ABSTRACT

In this era of advanced science, a number of wireless connections are available to transfer data. It has become a very common and a handy tool to access wirelessly from coffee shop to a conference hall and also resulting in radiation.

Light Emitting Diode (LED) is used in different areas of everyday life. The advantage of this device is that in addition to their lightening capabilities, it can be used for data transmissions as well. Data is sent through LED that varies in intensity faster than a human eye can.

Li-Fi stands for Light-Fidelity. Li-Fi is a wireless optical networking technology that uses light emitting diodes (LEDs) for transmission of data. The term Li-Fi refers to visible light communication (VLC) technology that uses as medium to deliver high-speed communication in a manner similar to Wi-Fi. Li-Fi provides better bandwidth, efficiency, availability and security than Wi-Fi and has already achieved high speeds in the lab. This technology is supported by a global ecosystem of companies driving the adoption of Li-Fi.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

One of the most important daily activities is the transfer of data from one side to another side. The current wireless radio networks which connect us to the internet are slow when multiple devices are connected. As the number of devices decreases then access to internet increases, because of the fixed bandwidth available, makes it very difficult to enhance high data transfer rates and for connecting to a secure network. But for data transfer the radio waves, a smallest part of the spectrum is available. Light-Fidelity (Li-Fi) is transmission of data through illumination by taking the fiber out of fiber optics by sending data through a LED light bulb that varies in intensity faster than the human eye can follow. Li-fi is fast and cheap wireless communication system. The LED intensity is modulated so rapidly that human eye cannot notice, so the output appears constant. More sophisticated technique could dramatically increase VLC data rate. University of Oxford and the University of Edinburgh are focusing on parallel data transmission using array of LEDs, where each LED transmit a different data stream. Mixtures of red, green and blue LEDs are used to alter the light frequency encoding a different data channel. Li-fi has been dubbed, has already achieved blisteringly high speed in the lab. Researchers from Heinrich Hertz Institute in Berlin, Germany, have reached data rates of over 500 megabytes per second using a standard white-light LED.

Light is inherently safe and can be used in places where radio frequency communication is often deemed problematic, such as in air craft cabin, hospitals, etc. So visible light communication has the potential to solve the problem of lack of spectrum space, but also can enable novel application as shown in figure 1.1. The visible light spectrum is unused, not regulated, and can be used for communication at very high speed.

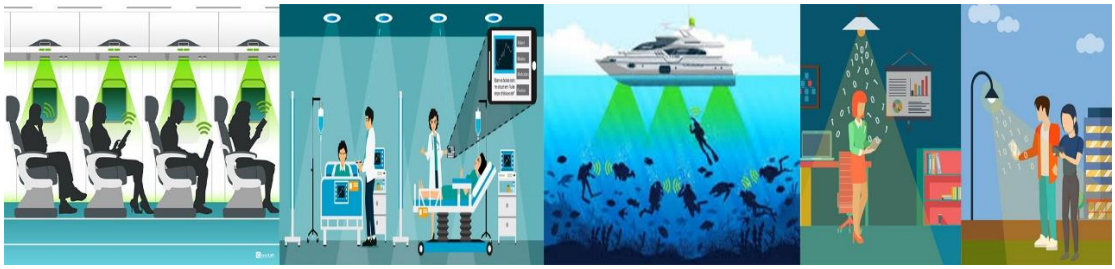


Fig. 1.1 Li-Fi Representation

This project aims to provide data transfer using encryption, session timeout, error checking, backup and header-based communication. Where user can interact with easy to use graphics user interface. Where LED is used for transmission and Phototransistor for reception. It works in indoor as well as outdoor. A Messenger application is developed using java, which provides all the features mentioned above. The name itself state that it is a messaging platform similar to WhatsApp, Telegram, etc. It controls Li-Fi hardware module according to user interactions on software. It demonstrates the use of light technology over Bluetooth and Wi-Fi.

1.2 Objective of the Project

- The prime objective of the project is to create an application that transmits data be it text, audio or video using Li-Fi technology for coping with the limited bandwidth problem we face in RF (Radio frequency) signals. For better, efficient, low cost, secure, digitally controlled and fast data transfer technique.
- One of the advantages of using Li-Fi over Wi-Fi is that it avoids radiation produced by Wi-Fi.
- The goal of our project is to transfer data with faster speed which is not easy to achieve through Wi-Fi and see whether transmission is possible through various mediums or not.
- To develop a system that allows users to interact with interface feasibly and achieve data security, data backup and error checking.

1.3 Applications

- **Smart Lighting**: Any private or public lighting including street lamps can be used to provide Li-Fi hotspots and the same communications.
- **Mobile Connectivity**: Laptops, smart phones, tablets and other mobile devices can interconnect directly using Li-Fi. Short range links give very high data rates and also provides security.
- **Hospital & Healthcare**: Li-Fi emits no electromagnetic interference and so does not interfere with medical instruments, nor is it interfered with by MRI scanners.
- **Aviation**: Li-Fi can be used to reduce weight and cabling and add flexibility to seating layouts in aircraft passenger cabins where LED lights are already deployed.

- **Underwater Communications**: Due to strong signal absorption in water, RF use is impractical. Acoustic waves have extremely low bandwidth and disturb marine life.
- **Vehicles & Transportation**: LED headlights and tail-lights are being introduced. Street lamps, signage and traffic signals are also moving to LED.

1.4 Literature Survey

The most of the people are using Wi-Fi Internet devices, which will be useful for 2.4-5GHz RF to deliver wireless Internet access surrounded our home, offices, schools, and some public places also. We are quite dependent upon these nearly ubiquitous services. While Wi-Fi can cover an entire house, school, the bandwidth is limited to 50-100 megabits per seconds (Mbps). It is a most current Internet services, but insufficient for moving large data files like HDTV movies, music libraries and video games. The most of it dependent upon 'the cloud' or our own 'media services' to store all of our files, including movies, photos, audio and video devices, games, the more and most bandwidth and speed should be needed to access this data. Therefore RF-based technologies such as today's Wi-Fi are not the optimal way. In addition, Wi-Fi may not be the most efficient way to provide new desired capabilities such as precision indoor positioning and gesture recognition. The optical wireless technologies, sometimes called visible light communication (VLC), and more recently referred to as Li-Fi. On the other hand, offer an entirely new paradigm in wireless technologies in the terms of communication speed, usability and flexibility, reliability.

VLC is the possible solution to the global wireless spectrum shortage. Li-Fi technology is a fast and cheap optical version of Wi-Fi. It is a based on Visible Light Communication. The VLC is a data communication medium using visible light between 400THz to 375THz as optical carrier for the data transmission and illumination. The data is encoded in the light to generate new data stream by varying the flickering rate, to be clearer, by modulating the LED light with the data signals, it illustrates the communication source. This is a whole new spectrum of possibilities as compared to the radio waves spectrum and is 10000 times more in size. Visible light is not injurious to vision and are a mandatory part of an infrastructure, therefore abundantly available and easily accessible. Comparing the number of radio cellular base stations (1.4 million) to the number of light bulbs (14 billion) installed already

the ratio is coincidently same i.e. 1:10000

This technology truly began during the 1990's in countries like Germany, Korea, and Japan where they discovered LED's could be switched on & off to send information. The D-Light project at Edinburgh's Institute for Digital Communications was funded from January 2010 to January 2012. Haas promoted this technology in his 2011 TED Global talk by achieving transmission of around 10Mbps – comparable to a fairly good UK broadband connection. Two months later he achieved 123Mbps. On 12th July 2011, he used a table lamp with an LED bulb to transmit a video of blooming flowers that was then projected onto a screen behind him. During the event he periodically blocked the light from lamp to prove that the lamp was indeed the source of incoming data and helped start a company to market it. PureLiFi, formerly PureVLC, is an original equipment manufacturer (OEM) firm set up to commercialize Li-Fi products for integration with existing LED-lighting systems. In October 2011, companies and industry groups formed the Li-Fi Consortium, to promote high-speed optical wireless systems and to overcome the limited amount of radio-based wireless spectrum available by exploiting a completely different part of the electromagnetic spectrum. A number of companies offer unidirectional VLC products which is not the same as Li-Fi.

VLC technology was exhibited in 2012 using Li-Fi. By August 2013, data rates of over 1.6 Gbps were demonstrated over single color LED. In September 2013, a press release said that Li-Fi, or VLC systems in general, do not require line-of-sight conditions. In October 2013, it was reported Chinese manufacturers were working on Li-Fi development kits.

Li-Fi technology uses a part of the electromagnetic spectrum that is still not greatly utilized. Light is in fact very much part of our lives for millions and millions of years and does not have any major ill effect. More over there is 10,000 times more space available in this spectrum and just counting on the bulbs in use, it also multiplies to 10,000 times more availability as an infrastructure, globally.

Karabi Deka, Parthana Bora, Pritam Kr. Goswami, Bhargobi Borah, Deepjyoti Chakraborty et al; in their paper title “Design of a Li-Fi based Data Transmission System” presented a brief survey on new technology for data communication such as Li-Fi and advantages of Li-Fi with existing technologies.

CHAPTER 2

DESIGN AND ANALYSIS

2.1 Methodology

The Li-Fi system consists of mainly two parts, the transmitter and the receiver. LED light is used as signal source between two end systems. Data is carried using LED light. The transmitter part chops the input signal with the required time period and transmits the data in the form of 1's and 0's using a LED bulb. These 1's and 0's are nothing but the flashes (on and off) of the bulb. The receiver part catches these flashes using a phototransistor and amplifies the signal to produce the output.

