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Data Transfers using LED with LiFi Visible Light

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Abstract: *Whether you're using wireless internet in a coffee shop, stealing it from the guy next door, or competing for bandwidth at a conference, you've probably gotten frustrated at the slow speeds you face when more than one device is tapped into the network. As more and more people and their many devices access wireless internet, clogged airwaves are going to make it increasingly difficult to latch onto a reliable signal.But radio waves are just one part of the spectrum that can carry our data. What if we could use other waves to surf the internet? One German physicist, DR. Harald Haas, has come up with a solution he calls "Data Through Illumination"taking the fibre out of fibre optics by sending data through an LED light bulb that varies in intensity faster than the human eye can follow. It is the same idea behind infrared remote controls, but far more powerful.Haas says his invention, which he calls D-Light, can produce data rates faster than 10 megabits per second, which is speedier than your average broadband connection. He envisions a future where data for laptops, smart phones, and tablets is transmitted through the light in a room. And security would be a snapif you cannot see the light, you cannot access the data.Li-Fi is a VLC, visible light communication, technology developed by a team of scientists including Dr Gordon Povey, Prof. Harald Haas and Dr Mostafa Afgani at the University of Edinburgh. The term Li-Fi was coined by Prof. Haas when he amazed people by streaming high-definition video from a standard LED lamp.*

Keywords: Blockchain, Ethereum, Smart Contracts, Crowdfunding.

I. INTRODUCTION

1.1 BACKGROUND

Li-Fi (Light Fidelity) is a high speed, wireless communication using visible light. It falls under the category of optical wireless communications. Data transmission takes place through LED (Light Emitting Diode) bulbs whose intensity varies. Based on this variation, communication occurs digitally. This technology has broad applications where the use of Wi-Fi (Wireless Fidelity) is limited or banned. It also takes out the adverse health effects of using electromagnetic waves. Unless the light is seen, data cannot be hacked, and so data transmission is secure. Data transmission is typically in terms of Gigabytes per second. [1]

The usage of light as a means to transmit data has been coined Li-Fi (Light - Fidelity) by Harald Hass at the University of Edinburgh [2]. The high-speed communication technology is similar to Wi-Fi but is faster, allowing users to send and receive more data in less time. By merely swapping incandescent bulbs with LEDs - which have electronic properties - Li-Fi could bring Internet gain access to more areas and could revolutionize the telecoms industry.

Recently, wireless technology has bloomed to a great extent where we require wireless technology to transmit many data every day. Nowadays, wireless communications have become important in the communication process. The primary way of wireless data transmission is by using electromagnetic waves, i.e., radio waves. However, radio waves can support less bandwidth because of compact spectrum availability and intrusion. Solution to this is data transmission using Visible Light Communication (VLC) [1]. Wi- Fi deals with wireless coverage within premises, whereas Li-Fi is perfect for high compactness wireless data coverage in a defined area and for mitigating radio interference issues. Li-Fi focuses on transmitting multimedia data between two terminals using LEDs.

Communication between two terminals in the 21st century is vital and occurs every day. Li-Fi plays an essential role in communication as discussed earlier which uses light for data transmission rather than radio waves used in wireless communication.

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The velocity of data transmission was about 10Mbps, though it is aimed to improve up to 100 Mbps by 2022 [3]. Li-Fi can be achieved by fitting a small microchip to every possible illumination device thereby, combining two basic functionalities: illumination and wireless data transmission. By doing this, the four essential problems (i.e., capacity, cost, efficiency, and security) faced in wireless communication these days would be solved. Thus, in the future, there would not be only 14 billion light bulbs, but 14 billion Li-Fi APs (Access Points) deployed worldwide -- for a cleaner, a greener and even brighter future.

1.2 PROBLEM STATEMENT

This project circumvents the main problems mitigating and limiting efficient data transmission (i.e., capacity, efficiency, availability, and security) when using the radio spectrum. Hence, it would help in reducing the over-reliance on Wireless- Fidelity (Wi- Fi) for data transmission.

