

Li-Fi Communication

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Abstract— Current era many people are using internet to accomplish their task through wired or wireless network. As number of users get increased in wireless speed decreases proportionally. Though Wi-Fi gives us speed up to 150mbps as per IEEE 802.11n, it is still insufficient to accommodate number of users. To remedy this limitation of Wireless Fidelity, we are introducing concept of Li-Fi. Li-fi stands for light fidelity which enables to transfer data and provide internet through the visible light signals which differentiates it from other technologies. This System has regulated the speed which human eye has not be perceived its blinking. At receiver by applying photosensitive detector, transmitted data can be received. This system can be demonstrated as bidirectional VLC [Visible light Communication] system where both computers can act as transceiver. Using a processing software, Arduino software and Arduino hardware the transmission of files occurs between two computers where LED [light emitting diode] and LDR[Light dependent resister] were in the same line of sight. It is observed that the system has worked better for white LED than the red LED and IR LED. So, VLC based text and file transfer system is implemented with white LED. The operational procedure is very simple-, if the LED bulb is on, you transmit a digital 1, if it's off you transmit a 0. The LEDs can be switched on and off very quickly, which gives nice opportunities for transmitting data. Hence all that is required is some LEDs and a controller that code data into those LEDs. All one has to do is to vary the rate at which the LED's flicker depending upon the data we want to encode.

Keywords: VLC[Visible light Communication], LED[Light emitting diode]

I. INTRODUCTION

Li-Fi [Light Fidelity] is an upcoming enhancement of wireless communication that is going to use the LED [Light emitting diode] bulbs to transmit the data without any wire. Transmitting the data from the sender to receiver becomes a vital factor in the rapid growing world. The currently used networks that connect us to the internet are slow due to: if many devices are connected onto the same network and are trying to access the internet at the same time from which user cannot effectively use the high data transfer rates because the bandwidth is fixed. When more than one device or the user are present in the same network then the data transmission is not secure, and the risks of security increases and each user cannot enjoy high speed streaming.

Li-Fi communication uses light to transmit the information from the sender to receiver, which is fast, effective and also secure when compared to the radio waves. It has a wide spectrum for transmitting when measured to the classical methods of wireless communication that depend on the radio waves. The principal behind the Li-Fi is that the information can be sent through the LED light bulbs that differ in the intensity faster than the human eye can observe.

Li-Fi was initiated by the German tech scientists which said Li-Fi communication is referred by the "data through gleam". Li-fi can be viewed as the light based Wi-Fi [Wireless Fidelity] which uses light to transmit the data instead of radio waves. In Wi-Fi as we use modems to transmit the data similarly, we use transceivers attached with the LED bulb which can not only radiance the room but also transmit the details. If the LED is "on" then a digital 1 will be transmitted and if the LED is "off" the digital 0 will be transmitted.

The conversions of on and off can take place at any moment and very quickly which cannot be observed with the human eye because of which the resultant appears to be constant. Li-Fi is a method through which it can change the way we connect to the internet.

II. OBJECTIVE

The researches and corresponding discussions with the mentors helped in formulating the objectives, scope and methodology of the study. The objective of the study aims at providing a data transfer technique which is non-hazardous for living creatures, fast, reliable and secure etc. The specific objectives of the current studies are as follows:

- To find out the different ways in which the light can be used to transfer data.
- To find out the current data transfer rate achieved and how it can be improved.
- To categorize the important factors which influence the efficiency of data transfer using light and analyze it for the optimal result.
- To probe and identify the important hurdles of data transfer using light.

III. RELATED WORK

Different approaches for implementing Li-Fi technology are presented below

Professor Harald Haas coined the term "Li-Fi" at his 2011 TED Global Talk where he introduced the idea of "wireless data from every light". He is a Chair Professor of Mobile Communications at the University of Edinburgh, and the co-founder of pure Li-Fi along with Dr Mostafa Afgani. Li-Fi is a derivative of optical wireless communications (OWC) technology, which uses light from light-emitting diodes (LEDs) as a medium to deliver network, mobile, high-speed communication in a similar manner to Wi-Fi.

In June 2018, Li-Fi passed a test by a BMW plant in Munich for operating in an industrial environment. BMW project manager Gerhard Kleinpeter hopes for the miniaturization of Li-Fi transceivers, for Li-Fi to be efficiently used in production plants

In June 2019, French company Oledcomm tested their Li-Fi technology at the 2019 Paris Air Show.

Oledcomm hopes to collaborate with Air France in the future to test Li-Fi on an aircraft in-flight.

