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Text Transmission Using Lifi Technology

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Abstract

Light Fidelity more commonly known as Li-Fi one of prominent Technology in this era. There are currently two trends being seen First, the extension of wireless services and other being increased in user demand for these services, but the available RF spectrum for usage is very limited. So, the new technology of Li-Fi became notable, which uses visible light as a source of communication. In this technology, LEDs are used to transmit data in the visible light spectrum. This technology can be compared with Wi-Fi and offers advantages with more accessible spectrum, efficiency, security, low latency and much higher speed. This research paper aims at designing a Li-Fi transceiver using Arduino that is able to transmit digital data. The software coding is done by using Arduino IDE. Successful transmission and reception of data signals is carried out on the transceiver. Hence this research work gives an innovative way of designing a transceiver which works by using off the shelf low cost components and using visible light spectrum

Keywords: Light Fidelity (Li-Fi), Visible Light Communication (VLC), Arduino, Light Emitting Diode (LED)

1. INTRODUCTION

Li-Fi can be regarded as light- based Wi-Fi, i.e. instead of radio waves it uses light to transmit data. In place of Wi-Fi modems, Li-Fi would use transceivers fitted with LED lamps that could light a room as well as transmit and receive information. It makes use of the visible portion of the electromagnetic spectrum which is underutilized. Li-Fi can be considered better than Wi-Fi because there are some limitations in Wi-Fi such as it uses 2.4 – 5 GHz radio frequencies to deliver wireless internet access and its bandwidth is limited to 50-100Mbps. With the increase in the number of Wi-Fi hotspots and volume of Wi-Fi traffic, the reliability of signals is bound to suffer. Security and speed are also important concerns. Wi-Fi communication is vulnerable to hackers as it penetrates easily through walls. In Visible Light Communication There are around 1.4 million cellular mast radio waves base stations deployed, with over 5 billion mobile phones. Mobile phones transmit over 600TB of data. another factor is, in wireless communication radio waves are used where Spectrum is one of the most essential requirement. With the advancement in technology and the number of users, the existing radio wave spectrum fails to fulfill this need. To resolve the issues of availability, security and scalability, the concept of Li-Fi is introduced that makes use of LED light in the transmission of data much faster and flexible than data that can be transmitted through Wi- Fi. [1,2,3] LED lights are becoming widely used for homes and offices for their luminous efficacy improvement. As shown in figure no 1, Visible light communication (VLC) is a new way of wireless communication using visible light. Typical transmitters used for visible light communication are visible light LEDs and receivers are photodiodes and image sensors. Location-based

services are considered to be especially suitable for visible light communication applications. An indoor visible data transmission system utilizing LEDs is proposed. In this system, these devices are used not only for illuminating rooms, but also for an optical wireless communication system. [1]

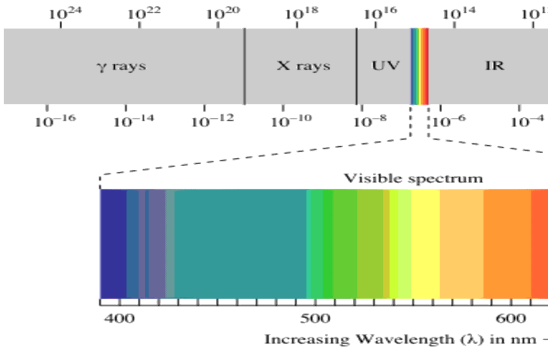


Figure no- 1

2. Literature survey

Now-a-days, Wi-Fi (Wireless Fidelity), is much usable with the frequency of 2.4-5 GHz radio frequencies to transmit data wirelessly. But these radio waves are harmful for living beings. So, the best alternative is Visible Light Communication (VLC), where LED lights are used to transfer the data wirelessly. [4,5] VLC is recently referred as LiFi. It is a term often used to describe high speed VLC in application scenarios where Wi-Fi might also be used. The term Li-Fi is similar to Wi-Fi with the exception that light rather than radio is used for transmission. By the end of AUGUST 2013, data rates of over 1.6 GBPS were achieved using Li-Fi (light fidelity). In APRIL 2014, the Russian company Stins Coman has announced the development of a Li- Fi wireless local network called Beam Caster. They achieved data rates of 1.25 GBPS.The market for LiFi-based products is estimated to be worth USD 1.72 billion in 2024. Further, it has a CAGR of around 63% for the forecast period of 2024-29. The utilization of LiFi or light Wi-Fi is particularly pronounced in areas that value fast connectivity, real-time communication, and high-security communication. There is a growing interest in the use of invisible light communication technologies across important sectors such as automobiles, aerospace, defense, and IoT. With Li-Fi, we can able to communicate under water, gives more security compares to Wi-Fi as light cannot pass through wall of the room.

