

RECENT ADVANCEMENTS IN LI-FI TECHNOLOGY

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Abstract— In this era of wireless technology, the number of devices accessing the internet is growing by the minute. This has unfortunately led to an increase in network complexity, shortage of wireless radio bandwidth and an increased risk of interference of radio frequencies. Therefore, there is a pressing need to find new means of wireless communication which is fast, reliable and error free. One such technology that promises to alleviate the problems as stated above is Light Fidelity or simply, 'Li-Fi'.

Keywords—Li-Fi, VLC, Wireless Communication

I. INTRODUCTION

Conventional wireless communication schemes like Wi-Fi predominantly use radio/micro wave frequencies for data transmission, primarily because of the availability of high sensitivity receivers and ability to provide broad coverage at low frequencies and line of sight communication at high frequencies. But, RF can support only a limited bandwidth due to confined spectrum availability. Therefore the expanding demand for wireless data has led to clogging of the radio spectrum. Li-Fi is the new prototype suggested by Dr.Harald Haas of University of Edinburgh, UK, that overcomes the shortcomings of Wi-Fi. This optical wireless technology provides remarkable connectivity in a localized environment. In this technology radio waves are replaced with visible light as the carrier. Data can be transmitted through LED light whose intensity varies rapidly. Dr.Haas believes that his invention, which he calls the 'D-light' can produce the data rates faster than 10Mbps.[1] In fact, in a recent breakthrough, UK scientists have achieved record data transmission speeds of 10 gigabits per second - more than 250 times faster than 'superfast' broadband - using LED light bulbs.

II. PRINCIPLE

The basic idea behind this communication scheme is transmission of 'Data through illumination'. The intensity of the LEDs is varied by changing the current passed through them at very high speeds. However, the human eye cannot perceive this change and the LEDs appear to have a constant intensity. This ON-OFF activity of LED lights enables data transmission using binary codes i.e., when the LED is ON, logical '1' is transmitted and when the LED is OFF, logical '0' is transmitted. [2]This method of using rapid pulses of light to transmit data is called

Visible Light Communication (VLC). Fig.1 shows the basic principle of VLC.

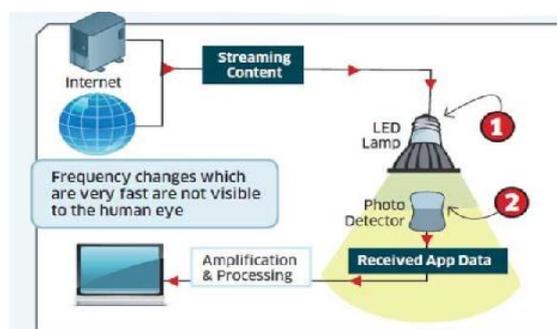


Fig.1 Basic principle of VLC

III. RELATED RESEARCHES

A. EXPERIMENTAL STUDY ON VISIBLE LIGHT COMMUNICATION BASED ON LED

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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. When the distance is greater than 85cm, the surface illumination of photodiode is less than 100 lx and when the distance is greater than 120cm, the surface illumination of photodiode is very weak i.e., close to 0 lx. The variation of bit error rate (BER) v/s communication distance was also tested and it was found that the system can provide a bit rate of up to 111.607Kbps at distances within 1.5m, and when the distance is high, the BER is very high and limits the bit rate.[3]

B. VISIBLE LIGHT COMMUNICATION: Recent Progress and Challenges

Dominic O'Brien, Hoa Le Minha, LubinZeng, Grahame Faulkner and HsiHsir Chou, Kyungwoo Lee, Daekwang Jung, YunJe Oh, Eun Tae Won Wireless World Research Forum .In this White Paper from the Wireless World Research Forum (WWRF), it was proved that performance of receiver need not be considered for bandwidths up to 100MHz. To increase data rates, performance of LEDs must be enhanced. It also identified the most challenging problem for VLC as the compatibility with PWM dimming systems. They proposed approaches that combine modulation with dimming. [4].

IV. ADVANTAGES OF LI-FI

1. Li-Fi can solve problems related to the insufficiency of radio frequency bandwidth because this technology uses Visible light spectrum that has still not been greatly utilized.
2. High data transmission rates of up to 10Gbps can be achieved.
3. Since light cannot penetrate walls, it provides privacy and security that Wi-Fi cannot.
4. Li-Fi has low implementation and maintenance costs.
5. It is safe for humans since light, unlike radio frequencies, cannot penetrate human body. Hence, concerns of cell mutation are mitigated.

