DATA TRANSMISSION USING LI-FI

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Abstract: In order to achieve to achieve the short distance communication the currently using technology such as Bluetooth and Wi-Fi fails to deliver the data with larger bandwidth and greater data rate. Visible light acts as comparable to the present wireless radio frequency communication by achieving larger bandwidth and high data rate. Because with larger frequency spectrum it is possible to provide a greater portion of the bandwidth to each user to shift information. A switching LED can be improbably causing annoyance, but data can there-fore be encoded in the light by varying the rate at the LEDs switch on and off to provide various strings of 1's and 0's. Hence the given data can be converted into binary format before transmission. The digital transmission has more advantages compared to the analog communication. The advantages of the Li-Fi are it has high data rates of about 10 Gbps. It has high security as light can't penetrate into walls. The applications are indoor broadcasting of information such as hospital management, industrial applications like communication inside the Aeroplan.

Index Terms – **Bluetooth, radio frequency communication, Visible Light Communication (VLC), high data rate, larger bandwidth.**

I. INTRODUCTION

The existing Wireless communication makes use of electromagnetic waves for communi-cation system. For instance, the deployment of Wi-Fi obviously brings several important benefits. Rather it is very favourable that numbers of equipment connect to each other us-ing wireless networks. Home-based Wi-Fi enabled device helps you to   connect PC, game console or laptop. There are no boundaries if you are using Wi-Fi, you can move from one room to another or even away from home you have the liberty to   access internet within the range of radial distance. Wi-Fi hotspots of an abstract idea are getting popularity among business communities and mobile wage-earner. For this reason ISPs are consolidating Wi-Fi switches to numerous spots for the scope of wide range. Visible light acts as comparable to the present wireless radio frequency communication by achieving larger bandwidth and high data rate. Because with larger frequency spectrum it is possible to provide a greater   portion of the bandwidth to each user to shift information. A switching LED can be   improbably causing annoyance, but data can there-fore be encoded in the light by varying the rate at the LEDs switch on and off to provide various strings of 1's and 0's.

The use of speed pulses of light to shift data without physical connection such manner is called as Visible light communication (VLC).The LEDs can be switched ON and OFF very speed which is not remarkable by human eye thus the light source appear to be continuously on. When these signals transmitted to the receiver via the wireless   channel, the photo diode will convert these optical signals to electrical signals and the original information will be recovered.

On the basis of visible light communication technology, the advanced technology called Li-Fi provide dual function of visible light LED for illumination and data   transmission. Li-Fi is very latest version of Wi-Fi which uses visible light in place of   radio waves. From here, visible light data transmission value has higher speed than other broadband. It overcome the problem related with Wi-Fi, because Li-Fi has wider network area so traffic handling capacity improved and it is cheaper than Wi-Fi. The VLC system is estimated with other wireless communication system that are in current use like LAN and Wi-Fi. LAN is available in very short range and it is not mobile. And Wi-Fi has low traffic handling capacity as number of user increases Wi-Fi becomes unable to achieve user's need. Li-Fi offers significant capability to resolve this problem compared with   Wi-Fi. It can able to transmits data by switching LEDs on and off instantly by changing light intensity which is not detected by human eye. That estimated data transmission rate is about 10Gbps by using white beamy LED. The indoor visible light communication uses visible light spectrum to provide high rate data transmission which at the same time used as energy efficient illumination. Through this, the construct of the both function of   communication and illumination offers opportunity for efficient cost reduction and carbon footprint reductions.

Light Fidelity (Li-Fi) is a new technology for wireless communication. In this article, Li-Fi technology will be analysed in details. Its applications, challenges and   limi-tations will be mentioned. Li-Fi will be compared with Wireless Fidelity (Wi-Fi). In indus-trial automation systems, production process should be fast and safely. Unlike   Wi-Fi, high-speed internet connection is provided using Li-Fi technology. For that reason, allow-ance of industrial automation systems of Li-Fi technology will be examined. Wireless communication system has become an unavoidable part of each day lives with the help of the technological devices (e.g. Smartphones, tablet). NCR corporation/AT&T invented Wireless Fidelity (Wi-Fi). Wi-Fi technology, which enables to ex-change data between two or more devices, utilizes radio waves to send data without using wires or cables. So, the Internet access can easily be provided in dual places such as public and private.

The Li-Fi is shortened as light fidelity. In this system, light emitting diodes are used. The visible light technology eliminates the Wi-Fi technology. The radiation from Wi-Fi is harmful for human health so this system utilizes the existing light to transmit the data and controlling the devices. The data is secured in this Li-Fi technology compare to Wi-Fi technology. The visible light has the wavelength from 380nm to 750nm.

Some of the works which are carried out by the research scholars are as follows,

Subham chaterjee et.al [1], an attempt is made to transmit the data by using Li-Fi but the methodology of working is different. They use LAN and clouds technology. To overcome this, without any wireless network protocols, the system is   developed in this project. . On the basis of visible light communication technology, the advanced technolo-gy called Li-Fi provide dual function of visible light LED for illumination and data transmission. Li-Fi is very latest version of Wi-Fi which uses visible light in place of radio waves.

Jia, Z, et.al [2] introduces the hybrid positioning method which uses less power. But the complexity is more. In this project an attempt is made to develop cost effective Li-Fi sys-tem for device switching and communication. The accuracy and speed will more com-pare to other system.