In this project we first convert the data file to be transferred into a binary stream of 0's and 1's which is fed into the Li-Fi TX hardware which transmits this data through light. We set a high threshold voltage as on state and a low threshold voltage as off state. Whenever the LED is in on state it transmits a 1 and when it is in off state it transmits a 0. The switching transistor is capable of toggling the state of led in nanoseconds which increases the speed of transmission to some extent. The Li-Fi RX after sensing the binary stream sends it to the system where the original data file is retrieved.

In this project a data file can be a text message or any file. The data file is sent using header-based communication. Where it follows four-way handshake as shown in figure 2.1. During header transfer, error checking is done at each level using parity.

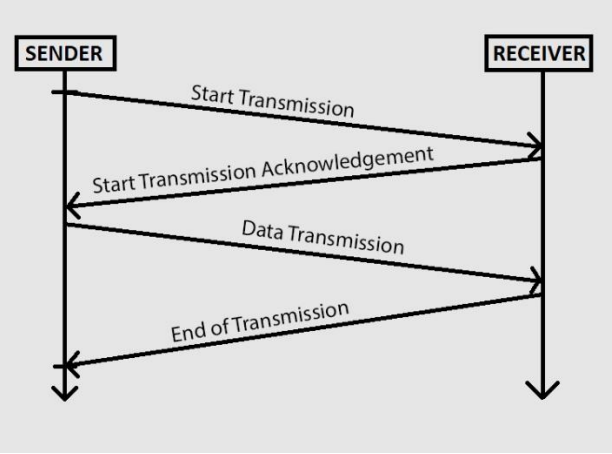


Fig. 2.1 Four-way handshake

Only text messages are encrypted using Caesar cipher. The text messages and metadata of files are stored in database for data backup. Text messages and files (file transfer) have different header formats.

a) Text Message:

Text messages are normal day to day messages which are sent using alphabets and numeric characters, between two or more users of desktops/laptops devices. Each user has a unique ID number which is a combination of digits, numbers or/and special characters used in headers.

Let us consider the sender and receiver ID's as follows in given examples.

Sender ID = 00000000000000000000000000000001

Receiver ID = 00000000000000000000000000000002

Text message = ab

Step 1: Start Transmission (ST)

To enable connection between two users, Sender initiates by sending start transmission header. Where header consists of sender ID (32 bytes) followed by Receiver ID (32 bytes), text (2 bytes) and parity (1 byte) as shown in figure 2.2. First column is sender ID number. Second column is receiver ID number. Third column is defined as 00, to represent it is a text header. Fourth column is parity that can be 0/1 accordingly, when no. of 1's in header are even then parity is 0 and vice versa.

Ex -

00000000000000000000000000000001 00000000000000000000000000000002 00 0

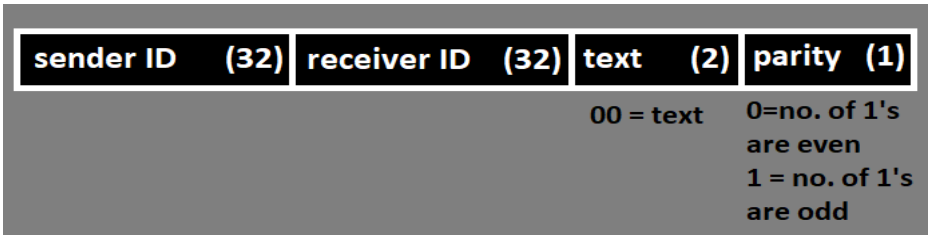


Fig. 2.2 ST-Text Header

Step 2: Start Transmission Acknowledgement (STA)

After successful reception of error free ST header, receiver sends start transmission acknowledgement header. Where header consists of sender ID (32 bytes) followed by receiver ID (32 bytes), text (2 bytes), parity (1 byte), acknowledgement (1 byte) as shown in figure 2.3. First column is sender ID number. Second column is receiver ID number. Third column is defined as 00, to represent it is a text header. Fourth column is parity that can be 0/1 accordingly, when no. of 1's in header are even then parity is 0 and vice versa. Fifth column is acknowledgement which is defines as 6.

Ex -

00000000000000000000000000000002 00000000000000000000000000000001 00 0 6

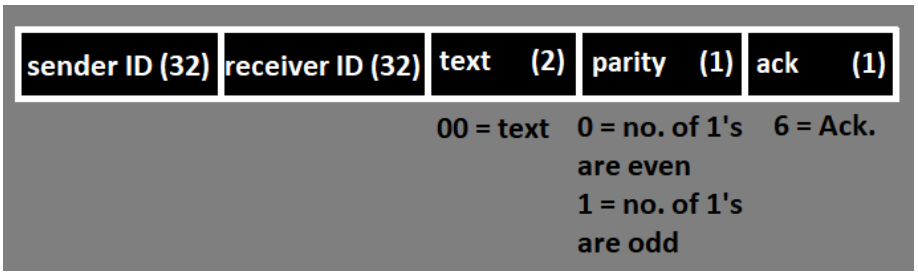


Fig. 2.3 STA-Text Header

Step 3: Data Transmission (DT)

After successful reception of error free STA header, sender sends data transmission header. Where header consists of encrypted payload and parity (1 byte) as shown in figure 2.4. First internal column is payload, which is actual text message. Second internal column is parity that can be 0/1 accordingly, when no. of 1's in header are even then parity is 0 and vice versa. Two internal columns are encrypted using Caesar cipher technique.

Ex -

Payload = ab
Parity = 0
Payload + parity = ab0

Encrypted (payload + parity) =]^,

a (ascii = 97), b (ascii = 98) and 0 (ascii = 48)

encrypted (97 - 4 = 93), encrypted (98 - 4 = 94) and encrypted (48 - 4 = 44)

] (ascii = 93), ^ (ascii = 94) and , (ascii = 44)

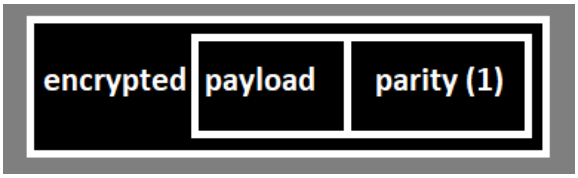


Fig. 2.4 DT-Text Header

Step 4: End of Transmission (ET)

After successful reception of error free DT header, receiver sends end of transmission header. Where header consists of end (1 byte) as shown in figure 2.5. It consists of single column where end is defined as 4, which indicates successful termination of session.

Ex -

4

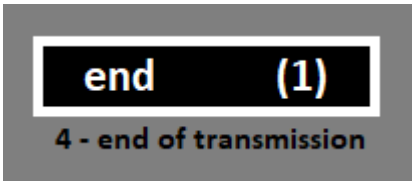


Fig. 2.5 ET-Text Header

The overall procedure is shown in figure 2.6. Before feeding headers to Li-Fi hardware all the headers are converted from ASCII to binary equivalent. Parity of headers are based on binary.

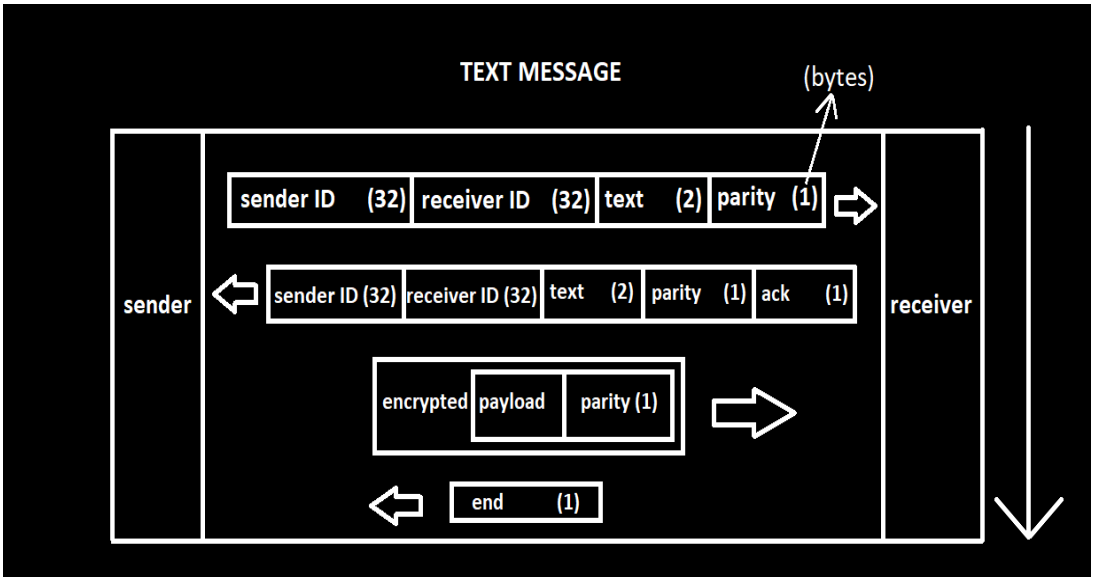


Fig: 2.6 Message format

b) File Transfer:

File transfer is the movement of one or more files from one location to another. It can be desktops/laptops devices. Each user has a unique ID number which is a combination of digits, numbers or/and special characters used in headers.

Let us consider the sender and receiver ID's as follows in given examples.

Sender ID = 00000000000000000000000000000001

Receiver ID = 00000000000000000000000000000002

File name = a.txt

File Size = 20 bytes

File Content = abcdefghijklmnopqrst

Step 1: Start Transmission (ST)

To enable connection between two users, Sender initiates by sending start transmission header. Where header consists of sender ID (32 bytes) followed by Receiver ID (32 bytes), file (2 bytes), parity (1 byte), file size in bytes and file name in text format as shown in figure 2.7. First column is sender ID number. Second column is receiver ID number. Third column is defined as 01, to represent it is a file header. Fourth column is parity that can be 0/1 accordingly, when no. of 1's in header are even then parity is 0 and vice versa. Fifth column is size of file in bytes. Sixth column is file name.

