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Communication via LED

[1]Prof. P.K. Karmore, [2]Mr. Saurabh Dubey, [3]Mr. Rohit Sadawarti,
[4]Mr. Shirish Wankhede, [5]Mr. Sachin Patil

[1]HOD, Department of CSE, Dr. Babasaheb Ambedkar College of Engineering and Research, Nagpur, India
[2]Department of CSE, Dr. Babasaheb Ambedkar College of Engineering and Research, Nagpur, India
[3]Department of CSE, Dr. Babasaheb Ambedkar College of Engineering and Research, Nagpur, India
[4,5]Department of CSE, Dr. Babasaheb Ambedkar College of Engineering and Research, Nagpur, India

Abstract: *This paper describes the use of light as a medium for communication between two systems. It takes out the "optics from the optical fiber". It demonstrates transmission and reception of live data between two systems that do not have any physical communication between them. It's the same idea behind infrared remote controls but far more powerful. This paper envisions a future where data for laptops, smart phones, and tablets is transmitted through the light in a room. It establishes a way for creating a communication medium that can transfer data with much higher speeds as compared to current wireless networks. The methodology used is the conversion of SERIAL-to-TTL, and vice-versa. It takes input from the system (transmitter) and gives output in the form of TTL logic signals that ultimately drives the LED circuit, enabling it to glow, but actually it is transmitting data.*

Keywords: *Li-Fi, LED, Security, VLC, TTL*

I. Introduction

A flickering light can be incredibly annoying, but has turned out to have its upside, being precisely what makes it possible to use light for wireless data transmission. 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'. This invisible on-off activity enables a kind of data transmission.

Information can therefore be encoded in the light by varying the rate at which the LEDs flicker on and off to give different strings 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 its potential to compete with conventional Wi-Fi has inspired the popular characterization Li-Fi. When signals reach the receiver through the indoor wireless channel, the photo diode will convert the optical signals to electrical ones and the original information will be recovered.

Fig. 1 represents a scene of indoor visible light communication system based on LED. The use of the visible light spectrum for high speed data communication is enabled by the emergence of the light emitting diode (LED) which at the same time is at the heart of the next wave of energy-efficient illumination. In that sense, the concept of combining the functions of illumination and communication offers the potential for tremendous cost savings and carbon footprint reductions. Compared with the traditional wireless access technique, the proposed system has many advantages: easy installation, high data rate, no electromagnetic interference and so on.

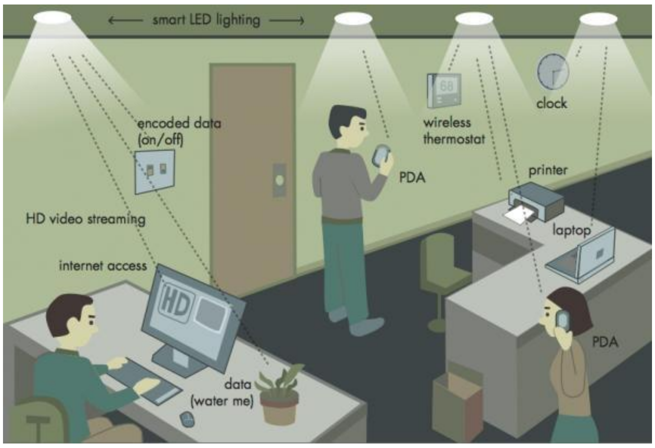

Fig. 1: Devices accessing internet through LED

II. Literature Review

The previous methods that are currently used for communication are LAN and WI-FI. But these two technologies have a lot of disadvantages. For example, LAN connection is not feasible at all places and it is not mobile. Same is the scenario with WI-FI technology, although it is mobile and can be accessed through distances, but the security issue arises.

At present, we have proposed the technology that would be able to make communication between the systems via visible light. Presently, we are demonstrating the transfer of files between systems and we have been able to demonstrate the exchange of live texts and various types of files between the systems. This technology uses a part of the electromagnetic spectrum that is still not greatly utilized- The Visible Spectrum. Light is in fact very much part of our lives for millions and millions of years and does not have any major ill effect. Moreover there is 10,000 times more space available in this spectrum and just counting on the bulbs in use, it also multiplies to 10,000 times more availability as an infrastructure, globally. 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 eyes cannot notice, so the output appears constant.

Traditionally, the light that we are using in our system was used just to illuminate the space, but under the scope of our project we have demonstrated the use of light for communication between the systems. The main advantage of using this system is the increased efficiency and security. More sophisticated techniques could dramatically increase VLC data rates. Teams at the University of Oxford and the University of Edinburgh are focusing on parallel data transmission using arrays 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's frequency, with each frequency encoding a different data channel.