Shruti V.H, N.V Uma Readdy et.al [5]an attempt is made to transmit the audio and device control by using power LEDs but this methodology of working in this project is to develop device control using switches and audio is changing, pause and play the songs using switches. Normal LED can transmit the data and device controlling in the   Li-Fi technology.

Gordon povey, et.al [8], it explains, how the receiving device will transmit data back to transmitter. Another important issue is interference from external light sources like sun light, normal bulbs; opaque materials in the path of transmission will cause in-terruption in the communication. Another disadvantage is that Li-Fi doesn't work in the dark or light can't pass through objects, so if the receiver is inadvertently blocked in any way, then the signal will immediately cut out.

G, Gayathri, K.R Vinothini et.al "Data and voice communication use Li-Fi", an attempt is made to transmit the data and audio through Li-Fi. In this paper, the data is transmitted and is displayed on LCD display. But in this project, the data communication is in between two PCs and device switching is done in this project [6].

Nikshep K.N, Sowmya G et.al [7] describes Visible Light Communications   tech-nologies are implemented in general applications like Internet access, vehicle to street light communication and broadcasting data through light signals using this concept to   develop a broadcasting audio signals helps to indoor navigation for blind   people and stores the audio, music in the system.

The main objective of the project is to transfer the data through LED light and later re-ceived by the photo diode at the receiver part. This makes to useful in Industrial automa-tion as like the monitoring the office along with the employ, if they enters to the company or exit from the company, and check the room conditions if the temperature exceeds then AC will turn on automatically. One more objective is to provide voice transmission i.e. like mp3 player.

The foremost intention of this development be in the direction of data must   transmit from one PC to another, eliminate wireless technology and through light. Another is, controlling of devices using this Li-Fi.The most important intention of the project is to give an efficient, low cost, secure, faster data and voice transmission.

- This device is developed in such a way that data can be transmitted through light and received by photodiodes.
- To achieve data transmission between one PC to another PC and controlling the devices like fan and light.
- Controlling and changing the audio by using the switches.
- Main aim is to continuously transmit the analog signals.
- Recommend a rule for the outline and execution of future advancement of the models

German physicist invented this Li- Fi technology in 21st century. Harald Hass who is called as father of Li-Fi technology utilizes the visible light as communication media and the data rate of this is 1 Giga bits per sec. the speed is more and data is secured.
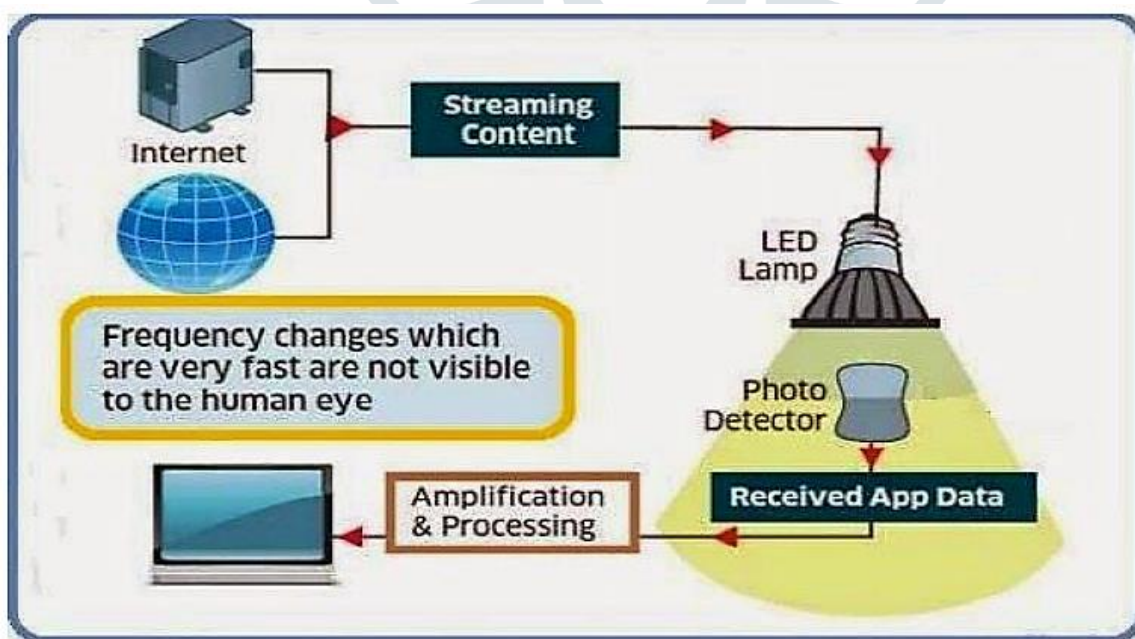

Figure 1.1: Concept of data Transmission through Light

In this system, not only data communication is done but also achieve the transmission of audio and device switching. By using this visible light, Control the devices like fan, light etc. So this system combines three applications. It is used in   industries and residential areas. In industries to transmit the data within the hall from one PC to another, no need to wait for network. This Li-Fi technology provides greater flexibility and transmission path for data communication.

The frequency band range of visible light is in between 430THZ to 770THZ and that of radio waves is in between 1HZ to 3THZ. Accordingly the observable beam   bandwidth is 400 times in excess of the radio frequency. Hence the data rate and speed is more than other technologies.

