

IC 201P – Design Practicum

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LiFi (Light Fidelity)

Group 17

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Abstract

Li-Fi, which is light fidelity, is one of the future technologies in the wireless communication sector. It is bidirectional, with a very high speed and is a fully networked communication which is wireless technology similar to Wi-Fi. In the present era, Wi-Fi is the most trending domain. As internet users almost double every year, there is an enormous load on the radio spectrum that leads to congestion. To get better bandwidth, efficiency and speed, a new technology Li-Fi has evolved.. Li-Fi can be simply put to be Wi-Fi but instead of radio waves light is used as a medium. Here, data is transmitted using light whose intensity varies faster than the human eye can capture. Instead of using modems, Li-Fi uses LED bulbs with transceivers. Data transmission in Li-Fi is about 100 times faster than Wi-Fi. Here, in this paper we explore the need for Li-Fi. Li-Fi technology, proposed by the German Scientist — Harald Haas, Harald Haas proposed the technology that transmits the data through illumination .Li-Fi is ideal for high speed wireless data transmission in confined areas. Li-Fi provides higher bandwidth, efficiency, availability and security than Wi-Fi and has already achieved high speed in the lab. We can implement this system for public internet access through street lamps to auto -piloted cars that communicate through their headlights. As the speed of light is higher hence the data transmission speed is so much faster than the existing system. In the future we can implement this technology for fast data access for the laptops, smart phones, and tablets that will be transmitted through the light in a room.

Problem Statement

Wifi has been great and revolutionized the way we connect to the internet but Wifi comes with some fundamental problems in terms of speed, security, cost, limited bandwidth, health concerns with radio waves and inefficient power consumption. If implemented successfully will solve all

these problems that come with Wifi and will revolutionize the way we will connect to the internet again.

Shortlisting of designs

We have our aim defined that we want to work with LiFi but as this technology is not well developed we went through so many models and failures of design to come up with a final model.

1. Sound Transmission Model

We brainstormed about using sound as our form of data. We collected all the components - Speaker, aux cable, solar panel and Laser light. We made the circuit and try to transfer to sound but there was a lot of noise and interruptions. We thought of possible errors and after discussing and brainstorming we found out that we need solar panel of less voltage compare to what we have. After correcting still we were not be able to made a robust model so we try to move forward with a more simple model.

2. Traffic light

We made a simple street light model where we used LDR sensor as light processor. The source of light is the ambient light. We code for the model and used arduino Uno. In presence of sun light the street will not work but when there is no ambient light, street light start will working on it's own without any switch mechanisms.

3. Text Transmission

After enough experimentation we finally consider text as out form of data transfer. We read the documentations available and then come up with a simple model. We made an app for the same for light transmission to LDR, then data is processed by arduinio uno and output is available on the LCD screen. This was our first successful model for LiFi Modelling.

4. Image Transmission

After text transmission we moved to image transmission and made our final model, describe below in details.