IV. METHODOLOGY

Li-Fi system is made up of mainly two parts i.e. the transmitter and the receiver. LED light can be used as source of signal between end systems. The modulated light from the LED can be used to carry data. The modulation and demodulation of data between transmitter and receiver ends can be done by microprocessor unit.

The input signal can be modulated with the sufficient time period and transmitted in the form of 1's and 0's by the help of LED lights and transmitter. Flashes of lights works as 0's and 1's. When the light is off it represents 0, and when it glows it depicts 1. Photodiode can be used to detect the flashes and then the signal can be

Amplified to produce the output. In order to improve performance, we can LED's in parallel in order to achieve higher data transfer rate. Data can be encrypted by different frequency by using different color LED lights. States can be toggled using switching transistor in nanoseconds which further will increase the transmission speed to some extent.

V. SYSTEM HARDWARE AND SOFTWARE CONFIGURATION

A. Hardware Components

1) Arduino UNO

Arduino is open-source electronics prototyping platform based on flexible, easy-to-use hardware and software. Today we will help you get started by showing you some of the options available and how easy it is to get started.

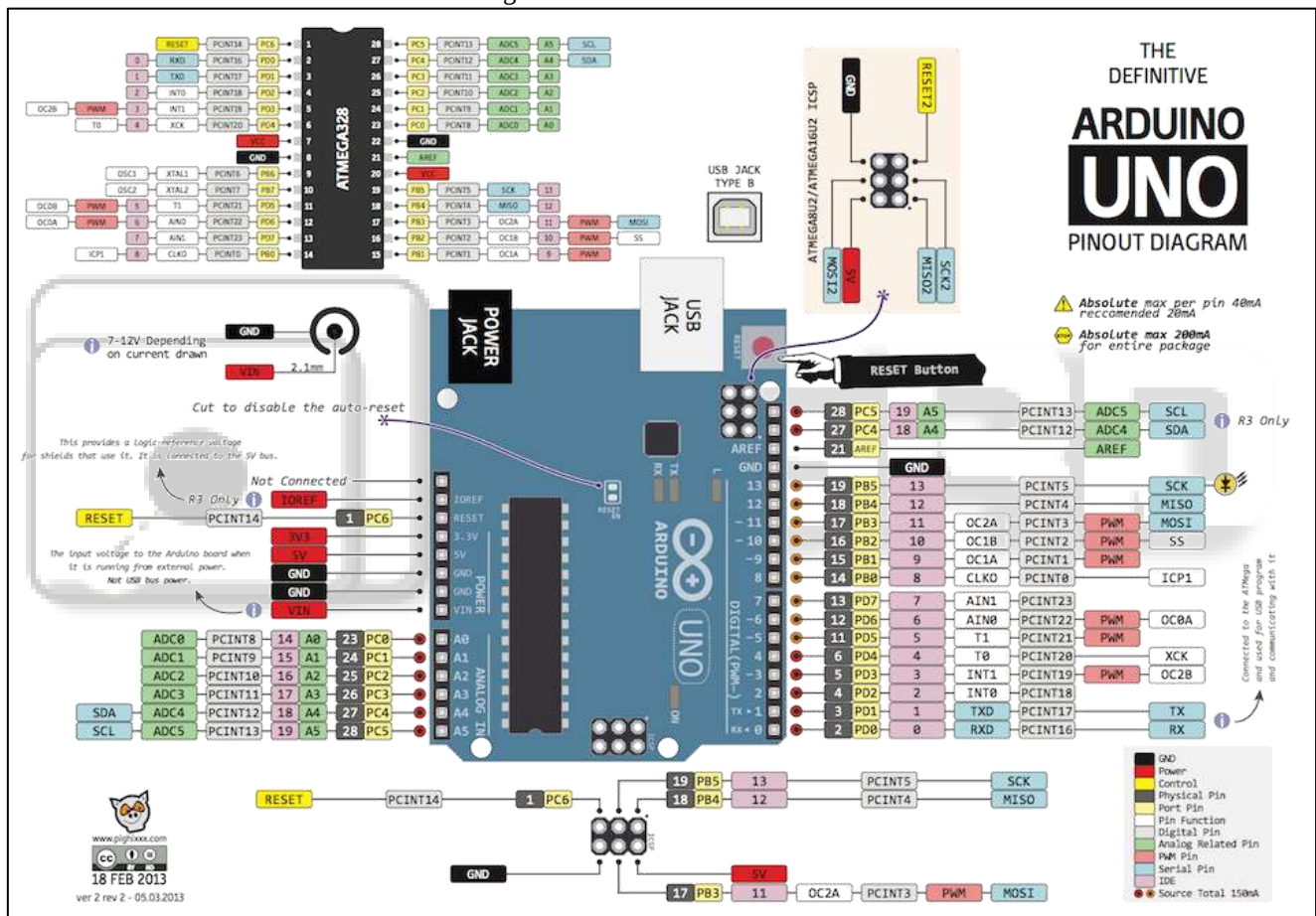


Fig. 1: Arduino UNO – Board Description

Arduino hardware is an open-source circuit board with a microprocessor and input/output (I/O) pins for communication and controlling physical objects (LED, servos, buttons, etc.). The board will typically be powered via USB or an external power supply which in turn allows it to power other hardware and sensors.