Ex -

00000000000000000000000000000001 00000000000000000000000000000002 01 0 20 a.txt

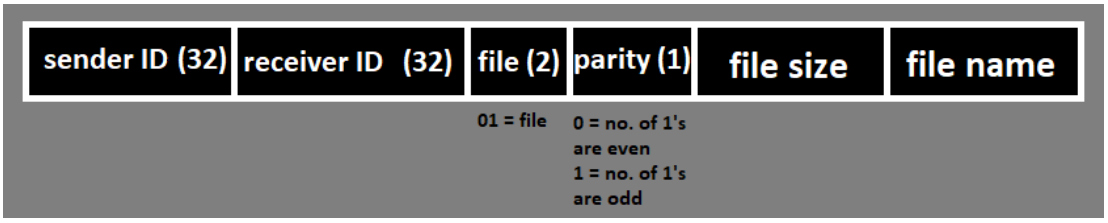


Fig. 2.7 ST-File Header

Step 2: Start Transmission Acknowledgement (STA)

After successful reception of error free ST header, receiver sends start transmission acknowledgement header. Where header consists of sender ID (32 bytes) followed by receiver ID (32 bytes), file (2 bytes), parity (1 byte), acknowledgement (1 byte) as shown in figure 2.8. First column is sender ID number. Second column is receiver ID number. Third column is defined as 01, to represent it is a file header. Fourth column is parity that can be 0/1 accordingly, when no. of 1's in header are even then parity is 0 and vice versa. Fifth column is acknowledgement which is defines as 6.

Ex - 00000000000000000000000000000001 00000000000000000000000000000002 01 0 6

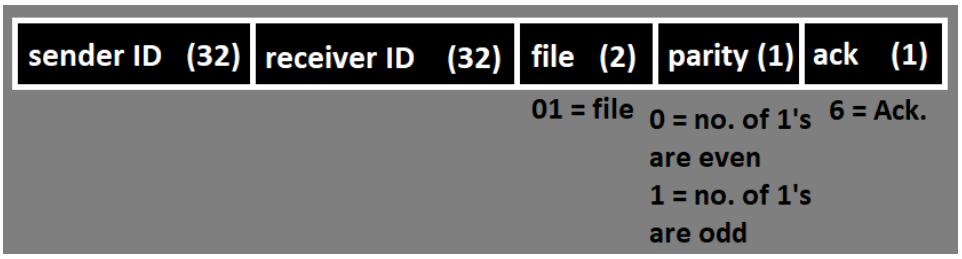


Fig. 2.8 STA-File Header

Step 3: Data Transmission (DT)

After successful reception of error free STA header, sender sends data transmission header. Where header consists of payload as shown in figure 2.9. It consists of single column where payload is actual data present in file.

Ex-

abcdefghijklmnopqrst

Fig. 2.9 DT-File Header

Step 4: End of Transmission (ET)

After successful reception of error free DT header, receiver sends end of transmission header. Where header consists of end (1 byte) as shown in figure 2.10. It consists of single column where end is defined as 4, which indicates successful termination of session.

Ex -

4

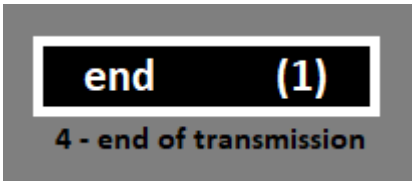


Fig. 2.10 ET-File Header

The overall procedure is shown in figure 2.11. Before feeding headers to Li-Fi hardware all the headers are converted from ASCII to binary equivalent. Parity of headers are based on binary.

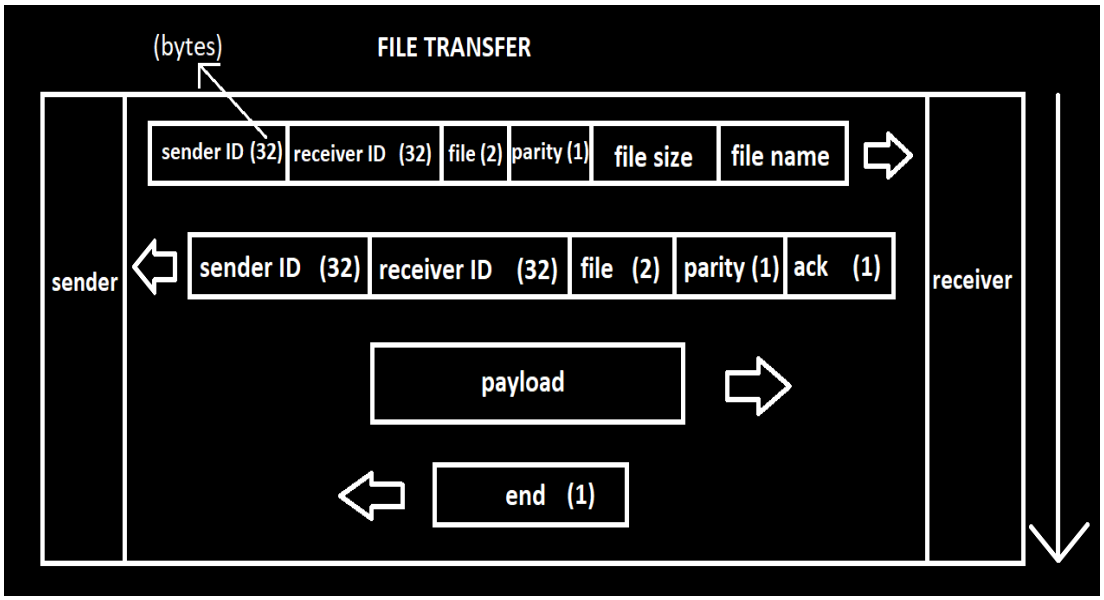


Fig: 2.11 File transfer format

2.2 Software and Hardware Requirements

Hardware Requirements

- **LED** (5mm white led)

  A light-emitting diode (LED) is a semiconductor light source that emits light when current flows through it. It is used to transmit (TX) data in Li-Fi Hardware.

- **Resistor** (100Ω)

  A resistor is a passive two-terminal electrical component that resists the flow of electricity. It is placed in series with LED to limit the current flow and prevent it from burns.

- **Phototransistor** (Vishay TEPT5600)

  The phototransistor is a semiconductor device that is able to sense light levels and alter the current flowing between emitter and collector according to the level of light it receives.

- **Digital LDR Module**

  The LDR Sensor Module is used to detect the presence of light / measuring the intensity of light. The output of the module goes high in the

presence of light and it becomes low in the absence of light. The sensitivity of the signal detection can be adjusted using potentiometer. Where LDR is replaced with phototransistor and also remove capacitor(C2) which is parallel to phototransistor as shown in hardware architecture in appendix 3.

- **PL2303 USB to TTL**

  It is used to connect serial device (Li-Fi Hardware) to your PC via USB port.

- **Jumper wires**

  Jumper wires are simply used to connector pins at each end, allowing them to be used to connect two points to each other without soldering.

Software Requirements

- **Operating System**

  An Operating System (OS) is an interface between a computer user and computer hardware. Li-Fi works on Windows, Linux and macOS.

- **PL2303 driver**

  A device driver or hardware driver is a group of files that enable one or more hardware devices to communicate with the computer's operating system. PL2303 driver for windows and macOS are to be downloaded additionally whereas it is inbuilt in Linux.

- **MySQL Database and MySQL java connector**

  MySQL is an open-source relational database management system. Which interact with Li-Fi Messenger using java connector.

- **RXTX java library**

  The need to communicate with devices connected to serial ports is a common application requirement. Falling outside the purview of the Java SE platform, serial and parallel port communication has been addressed with a project called RXTX.

- **JVM** (Java Virtual Machine)

  Java Virtual Machine (JVM) is an engine that provides runtime environment to drive the Java Code or applications. It converts Java bytecode into machines language.

2.3 Flow Chart

The entire flow of the execution is represented in the figure 2.12.