1.3 AIM AND OBJECTIVES

The aim of this project is to design and construct a data transmission system (made up of the receiver and the transmitter) that transmits text data effectively using Li-Fi technology.

The Objectives of the project are:

1. To design and construct the transmitter's microcontroller unit.
2. To design and construct the receiver's microcontroller unit.
3. To Implement the Java code on the PC (Transmitter & Receiver) to enable text data processing.

1.4 METHODOLOGY

To achieve the various objectives of this project, the following steps would be taken

1. To review related works and theories on this project work.
2. To draw block diagram that illustrates the implementation of the system
3. To design the circuit diagram for the Transmitter and the Receiver in the system.
4. To assemble the components on a Breadboard and then on a Vero board
5. To package the assembled components into a Li-Fi text transmission system.
6. To test and analyse the Li-Fi text transmission system to ensure it meets the design details.

II. LITERATURE REVIEW

Data processing is the act of handling or exploits data in some fashion. Regardless of the activities involved in it, processing attempts to assigned meaning to data. Thus, the goal of processing is to transform data into information. Data processing is the process through which data are gathered, assigned meaning, communicated in front of significant people and retained for future use. Hence, data processing can be defined as a series of activities or functions that switches data into useful information. We use the term 'data processing system' to include the resources that are used to accomplish the processing of data [6].

Inside the context of data processing, data are identified as numbers or character types that represent measurements from the real world. A single datum is a single measurement from the real world. Measured information can then be algorithmically derived and logically deduced and statistically calculated from multiple data. Information is defined as either a meaningful response to a query or a useful stimulus that can cascade into further inquiries [7].

III. THREE SYSTEM DESIGN

The design of the Li-Fi data transmission system to be controlled was divided into two sections; the hardware section and software section.

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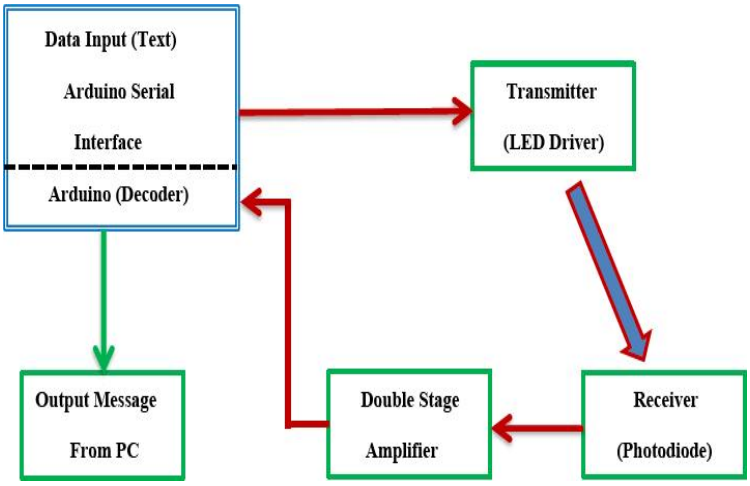

Figure1: Li-Fi Data Transmission System block diagram

In the system, an Arduino microcontroller is used as the encoder and the decoder of the data transmitted via the blinking LED and received by the photodiode.

The circuit diagram of the Li-Fi system is divided into two major parts as shown in figure. The transmitter part placed above while the receiver part is placed below. The circuit diagram shown in details how the hardware components of the system are connected for data transmission. However, during the implementation of the system, a single microcontroller (Arduino board) is used.