Arduino also has an open-source software component which is similar to C++. The Arduino integrated development environment (IDE) allows you to write code, compile it, and then upload it to your Arduino for standalone use in prototyping and projects. All of this was designed to be easy to use to let artists and makers freely develop their ideas into real objects. If you are

interested in building something yourself, have a look to see the hardware options, and software available to get your started.

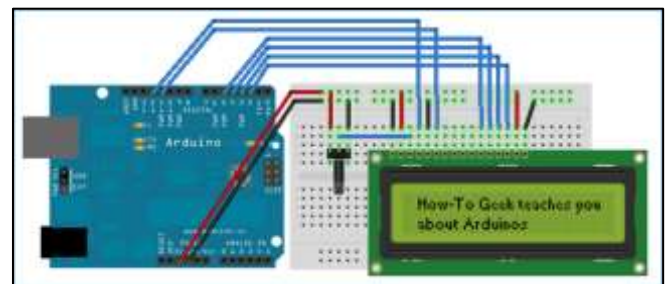


Fig. 2: Arduino UNO with display

2) LDR

A Light Dependent Resistor (aka LDR, photoconductor, photocell, or photoresistor.) is a device which has a resistance which varies according to the amount of light falling on its surface, when light falls upon it then the resistance changes.

Light dependent resistors or LDRs are often used in circuits where it is necessary to detect the presence of light, or the ambient level of light, often to create a light triggered switch.

Different LDR's have different specifications, a typical LDR has a resistance in total darkness of 1 MOhm, and a resistance of a couple of kOhm in bright light (10-20kOhm @ 10 lux, 2-4kOhm @ 100 lux). It is not uncommon for the values of resistance of an LDR to be several megohms in darkness and then to fall to a few hundred ohms in bright light. With such a wide variation in resistance, LDRs are easy to use and there are many LDR circuits available. LDRs are made from semiconductor materials to enable them to have their light sensitive properties. Many materials can be used, but one popular material for these LDR's is cadmium sulphide (CdS).

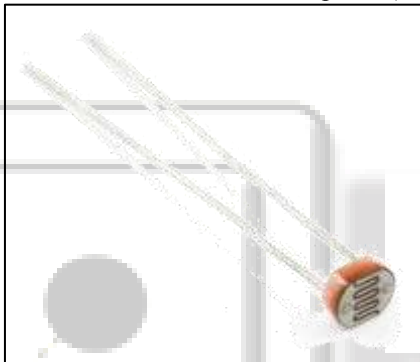


Fig. 3: LDR - Light Dependent Resistor

3) LED – Light Emitting Diode:

Light Emitting Diodes or LED's, are among the most widely used of all the different types of semiconductor diodes available today and are commonly used in TV's and colour displays.

They are the most visible type of diode, that emit a fairly narrow bandwidth of either visible light at different colored wavelengths, invisible infra-red light for remote controls or laser type light when a forward current is passed through them.

The "Light Emitting Diode" or LED as it is more commonly called, is basically just a specialized type of diode as they have very similar electrical characteristics to a PN junction diode. This means that an LED will pass current in its forward direction but block the flow of current in the reverse direction.

Light emitting diodes are made from a very thin layer of fairly heavily doped semiconductor material and depending on the semiconductor material used and the amount of doping, when forward biased an LED will emit a colored light at a particular spectral wavelength.

When the diode is forward biased, electrons from the semiconductor's conduction band recombine with holes from the valence band releasing sufficient energy to produce photons which emit a monochromatic (single color) of light. Because of this thin layer a reasonable number of these

photons can leave the junction and radiate away producing a colored light output.

4) Resistors:

Resistors are the most commonly used component in electronics and their purpose is to create specified values of current and voltage in a circuit. A number of different resistors are shown in the photos. (The resistors are on millimeter paper, with 1cm spacing to give some idea of the dimensions). Photo 4.1 shows some low-power resistors, while photo 4.2 shows some higher-power resistors. Resistors with power dissipation below 5 watt (most commonly used types) are cylindrical in shape, with a wire protruding from each end for connecting to a circuit (photo 4.1). Resistors with power dissipation above 5 watt are shown below (photo 4.2).