II. SYSTEM DESIGN

In this sub-section we are going to discuss about the flow for the proposed methodology. The visible light is used as light transmitter an air as transmission medium in this system. This system includes audio transmission, device switching and data transmission between PC to PC. The expenditure effectual of Li-Fi system is developing in this project to achieve the secured data communication and controlling of devices.
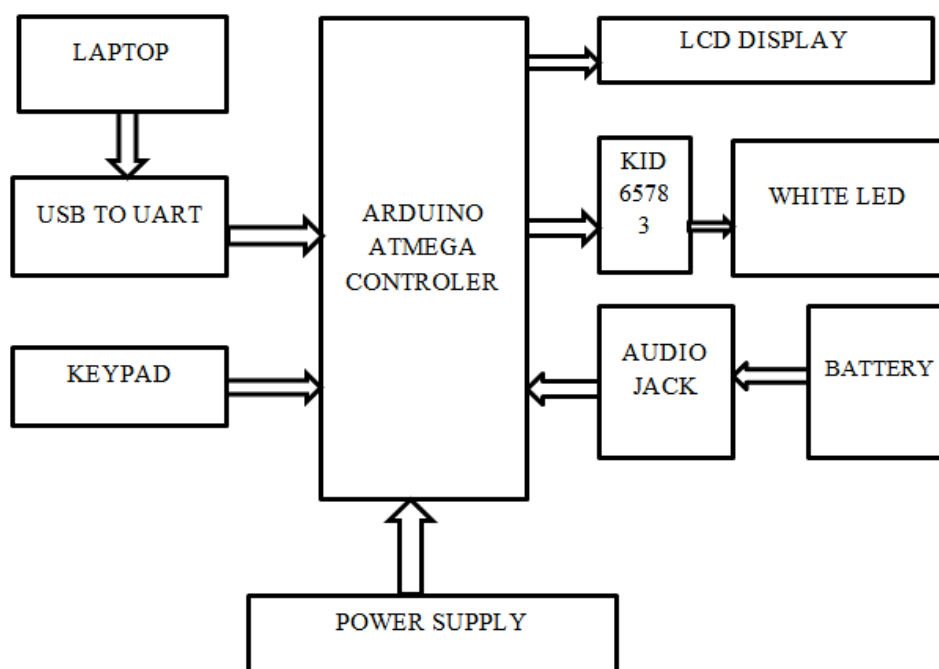

Fig2.1: Data transmission and device control section

The above figure shows the transmitter section for the LI-Fi system which contains Output devices such as LCD, Laptop, Bulb, Fan, speaker. The energy can be generated using Solar panel. The working is illustrated in the above figure.

The building block illustration of Li-Fi structure is as revealed below figure 2.1. The build-ing block illustration of data communication consists of transmitter unit and receiver unit. The transmitter consists of PC, switches, Arduino microcontroller, LCD display, encoder, preamplifier, power amplifier and LED.

The receiver part consists of light receiver, amplifier, power amplifier, decoder, Bulb, Fan, voltage panel, LCD or PC 2 display, relays and Arduino microcontroller. The communication is achieved between one PC to another through visible light is as shown in this figure 2.2. This includes the controlling of devices like a bulb using relay switch An additional function of this system is audio transmission. The block diagram of audio transmission is as shown below figure 2.3, which consists of switches, SD card, audio jack, Arduino microcontroller and LEDs. This audio system can also be used for naviga-tion purpose by giving voice as input instead of music.
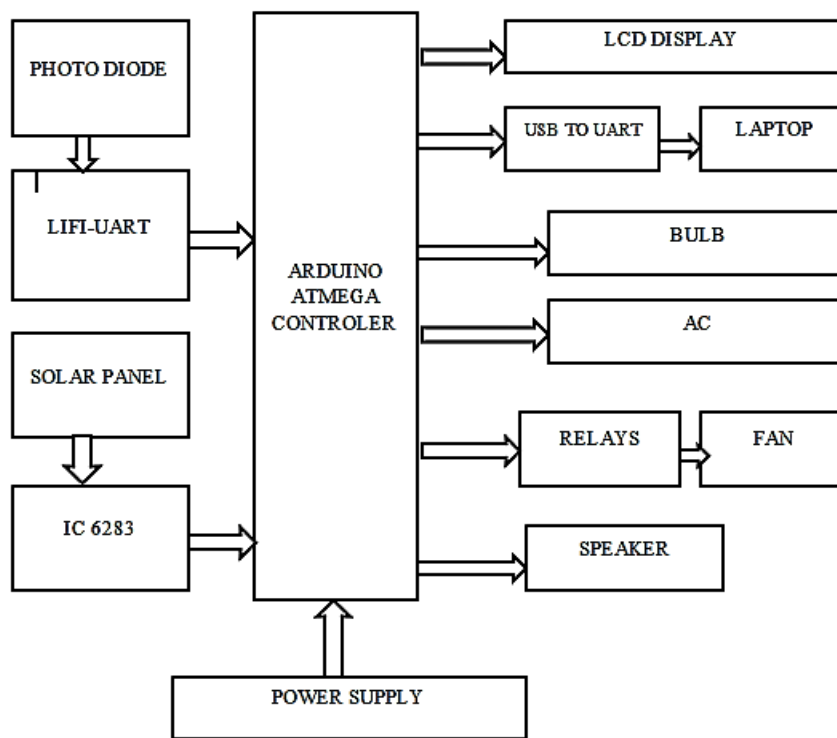
Figure 2.2: Receiver section of device control