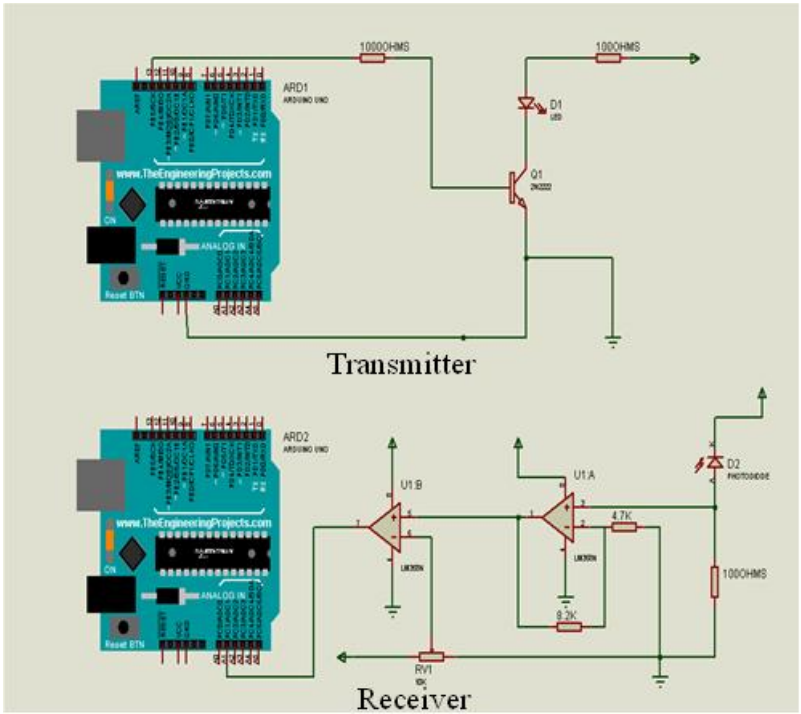

Figure 2: Circuit Diagram of the System

IV. SYSTEM IMPLEMENTATION AND TESTING

This Stage is the development and construction stage. The testing of the system components is carried out in this stage.

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4.1 ARDUINO SETUP

The Arduino board features a serial communication interface (which includes a Universal Serial Bus (USB) controller on most models) which was used for loading programs from a personal computer to the board. The Arduino IDE was used to program the Arduino. The Arduino via the code was made to perform various tasks like switching on or off the LED in the transmitter's circuit and as well reading the analogue signal read from the photodiode in the receiver's circuit.

In other not to make the system less bogus and redundant, the Arduino board was used as the micro-controller as well as the Power Supply Unit (PSU) for the circuits. It supplies a voltage of about 5V from its VCC port when connected to the PC via the serial connector cable and acts as the virtual ground.

4.2HARDWARE IMPLEMENTATION

The Li-Fi data transmission system is set up such that a single Micro Controller - Arduino board is used to encode, decode and supply power to the transmitter and receiver circuits After the design and calculations of the resistor values in the transmitter and receiver, all the components of the circuit were implemented on a breadboard carefully with the aid of jumper wires and a multimeter was used to test the continuity of the circuit from point to point.

In other to ensure the proper testing of the system and circumvent its proneness to errors, the transmitter and receiver circuits were implemented on a single breadboard and the LED and photodiode were in close proximity to one another as shown in figure.