Fig. 4.1: Some low-power resistors



Fig. 4.2: High-power resistors and rheostats

B. Software configuration

1) Arduino IDE

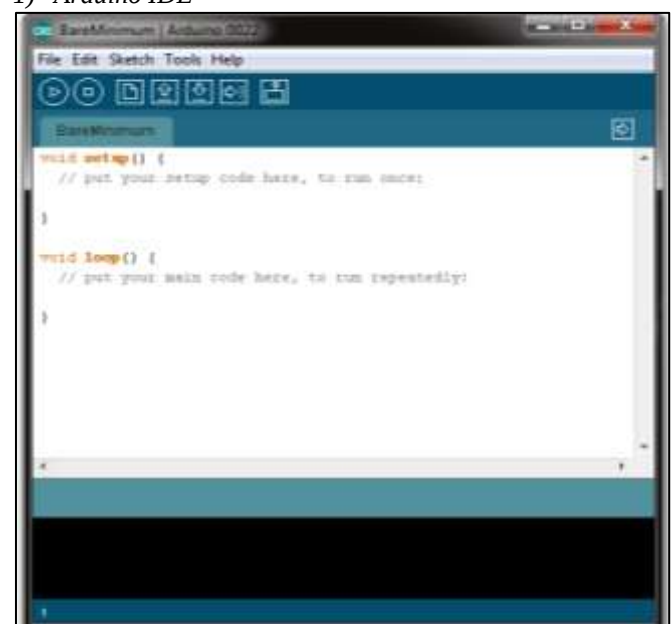


Fig. 5: IDE

It is a cross platform developer tool written in Java. It allows you to control all of the software functions of your Arduino.

Each program that you write is called a sketch and is compiled and uploaded to your Arduino using the IDE. A lot of sketches are freely available online and the IDE even comes with a plethora of examples to get you started with just about every function your Arduino is capable of.

VI. EXPERIMENTAL RESULTS

The tests are performed in a closed lab room, at night time, so that the effect of ambient constant illumination due to other luminaires or sunlight can be considered negligible and it becomes easier to obtain the results. Nevertheless, the Li-Fi technology works in daylight also, because the constant illumination from the sunlight on the receiver PD does not affect the modulated intensities.

In a typical setup, the transmitter (LED) is connected to the data network (Internet through the modem) and the receiver (photo detector/light sensor) on the receiving end receives the data as light signal and decodes the information, which is then displayed on the device connected to the receiver. The receiver (photo detector) registers a binary '1' when the transmitter (LED) is ON and a binary '0' when the transmitter (LED) is OFF. Thus flashing the LED numerous times or using an array of LEDs (perhaps of a few different colours) will eventually provide data rates in the range of hundreds of Mbps.

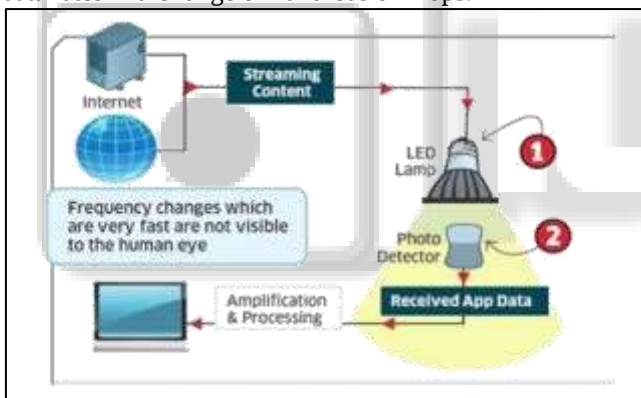


Fig. 6: Block diagram of Li-Fi Sub System

Hence all that is required, is some or an array of LEDs and a controller that controls/encodes data into those LEDs. All one has to do is to vary the rate at which the LEDs flicker depending upon the data input to LEDs. Further data rate enhancements can be made in this method, by using array of the LEDs for parallel data transmission, or using mixtures of red, green and blue LEDs to alter the light's frequency, with each frequency encoding a different data channel.

VII. CONCLUSION

Although there's still a long way to go to make this technology a commercial success, it promises a great potential in the field of wireless internet. A significant number of researchers and companies are currently working on this concept, which promises to solve the problem of lack of radio spectrum, space and low internet connection speed. By deployment of this technology, we can migrate to greener, cleaner, safer communication networks.

The very concept of Li-Fi promises to solve issues such as, shortage of radio-frequency bandwidth and eliminates the disadvantages of Radio communication technologies. 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.

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