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LIGHT FIDELITY FOR DATA COMMUNICATION

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Abstract— **Over the years, the overdependence on Wireless Fidelity (Wi-Fi) for data transmission necessitated the need for an alternate and more reliable means of communication, hence, Light Fidelity (Li-Fi). It involves the use of Light light-emitting diode to transmit data by blinking (i.e., switching them On and Off) at a speed not noticeable to the eye. This paper proposed the development of the Li-Fi system -using off-the-shelf electronic components.**

In this project, we are implementing Li-Fi communication using two Arduino. Here the text data is transmitted using LED and Push buttons. It is decoded on the receiver side using LDR. Also, by developing a user (Receiver PC) interface using Embedded C programming, the sample data (text, voice and image) transferred was monitored and the speed, efficiency, security and capacity of the system was examined. In the receiver section, the LDR sensor receives the visible light pulses from the transmitter side and converts it into interpretable electrical pulses, which is fed to the Arduino and receives this pulse and converts it into actual data. Then the data is displayed on a 16*2LCD display.

The nature of radio waves used in Wi-Fi has made connection unstable and vulnerable to external threats. That is several security features were placed on Wi-Fi system based on security standards in order to make wireless networks more secure. These features are still vulnerable especially if the technology catches up and more people will figure it out how to exploit these features on other hand LI-fi is considered as more secure mainly because even in absence of encryption and other security features, the nature of connection makes it easier to secure connection. The addition of more security protocols to Li-Fi will not only enable high speed but also create opportunity to creative security to make connections more secure.

Keywords— LIFI, LDR Sensor, Wireless Communication, Visible light communication (VLC)

I. INTRODUCTION

LI-FI (Light Fidelity) is a fast and cheap optical version of Wi-Fi, the technology of which is based on Visible Light Communication (VLC). Li-Fi is transmission of data through illumination by taking the fiber out of fiber optics by sending data through a LED light bulb that varies in intensity faster than the human eye can follow. Li-Fi is the term some have used to label the fast and cheap wireless communication system, which is the optical version of Wi-Fi. The term was first used in this context by Harald Haas in his TED Global talk on Visible Light Communication. At the heart of this technology is a new generation of high brightness light-emitting diodes if the LED is on, we transmit a digital 1, if it's off you transmit a 0,They can be switched on and off very quickly, which gives nice opportunities for transmitted data. It is possible to encode data in the light by varying the rate at which the LEDs flicker on and off to give different strings of 1s and 0s. The LED intensity is modulated so rapidly that human eye cannot notice, so the output appears constant. More sophisticated techniques could dramatically increase VLC data rate.

Li-Fi, as it has been dubbed, has already achieved blisteringly high speeds in the lab. Researchers at the Heinrich Hertz Institute in Berlin, Germany, have reached data rates of over 500 megabytes per second using a standard white-light LED. Haas has set up a spin-off firm to sell a consumer VLC transmitter that is due for launch next year. It is capable of transmitting data at 100 MB/s - faster than most UK broadband connections. Li-Fi stands for 'Light Fidelity'.

Li-Fi is the terms have been used to label the fast and cheap wireless communication system, which is the optical version of Wi –Fi. One of the biggest attractions of VLC is the energy saving of LED technology. 9%of the worldwide electricity is

used for lighting. Thirty billion light bulbs are in use worldwide. Assuming that all the light bulbs are exchanged with LEDs, one billion barrels of oil could be saved every year, which again translates into energy production of 250 nuclear power plants. Driven by the progress of LED technology, visible light communication is gaining attention in research and development. The VLC Consortium (VLCC) in Japan was one of the first to introduce this technology.

II. LITERATURE REVIEW

Using a standard white-light LED, researchers at the Heinrich Hertz Institute in Berlin, Germany, have reached data rates of over 500 megabytes per second. Li-Fi Consortium was formed in October2011 by a group of companies and industry groups to promote high-speed optical wireless systems and overcome the limited amount of radio based wireless spectrum. According to the Li-Fi Consortium, it is possible to achieve more than 10 Gbps of speed, theoretically which would allow a high-definition film to be downloaded in just 30 seconds.

Researchers at the University of Strathclyde in Scotland have begun the task of bringing High-speed, ubiquitous, Li-Fi technology to market WANG Jia-Yuan, ZOU Nian-Yu, WANG Dong, IRIEKentaro, IHA Zensei, NAMIHIRA Yoshinori.

