j;

  width = *bitmap++;
  height = *bitmap++;

#ifdefBITMAP_FIX

  if((y &7) || (height &7))
  {
    this->FillRect(x, y, width, height, PIXEL_OFF);
  }
  for(j = 0; j <((height+7) / 8); j++)
```

```
#else
  for(j = 0; j < height / 8; j++)
#endif
  {
  GLCD.GotoXY(x, y + (j*8));
  for(i = 0; i< width; i++)
  {
     uint8_tdisplayData = *bitmap++;
       if(color == BLACK)
      GLCD.WriteData(displayData);
     else
        GLCD.WriteData(~displayData);
  }
  }
}
voidglcd_init()
{
  GLCD.Init();
}
voidwelcome_page()
{
  GLCD.CursorTo(0, 2);
  GLCD.SelectFont(System5x7);
  GLCD.print("         LI-FI");
  delay(3000);
  GLCD.ClearScreen();
}
voidsetup()
{
  Serial.begin(57600);
  Serial.println("Program Started");
  GSerial.begin(400);
  glcd_init();
  welcome_page();
}
voidloop()
{
  serial_get_command();
  /*if(GSerial.available() > 0)
  {
    inchar = GSerial.read();
    GLCD.print(inchar);
  }
}
```

5. ADVANTAGES AND DISADVANTAGES

5.1 ADVANTAGES OF LI-FI

There are many advantages of Li-Fi (Light Fidelity) technology which makesit a promisingalternative to traditional wirelesscommunication technologies such as Wi-Fi. Some key advantages of Li-Fi are listed below:

1. **High Data Transfer Rates**: As compared to Wi-Fi, Li-Fi can provide significantly faster data transfer rates. As visible light communication (VLC) can achieve very higher data rates in the gigabits per second (Gbps) range, which surpasses the capabilities of traditional radio frequency-based communication systems.
2. **Increased Bandwidth**: The visible light band accessible to use with Li-Fi is around 10,000 times more significant than the total radio-frequency Wi-Fi range. Since Li-Fi has much more bandwidth than traditional WI-Fi, it can reduce network congestion by supporting a large number of devices simultaneously.
3. **Improved Security**: Li-Fi communication is confined to a small area which is illuminated by light and as light cannot penetrate through walls, it makes Li-Fi signal more secure and less susceptible to unauthorized access from outside the physical space, enhancing overall security more than traditional Wi-Fi.
4. **Reduced Electromagnetic Interference**: Li-Fi utilizes visible light, unlike Wi-Fi, which operates in the radio frequency spectrum. Thus minimizingelectromagnetic interference insensitive environments such as hospitals, aircraft, and industrial settings where precise electronic equipment is crucial. Hence, making data transfer available in these areas.
5. **Energy Efficiency**: Li-Fi uses light-emitting diodes (LEDs) for data transmission which are energy-efficient and have a longer lifespan compared to traditional lighting sources. Overall energy efficiency can be achieved in smart lighting systems by integrating data communication with illumination.
6. **No Radio Frequency Interference**: Li-Fi avoids interference with radio frequency-based devices as it operates in the visible light spectrum. Thus making Li-Fi suitable for use in

environments where radio frequency interference is a concern, such as in hospitals or research facilities.

5.2 DISADVANTAGES OF LI-FI

1. Line-of-Sight Communication: Any obstacle like walls or physical barriers between the transmitter and receiver can disrupt the communication as Li-Fi relies on the line-of-sight betweenthe transmitter (LED) and thereceiver (photodetector). Thus, it limitsthe coverage area and requires careful positioning of devices.

2. Limited Range: As visible light cannot penetrate through walls, the signal range is restricted to the area which is illuminated by the light source making it's range limited. Hence, the range of Li-Fi is generally shorter compared to Wi-Fi.

3. Sensitivity to Ambient Light: Ambient light is an issue that may reduce the efficiency of Li-Fi communication. As sunlight or other luminous sources enter the transmitter's area, the signals may be distorted, leading to the reduced efficiency of the technology.

4. Equipment Requirements: Li-Fi necessitates the use of unique devices such as LED light bulbs equipped with the capability to communicate and compatible receivers. As a result, should an organization decides to install Li-Fi technology retrospectively, it will be necessary to acquire new equipment or update fixtures

5. Security Concerns: Although Li-Fi minimizes the risk of intrusion via physical isolation, certain security threats remain. For instance, the interception of the signal is possible if anyone has clear vision of the LED to which it is transmitting. This raises security concerns, since interception is conceivable.

6. Incompatibility with Existing Devices: The majority of current equipments are designed for radiofrequency communication, mainly for Wi-Fi.Adapting existing devices to Li-Fi may require additional hardware or modifications, making the transition challenging and costly.