V. LIMITATIONS OF LI-FI

1. Only works if there is direct line of sight (LOS) between the transmitter and receiver.
2. Data transmission can be easily obstructed by opaque obstacles.
3. The use of very high frequencies (400-800THz) limits it to very short distances and point to point communications only. [5]

VI. APPLICATIONS OF LI-FI

1. Healthcare sector: This technology can be implemented in hospitals where usage of Wi-Fi is unsafe, as it may interfere with gadgets in the vicinity and block the signal for monitoring equipment such as MRI equipment.
2. Road Safety and Traffic Management: Li-Fi can be used for communication between the LED lights of vehicles so as to avoid collision. It can also be implemented in the traffic lights for vehicle to roadside communication to update vehicular traffic information.
3. Smart Lighting: Any private or public lighting including street lamps can be used to provide Li-Fi hotspots. This has a two-in-one benefit of lighting

as well as wireless communication and data transfer.

4. Aviation: LED lights are already deployed in aircraft cabins. This can be integrated with In-Flight Entertainment (IFE) Systems to reduce cabling. This will in turn reduce the weight of the aircraft and the extra cost associated with cabling. [6]
5. Underwater Communication: Use of radio frequencies (RF) for underwater communication is impractical due to strong signal absorption. Sound waves can be employed but they may prove to be detrimental to marine life. Li-Fi can be employed in such cases for underwater communication.
6. Hazardous Environments: Li-Fi is a safe alternative to RF communication in environments such as mines and petrochemical plants which are susceptible to electromagnetic interferences.

VII. PROPOSED WORK

The proposed plan of action for our project is to establish an optical wireless communication model that gives high data rates (in the order of MHz) and transmission distances of up to 1m. This model should effectively be able to transmit data from one device to another using LEDs, thereby establishing a Li-Fi network in a localized environment. The system block diagram to be used for this project is shown in Fig.2. The system architecture consists of a transmit section and a receive section. The transmit section consists of the data input which is then fed into a switching control system. Based on the data, the switching control generates a stream of 1s and 0s thereby encoding the data in binary. The output of this control is given to the array of LEDs which turn OFF and ON at extremely high speeds. This ON-OFF modulation of the LED light transmits the data. LED is the choice for light source since it consumes very less power when compared to fluorescent lamp or a light bulb. It consumes about one-tenth the power when compared to conventional methods of lighting. Also, the lifetime of a typical LED bulb is several tens of thousands of hours. LEDs are also fast switching with good visibility. Thus, LEDs are ideal for use as the downlink transmitter. For the uplink transmitters, Infrared (IR) can be chosen to be the uplink transmitter for user convenience. This avoids fitting an LED light source on or next to the mobile devices. The receive section consists of a photodiode, e.g. silicon photo detector or an Infrared germanium cylindrical detector. The photo detector demodulates the incoming received signal based on the sequence of 1s and 0s. The demodulated signal is then sent to a filter to remove unwanted noise. This filtered signal is then amplified using signal amplification mechanism. The filtered and amplified signal is then given to an output device such as an LCD display or a speaker.

The input signal is thus remotely transmitted and received. Thus, a Li-Fi network is established.

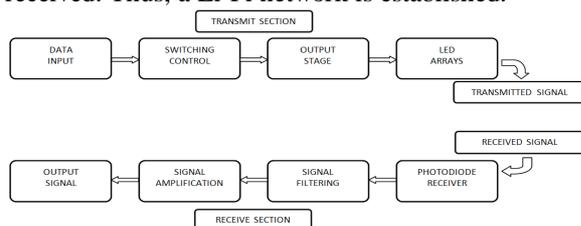


Fig.2 System Block Diagram

CONCLUSION

Li-Fi has great potential in the field of wireless data transmission. It is a promising alternative to conventional methods of wireless communications that use radio waves as data carrier. Many enhancements can be made to the existing technology. For example, encoding and decoding can be implemented directly in the transmitter and receiver part of the circuit. This would reduce error in transmission. Also, by using fast-switching LEDs, data transmission rates can be further enhanced. The driving speed of the circuit can be improved by using fast-switching transistors.

If this technology is put into full-fledged practical use, every LED can be used like a Wi-Fi hotspot to transmit wireless data. This can lead us to a safer and greener future.

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