The Journal of China Universities of Posts and Telecommunications. In this paper, the illumination of the receiving surface for different distances between the LED and photodiode receiver was tested. It was found that with the increase in communication distance, the illumination sharply reduced.

H. Park proposed a smart home and industrial communication model based on a combination of energy harvesting wireless sensor networks (EH-WSN) and hybrid LiFi/WiFi communication technology. This is called the EH-HL model. In this model, energy is derived from renewable sources such as thermal energy, solar energy, and wind power, and used for wireless sensor networks. Combining LiFi and WiFi technology, data is transmitted at high speed for two-way multidevice.

Jayant, Swapnaja, and Roopali proposed a system that acts as an intermediary between cloud service providers and organizations that use the cloud to store their data. IoT devices are used to collect real-time and continuous data to make better business decisions and improve customer satisfaction. In certain systems, data stored in the cloud is encrypted using the ASE algorithm, a 128-bit symmetric key encryption algorithm.

III. EXISTING SYSTEM

In today world communication between the devices is much common. These devices are using radio waves for short range wireless transmissions. Wi-fi and Bluetooth are currently the two prominent short-range wireless technologies. The radio wave spectrum has certain key limitations which includes bandwidth consumption, efficiency, availability and security.

IV. PROPOSED SYSTEM

Li-fi is a new technique of data transmission. LIFI data is transmitted by modulating the intensity of the light, which is then received by a photo detector. VLC (Visible Light Communication) technology consists of a light source as a transmitter and photo detector as receiver. In transmitter the electrical signals are converted into optic signals and transmitted through LED. The receiver contains photo detector. The photo detector converts the optic signal into electrical signal. This method is made sophisticated by using more than one led at a given time. By this way more information can be passed and hence a faster data communication is possible.

A. Objectives

The objectives of the project are:

- For high-speed data transmission.
- Increased bandwidth compared to Wifi.
- Enhanced security.
- Reduce the electromagnetic interference.

V. METHODOLOGY

- **Step1:** Data must be converted from electrical to optical signals in order to transmit.
- **Step2:** The data will be converted as a binary value and the data will be transmitted through light using li-fi transmitter.
- **Step3:** The light from the transmitter side is received by the photo detector (li-fi receiver).
- **Step4:** Again, the binary values are converted into optical signals. And convert the optical signals to electrical signals. So, the user can view their results using PC's.
- **Step5:** By using visible light communication technology. No data loss occurs. The data can be transferred safe and sec.

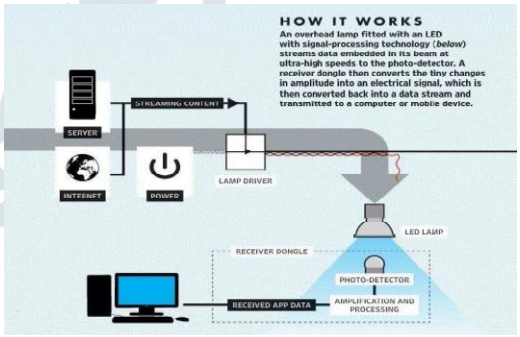

Fig.1 Diagram of Li-fi system

VI. CONSTRUCTION

Li-Fi is a fast and cheap optical version of Wi-Fi. It is based on Visible Light Communication (VLC). VLC is a data communication medium, which uses visible light between 400 THz (780 nm) and 800 THz (375 nm) as optical carrier for data transmission and illumination. It uses fast pulses of light to transmit information wirelessly. The main components of Li-Fi system are as follows:

a) a high brightness white LED which acts as transmission source.

b) a LDR sensor with good response to visible light as the receiving element.

LEDs can be switched on and off to generate digital strings of different combination of 1s and 0s. To generate a new data stream, data can be encoded in the light by varying the flickering rate of the LED. The LEDs can be used as a sender or source, by modulating the LED light with the data signal. The LED output appears constant to the human eye by virtue of the fast-flickering rate of the LED. Communication rate greater than 100 Mbps is possible by using high speed LEDs with the help of various multiplexing techniques. VLC data rate can be increased by parallel data transmission using an array of LEDs where each LED transmits a different data stream.