The audio transmitter part consists of 1x4 keypad, audio jack, led's and arduino is as shown below figure 2.3.
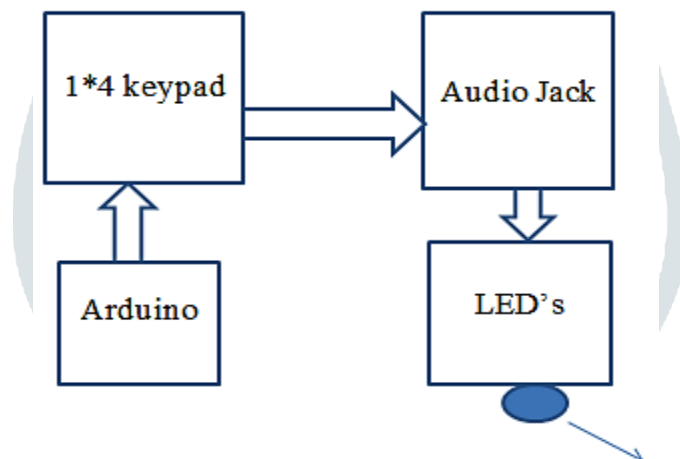

Figure 2.3: Audio transmission section

The visible light communication system is used to transmit data and audio. The audio and data is transmitted through LEDs. In this visible light acts as light transmitter and air is the transmission medium. Photodiodes receives the signal and is decoded to digital signal then it is pre amplified to get analog signal back. Then the data will   displayed on PC and music player plays the selected song.

　　　　Device switching is the process that can control the devices like bulb and fan. The algorithm for device switching is first the input is send to microcontroller through   key-board. Then the data is transmitted to power LEDs by controller and is retrieved by re-ceiver and is decoded to get original data and through relays we can control the   cor-responding device.

　　　　For data communication, the input data will generated by keyboard of PC1. Then the input is fed to the microcontroller. The keyboard is connected to PC through serial ports. Then the data will displayed on LCD display. This input data is encoded by using encoder. The encoded signal is passed to pre amplifier. The preamplifier provides the small electrical signal for remaining process of amplification. It is used to strengthen the signal without any degradation of signal to noise ratio [6].

The signal is then transmitted to power amplifier where the low power signals are converted to level suitable for transmission through visible light. Then the signal is trans-mitted through light. LED is used as downlink transmitter in this system.

The receiver consists of light receiver to receive the data and amplifier to amplify the signal. Then the signal is decoded and is transmitted to microcontroller. The original signal is obtained and is displayed on another PC.
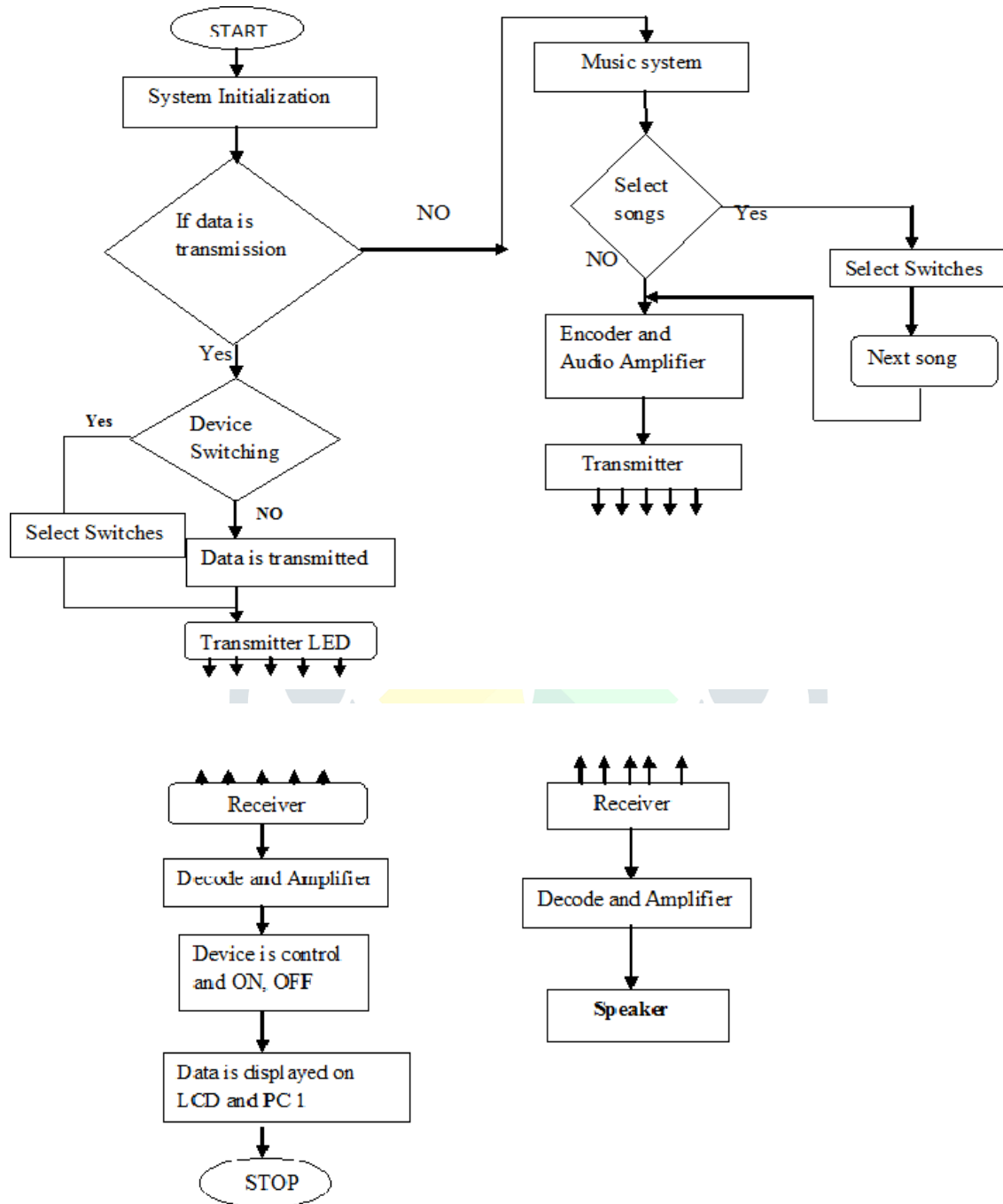
The Flow chart for the proposed system is as follows