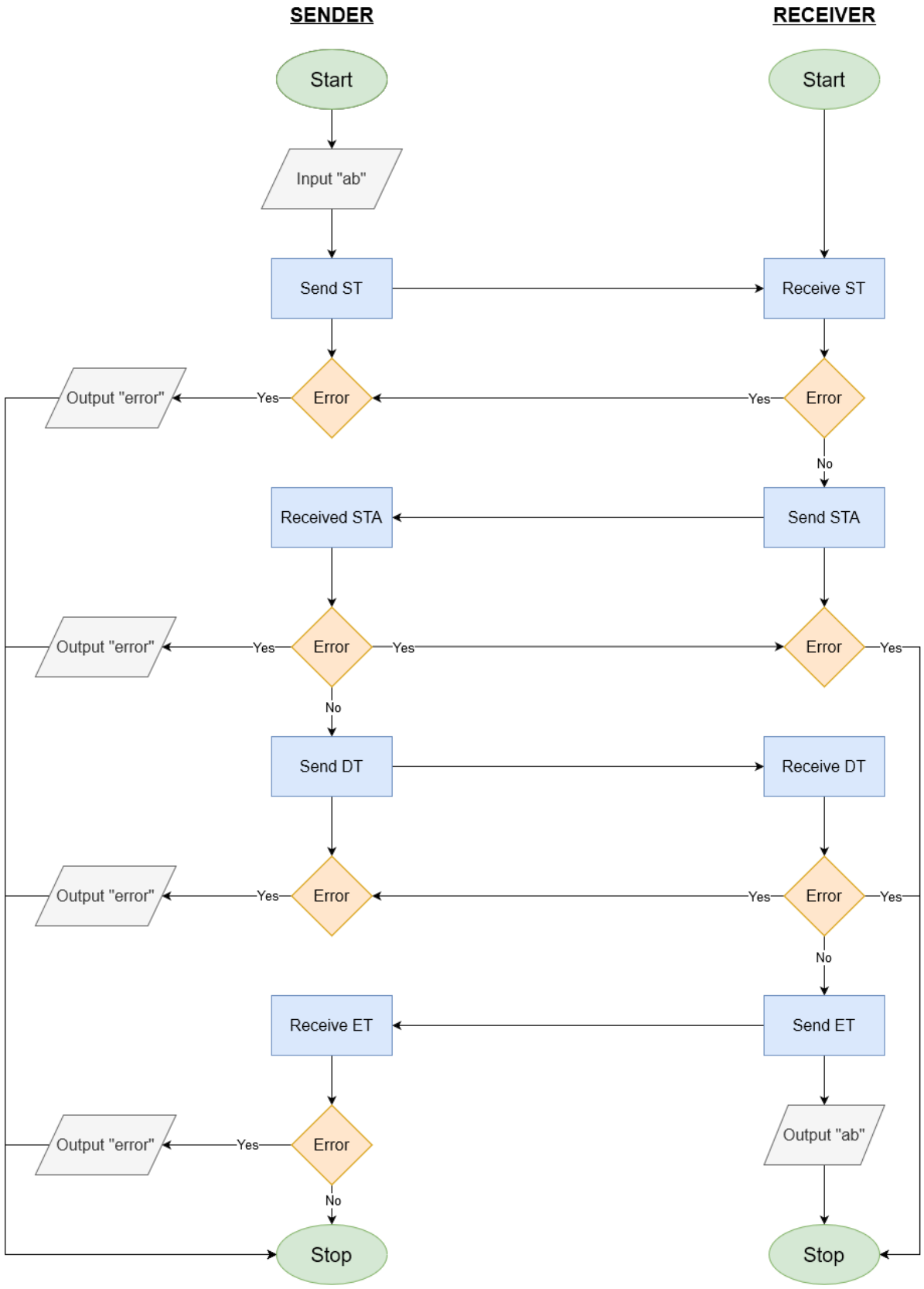


Fig: 2.12 Flow chart of headers

CHAPTER 3

IMPLEMENTATION

3.1 Hardware Module

Li-Fi hardware module uses LED (Light Emitting Diode) to transmit (TX) and phototransistor to receive (RX) as shown using arrow marks in figure 3.1. It is connected to laptop/desktop using USB (Universal Serial Bus) port. The circuit diagram/hardware architecture is shown in appendix 3.

When the data received from USB to Li-Fi hardware is 0, then LED turns off. Similarly, turns on when it is 1. Phototransistor (Receiver) sends 1 from Li-Fi hardware to USB, when LED is on. Similarly, 0 when LED is off. The data is sent and received using RXTX java library which controls USB.

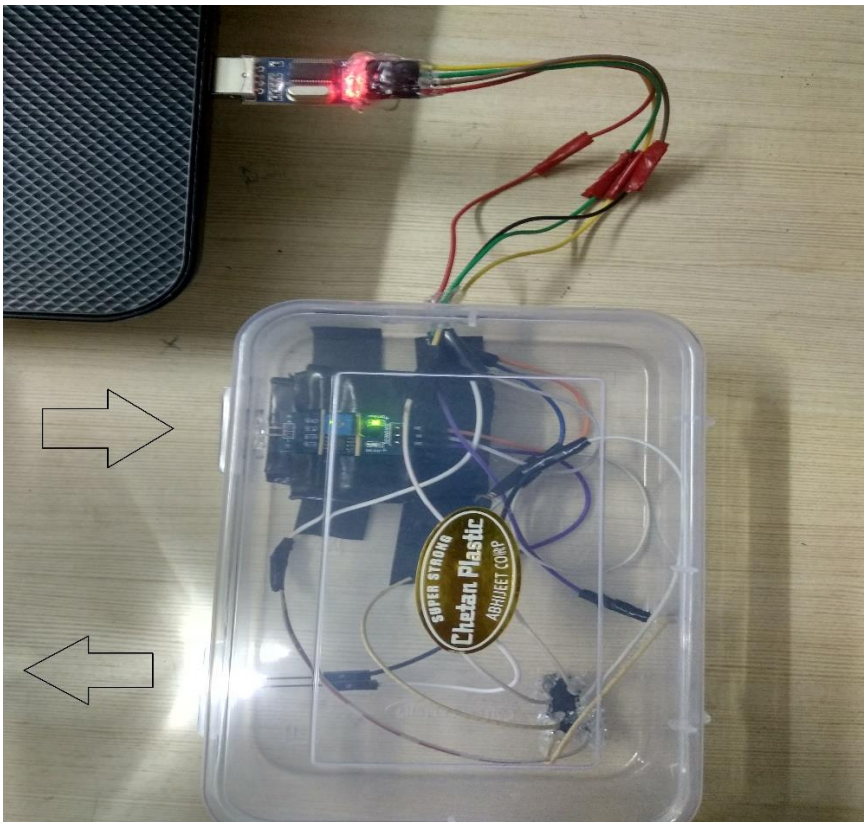


Fig: 3.1 Li-Fi Hardware

It even works when placed under ambient light. It can transmit data through water, glass or plastic. The only thing is that we need to adjust the detector in such a way that it can receive the light that has been refracted due to the change in mediums. Data can't be transmitted is an opaque object is placed between sender and receiver. It can also be seen that the intensity of light received by phototransistor is to be

selected/set properly for being able to receive the data.

PL2303 USB to TTL module is used to send data from USB to Li-Fi hardware module. Where it works with Windows, Linux, macOS, etc. Jumper wires are used to connect all the internal circuits.

3.2 Connection Module

Connection module acts as a bridge between hardware and software. It enables connection between Li-Fi Messenger and Li-Fi hardware. After connecting Li-Fi hardware to laptop/desktop, then click on scan button to scan on which port it is connected to. Using dropdown list appropriate port is selected, which is COM3 in figure 3.2. Next three fields are MySQL database credentials. Database is used to store text messages and metadata of files transferred. Host name, port number, username and password are required to connect with database. Previously entered database credentials are saved in system to avoid redundancy. It automatically fills the details and can be changed there it self if required. Launch button activates Li-Fi Messenger.

