DATA TRANSFER USING LIGHT FIDELITY TECHNOLOGY

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Abstract—Lifi technology is the newest technology that has lots of scope to research on. We present the wireless communication system for data transfer using light fidelity. Transferring data is done through many methods. It transfers data in the form of light signals instead of radio signals. As simple as it sounds, it is also an efficient method. It was introduced in 2011 by Professor Harald Haas during his TED Global Talk where he introduced the idea of “wireless data from every light”. Since light fidelity transfers data in the form of light signals, it is also called as Visual light communication. This method overcomes errors during maximum transmission rate in existing system and it is more efficient. Our idea is to send a data through Lifi and compare it with other existing technologies like Wifi. The parameters used for comparison and analysis are the data rate in which the data is sent, time in which the data is sent, data sent in one hour, data efficiency and error rate.

Index Terms—Lifi(light fidelity), Wifi(wireless fidelity), visual light communication, wireless communication, radio signals, light signals

I. INTRODUCTION

Li-Fi (Light Fidelity) is a wireless communication which travels at great speed using visible light, hence the name visible light communication. It is characterized as optical wireless communication. Transmission of data takes place through LED bulbs which is varied by its intensity. The subtle changes in its brightness brings about the transmission of data. Light is a rich infrastructure for Lifi technology to use. Based on this variation in intensity, communication occurs digitally.[(1),(6)]

Harald Haas during his speech in 2011 Ted Talk introduced the new term ‘Lifi’ and how it is going to revolutionize the world. He proved his theory by practically demonstrating by sending a video with a speed of 10Mbps. Scientists in Germany created a wireless network capable of transferring in a speed of 800 Mbps[2]. They used RGB(red, green and blue) and white lights in transmitter side. Other technologies are being compared with Light Fidelity communication to check its efficiency. To explain it simply, light fidelity can be compared to Wifi but here data is transferred through light signals. The use of routers or modems are eliminated here as only light signals are sent. In the transmitter side, there is an LED bulb which sends out data signals to the receiver side. Transmission is smooth unless an object is in front of it. The reason why an object obstructs the transmission of data is simply due to the fact that light rays are being blocked.

Harald hass sent a video using a LED lamp which to a solar cell with the laptop acting as the receiver. The Wifi usage around the world is 4,156,932,140 which is 54% of the world’s population[7]. Definitely lots of these people use Wifi inside their homes and rooms. So what if we replace it with the more efficient and cheaper Lifi. It will save a lot of power around the world and work towards a greener environment. There are still around 4.3 billion people without internet. It is also estimated that 50 billion devices will be connected by the internet by 2020. Such an extension of internet can only work if it is neutral. This means that we must use existing infrastructure as much as possible. This is where the LED lamp and solar cell come in.

The light fidelity also has its own disadvantages. For instance, if the light source is blocked by an object, transmission is cut. If the LED lamp isn’t of higher power, the data can be lost along the way. The data if lost along the way may also cause an error in transmission. Sunlight is also a major factor in affecting the LED lamp. It overlaps with the light rays transmitting to the receiver module. So, it is advised that the Lifi transmission be indoors.

II. WORKING OF THE PROJECT

A. OVERVIEW OF LIFI

As discussed earlier, we send the data using the transmitter module and the receiver module. This technology uses the visible light spectrum where the space is ten thousand times more available. Basic light sources like light bulb and street lights help this case[2]. It is a subset of Optical wireless communication[4]. It is also easily understandable to other people as the basics of this technology deals with light. The data is transferred with the flicker of the LED lamp. The input is treated as 1 if the LED is “on” and 0 if the LED is “off”. It is impossible to track it using the naked eye. But the photodiode receives and decodes it properly[4].
B. METHODOLOGY

An Lifi module which is commercially sold consists of a transmitter module and a receiver module. The transmitter module consists of an input which can consist of an ultrasonic sensor or PIR sensor, micro controller, power supply and an IC to drive the LED lamp[5]. The higher the power of the LED lamp, higher is the efficiency of the IC. The receiver side consists of a photodiode which receives the data and sends it to the micro controller for decoding the data.

The basis of our project is to send data like ‘#1’ to the receiver photodiode. The input we are using is the ultrasonic sensor. The ultrasonic sensor sends a pulse to the microcontroller if an object is sensed. If there is no object in its range, then the data is not sent. The power supply gives the necessary AC input to drive the circuit. The crystal oscillator sends a clock pulse to the microcontroller. The microcontroller then sends signals to the IC to drive the LED lamp. The LED lamp emits light rays which will be transmitted to the receiver photodiode.

The receiver photodiode detects the light rays coming from the transmitter side and checks if the data is sent as a whole or only partial output was sent. This may happen if the sent data loses its signal while transmission. The received signal is sent to another microcontroller which decodes the received signal. The data is displayed on an LCD screen or in a PC.