Figure 2.4: Flow chart

•In the initial conditions both the transmitter and receiver can be connected and gives the power to Microcontroller. Both the Sides power is ON then start the functions.

•When the power is ON, the system is initialize then it ready to perform the tasks. It checks the conditions if it's the data transmission are ON then condition is   satisfied it will ready to perform data transmission else it goes to music section.

•In the data transmission the data is created or typed through using keypad of PC, the data is transmitted through the LED.

•In the receiver section photo detector receives the signal data and gives the data in amplifier and decoder unit.

•The decoder converts non coded form to coded form and amplifies the signals, it removes unwanted noise occurs in the signal. The strong signal can be transmitted to output devices like LCD display.

•In the display units are using LCD and PC 2 for displaying the output. If any data is generated in the transmitted side, same data is displayed on the output of PC2.

•In the data transmission section can also control the devices by using the switches. If the switch 1 is pressed, device 1 is ON and Fan is ON in the receiver side.

•When the switch 2 is pressed in transmitter section, device 2 is OFF and Fan is Turn off automatically.

•When the switch 3 is pressed in the transmitter side, device 2 is ON and Bulb is Turn ON in the receiver section.

•When the switch 4 is pressed, device 2 is OFF and Bulb is Turn OFF automatically in the receiver section so it displays in the LCD.

•Another application is the music player sections, it the data transmission condition is false then it goes to music sections.

•The music player is an audio jack; audios can be stored in SD card and inserted in the jack. Then next process is to selecting the songs. If the song is changes by   using switches else the continuous audio is played.

•If the selected songs is transfers in the amplifier and encoder section, this sections the signal is converted into another form and amplifies the signal then transmitted through LED.

•In receiver part, voltage panel is receives the signal in analog light intensity form, it can be decoded and amplifies by the amplifier sections. The signals are converted into non coded form to coded form and amplify these signal and gives original audio signal.

•The output unit is the speaker, it receives decoded signals and amplified signal and speakers gives original audio in the music section. The main advantage of this sec-tion is to change the audio files by using switches.

•When switch 1 is pressed, the music section will initialize and it ready to perform.

•When the switch 2 is pressed for selecting the next song.

•When switch 3 is pressed, it performs pause and play function in the music section.

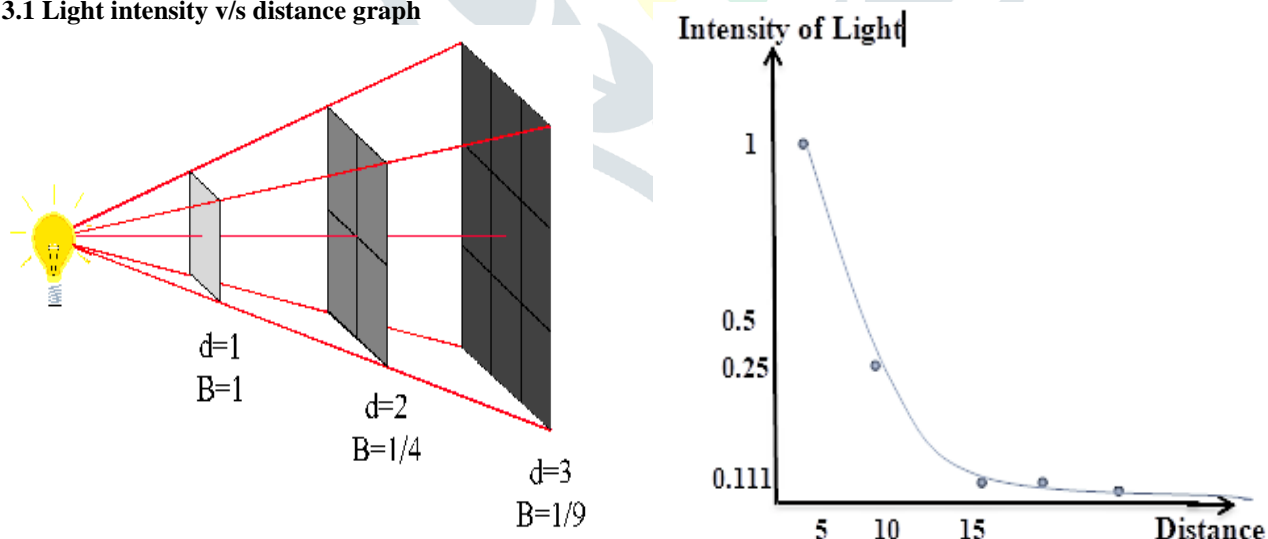## III. MATHEMATICAL MODEL

3.1 Light intensity v/s distance graph

Figure 3.6: (Left) Light source with object   (Right) Intensity of light and distance graph.

