Analog Communication

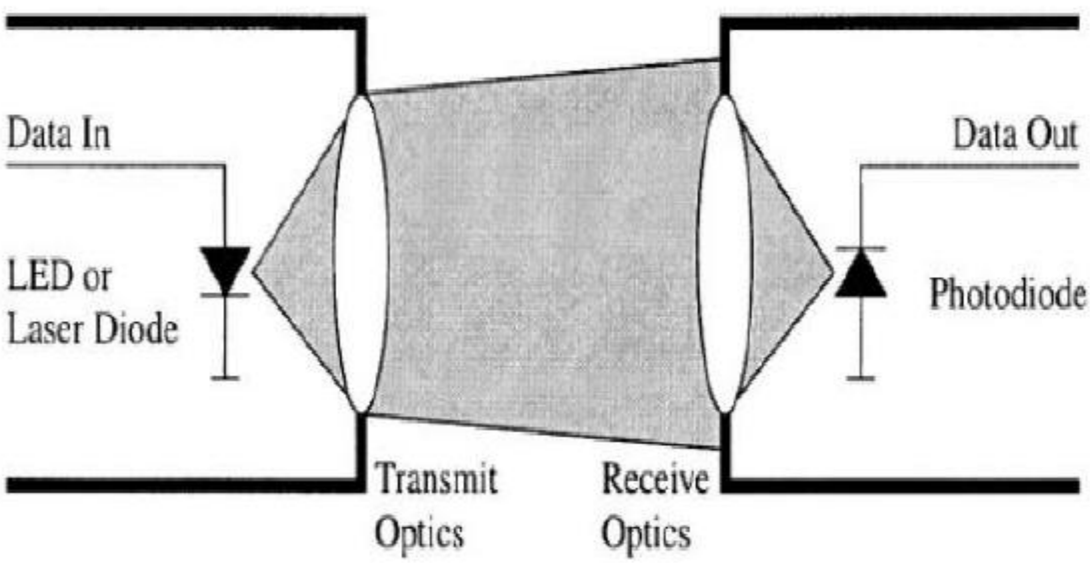
Project

LiFi and Speech Recognition

Team No. 9

ID	Name
45	احمد ناصر عبد السلام عكاشة
54	اسلام جمال السيد اسماعيل خليفه
231	محمد عصام الدين حسن صادق
236	محمد محمد مصطفي عبودي
237	محمد محمود خليل ابراهيم
238	محمد محمود عبد الفتاح محمد
260	مصطفي يحيي زيدان علي احمد
262	معتز صبحي ذكي محمد

Optical wireless communications (OWC)
is a form of optical communication in which unguided visible, infrared (IR), or ultraviolet (UV) light is used to carry a signal.
OWC systems operating in the visible band (390–750 nm) are commonly referred to as visible light communication (VLC).
VLC systems take advantage of light emitting diodes **(LEDs)** which can be pulsed at very high speeds without noticeable effect on the lighting output and human eye.
VLC can be possibly used in a wide range of applications including wireless local area networks, wireless personal area networks and vehicular networks among others.
A brief history:
Wireless communications technologies became essential very quickly during the last few decades of the 20th century, and the early 21st century. The wide-scale deployment of radio-frequency technologies was a key factor in the expansion of wireless devices and systems. However, the portion of the electromagnetic spectrum used by wireless systems is limited in capacity, and licenses to use parts of the spectrum are expensive. With the rise in data-heavy wireless communications, the demand for RF spectrum is outstripping supply, causing companies to consider options for using parts of the electromagnetic spectrum other than radio frequencies.



Optical wireless communication diagram

Optical networking for agility:
Another optical networking technology, free space optics (FSO), uses lasers without the optical fibers, transmitting data through the air. Although it has lower capacity than fiber-based optical networking and is subject to interference from certain types of precipitation, FSO can provide high-capacity wireless connectivity with very little lead time. FSO can also transmit data over longer distances than Wi-Fi and, in some use cases; it can do so for far less money than if fiber has to be pulled.

Theory behind Light fidelity:

LiFi is high speed bidirectional networked and mobile communication of data using light. LiFi comprises of multiple light bulbs that form a wireless network.

When an electrical current is applied to a LED light bulb a stream of light (photons) is emitted from the bulb. LED bulbs are semiconductor devices, which mean that the brightness of the light flowing through them can be changed at extremely high speeds. This allows us to send a signal by modulating the light at different rates. The signal can then be received by a detector which interprets the changes in light intensity (the signal) as data.

The intensity modulation cannot be seen by the human eye, and thus communication is just as seamless as other radio systems, allowing the users to be connected where there is LiFi enabled light. Using this technique, data can be transmitted from a LED light bulb at high speeds.

LiFi's early developmental models were capable of 150 megabits-per-second (Mbps). Some commercial kits enabling that speed have been released. In the lab, with stronger LEDs and different technology, researchers have enabled 10 gigabits-per-second (Gbps), which is faster than 802.11ad.

Benefits of LiFi:

- Higher speeds than Wi-Fi.
- 10000 times the frequency spectrum of radio.
- More secure because data cannot be intercepted without a clear line of sight.
- Eliminates neighboring network interference.
- Does not create interference in sensitive electronics, making it better for use in environments like hospitals and aircraft.

By using LiFi in all the lights in and around a building, the technology could enable greater area of coverage than a single WiFi router. Drawbacks to the technology include the need for a clear line of sight, difficulties with mobility and the requirement that lights stay on for operation.