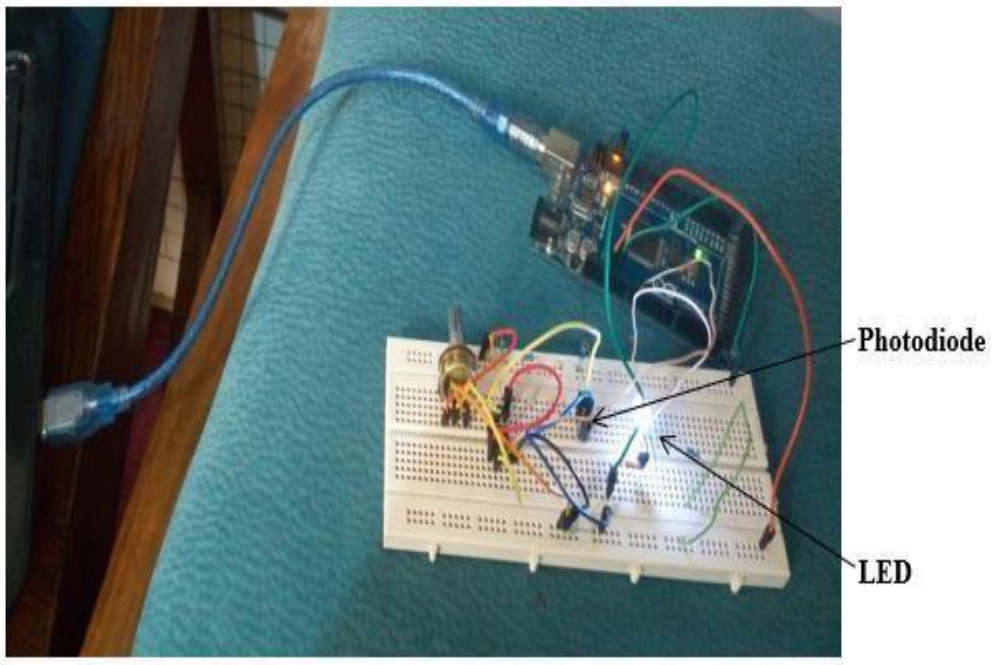

Figure 3: Breadboard Implementation diagram

After several tests, the components on the breadboard were then soldered carefully using the same circuit configuration on separate Vero boards as shown in figure 4 and 5. A multimeter is used after soldering to detect dry joints, bridging of joints and test for continuity of lines on the Vero board. This helps to reduce the strain of constructing the circuit and detecting causes of error before using the circuit.

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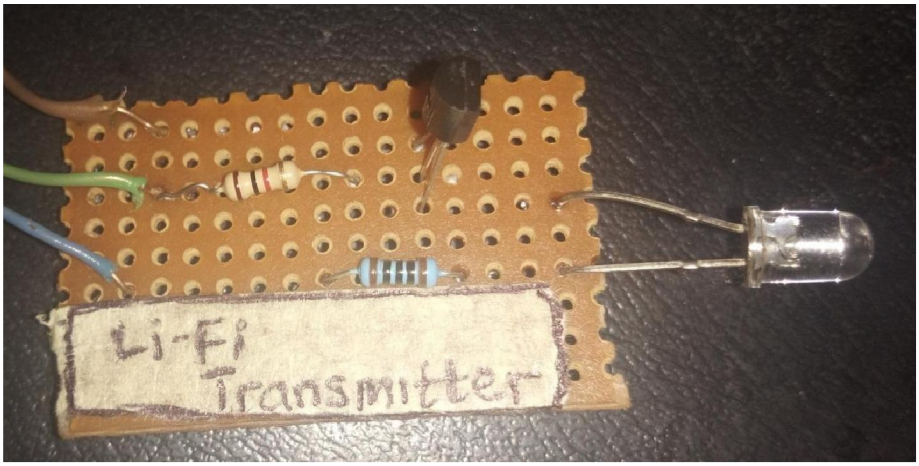