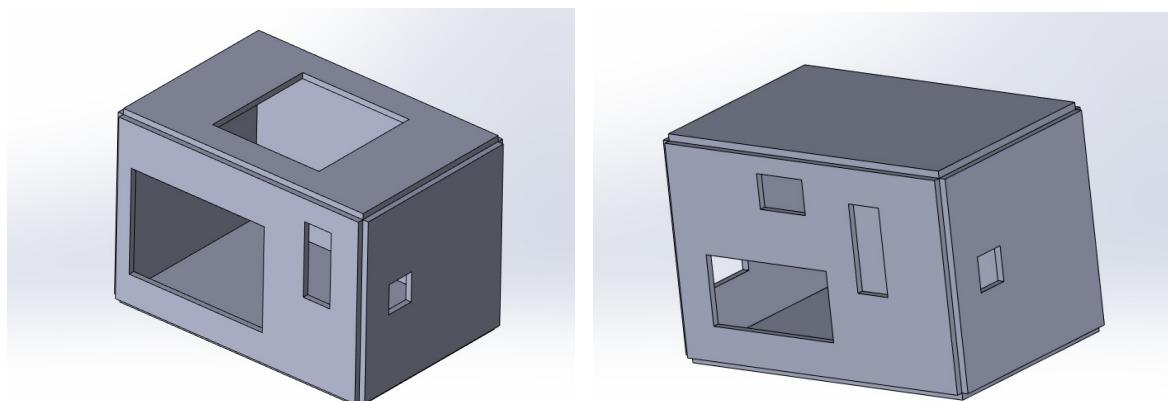
Design

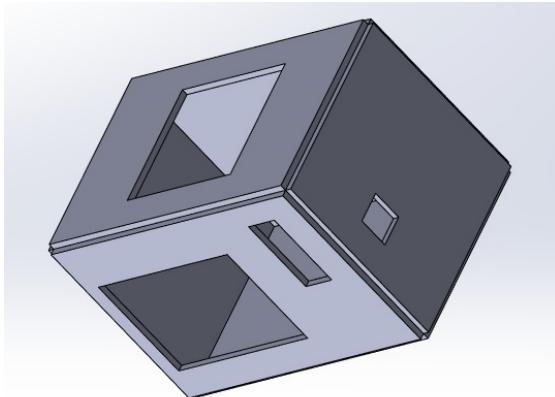
For LIFI what matters most the electrical circuit because we have to do transmission and receive the signal and process the signal using the microcontroller board. So, In mechanical design we do not have much to do. We try to shape our model using the acrylic sheet, Laser cutting and assembling the model.

We carefully measure the dimensions of each side and made slots for the solar panel, LED and input/output ports for power supply and connecting to the laptop.