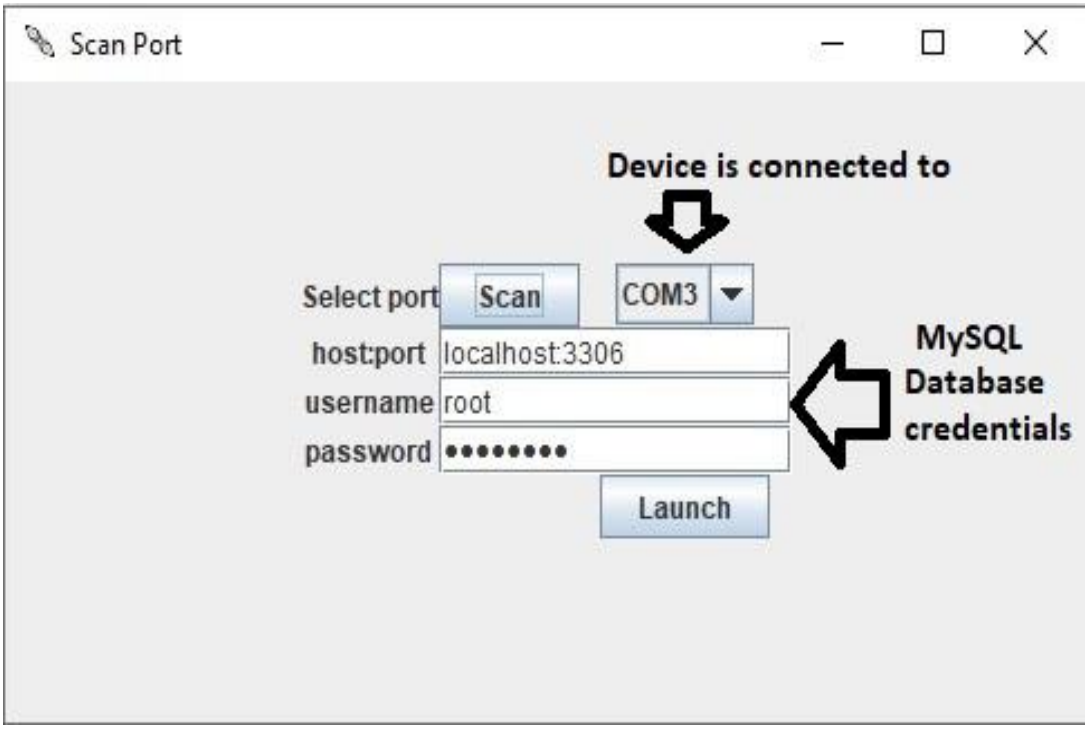


Fig: 3.2 Connection Frame

3.3 Homepage

Homepage consists of many buttons and fields as shown in figure 3.3. All the

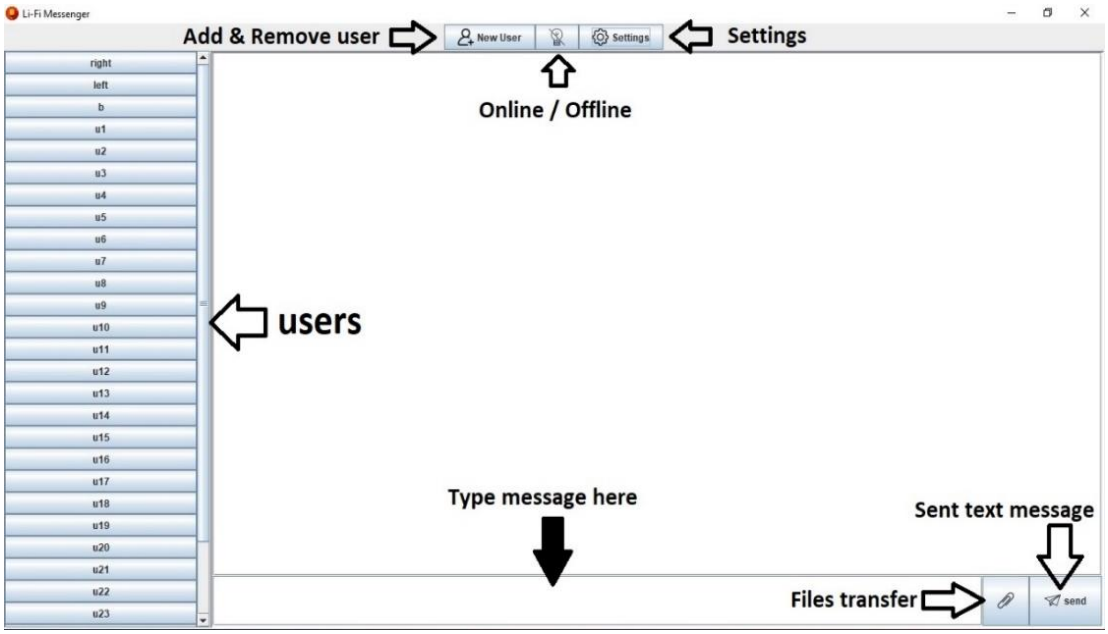


Fig: 3.3 Homepage

users are placed to the left side of homepage. Top three buttons are settings, new user and online/offline is used to activate/deactivate connection between Li-Fi Messenger and Li-Fi Hardware. where user and settings are discussed in detail below. Middle field displays text messages and metadata of files transferred from database for appropriate user to the left. Bottom text field is used to type text message and send it using send button. Paper clip image button is used for file transfer.

3.4 Setting Module

In order to establish communication between two recipients. They need to communicate at same speed. Baud rate is simply the number of bits transmitted per second. Which can be adjusted using drop down list or custom text box as shown in figure 3.4. Appropriate radio buttons to their left are to be selected before saving. It needs to restart to apply changes. It can be verified using present baud rate text.

Each used has a unique ID number which can be a combination of digits, alphabets or/and special symbols and ranges to 32 characters. These details are to be entered initially to make thing work.

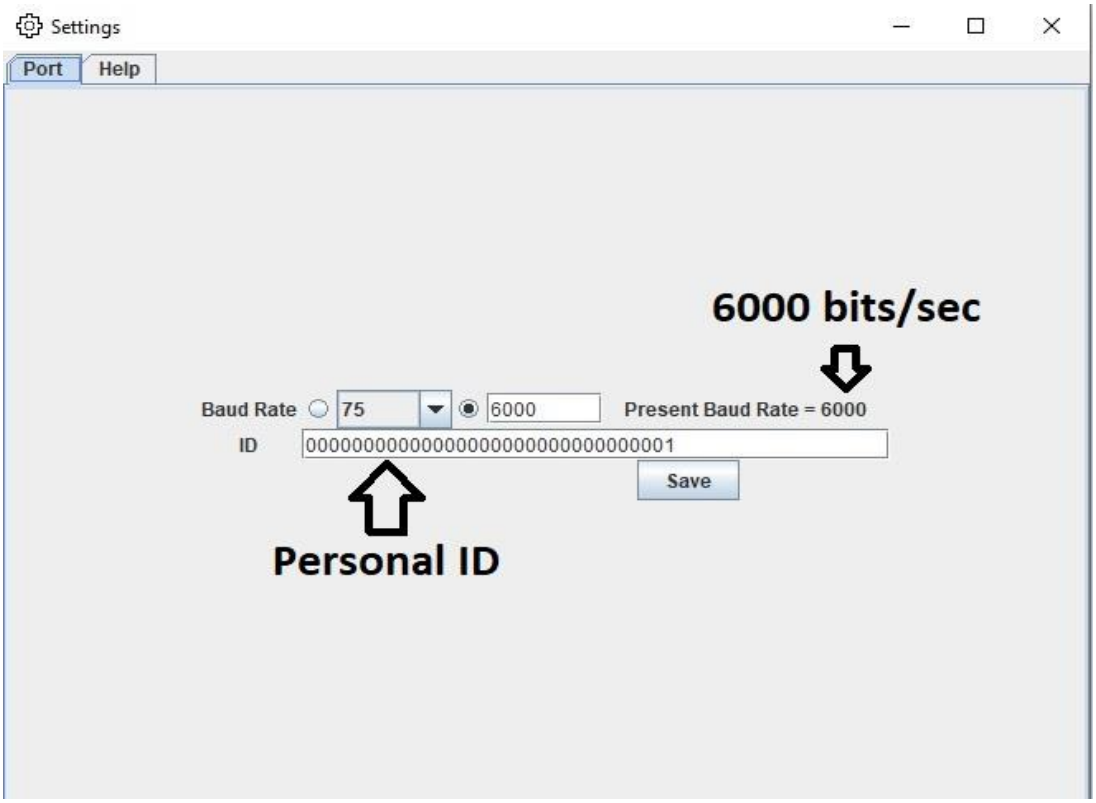


Fig: 3.4 Setting Frame

3.5 Help Module

Help module is used to send any query or feedback to Li-Fi Messenger author. Send button opens/redirects to default web browser, it opens gmail and place subject, body and receiver details appropriately. User need to click on send button in web browser. Clear button is used to clear the content on help module.

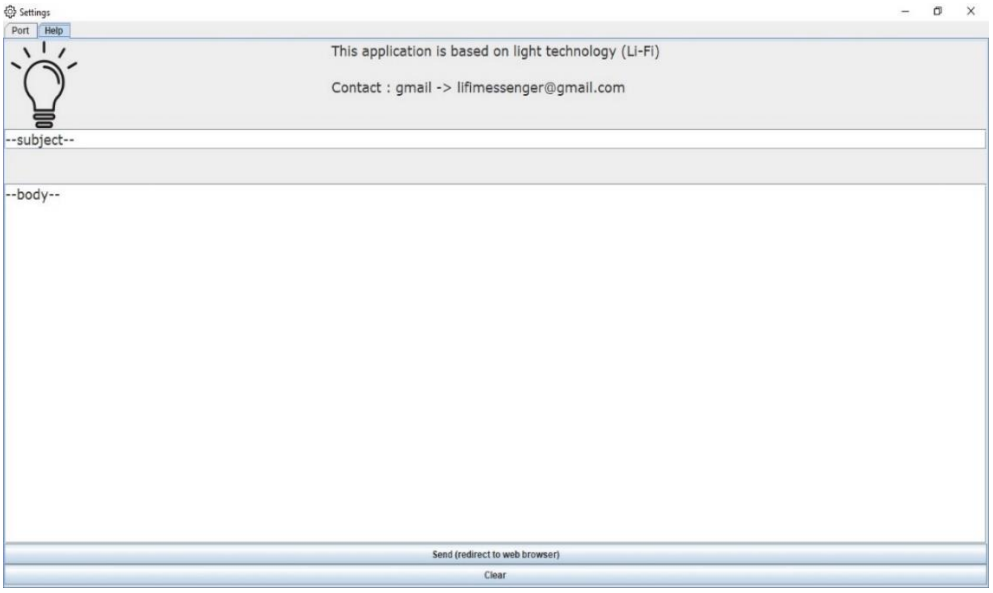


Fig: 3.5 Help Frame

3.6 User Data Module

User data module is used to manipulate user data. Add button is used to add

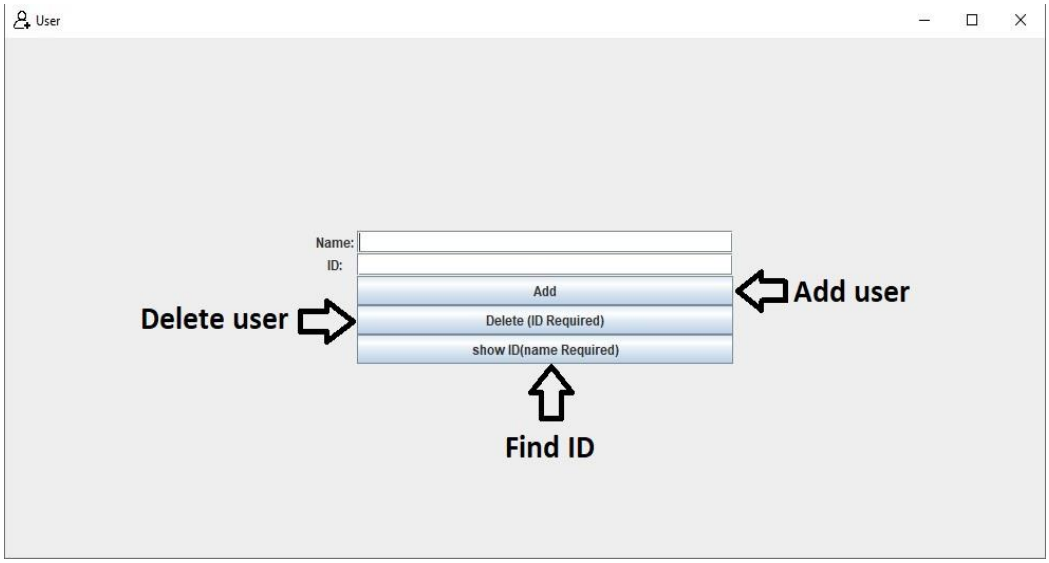


Fig: 3.6 User Data Frame

user, which requires user's ID and name. Delete button is used to delete user, which requires user's ID. Show ID button is used to get the ID of specific user, which requires user's name.