- **Software required**

  Arduino IDE 1.8.5(programmable platform for Arduino)

- **Hardware required**
  1. Bread board
  2. Arduino (nano, uno)
  3. LDR (light dependent resistor)
  4. LCD (liquid crystal display)
  5. I2C interface
  6. LED (light emitting diode)
  7. Jumper wires
  8. push buttons

we are implementing Li-Fi communication using two Arduino (Nano, Uno). Here the text data is transmitted using LED and 4 Push buttons. And it is decoded on the receiver side using LDR. In transmitter part of Li-Fi communication, the keypad is used as input. That means we'll be selecting the text to be transmitted using the keypad. Then the information is processed by the Arduino. It converts the information in to binary pulses which can fed to an LED source for transmission. In the receiver section, the LDR sensor receives the visible light pulses from the transmitter side and converts it into interpretable electrical pulses, which is fed to the Arduino and receives this pulse and converts it into actual data. Then the data is displayed on a 16*2LCD display.

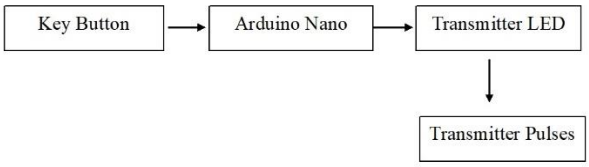

Fig.2 Transmitter Block Diagram

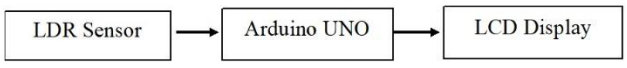

Fig.3 Receiver Block Diagram

VII. WORKING

A new generation of high brightness light-emitting diodes forms the core part of light fidelity technology. The logic is very simple. If the LED is on, a digital 1 is transmitted. If the LED is off, a digital 0 is transmitted. These high brightness LEDs can be switched on and off very quickly which gives us a very nice opportunities for transmitting data through light [12]. The working of Li-Fi is very simple. There is a light emitter on one end, for example, an LED, and a photo detector (light sensor) on the other. The photo detector registers a binary one when the LED is on; and a binary zero if the LED is off. To build up a message, flash the LED numerous times or use an array of LEDs of perhaps a few different colors, to obtain data rates in the range of hundreds of megabits per second.

The data can be encoded in the light by varying the flickering rate at which the LEDs flicker on and off to generate different strings of 1s and 0s. The LED intensity is modulated so rapidly that human eye cannot notice, so the light of the LED appears constant to humans [13]. Light-emitting diodes (commonly referred to as LEDs and found in traffic and street lights, car brake lights, remote control units and countless other applications) can be switched on and off faster than the human eye can detect, causing the light source to appear to be on continuously, even though it is in fact 'flickering'. The on-off activity of the bulb which seems to be invisible enables data transmission using binary codes: switching on an LED is a logical '1', switching it off is a logical '0'. By varying the rate at which the LEDs flicker on and off, information can be encoded in the light to different combinations of 1s and 0s. This method of using rapid pulses of light to transmit information wirelessly is technically referred to as Visible Light Communication (VLC), though it is popularly called as Li-Fi because it can compete with its radio-based rival Wi-Fi. Figure 4 shows a Li-Fi system connecting devices in a room.

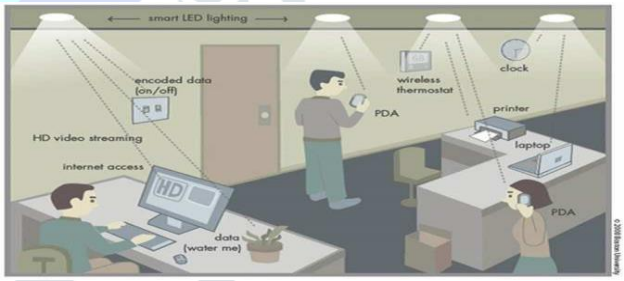

Fig.4 Li-Fi system connecting devices in a room

Many other sophisticated techniques can be used to dramatically increase VLC data rate. Teams at the University of Oxford and the University of Edinburgh are focusing on parallel data transmission using array of LEDs, where each LED transmits a different data stream. Other groups are using mixtures of red, green and blue LEDs to alter the light frequency encoding a different data channel.

VIII.RESULT

Now that the software and the hardware have been interfaced together with the help of the Arduino Uno & Nano Board, we see that when input command is given the data is transmitted through Arduino nano to LED. This LED transmits the data through light as transmitter, this light is sensed by LDR sensor at receiver side. LDR sensor will transmit the received data to Arduino Uno and receives this pulse and converts it into actual data. Then the data is displayed on a 16*2LCD display.

IX. OUTPUT

The push buttons give the input commands as per the required data.