Expressed mathematically:

$$B \propto \frac{1}{d^2}$$

In words:

The Apparent Brightness (B) of a source is inversely proportional to the **square of its distance (d)**

Implications:

For a light source of a given Luminosity...

Closer = Brighter

Move 2x closer to a light source

It will appear $2^2 = 4$ times brighter.

Farther = Fainter

Move 2x further away from a light source

It will appear $2^2 = 4$ times fainter

Let Pes and Pem are the error probability of a high bit being received as a low bit and a low bit being received as a high bit, respectively, then for a coherent receiver we have

$$P_{eS} = P_{eM} = \frac{1}{2} erfc\left(\sqrt{E_b / 4N_o} \right)$$

Where Eb /No is the energy-to-noise spectral density ratio and erfc (.) is the complementary error function.

IV. RESEARCH METHODOLOGY

4.1 Optical Channel

The bandwidth of the optical channel in a LOS configuration is reported higher than 88MHz [5]. Therefore, the optical pass loss is the most important quantity to characterize the channel and relates the transmitted and received optical powers via

$$P_r = H(0)P_t \quad \text{(W)} \qquad (2)$$

where t P is the transmitted optical power, r P is the received optical power, and H(0) is the optical path loss. This approximation is particularly accurate in directed-LOS links. Considering the LOS link geometry shown in Fig. 4.2, the LOS channel path loss is defined as [2]

$$H(0)_{LOS} = \frac{A}{d^2} R_0(\phi) T_s(\psi) g(\psi) \cos\psi \qquad (3)$$

where d is the distance between the transmitter and the receive, φ is the angle with respect to the transmitter, ψ is the angle with respect to the receiver, T(ψ) is the filter gain, g (ψ) is the concentrator gain, and R φ is the transmitter radiant intensity given by [2],

$$R_0(\phi) = \left[\frac{m+1}{2\pi} \right] \cos^m \phi \quad \text{(W/sr)} \qquad (4)$$

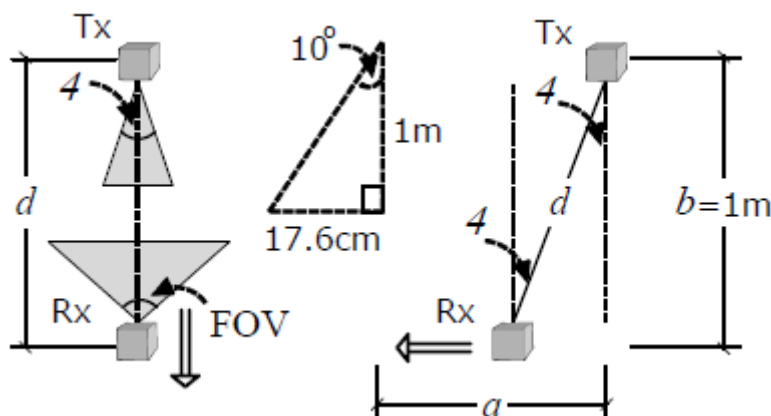$$m = \frac{\ln 2}{\ln(\cos\alpha)} \qquad (5)$$

Figure 4.1: Vertical and horizontal coverage scenarios.

4.1.1 Comparison of the Models

This describes the overall functions of the system; number of applications can be added in the Li-Fi technology because it is a user friendly for all applications. The Li-Fi technology is better than other networks technology like Wi-Fi, Ethernet etc. point to point transmission of Li-Fi technology frequency band is 100x Tera HZ but in Wi-Fi   frequency range is 2.4GHz, 4.9GHz,5GHz and the range of Li-Fi is 10meters from the light. Main characteristics and comparison of Li-Fi and other network is shown in below table.

Table 3.1: The distinctiveness of Li-fi and other networks

PARAMETER	LI-FI	WIFI	ETHERNET
IEEE standards	802.15.147	802.11b	802.3
Frequency bands	100 x tera HZ	2.4GHZ	
Cots	Cheap	Expensive	Medium
Data trans.medium	Light	Radio Spectrum	UTP.STP.O.F
Network topology	Point to point	Point to point	Bus star
Speed	1-3.5GBPS	54-250MBPS	100-1000MBPS
Range	10mts	20-100 mts	100-185 mts
Security	High	Medium	High
Power Energy	Available	Less available	Available
QOS			
Data rate	Very high	High	High
Wireless spectrum Reliability		2.4 GHZ 5GHZ	None
Reliability	High	High	Very high
Release date	2011	1990	1980