C. HARDWARE COMPONENTS

The main hardware components of the system are as follows:

1) Ultrasonic sensor
2) Microcontroller
3) Power supply circuit
4) Lifi Transmitter module
5) Lifi Receiver module
6) Passive components such as resistor and capacitors

1) ULTRASONIC SENSOR: The ultrasonic sensor that we use in our project is HC-SR04. It is used to detect objects in the range 3 cm to 3 m. The ultrasonic sensor detects the objects and displays it in the PC by means of a serial communication adapter. Any hardware component need an input like the switch to activate the circuit. Here, the ultrasonic sensor acts as a switch and turns on the circuit when an object is detected[8].

2) POWER SUPPLY: The power supply consists of the bridge rectifier, voltage regulator and passive components. Here, the circuit is connected to an AC adapter. The bridge rectifier is a component which is used to power up various electronic component present in the circuit[9]. Since we are using a AC input, it converts it into DC input and sends to the device. It is constructed using four or more diodes depending on its load current requirements. The voltage regulator that we use is the 7805 component. It regulates the voltage level in the circuit[10]. If not, the whole circuit may be destroyed. Then we have to solder all the components again.

3) MICROCONTROLLER: The microcontroller that we are using is the PIC microcontroller PIC16f877A. It is a 40 pin microcontroller out of which 33 are input pins and 7 are output pins[11]. The clock pulse for the microcontroller is given by the crystal oscillator. The program for the

Fig. 1. Block Diagram of transmitter module

Fig. 2. Block Diagram of receiver module
microcontroller is dumped using program dumper.

4) LIFI TRANSMITTER MODULE: The Lifi transmitter consists of an LED lamp and an IC. The IC is of range so as to drive the LED lamp which is of high power. Since we needed an efficient LED lamp, a higher range IC was used. It is commercially available and is concealed on arrival. So the exact IC is known only to the manufacturer[12].

5) LIFI RECEIVER MODULE: The Lifi receiver module consists of a photodiode which receives the light signal. It consists of also a microcontroller to decode the data that bis transmitted. The lifi receiver module also consists of an LCD to display the recived data.

D. SOFTWARE REQUIRED

The main software requirements of the Lifi data transfer circuit is:
1) Proteus design suite
2) mikroC for PIC
3) Hyperterminal

1) PROTEUS DESIGN SUITE: Before the actual hardware setup, it is advisable to check the circuit connections in softwares like Proteus. We can build the circuit beforehand. It can test the PCB board for any errors. It can run the hardware setup and display the output to the user[13]. It is very cost efficient and can also save a lot of time.

Fig. 3. Transmitter side using Proteus software

In figure 3, the black box indicates the virtual terminal. In the hardware setup it can be used to indicate the input using the LCD screen or in our using hyperterminal. Instead of using ultrasonic, we use a switch as an input. The duration of pressing the switch indicates the distance in cm. If we long press the switch, then it shows that the object is out of range.

We have to press the run button in order to check the connectivity of the circuit we have layed out. If there are any errors, then it displays with the regarding electronic component.

Fig. 4. Receiver side using Proteus software

In the receiver side if the data is received using the photodiode, here ‘#1’, then the output display changes to Lifi output. The output is displayed in the virtual terminal. If there are any errors, then it also displays the error with the regarding electronic component.

2) mikroC FOR PIC: For the microcontroller to carry out its function, we need to program it accordingly. The PC understands only machine level code, so the C program that we type for PIC 16f877A microcontroller is converted to hexadecimal code. This is dumped into the microcontroller using the programmer dump[14]. The version we used is mikroC Pro for PIC.

Fig. 5. mikroC for PIC software

3) HYPERTERMINAL: In figures 3 and 4, we have seen that there’s a virtual terminal which displays the output. By using serial communication, we can show the same output in a PC using the hyperterminal. It connects PC using TCP/IP con-nexions[15],[16]). We use the hyperterminal private edition version 7.0 for our PC.
III. RESULTS

The prototype looks like figure 6 and 7. The light rays transmit from transmitter to receiver. In transmitter side, we have programmed the microcontroller to send a data to the receiver. After light rays are transmitted, the receiver photodiode receives the light rays and decodes the data using its own microcontroller. To prove that the LiFi is an efficient method, we use Wifi as means to compare and analyze. We send a data which is same in both transmissions - the light fidelity communication and the wireless fidelity communication. We check the comparison using different parameters like the data rate, time taken for the data to reach the receiver side, error rate, efficiency and the data sent in an hour.

In figure 6, apart from the hardware setup of receiver, it consists of an adapter for serial communication. This adapter helps us to display the output in Hyperterminal.

IV. CONCLUSION AND FUTURE ENHANCEMENTS

The hardware and software components along with the working of the LiFi transmission device are presented here. The prototype is able to send message to the receiver side. The developed system demonstrates how the device can be helpful to transmit messages swiftly and how cheap internet can be given to rural places to help them in real-time. The system can provides cost-efficient device and also can be globally operated once enhanced.

The future enhancements for the transmission of data using Light fidelity technology is as follows:

- The LiFi technology is an upcoming revolution and it overcomes other shortcomings of other technologies like wireless fidelity communication. Commercially if available, each LED lamp can be used to see for cheaper prices.
- As the LiFi technology becomes cheaper, it leads to a greener, safer and cleaner environment with less electronic components.
- Unlike Wireless fidelity, the LiFi cannot be hacked by unknown sources.

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