Figure 4: Li-Fi Transmitter

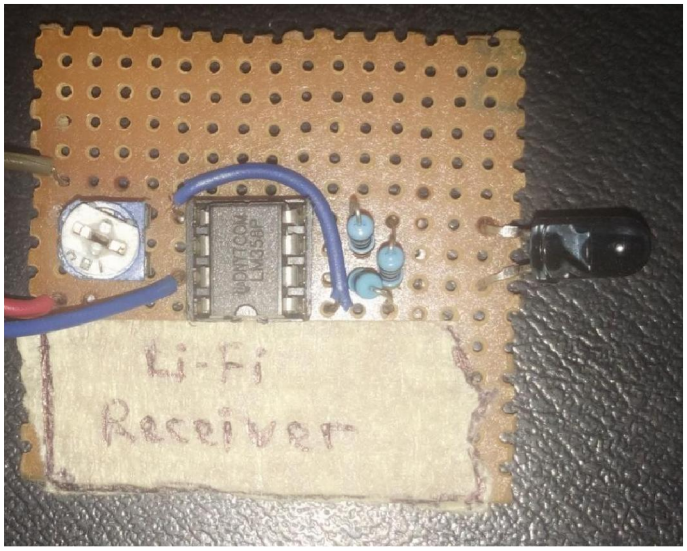

Figure 5

4.3 SOFTWARE IMPLEMENTATION

The only implementation of software design carried out is the creation of the application that decodes the sent message from the transmitter and displays it on its output window. The application is a Java application created using NetBeans Programming interface. The Arduino library was imported to the NetBeans IDE, as this is an external library specially designed to ensure the Java application can communicate with the Arduino microcontroller effectively.

Figure 6: Java Application on Receiver PC

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The Graphical User Interface (GUI) developed from the program is shown in figure. It has a connect button and a system generated port list to give the user flexibility in the selection of ports on the Receiver PC.

The application is open through its link stored in the NetBeans IDE used to create it. The application prompts the user to connect the Arduino microcontroller to one of the ports from the drop-down list of ports shown in figure 4.3.1. The port to be chosen can be determined by carefully viewing the port number from the Arduino IDE used to upload the micro controller-encoding program onto the Arduino board. The port to connect to is automatically chosen. Any error in connecting to the right port would impede the user from viewing the message sent from the first computer.

After successfully connecting to a port, a message is displayed to acknowledge that a port has been chosen correctly as shown figure 7.

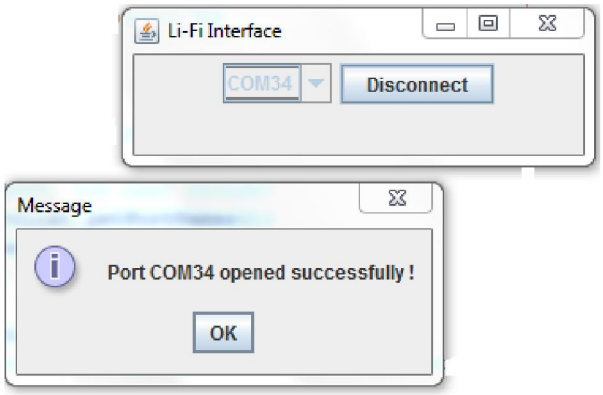

Figure 7: Li-Fi Receiver Port Selector Interface

The 'Connect' button now becomes locked and changes to 'Disconnect' to prevent the user from changing the port when a message is being received and thus disrupting the decoding process.

V. TESTS AND RESULTS

The final design verification was done using the complete system; a transmitter, receiver and software, and the results are shown in figure 8 and figure 9.