After performing add or remove operation, it needs to be restarted to apply changes. Added users are displayed to the left of homepage.

CHAPTER 4

TESTING AND RESULTS.

In order to know whether the prescribed project is working properly or not testing has to be done. They are two feature text messages and file transfer to be tested.

Benefits of Testing

- Better Quality Products
- Satisfied Customers
- Improve User Experience
- Project Optimization

a) Text Message:

Testing:

Let us send a text message "hai" from one device to other as shown in figure 4.1.

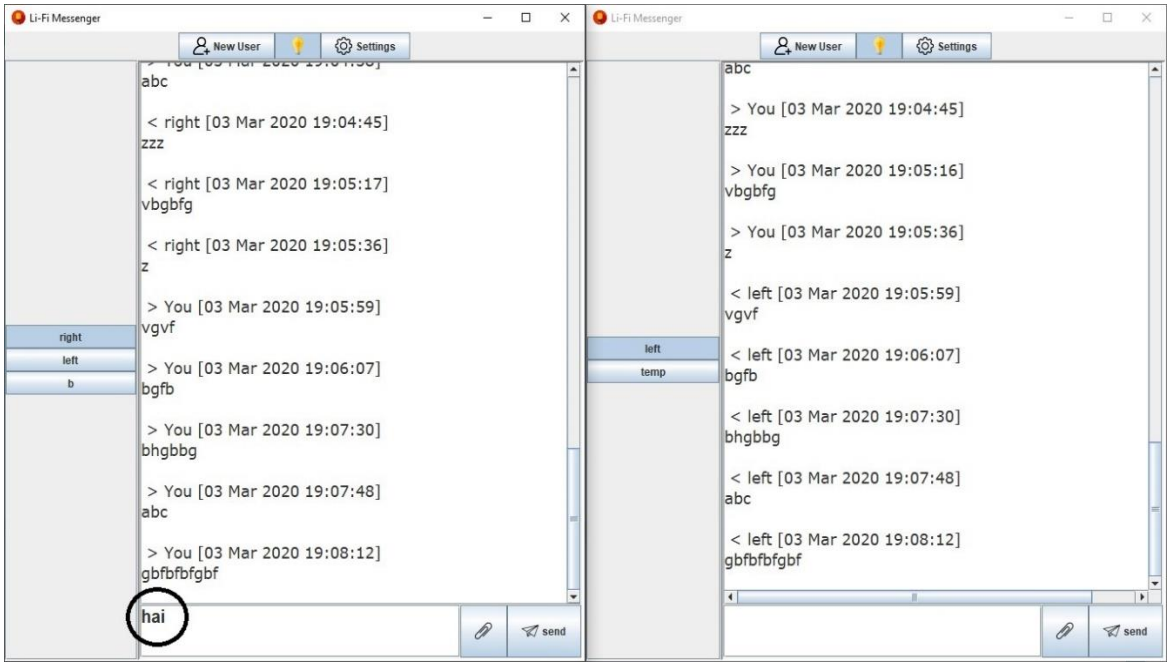


Fig: 4.1 Text message test 1

Let us consider left module username as 'left' and right module username as 'right'. Both the users should be in online and working at same baud rate. 'left' types "hai", and sends it using send button. In the background estimated delivery time is calculated and displayed on 'left' user screen.

Results:

After successful four-way handshaking, message is displayed on screen as shown in figure 4.2. > and < are used to indicate sent and received.

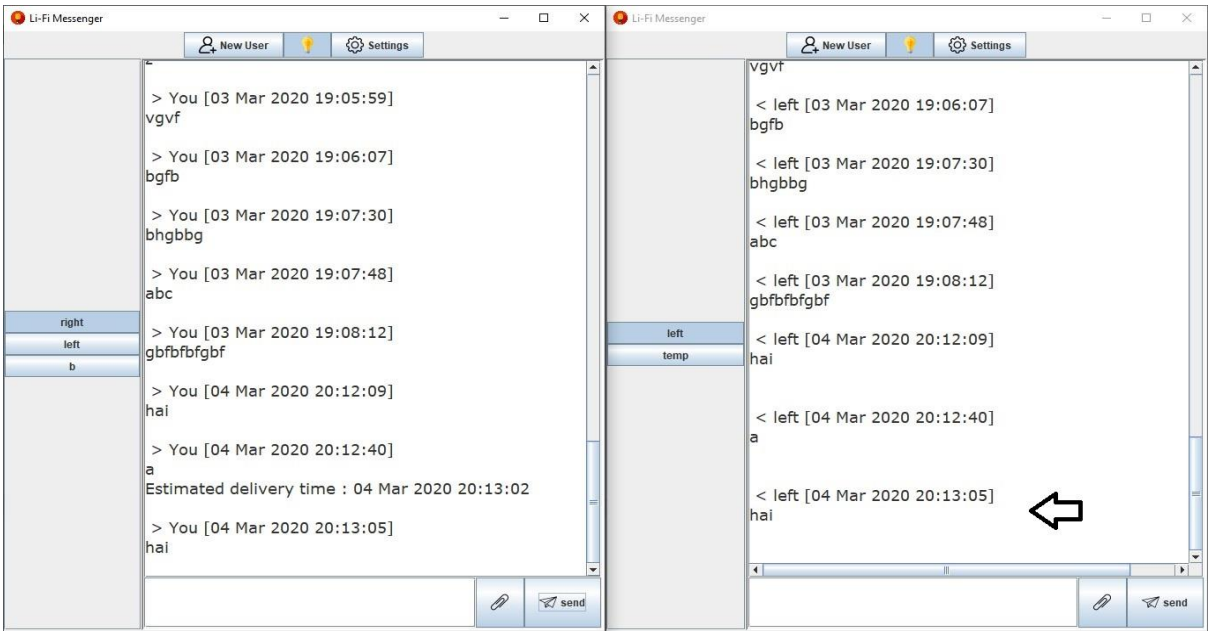


Fig: 4.2 Text message test 2

b) File Transfer:

Testing:

Let us send a file "Project1.layout" from one device to other as shown in figure 4.3.

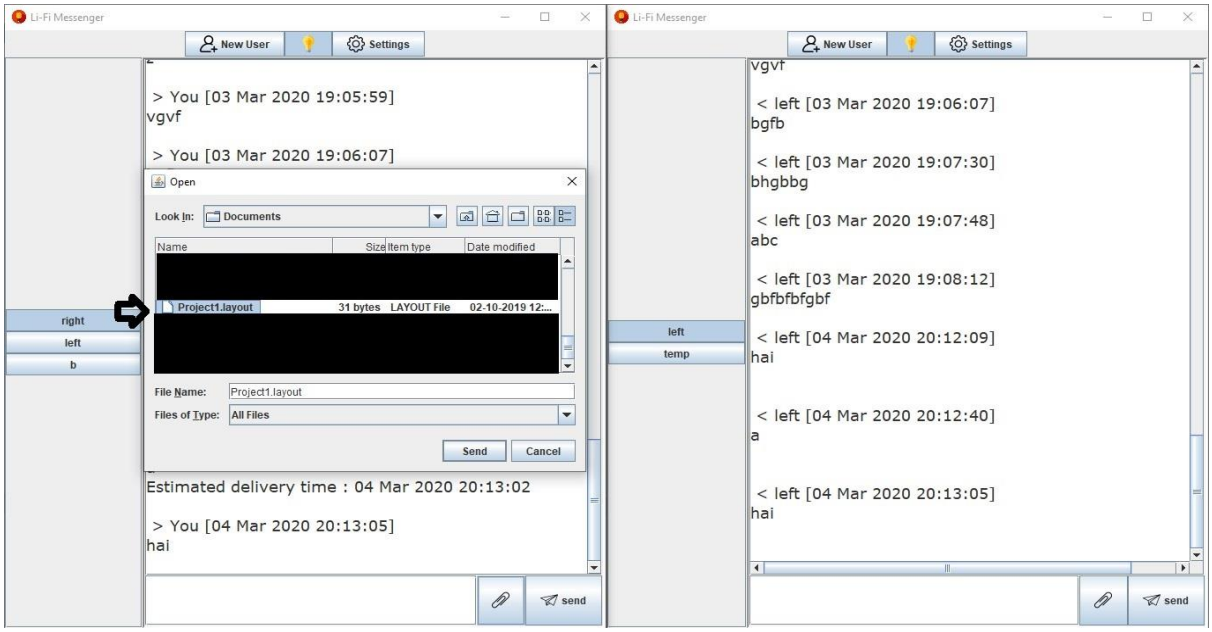


Fig: 4.3 File transfer test 1

Let us consider left module username as ‘left’ and right module username as ‘right’. Both the users should be in online and working at same baud rate. ‘left’ sends a file “Project1.layout”. In the background estimated delivery time is calculated and displayed on ‘left’ user screen.

Results:

After successful four-way handshaking, File path is displayed on ‘right’ user and file name is displayed on ‘left’ user as shown in figure 4.4. > and < are used to indicate sent and received.