3. Circuit Design & Working

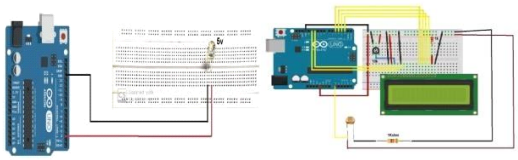


Figure no-2(Design prototype)

Component list

Name	Capacity	Quantity
LDR		1
LCD	16*2	1
BREADBROAD		1

JUMPER WIRES		
LED	5V	1
RESISTANCE	1kΩ	2
VERIABLE RESISTOR	100kΩ	1
ARDUINO BOARD		2
PCB		1

Table no 01.

4. Hardware details

LED falls within the family of P-N junction devices. The light emitting diode (LED) is a diode that will give off visible light when it is energized. In any forward biased P-N junction there is, with in the structure and primarily close to the junction, a recombination of hole and electrons. This recombination requires that the energy possessed by the unbound free electron be transferred to another state.

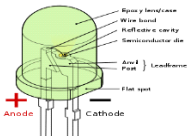


Figure no-3

LED is a component used for indication. All the functions being carried out are displayed by led. The LED is diode which glows when the current is being flown through it in forward bias condition

An LDR is a component that has a (variable) resistance that changes with the light intensity that falls upon it. This allows them to be used in light sensing circuits. [9]

The flow of charge through any material encounters an opposing force similar in many respects to mechanical friction, this opposing force is called resistance of the material. In some of the electric circuit, the resistance is deliberately introduced in form of resistor. Resistance is measured in ohms, the symbol for ohm is an omega ohm. 1 ohm is quite small for electronics so resistances are often given in kOhm and MOhm.

Fig.4 Symbol of Resistor

Resistors used in electronics can have resistances as low as 0.1 ohm or as high as 10 Mohm.

Fig.5 Resistor of 1000ohm

VARIABLE RESISTOR

A variable resistor is the most significant component found in many electrical devices for controlling the tone, bass as well as volume. ATmega328P, it consists other components such as crystal oscillator, serial communication, voltage regulator, etc. to support the microcontroller. Arduino Uno has 14 digital input/output pins (out of which 6 can be used as PWM outputs), 6 analog input pins, a USB connection, A Power barrel jack, an ICSP header and a reset button Along with A.

Jumper wires

Figure no-6

Jumper wires are simply wires that have connector pins at each end, allowing them to be used to connect two points to each other without soldering. Jumper wires are typically used with breadboards and other prototyping tools.

Fig. No-7 Breadboard

A breadboard is a construction base for prototyping of electronics. Because the solderless breadboard does not require soldering, it is reusable. This makes it easy to use for creating temporary prototypes and experimenting with circuit design. For this reason, solderless breadboards are also popular with students and in technological education.

Arduino Board

Figure no-8

Arduino Uno is a microcontroller board based on 8-bit ATmega328P microcontroller. Along with ATmega328P, it consists other components such as crystal oscillator, serial communication, voltage regulator, etc. to support the microcontroller. Arduino Uno has 14 digital input/output pins (out of which 6 can be used as PWM outputs), 6 analog input pins, a USB connection, A Power barrel jack, an ICSP header and a reset button.

5. Microcontroller – LCD Interfacing

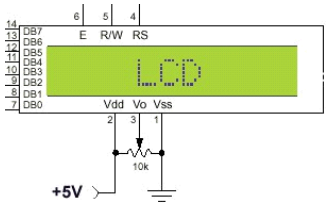


Fig.no-9 Microcontroller-LCD Interfacing

The LCD panel's Enable and Register Select is connected to the Control Port. The Control Port is an open collector / open drain output. Therefore, by incorporating the two 10K external pull up resistors, the circuit is more portable for a wider range of computers, some of which may have no internal pull up resistors. It makes no effort to place the Data bus into reverse direction. This will cause no bus conflicts on the data lines. [10] As a result It cannot read back the LCD's internal Busy Flag which tells about the LCD has accepted and finished processing the last instruction [20]. This problem is overcome by inserting

known delays into my program. The 10k Potentiometer controls the contrast of the LCD panel. A power supply of 5volt is used here. The user may select whether the LCD is to operate with a 4-bit data bus or an 8- bit data bus. If a 4-bit data bus is used, the LCD will require a total of 7 data lines. If an 8-bit data bus is used, the LCD will require a total of 11 data lines [20]. LCD with 8-bit data bus is used for this design. The three control lines are **EN**, **RS**, and **RW**. EN line must be raised/lowered before/after each instruction sent to the LCD regardless of whether that instruction is read or write text or instruction. In short, I manipulate EN when communicating with the LCD.