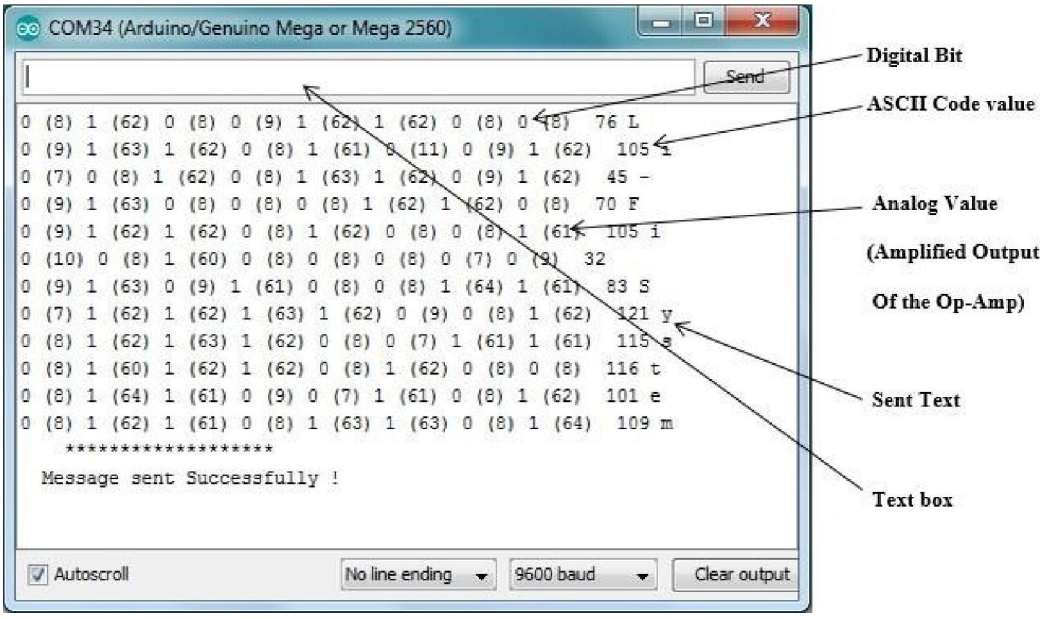

Figure 8: Encoding and decoding monitor

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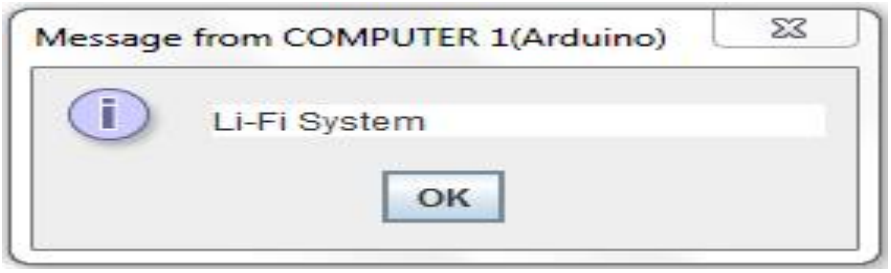

Figure 9: The Li-Fi Receiver Interface

VI.CONCLUSION AND RECOMMENDATION

CONCLUSION

The aim of this project was to design a Li-Fi Data Transmission system to send data (limited to text – strings) from a PC to another PC. The Data Transmission system constructed when tested showed satisfactory performances. The Li-Fi data transmission system constructed was very cheap making it satisfy the major aim of the project – incorporation of a Li-Fi medium using off the shelf electronic devices. Therefore, a Li-Fi prototype has been designed which demonstrates the basic principle and supports the claim of the advantages of Li-Fi over Wi-Fi. The system constructed has some limitations also. The Li-Fi prototype designed does not support multi-user access. The speed achieved with this prototype is 11,520 bps only which is not of the high order of Gbps. Also, this prototype is not bidirectional. Hence, it is only used for broadcast purposes. The limitations of this work can be removed by using higher-end devices.

RECOMMENDATION

For a personal project, the project is very good as it uses simple off the shelf electronic devices and is incredibly cheap. However, if the project is to be commercialized, more sophisticated Graphical User Interface (GUI) would have to be created and more functions incorporated at the receiver PC. Also, messages to be sent from the transmitting PC need not be sent through the Arduino serial monitor using an application designed specifically for that purpose.

Furthermore, a specially made chip - Integrated Circuit (IC) could be manufactured for the encoding circuit to encode data as the microcontroller and at the receiver to decode data sent in bits and interpret it correctly without the aid of the whole Arduino board, which makes it look more bogus and less portable. This special chip can be connected to the computer system just like a modem and would get its supply from the USB port of the computer. This set up would greatly improve the portability of the device as well as prevent its proneness to error.

I would recommend that the main improvement of this system should focus on the process of transferring data to and from a PC either in half-duplex mode or even simultaneously.

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