The dimensions of each sheets -

Dimensions (cm x cm)	Quantity
18 x 12	10
12 x 10	4
20 x 18	5
18 x 10	2
20 x 12	2

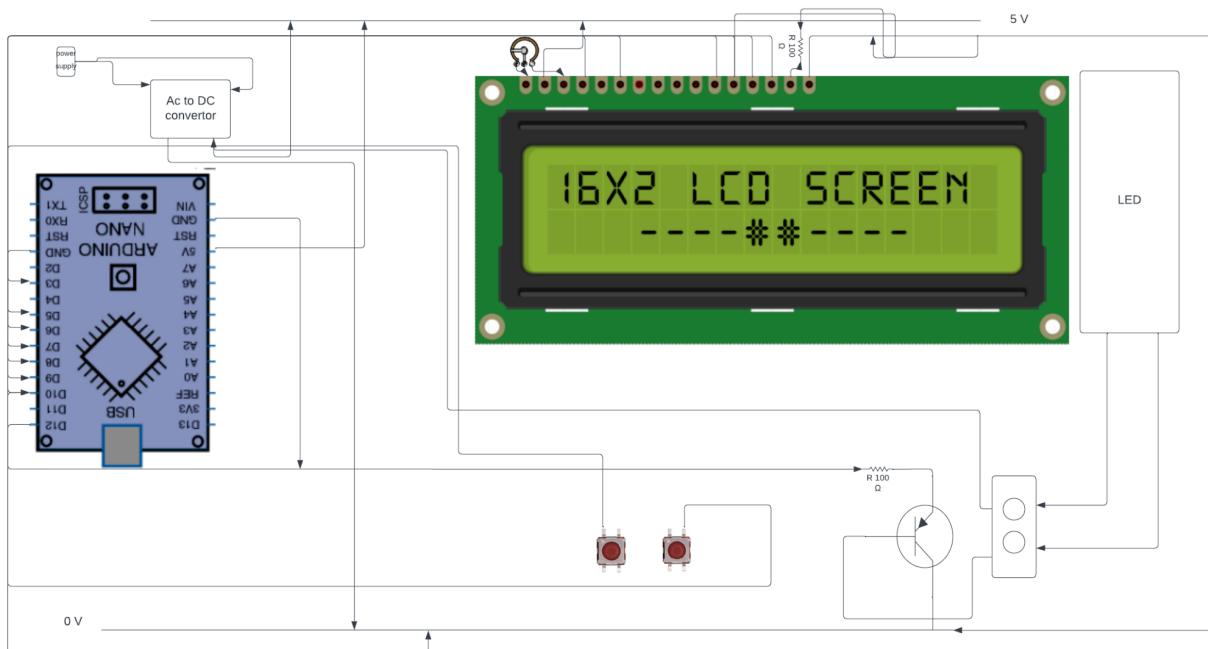




Electrical Schematic

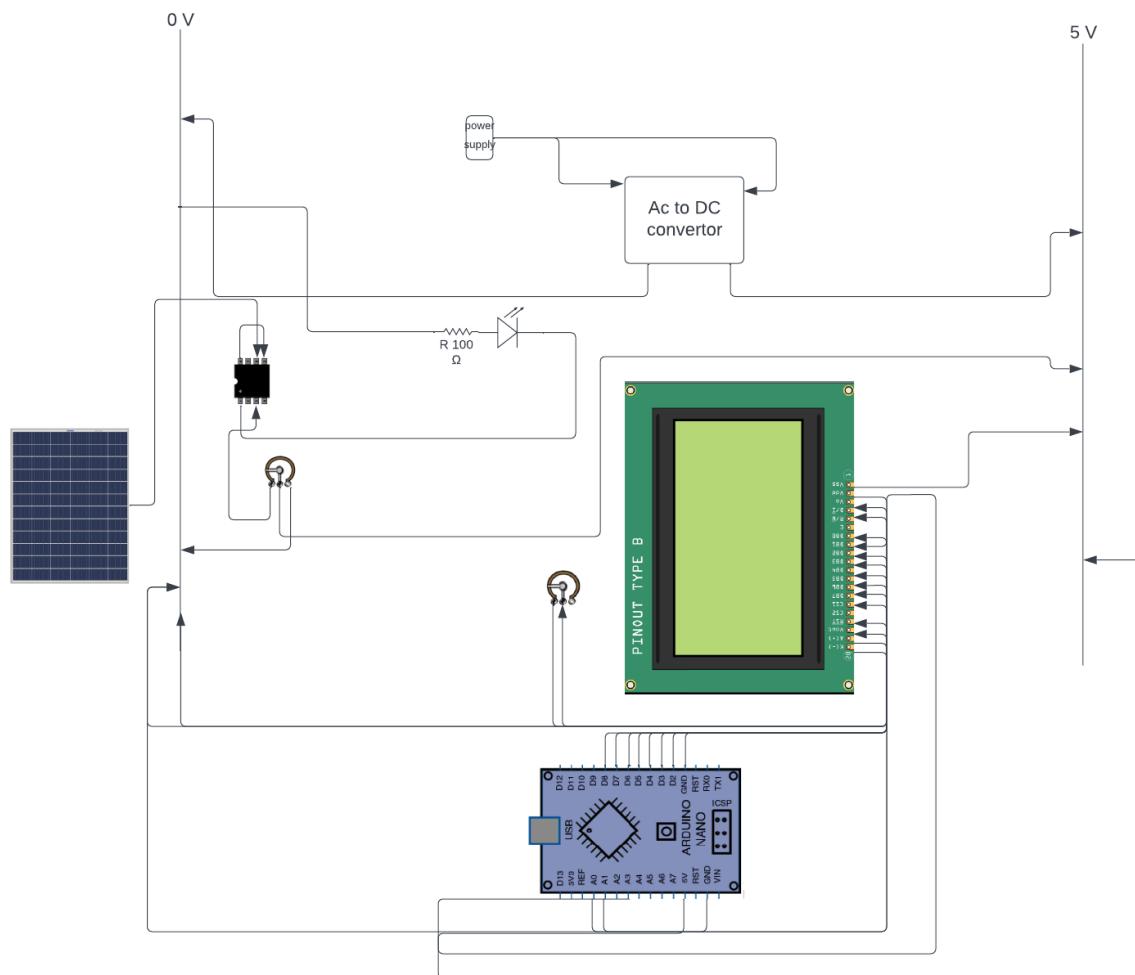
Below are the schematic for the transmitter and receiver.

Transmitter circuit consists of LEDs for transmitting light signals processed by a microprocessor board. The push buttons control the transmission of image and text respectively. We used the Ac to DC buck converter for converting the 12V coming from 12V/2A DC power supply to 5V as per the circuit requirement.



Transmitter

Receiver is consisting of the solar panel for receiving the light signal coming from the LED. We used potentiometer for voltage regulation in the circuit. The resistor in the circuit is used to control the current level in the circuit. It lower down the value of current. The graphical LCD 128 x 64 is used for displaying the text and image. Whole graphical LCD is working as a matrix of size 128 X 64 and we can regulate each pixel for display of image and text.