6. Flow chart

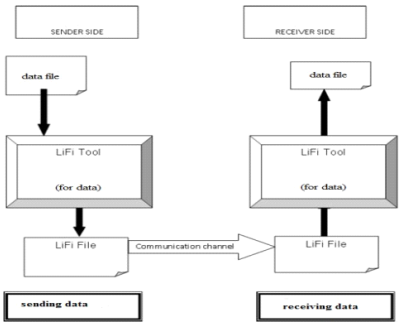
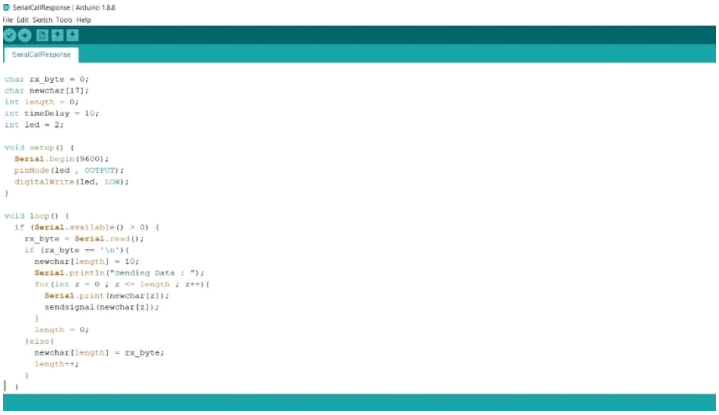


Fig no-10 Flow Chart of LiFi communication.

7. Software Details

Introduction to Arduino Software

The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino hardware to upload programs and communicate with them.



```
char rx_byte = 0;
char newchar[17];
int length = 0;
int timeDelay = 10;
int led = 2;

void setup() {
  Serial.begin(9600);
  pinMode(led , OUTPUT);
  digitalWrite(led, LOW);
}

void loop() {
  if (Serial.available() > 0) {
    rx_byte = Serial.read();
    if (rx_byte == '\n'){
      newchar[length] = 10;
      Serial.println("Sending Data : ");
      for(int z = 0 ; z <= length ; z++){
        Serial.print(newchar[z]);
        sendsignal(newchar[z]);
      }
      length = 0;
    }else{
      newchar[length] = rx_byte;
      length++;
    }
  }
```

Fig no11-IDE Software interface.

The Arduino IDE supports the languages C and C++ using special rules of code structuring. The Arduino IDE supplies a software library from the Wiring project, which provides many common input and output procedures. User-written code only requires two basic functions, for starting the sketch and the main program loop, that are compiled and linked with a program stub main() into an executable executive program with the GNU toolchain HYPERLINK "https://en.wikipedia.org/wiki/GNU_toolchain", also included with the IDE distribution. The Arduino IDE employs the program argued to convert the executable code into a text file in hexadecimal encoding that is loaded into the Arduino board by a loader program in the board's firmware.

8. Result

The Li-Fi system proposed in this paper is capable of transmitting data between two devices at the speed of a few kbps. The working model and output of the LI-FI communication for transmitting data as shown in the fig.

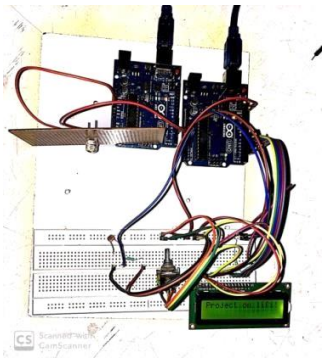


Fig: 12 Working Model of LiFi communication.

The main requirement is line of sight between the sender and the receiver and hence it can be used to transmit data within a room. Li-Fi technology is based on (Visible Light Communication) VLC technology. VLC is one of the advanced optical wireless communication technologies in which light in the visible region is used as a medium for data transmission. It is more secure and achieves high data rates as compared to conventional wireless technologies like Wi-Fi, Bluetooth, etc. [12]

9. Conclusions

The Li-Fi transceiver using Arduino is designed that is able to transmit digital data. The PCB layout and schematics are sketched. The results show the transmission of data string on the serial port monitor. After ensuring the successful transmission of data string were transmitted and received successfully. This data transmission was seen on LCD interface. Therefore, a Li-Fi prototype has been designed which demonstrates the basic principle and also supports the claim of the advantages of Li-Fi over Wi-Fi. The speed achieved with this prototype is approx. 115,200 bps only. It is not of high order of Gbps. Also, this prototype is not bidirectional. Hence it is only used for broadcast purposes. [11] LiFi is much more efficient when it comes to cost and power consumption. Since it makes use of LED bulbs for communication, these bulbs can double up as regular lighting for a household reducing power consumption of a LiFi network and making it far efficient than existing technologies alongside not requiring any additional hardware for implementation would reduce the cost of setting up LiFi. Due to the use of LED bulbs, LiFi can be made available everywhere by replacing traditional LED bulbs with LiFi compatible bulbs. Since LiFi makes use of visible light spectrum, it cannot penetrate through optically opaque objects like walls making it difficult for unauthorized access unlike present Wi-Fi which could be accessed from beyond walls and making it vulnerable to unauthorized access. Applications includes Under Water Communication system, Vehicle Underground or Tunnel Navigation System so we can use Li-Fi in future in which data for smart phones, tablets etc. can be dealt using lights fitted in the room. Radio waves cannot be used by commuters in aircrafts. LED-based lights are already used in aircraft cabins and each of these lights could be potentials VLC transmitters to provide both illumination and media services for travelers. Moreover, this will reduce the aircraft construction costs and its weight. Underwater ROVs (Remotely Operated Vehicles) operate from large cables that supply their power and allow them to receive signals from their pilots above. They

could also use their front lights to communicate with each other, processing data independently and sending their information back to the surface [11].

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