6. APPLICATIONS OF Li-Fi

6.1 APPLICATIONS

Because of its intriguing features and benefits Li-Fi (Light Fidelity) technology has many uses in a variety of industries. These are a few noteworthy uses of Li-Fi:

1. **Indoor Wireless Communication:** Li-Fi is a good option for indoor wireless communication particularly in places like theatres, museums, hospitals and libraries where standard Wi-Fi might not work as well. It can offer homes businesses and offices high-speed internet access.
2. **Healthcare:** Li-Fi can be used in healthcare environments where it is necessary to reduce radio frequency interference especially in areas such as patient rooms and operating rooms. It makes it possible for medical equipment and devices to communicate securely and quickly.
3. **Aviation and Aerospace:** Passengers can have dependable and quick internet access by using Li-Fi for in-flight data transmission in aircraft. Li-Fi can improve communication between spacecraft components in aerospace applications.
4. **Underwater Communication:** Li-Fi has the potential to be used in underwater communication an area that presents difficulties for traditional radio frequency signals. It is applicable to data transfer between devices that are submerged.
5. **Smart Lighting and the Internet of Things:** Combining data communication and lighting capabilities Li-Fi integration with smart lighting systems can offer both. Because it facilitates communication between linked devices it is essential to the Internet of Things (IoT).
6. **Traffic Management:** Intelligent traffic management systems have the potential to utilize Li-Fi technology. Li-Fi enabled traffic signals for instance have the ability to communicate with cars enhancing traffic flow and lowering accident rates.
7. **Secure Environments:** Li-Fi’s characteristics make it appropriate for secure environments where maintaining data privacy is crucial. It is perfect for use in secure research labs government buildings and defense installations.

8. **Education and Offices:** Li-Fi can be used toprovide high-speed internet access in academic settings and office buildings facilitating activities like video conferencing online learning and group projects.

9. **Industrial Settings:** Where security and electromagnetic interference are major concerns Li-Fi can find use in industrial settings like manufacturing plants and warehouses.

6.2 REPLACEMENT FOR OTHERS TECHNOLOGIES:

Li-Fi technology is a viable substitute for other communication technologies, especially in locations where radio wave usage is prohibited, such as environmentwhere Bluetooth, infrared, Wi-Fi, andthe internet are banned. There are a few benefits that come along with Li-Fi, including

- A wide spectrum over visible wavelengths
- Exceptionallyhigh colour fidelity
- Instant start time
- Simple terminal management
- Dynamic dark (brightness modulation for enhanced video contrast)
- Trouble-free integration intoexisting lightengine platforms

Li-Fi, a significant source of transmission in this developing technology, overcomes the drawbacks of conventional Wi-Fi and other technologies and is very beneficial and implementable in a variety of industries.

Table 6.1: Comparison of Li-Fi with other techniques

	Cost	Reliability	Feasibility	Usability
Modulated Ultrasonic	High	Low	Low	High
Electromagnetic Spectrum	High	Low	High	High
Sound	Low	Low	High	Low
Li-Fi	Low	High	High	High

7. RESULT

This experiment gave us a glimpse into a new technology that will be used for data communication: LED light. In this experiment, we came to the conclusion that any LED light with embedded microprocessor functionality might be used for data transmission and reception. Additionally, if the light is visible, an increase or decrease in intensity will not interfere with communication between the transmitter and receiver. However, data transfer is not possible when a barrier stands between the transmitter (light) and receiver (LDR). Therefore, clear lighting is necessary for ongoing conversation. This technology can be advantageous because it is safer than Wi-Fi as data theft is not a concern here. The goal of this project is to createa straightforward and inexpensive data communication system that sends data utilizing LED. Butit can be further improved to read alpha-numeric dataand toenable video communication via a camera or otherdigital device. There are several options that can be investigated further. If this technology can be implemented practically, every light bulb could be utilised as a Wi-Fi hotspot to send wireless data, and we would be moving toward a future that is cleaner, greener, safer, and brighter. Li-Fi is a notion that is now generating a lot of interest, not least because it might provide a true and highly effective replacement for radio-based wireless. The airways are getting increasingly congested as more people and their numerous devices use wireless internet, making it harder and harder to receive a dependable, high-speed connection. This may address difficulties like the lack of radio-frequency bandwidth and provide internet access in places where conventional radio-based wireless is prohibited, such airplanes and hospitals. However, one drawback is that it only functions in a straight line of sight. Hence, through this prototype text data is transmitted successfully and work is going on to enable image communication.