V. RESULTS AND DISCUSSION

In this subsection we are going to discuss about the results which are obtained for the proposed during the experimental phase. The snaps are as follows,
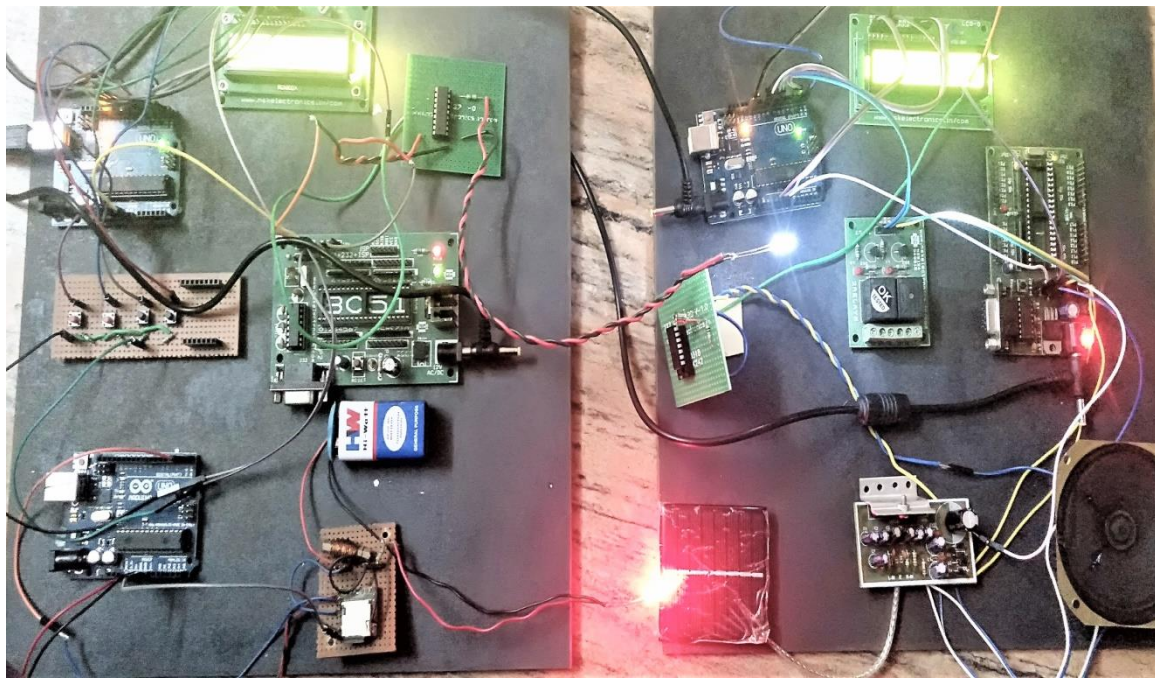
Figure 4.1: Designed system

The above diagram shows the overall designed and implementation of lighting control network system. So, we have achieved all the three objectives of the project .Namely, au-dio transmission through light. Here 8051 micro-controller is used just for taking the 12 volt supply from this board to relays and LCD display and also to the working of the push buttons. Here we have used three arduino boards one is for the audio transmission and other two for the   device switching.

The audio transmission output using the Li-Fi technology is as shown in the below figure,
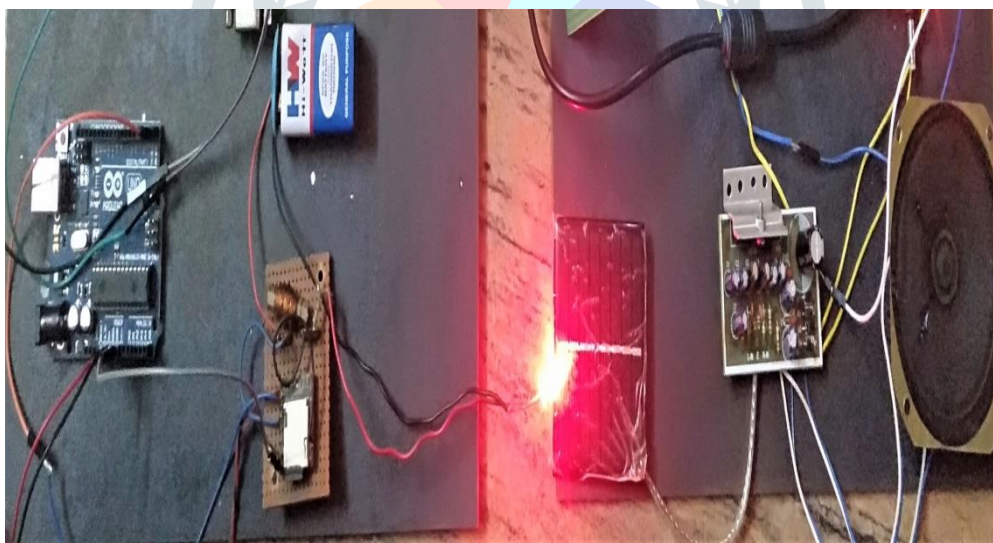

Figure 4.2: Audio transmission through light.

In order to achieve Audio transmission through light we require arduino UNO board, SD card reader with coil in order to energize the signal or information, this is shown in above figure 4.2. So the supply is to be   taken from the 9volt battery. So through the LED light we have made to pass this light and on to the solar panel later the signal is amplified fur-ther and got output from the speaker.
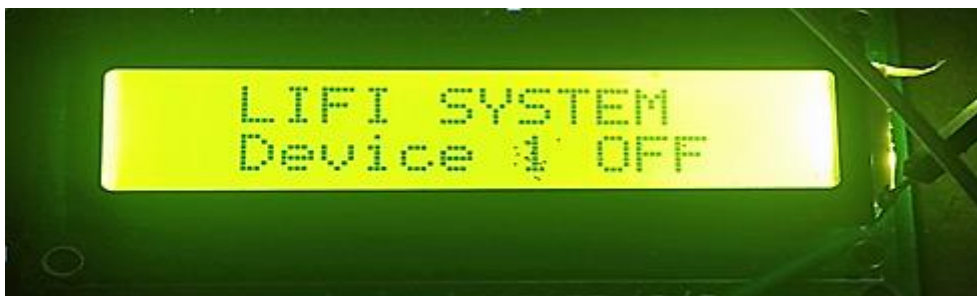
Figure 4.3 Device switching through light.