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. Harald 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. In the year 2011, European FP7 project OMEGA demonstrated a user, able to download several HD-video streams in parallel. In [9], Ragan Sagotra and Reena Aggrawal proposed a system that employs wavelength division multiplexing, to transmit multiple data streams from different data sources simultaneously and transmission of audio song and also an image was demonstrated.

III. Light Fidelity Technology Implementation

For the transmission and receiving purpose, the IC MAX232 is used. The ICMAX232 is used for converting serial-to-TTL conversion. Pin 8-9 of the IC is used for transferring the data, whereas the pin 10-7 is used for receiving the data. Data from system is collected on pin 3, for transmitting and on pin 2, for reception.

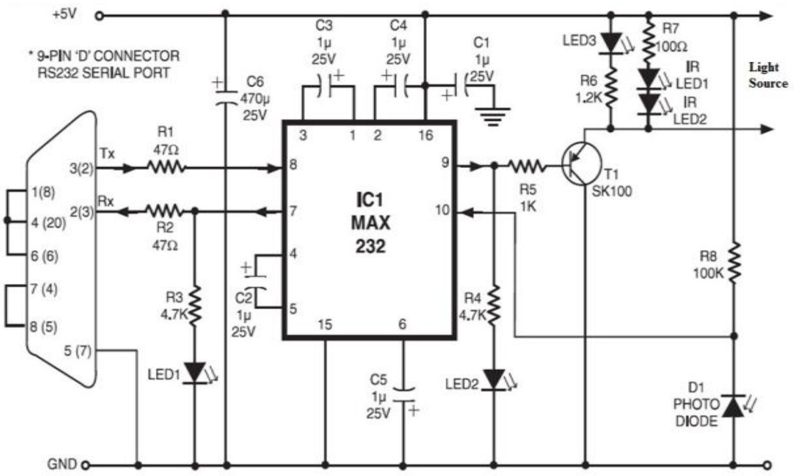

Fig.2: Circuit Diagram for driving LED and photo-diode

The above shown model is connected to both the systems that are preparing to communicate. Following fig. 3 shows the overview of the communication process:

Fig.3: Flow of data through actual circuit

IV. Experimental Results

The system is capable of changing the baud rate or the rate at which the transmission takes place. Also, within the scope of the system options for setting parity, stop bits and data bits have also been included.

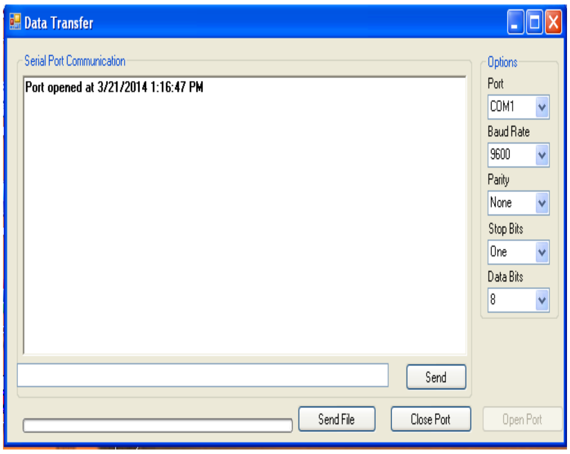

Fig. 4: Primary user interface

Figure 4, shows the main and initial data transfer dialogue box that is intended to send files and receive files. Various options are available in this screen, including the baud rate setting and a blank bar for live feeding. In this window, the user can have a view of following options:

1. Port: This option id given to set the communication port in the system, through which the communication will take place.
2. Baud rate: This option enables the user to set the baud rate or bit/second rate that will determine the speed of data transfer between the systems. Options for baud rate start from 600 to 9600.
3. Parity: The value for this option is pre-decided in the software. However, the user can change it, but it must not be changed.
4. Stop Bits: This option enables the user to determine the stop bit in a transmission.
5. Data bits: This option enables the user to decide the number of bits that will form a packet. The value for this option is also pre-embedded in the system and need not be changed.

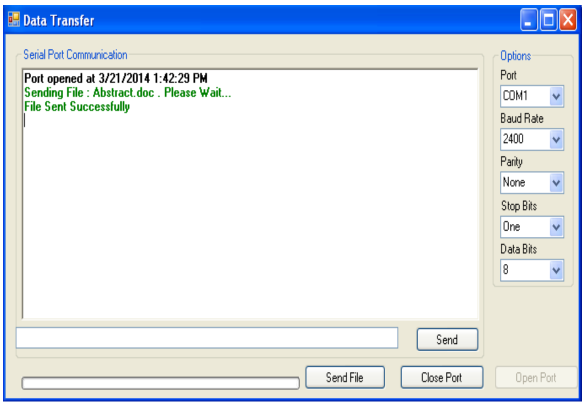

Fig.5: Sending file from system 1

In figure 5, system 1 sends a file to another system. After clicking on the "SEND FILE" option, a dialogue box appears on system 2 asking the user about where to save the file and the new name of the file. This system can send various types of files including .doc, .txt, .mp3, .jpg, etc. the system is able to transfer and receive all types of files between the systems.