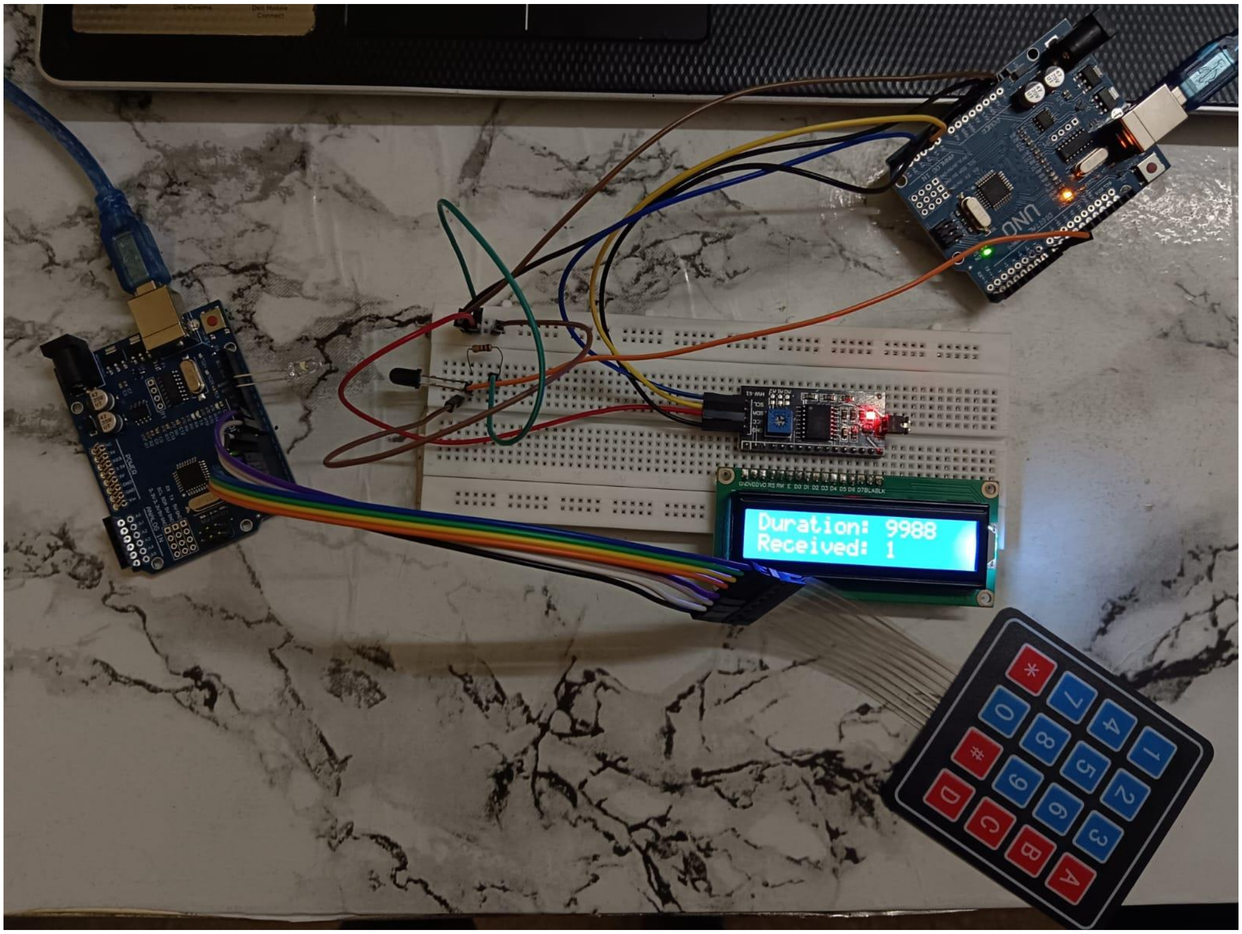


Figure 7.1 Final circuit showing Li-Fi Based text Transmission

8. CONCLUSION

The implicit operations of Visible Light Communication (VLC) or Li-Fi are vast and promising. We can have a more connected, safer, and cleaner future, if this technology is implemented on a large scale i.e., every light bulb could serve as a Wi-Fi hotspot. Li-Fi addresses the challenges of crowded airwaves as it provides an efficient alternative to radio-waves based wireless communication, thus increasing the interest in Li-Fi. As more devices connect to wireless networks, VLC could alleviate the shortage of radio-frequency bandwidth. Also, in environments where traditional radio-based wireless communicationis restricted, such as in aircraft or hospitals, internet can be provided using Li-Fi. Although it has many advantages, there is a noteworthy limitation i.e., its dependency on a direct line of sight, a challenge on which researchers are actively working to overcome. Currently, companies with a remarkable market share in LiFi are Nakagawa Laboratories, Oledcomm, LVX System, and ByteLight.

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