To provide the message to the program we can use the UART which is as shown in the below figure,
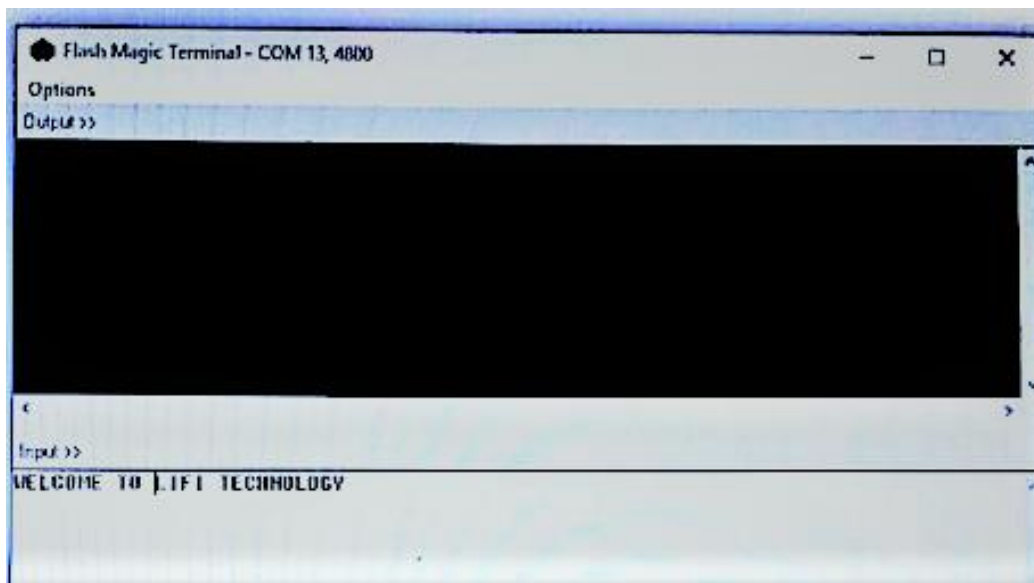

Figure 4.4: Inputting the message

Through light we can able to transmit the data or message .At the receiver side, the mes-sage what we have sent is to be displayed.

For example here at the transmitter side, the message is "DATA IS TEXT" OR "PC-PC transmission data" is to be displayed in the pc placed at the receiver side.
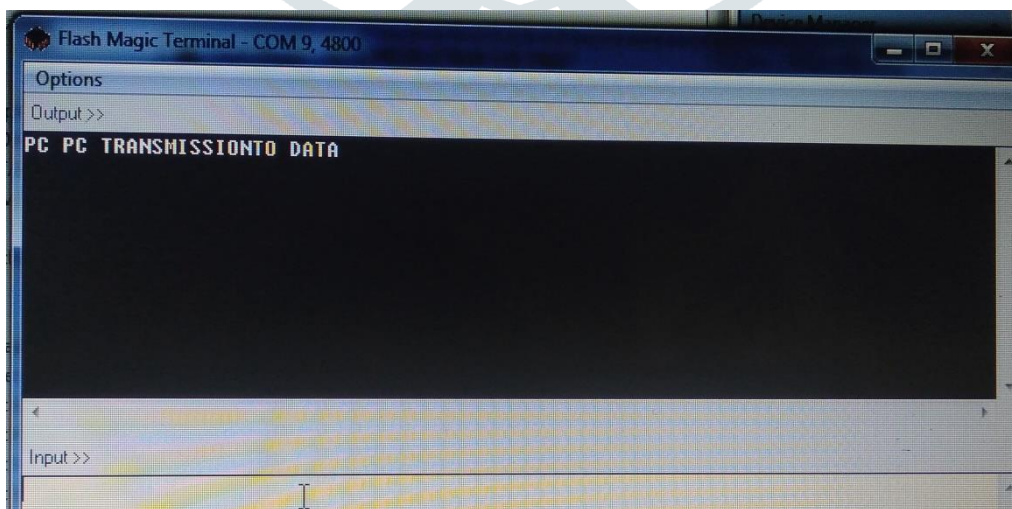

Figure 4.5: output of pc-pc communication.

CONCLUSION

In this system, light emitting diodes are used. The visible light technology elimi-nates the Wi-Fi technology. The radiation from Wi-Fi is harmful for human health so this system utilizes the existing light to transmit the data and controlling the devices. The data is secured in this Li-Fi technology compare to Wi-Fi technology. The visible light has the wavelength from 380nm to 750nm.

Here audio transmission is achieved by using IC 6283 to amplify the signal and get back to the original signal at the output side by using keypad and can be audible the voice using speaker. In-order to enhance the background music we have used IC 6283.Similarly device switching is achieved by using relay and push buttons. Normally IC 7404 is used to convert the data to original signal and displayed in the LCD screen that which device is to be active is displayed. Also PC-PC communication is achieved by us-ing LED light from one PC to another PC. Respective results pics are as shown in the re-sults and analysis sections.

Future Scope

Further this system is developed to transmit pictures, graphics, videos etc. And we can give voice input and is used for navigation purpose. The switching device application can be further modified to control the street light.

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