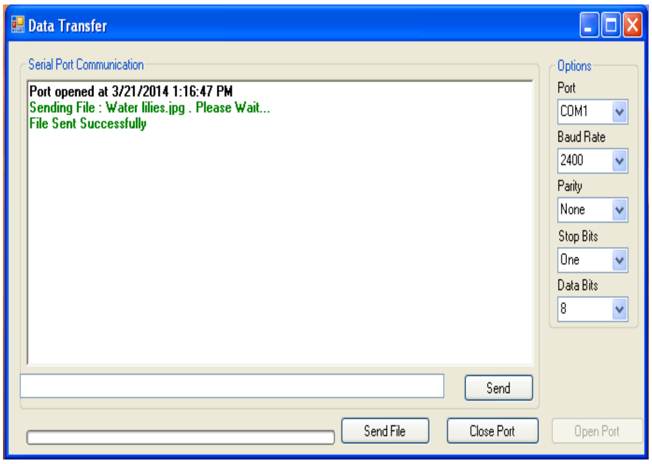

Fig. 6: Sending an image file from system 1

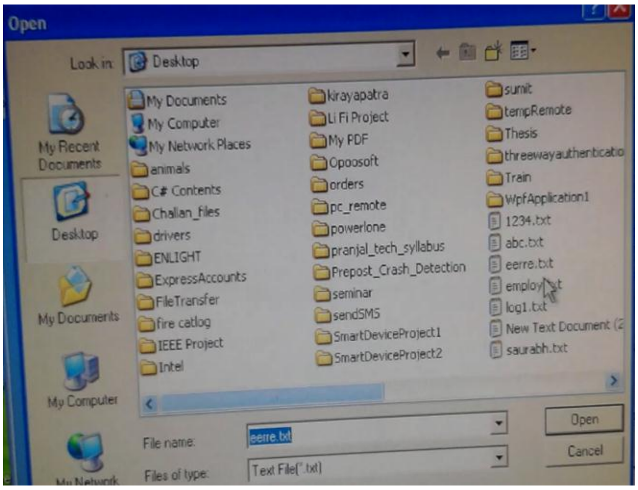

Fig.7: Transferring file named "eerre.txt"

After clicking on the "open" button in figure 7, the receiver on the other side asks the user to enter a new name for the file to save the file on the other system, as shown in figure 8, the user is independent of saving any name for the file that is to be received.

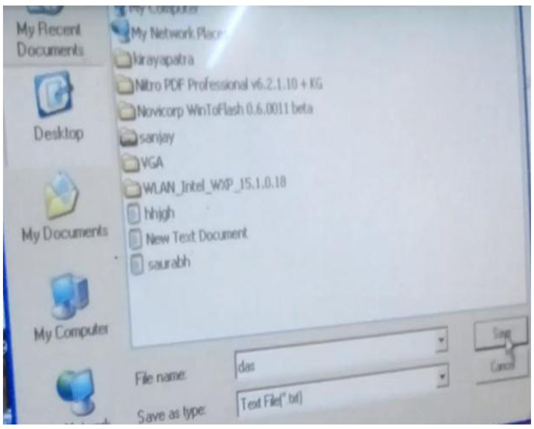

Fig. 8: changing file name on other system

Once the file name is given, the transmission begins and the transmitter starts sending the file. The LED attached on the sending side starts glowing and the photodiode sensor on the receiver's side starts receiving the signals and interprets them. The file received is shown only when the process of transmission is over.

Fig. 9: File sending process through LED.

Figure 9 shows actual data transfer through light. The white LED glows and transfers file, while on the opposite side a photo-diode senses the minute fluctuations and receives the data.

V. Conclusion

Light is inherently safe and can be used in places where radio frequency communication is often deemed problematic, such as in aircraft cabins or hospitals. So visible light communication not only has the potential to solve the problem of lack of spectrum space, but can also enable novel application. The visible light spectrum is unused; it's not regulated, and can be used for communication at very high speeds. All one has to do is to vary the rate at which the LED's fluctuation depending upon the data we want to encode. By this proposed system we concluded that light can be a very good medium of transferring data between systems.

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