Comprehensive Summary of Modulation Techniques for LiFi:

Since LED lights emit incoherent light only intensity modulation and direct detection can be used. Single carrier modulation techniques are straightforward to implement, but for data rates higher than about 15 Mbps computationally complex equalization techniques are required in frequency selective LiFi channels. Moreover, single carrier techniques suffer from DC wander effects. Alternatively, multicarrier modulation techniques offer a viable solution for high speed LiFi in terms of power efficiency, spectral efficiency and computational efficiency. In particular, orthogonal frequency division multiplexing (OFDM) based modulation techniques offer a practical solution as they are based on fast Fourier transformations for which very computational effective digital signal processing implementations exist. LiFi modulation techniques need to also satisfy illumination requirements. Flickering avoidance and dimming control are considered in the variant modulation techniques presented.

Hardware implementation:

Now, we are going to see how we can transfer and receive audio signals using a simple LED and solar cell plate.

Materials required:

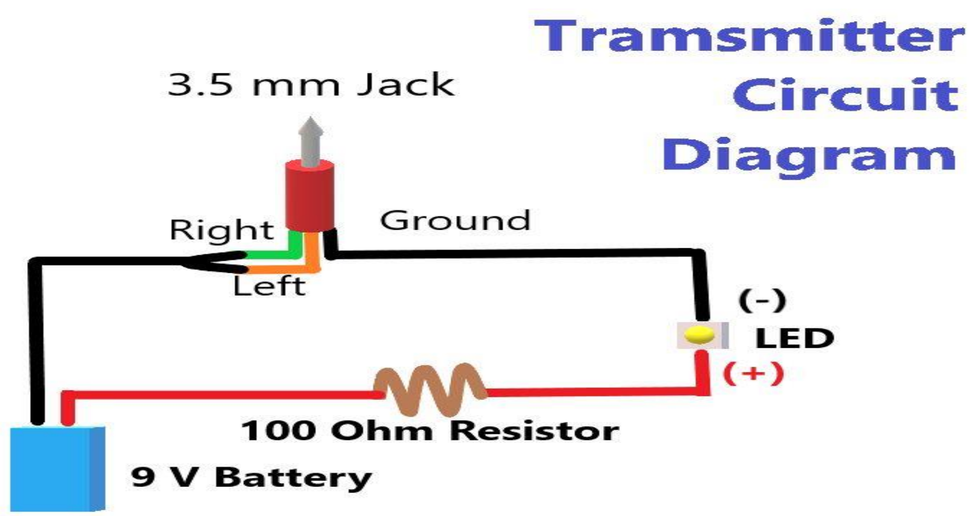
1. 5-6V Solar Panel
2. 1 W Ultra Bright LED
3. Aux cable
4. 3.5 mm Jack
5. 9V Battery
6. Pre amplified speaker

We have two circuits one for Receiver side and other for transmitter side:

Transmitter Circuit for Li-Fi:

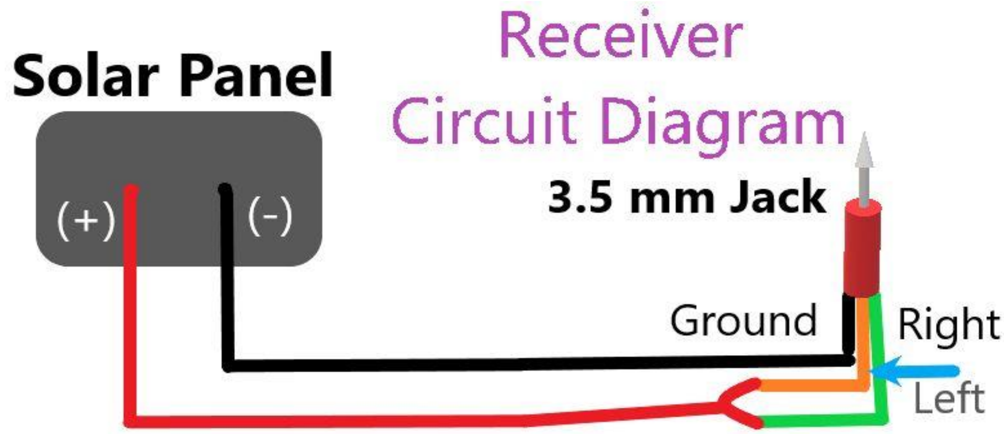
On transmitter side, we have white Bright LED and battery which are connected to 3.5mm jack and jack will be connected to audio source. Here we are using battery to power up the LEDs because there is less power coming from the audio source which is not enough to power the LEDs.

Connections are shown below in the circuit diagram:



<u>Receiver Circuit for Li-Fi:</u>

On receiver side, we are using Solar panel and a speaker which is connected by an Aux cable. An amplifier circuit maybe used at receiving end.



<u>Working of Audio Transfer circuit using Li-Fi</u>

(Deeper look in technical info):

In transmitter side, when we **connect 3.5mm jack to audio source LED** will glow but there is no fluctuation in the intensity of light when the audio source is OFF. As soon as you play the audio, you will see that there is frequent change in intensity of light. When you increase the volume, LED's intensity is changing faster than the human eye can follow.

Solar panel is so sensitive that it can catch small intensity change and correspondingly there is change in the voltages at output of solar panel. So, when the light of LED falls on the panel**, voltages will varies according to the intensity of light** .Then voltages of solar panel is fed into amplifier (Speaker) which amplifies the signal and giving the audio output through the speaker connected to the amplifier.

Output will come as long as solar panel is in contact of LED's. You can put the LED's at maximum 15-20cm distance from the solar panel to get the clear audio output. You can further increase the range by increasing the area of solar panel and higher wattage Power LED.