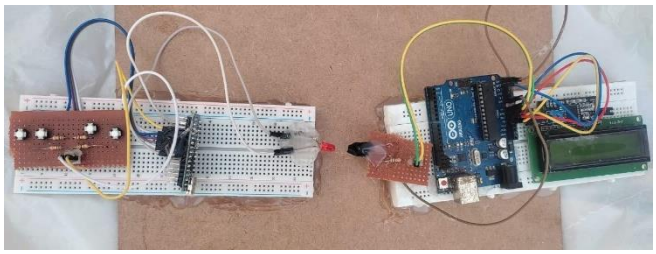

Fig. 5: Circuit

As we can see in the below figure whenever the input is given light glows, this light is sensed by LDR sensor and transmits to LCD display as output.

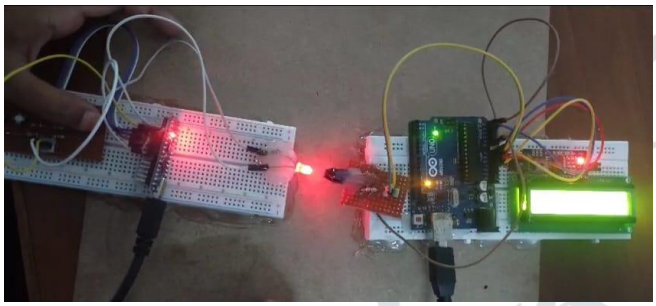

Fig. 5.1: Transmitting Data.

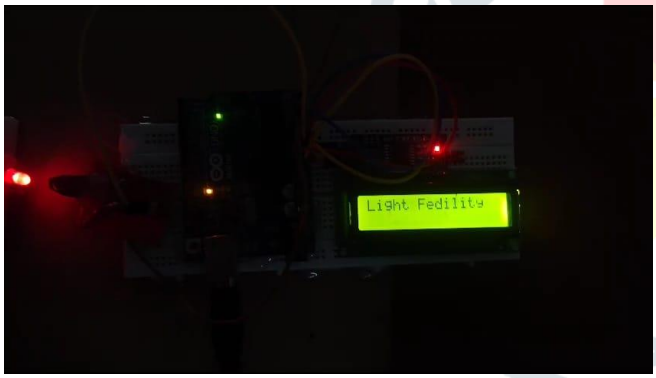

Fig.5.2: Received output.

X. CONCLUSION

The possibilities are numerous and can be explored further. If his technology can be put into practical use, every bulb can be used something like a Wi-Fi hotspot to transmit wireless data and we will proceed toward the cleaner, greener, safer and brighter future. The concept of Li-Fi is currently attracting a great deal of interest, not least because it may offer a genuine and very efficient alternative to radio-based wireless. As a growing number of people and their many devices access wireless internet, the airwaves are becoming increasingly clogged, making it more and more difficult to get a reliable, high-speed signal. This may solve issues such as the shortage of radio-frequency bandwidth and also allow internet where traditional radio-based wireless isn't allowed such as aircraft or hospitals. One of the shortcomings however is that it only works in direct line of sight.

Features such as high bandwidth, non-interference with radio waves (in electromagnetic-sensitive areas), and non-hazardous to health has made VLC an attractive technique for future communication. Li-Fi is 100 times faster than analogous Wi-Fi, which uses RF for communication. The optical wireless communication system is a good replacement for the regular communication system. VLC is a rapidly growing segment in the field of communication.

XI. FUTURE SCOPE

The future of Li-Fi technology depends on further research and development to overcome challenges such as the limitation of signal propagation through obstacles and the need for standardized protocols. As these challenges are addressed, Li-Fi is expected to find increasing adoption in a wide range of applications, contributing to the growth of the Internet of Things (IoT) and high-speed wireless communication.

- **High-Speed Data Communication**: Li-Fi can provide extremely high data transfer rates by utilizing visible light, which has a much larger bandwidth compared to radio frequencies. This makes it well-suited for scenarios where rapid data transfer is essential, such as in industrial automation, healthcare, and entertainment.
- **Healthcare**: Li-Fi can be used in healthcare environments where RF signals might interfere with sensitive equipment. It can facilitate high-speed communication between medical devices, enabling real-time monitoring and data exchange.
- **Consumer Electronics**: Li-Fi technology can be integrated into consumer electronic devices like smartphones, tablets, and laptops, providing users with high-speed, secure, and reliable wireless connectivity.

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