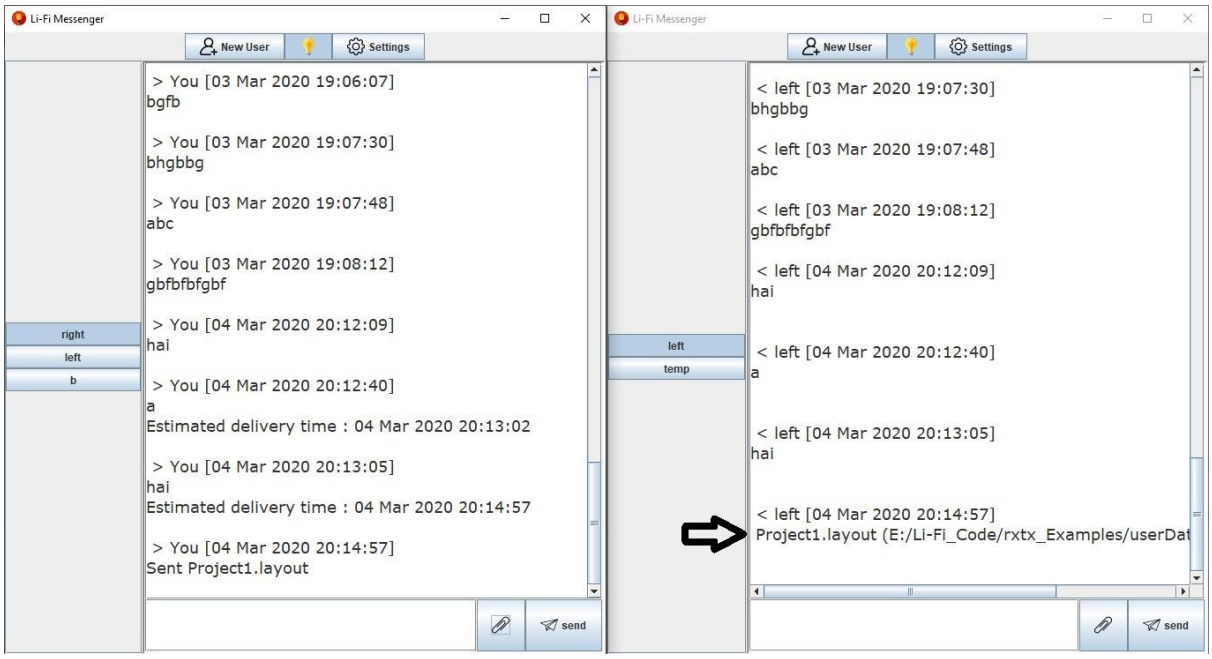


Fig: 4.4 File transfer test 2

CHAPTER 5

CONCLUSIONS

5.1 Conclusions

1. The planning, design, implementation or execution of the whole work has successfully done. If this Li-Fi technology can be put into practical use, every bulb can be used something like a Wi-Fi hotspot to transmit wireless data and we will proceed toward a cleaner, greener, safer and brighter future.
2. The concept of Li-Fi is currently attracting a great deal of interest because it may offer a genuine and very efficient alternative to radio-based wireless. As growing number of people and their many devices access wireless internet, the airwaves are becoming increasingly clogged, making it more and more difficult to get a reliable, high-speed signal. This may solve issues such as the shortage of radio-frequency bandwidth and allow internet where traditional radio-based wireless isn't allowed such as aircraft or hospitals.
3. One of the shortcomings however is that it only works in direct line of sight. It can be overcome by introducing a false ceiling concept where we can have a broader area for communication with increased line of sight.
4. Li-Fi is the upcoming and growing technology acting as catalyst for various other developing and new inventions/technologies. Therefore, there is certainty of development of future applications of the Li-Fi which can be extended to different platforms and various walks of human life.

5.2 SCOPE OF FUTURE WORK

The scope of Li-Fi is vast. Li-Fi is an emerging technology and hence it has vast potential. The area of Li-Fi is very broad in the manner of hospitals, academics, airlines and more. It can be used in the places where it is difficult to lay the optical fiber like in hospitals and nuclear power plants. In operation theatre, Li-Fi can be used for modern medical instruments. In traffic signals Li-Fi can be used. We can communicate with the LED lights of the cars and reduce the traffic congestion by implementing thousand and millions of street lamps to transfer data. In aircraft, Li-Fi can be used for data transmission without interfering with radar communication.

A portable Li-Fi can be brought into existence using the said principles, with

which we can transmit and receive data at very high-speed rate. This can be used in a smart phone which has a photo detector in it. Consider a series of LEDs in the smart mobile nearer to the light detector and as how a Wi-Fi option is provided in the mobile, if an option known as Li- Fi is present, if we turn it ON the LEDs which are placed nearer to the light detector which is working as a normal LED on the phone will start acting as a portable Li-Fi where these LEDs will do the operations as mentioned above and the photo detector which is in the mobile will sense it and data will be transmitted in which ever place we are.

REFERENCES

1. Design of a Li-Fi based Data Transmission System (International Journal of Innovative Research in Science, Engineering and Technology - Vol. 6, Issue 9, September 2017).
2. LIGHT FIDELITY DATA TRANSMISSION PROJECT REFERENCE NO.: 39S_BE_1098
3. Forget Wi-Fi. Meet the new Li-Fi Internet | Harald Haas (TED).

APPENDIX-1

SOURCE CODE

Module 1: Connection Module

```
//get port name
Global.portName = jcb.getSelectedItem().toString();

//connect to database
Class.forName("com.mysql.cj.jdbc.Driver");
Global.con = DriverManager.getConnection("jdbc:mysql://" + hostTextField.getText() +
        "/?" , usernameTextField.getText() , String.valueOf(passwordTextField .getPassword()));
Global.stmt = Global.con.createStatement();
Global.stmt.executeUpdate("CREATE DATABASE IF NOT EXISTS "+ Global.DATABASENAME +";");
Global.stmt.executeUpdate("use "+Global.DATABASENAME);

//Launch Li-Fi messenger
SwingUtilities.invokeLater(new Runnable() { public void run() { new LIFI(); } } );
```

Module 2: Homepage

```
//Left and Right Panel
JPanel panelLeft = new JPanel();
JPanel panelRight = new JPanel();
JPanel panelTop = new JPanel();

//Create a border
Border panelRightBorder = BorderFactory.createLoweredBevelBorder();
panelRight.setBorder(panelRightBorder);

//Create a GridBag
GridBagConstraints c = new GridBagConstraints();
c.fill = GridBagConstraints.BOTH;  //fill panel HORIZONTALly and VERTICALly

//Left panel
c.weightx = 0.2;  //20% (row)
c.weighty = 1;    //100% (column)
c.gridx = 0;
c.gridy = 1;
JScrollPane scrollPaneLeft = new JScrollPane(panelLeft,
                                ScrollPaneConstants.VERTICAL_SCROLLBAR_AS_NEEDED,
                                ScrollPaneConstants.HORIZONTAL_SCROLLBAR_AS_NEEDED);
jfrm.add(scrollPaneLeft,c);

//right panel
c.weightx = 0.8;  //80% (row)
c.weighty = 1;    //100% (column)
c.gridx = 1;
c.gridy = 1;
jfrm.add(panelRight,c);

//top panel
c.weightx = 1;
c.weighty = 0.004;
c.gridx = 0;
c.gridy = 0;
c.gridwidth = 2;
jfrm.add(panelTop,c);

//top panel buttons
//new user
ImageIcon newUserButtonIcon = new ImageIcon("icons/add.png"); // load the image
image = newUserButtonIcon.getImage(); // transform it
newimg = image.getScaledInstance(20, 20,  java.awt.Image.SCALE_SMOOTH);
```

```
44  newUserButtonIcon = new ImageIcon(newimg);  // transform it back
45  JButton newUserButton = new JButton("New User", newUserButtonIcon);
46
47  //offline (delare at starting of class)
48  image = offlineToggleButtonIcon.getImage(); // transform it
49  newimg = image.getScaledInstance(20, 20,  java.awt.Image.SCALE_SMOOTH);
50  offlineToggleButtonIcon = new ImageIcon(newimg);
51  offlineToggleButtonIcon = new ImageIcon(newimg);  // transform it back
52  JToggleButton offlineToggleButton = new JToggleButton(offlineToggleButtonIcon);
53
54  //online (delare at starting of class)
55  image = onlineToggleButtonIcon.getImage(); // transform it
56  newimg = image.getScaledInstance(20, 20,  java.awt.Image.SCALE_SMOOTH);
57  onlineToggleButtonIcon = new ImageIcon(newimg);  // transform it back
58
59  //settings
60  ImageIcon settingButtonIcon = new ImageIcon("icons/settings.png"); // load the image
61  image = settingButtonIcon.getImage(); // transform it
62  newimg = image.getScaledInstance(20, 20,  java.awt.Image.SCALE_SMOOTH);
63  settingButtonIcon = new ImageIcon(newimg);  // transform it back
64  JButton settingButton = new JButton("Settings", settingButtonIcon);
65
66  //create layout for users
67  panelLeft.setLayout(new GridBagLayout());
68  GridBagConstraints leftGBC = new GridBagConstraints();
69  leftGBC.fill = GridBagConstraints.HORIZONTAL;
70  leftGBC.weightx = 1;
71  leftGBC.gridx = 0;
72
73  JToggleButton users[] = new JToggleButton[ count/2 ];
74  String userDetails[] = new String[ count ];
75  ButtonGroup bg = new ButtonGroup();
76  for( i = 0 , j = 1 ; i < ( count / 2 ) ; i++ , j++ )
77  {
78      try
79      {
80          userDetails[i]=Global.fileUsers.readLine(); //name string
81          users[i] = new JToggleButton(userDetails[i]);   //button creation
82          userDetails[j]=Global.fileUsers.readLine(); //ID string
83          users[i].setActionCommand(userDetails[j]);  //replace string when clicked (internally)
84          panelLeft.add(users[i] , leftGBC);      //add buttons to panel
85          bg.add(users[i]);               //group buttons
86      }
87      catch(IOException e) {
88      JOptionPane.showMessageDialog(new JFrame(),e.toString(),"Error", JOptionPane.ERROR_MESSAGE);
89      }
90  }
91
92  //inside right panel
93  panelRight.setLayout(new GridBagLayout());
94  GridBagConstraints c1 = new GridBagConstraints();
95  c1.fill = GridBagConstraints.BOTH;
96
97  //send text area
98  c1.weightx = 1;
99  c1.weighty = 0.05;
100 c1.gridx = 0;
101 c1.gridy = 1;
102 Global.sendMessageTextArea = new JTextArea();
103 Font font = new Font("Arial", Font.BOLD, 20);  //font style
104 Global.sendMessageTextArea.setFont(font);
105 JScrollPane scrollPane = new JScrollPane(Global.sendMessageTextArea);
106 panelRight.add(scrollPane ,c1);
107
```

```
108   //share button
109   c1.weightx = 0.005;
110   c1.weighty = 0.05;
111   c1.gridx = 1;
112   c1.gridy = 1;
113   ImageIcon sendIconShare = new ImageIcon("icons/clip.png");
114   image = sendIconShare.getImage(); // transform it
115   newimg = image.getScaledInstance(20, 20,  java.awt.Image.SCALE_SMOOTH);
116   sendIconShare = new ImageIcon(newimg);  // transform it back
117   JButton shareButton = new JButton("",sendIconShare);
118   panelRight.add(shareButton ,c1);
119
120   //send button
121   c1.weightx = 0.005;
122   c1.weighty = 0.05;
123   c1.gridx = 2;
124   c1.gridy = 1;
125   ImageIcon sendIcon = new ImageIcon("icons/paperplane.png");
126   image = sendIcon.getImage(); // transform it
127   newimg = image.getScaledInstance(20, 20,  java.awt.Image.SCALE_SMOOTH);
128   sendIcon = new ImageIcon(newimg);  // transform it back
129   JButton sendButton = new JButton("send", sendIcon);
130   panelRight.add(sendButton ,c1);
131
132   //receive text area
133   c1.weightx = 1;
134   c1.weighty = 1;
135   c1.gridx = 0;
136   c1.gridy = 0;
137   c1.gridwidth = 3;   //fill 4 rows
138   Global.receiveMessageTextArea.setEditable(false);   //read only
139   Font f1 = new Font("Verdana", Font.PLAIN, 18);
140   Global.receiveMessageTextArea.setFont(f1);
141   JScrollPane scrollPane1 = new JScrollPane(Global.receiveMessageTextArea);
142   DefaultCaret caret = (DefaultCaret) Global.receiveMessageTextArea.getCaret();
143   caret.setUpdatePolicy(DefaultCaret.ALWAYS_UPDATE);  //always scroll down
144   panelRight.add(scrollPane1 ,c1);
```