Receiver Circuit

Components

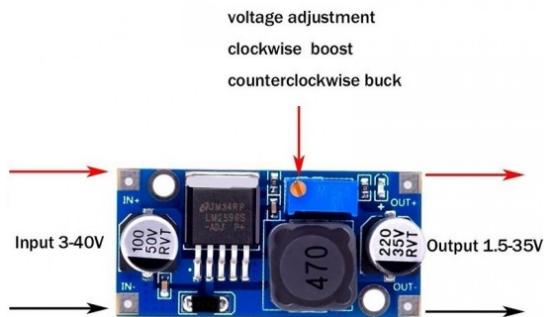
Solar Panel

Solar panel is an assembly of photovoltaic cells mounted in a framework for generating energy.



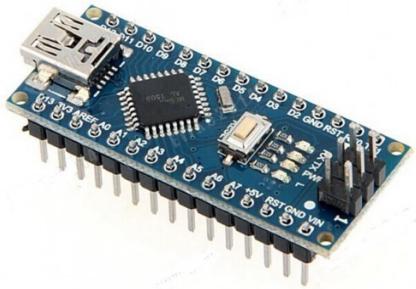
LM2596 Buck Converter

The LM2596 series of regulators are monolithic integrated circuits that provide all the active functions for a step-down (buck) switching regulator, capable of driving a 3-A load with excellent line and load regulation.



Arduino Nano CH340G

The Arduino Nano is a small, complete, and breadboard-friendly board based on the ATmega 328P released in 2008. It offers the same connectivity and specs of the Arduino Uno board in a smaller form factor. Arduino Nano CH340 has a lower cost USB-Serial Chip that makes it less in price than Arduino Nano with FTDI USB-Serial Chip used on older versions of Arduino Nano. The Arduino Nano is a small, complete, and breadboard-friendly board based on the ATmega328 (Arduino Nano 3. x).



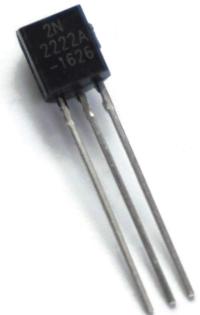
Potentiometer

A potentiometer is a three-terminal resistor with a sliding or rotating contact that forms an adjustable voltage divider. If only two terminals are used, one end and the wiper, it acts as a variable resistor or rheostat.



Transistor

A transistor is a type of a semiconductor device that can be used to both conduct and insulate electric current or voltage. A transistor basically acts as a switch and an amplifier. In simple words, we can say that a transistor is a miniature device that is used to control or regulate the flow of electronic signals.



Push Button

Push button is a simple switch mechanism to control some aspect of a machine or a process.



16 x 2 LCD Screen

A 16x2 LCD means $16 \times 8 = 128$ pixels. So, it can display not only simple text or numbers within a fixed size but also simple graphics.



6" x 4" PCB

General purpose prototyping board, commonly known as Vero Board or Zero PCB. This product is of size 6 inches by 4 inches. It has hole spacing of standard 2.54mm. The solder pads are tin coated which makes it soldering friendly.



12V/2A DC Power Supply

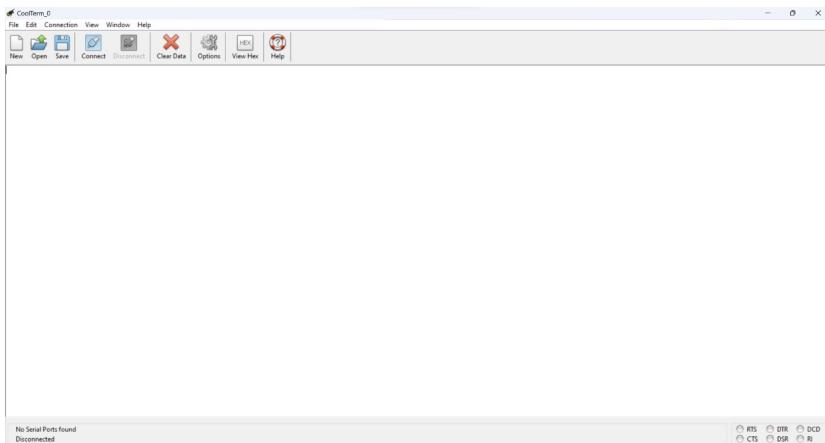
Unregulated 12VDC power supplies are basic power supplies with an AC input and an unregulated 12VDC output. The output voltage changes with the input voltage and load.



App



LiFiVerse



CoolTerm

LiFiVerse Mobile Application

We built this application for our prototype. This application is basically used as a transmitter to send the text from one device (mobile) to another (Display). This application uses mobile flash light which glows for some fixed time for every string and then that is detected by LDR and sends a signal to an arduino which decodes the light signal and prints the string sent through the mobile app on the display.

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.

Working

Working of Transmitter circuit

The transmitter section comprises of a keyboard connected with a PS2 connector and interfaced directly with microcontroller IC AT89S52. IC AT89S52 also referred as 8051, is a 40 pin IC, used to provide serial data communication. A crystal oscillator with a frequency of 11.0592 Mhz is used to provide the desired clock frequency to the microcontroller for its working. Two paper capacitors of 27 pf are used to stabilize the clock frequency. A 9v dc voltage is provided to the transmitter section with the help of a battery, which is step down to 5v using voltage regulator IC 7805. A capacitor of 10uf and a resistor of 10k ohms are connected with the microcontroller to provide the reset function. Two transistors, one NPN (IC TIP L6 122) and the other PNP (IC BC5578) are together used as a Darlington pair and are used to provide push pull amplification. The output of this transistor pair is connected to a led torch. A green led is used which glows if the caps lock key is on. The keyboard can be used to send alphanumeric data. The spacebar, backspace, delete and enter commands can also be used. If the caps lock key is on then alphabets in the uppercase and special characters (!,@,#,\$,%,&,*,(,)) can also be transmitted. When a key is pressed on the keyboard, the ASCII code of that key is sent directly to the microcontroller. The microcontroller converts the ASCII code into binary and sends this data to the transistor pair. The PNP transistor works at off state i.e. it reads zero in the binary code, while the

NPN transistor works at on state i.e. it reads one in the binary code. This transistor pair then sends the binary pulse containing zeros and ones to the led torch. The led torch is on when it reads a one and is off when it reads a zero. The blinking of led light is so fast that it cannot be detected by a human eye.

Working of Receiver circuit

The receiver section comprises of a photodiode connected to the PNP transistor (IC BC 5578). A 9v battery is attached to the circuit to provide the power supply. A voltage regulator IC 7805 is used to step down the 9v dc supply to 5v dc supply for the working of the microcontroller AT89S52. The microcontroller is connected with a crystal oscillator of 11.0592 Mhz to provide the clock frequency, along with two paper capacitors of 27pf to stabilize this frequency. A 10 uf capacitor is also connected to the microcontroller to provide the reset function. A button switch is used to provide the manual reset function. The microcontroller is interfaced with the 16x2 LCD to display the data that is sent by the transmitter.

The light from the led torch is made to fall on the photodiode. The photodiode detects the blinking of the led, and transmits this train of ones and zeros to the transistor. The PNP transistor is in on state when a zero is detected by it and is in off state when a one is detected. This on and off state of transistor is read by the microcontroller and it converts this binary code so formed as a result of on and off , into an ASCII code. The microcontroller then sends this ASCII code to the 16x2 LCD for display, which is directly interfaced with microcontroller.

Future Scope

As light is everywhere and free to use, there is a great scope for the use and evolution of Li-Fi technology. If this technology matures, each LED Bulb can be used to transmit data. As the Li-Fi technology becomes

popular, it will lead to a cleaner, greener, economical, and safer communication system. Although Li-Fi promises to solve issues such as, shortage of radio-frequency bandwidth and eliminates the disadvantages of radio communication technologies, it is also associated with short range and the need of a light source. As such Li-Fi is not likely to replace Wi-Fi completely, but the use of two together i.e. Wi-Fi and Li-Fi can prove to improve quality of life.

The complimentary layer can support both mobile wireless networks and enterprise networks, and according to a report by [Global Market Insights](#), it is set to be worth \$9 billion in the coming years.

Currently, companies with a noteworthy market share in LiFi include Nakagawa Laboratories, Oledcomm, LVX System, and ByteLight.

Uniqueness

We are successful in transferring both text data and images at a cost which is 10 times cheaper than similar products available in the market.

We can easily update the model and improve it by using laser if the model is not to be implement in the household but in isolation. Along with that we can update the mobile application with more features like generalization.

We do not need additional light source in households or classroom if we are implementing this model in houses.

References

[1] <https://www.irjet.net/archives/V4/i9/IRJET-V4I973.pdf>

[2] <https://www.electricalindia.in/>

[3]https://rcs.cic.ipn.mx/2018_147_12/Transmission%20and%20Reception%20of%20Images%20via%20Visible%20Light.pdf