Module 3: Setting Module

```
1   //baud rate using droup down list
2   infoToFile += fixedBRComboBox.getSelectedItem().toString() + "\n";
3   //or
4   //baud rate using custom text box
5   infoToFile += customBR.getText() + "\n";
6   //user ID
7   infoToFile += uniqueID.getText() + "\n";
8
9   //save the content
10  new RandomAccessFile("lifiSettings.txt","rw").setLength(0);  //clear the content
11  Global.fileSettings.seek(0);
12  Global.fileSettings.writeBytes(infoToFile);
```

Module 4: Help Module

```
String url = "https://mail.google.com/mail/?view=cm&fs=1&to=lifimessenger@gmail.com&su="+
             subject.getText()+"&body="+body.getText();
url = url.replace(" ", "+");  // space encoding in url

//redirect to browser along with url
java.awt.Desktop.getDesktop().browse(new URI(url));
```

Module 5: User Data Module

```
//add user
//create table `userID` (dataDB text(52428800));
Global.stmt.executeUpdate( "create table `"+idTextField.getText()+"` (dataDB text(52428800));" );
//write user data into file
Global.fileUsers.writeBytes(nameTextField.getText()+"\n"+idTextField.getText()+"\n");

//remove user
Global.stmt.executeUpdate( "drop table `"+idTextField.getText()+"`;" ); //drop tabel `userID`
//remove user data from file

//Find user ID
while((s=Global.fileUsers.readLine()) != null)
{
    if(s.equals(nameTextField.getText()))
    {
        i++;
        JOptionPane.showMessageDialog(new JFrame(), "ID = "+Global.fileUsers.readLine());
        break;
    }
    Global.fileUsers.readLine();
}
if(i == 0)
    JOptionPane.showMessageDialog(new JFrame(), "No user with name " +
    nameTextField.getText(), "Error", JOptionPane.ERROR_MESSAGE);
```

APPENDIX-2

DATA BASE INFORMATION

Description of table

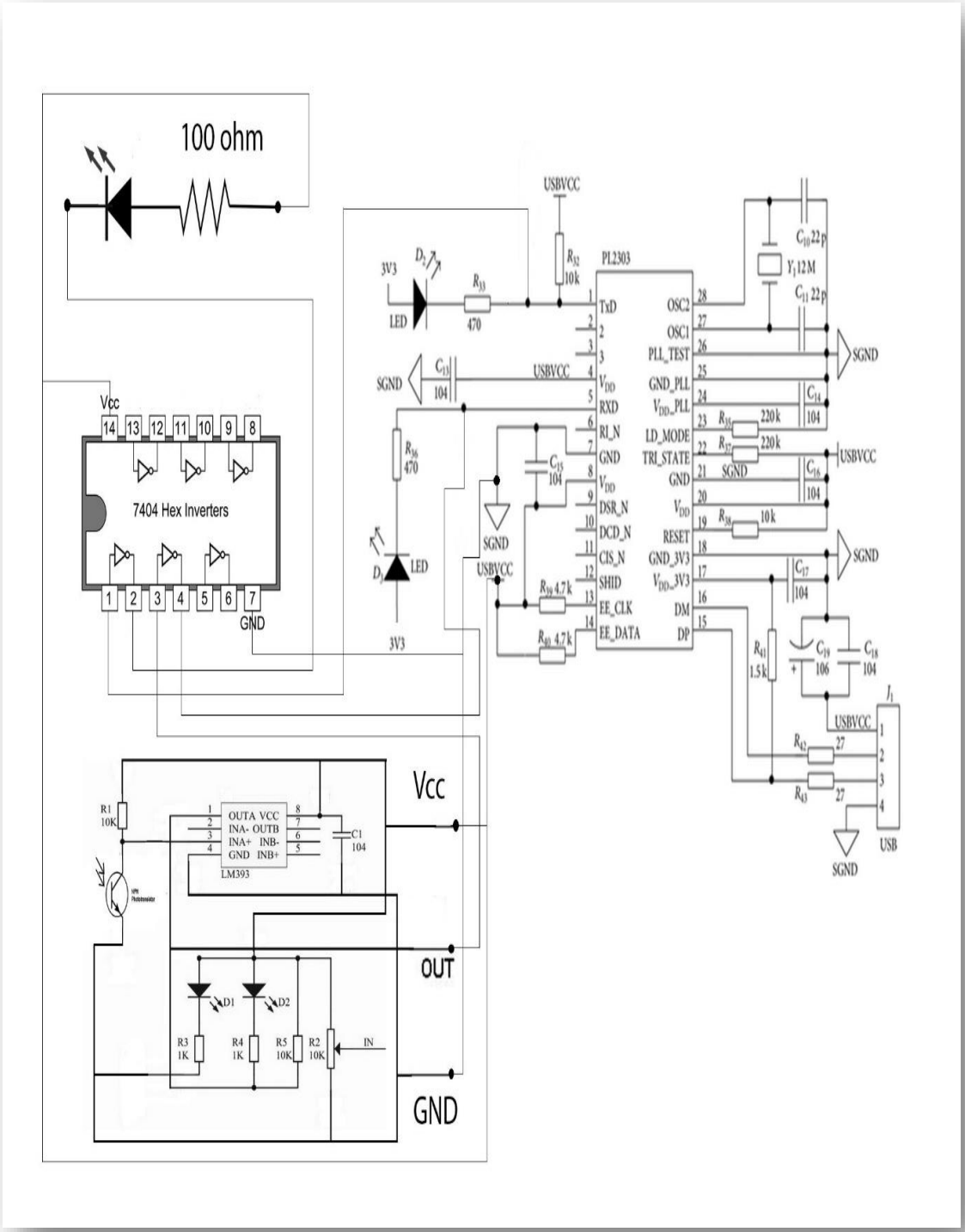
S.no.	Name/Field	Type	Null
1	dataDB	text(52428800)	Yes

Sample table

dataDB
> You [10 Feb 2020 18:22:34] **hai**
< right [10 Feb 2020 18:22:44] **bye**

APPENDIX-3

CIRCUIT DIAGRAM



APPENDIX-4

SETUP

WINDOWS

1. Install java and set environment variable.
2. Install MySQL and start it.
3. Install - https://drive.google.com/drive/folders/12-O38U326dD9QfpFEw8Hd0TkUTgAIGuV
4. Install all drivers and connectors using readme.txt
5. Install - https://drive.google.com/open?id=1JRP3FmBWClGHIZIrs8902Z9Y8fPBY8sp
6. Plug in the device.
7. Compile using javac LIFI.java
8. Run using javaw LIFI (or) java LIFI

LINUX

1. Install java if not present.
2. Install MySQL if not present and start it.
3. Install - https://drive.google.com/open?id=19IFSb9CUPv2UULx7C5NzJaYN9qbd2B0a
4. Install - https://drive.google.com/open?id=1fackwe16W9oFWi7yuQOTvBqKSsbAAaaO
5. Plug in the device.
6. Compile and run using readme.txt

macOS

Works on macOS (not tested).