A Review on Li-Fi Technology

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Abstract: Presently internet has become a major demand; communities are in search of Wi-Fi hot spots. Light Fidelity was invented by Professor Harald Hass of university of Edinburgh. Li-Fi is a latest technology in present day communication system which makes the use of LEDs, Light Emitting Diodes that helps in the transmission of data much faster and flexible than the data that can be transmitted through Wi-Fi. It is basically a technology of visible light communication system which utilizes light emitting diodes as a medium of high speed communication in similar manner as Wi-Fi. Orthogonal Frequency Division Multiplexing (OFDM) based light fidelity (Li-Fi) scheme provides the opportunity of high speed data transmission along with room illumination.

Keywords: Transmissions, Light Fidelity, Interferences, OFDM, LED.

1. INTRODUCTION

In wireless communication network which we use, face the difficulty of access speed when connected to various devices. It creates a fixed bandwidth which is available for the particular user makes it more difficult to achieve high data transfer rates and connect to a secure network [1][2]. We have multiple users increase, it creates some aperture between the connections through which it is convenient for the hackers to get through the connections. Nowadays, the rising demand for wireless data communication, the existing radio spectrum below 10 GHz has become general problem when connected to multiple users, the inadequate [3]. The wireless communication company has replied to this challenge by considering the radio spectrum beyond 10 GHz. There are many reasons which have been considered for the necessity to converge IEEE 802.x wireless network technologies. Expected to ever-increasing stipulation for wireless communications, Wi-Fi is facing many challenges, manageability, service scalability, capacity, namely interoperability, cost effectiveness, availability, efficiency and security [4][5]. In the line of discovering these issues, the scientist has discover a new substitute method for wireless communication using Li-Fi technology, where the data is delivered via visible light alternatively of radio. Li-Fi is principally transmission of data, via the illumination of a Li-Fi source. It is a p–n junction diode that emits light when activated. When a suitable current is applied to the leads, electrons are able to recombine with electron holes within the device, releasing energy in the form of photons. This effect is called electroluminescence, and the colour of the light is determined by the energy band gap of the semiconductor. LEDs are typically small and integrated optical components may be used to shape the radiation pattern.

The Chair of Mobile Communication at the University of Edinburgh, is recognized as the inventor of Li-Fi. He coined the term Li-Fi and is the Co-inventor of pure Li-Fi Company. He demonstrated a Li-Fi prototype at the TED Global conference in Edinburgh, since 12th July 2011. They utilized a table lamp with an LED bulb to transfer a video of a conference in Edinburgh, since 12th July 2011. They utilized a table lamp with an LED bulb to transfer a video of a conference in Edinburgh, since 12th July 2011. They utilized a table lamp with an LED bulb to transfer a video of a conference in Edinburgh, since 12th July 2011. They utilized a table lamp with an LED bulb to transfer a video of a conference in Edinburgh, since 12th July 2011. They utilized a table lamp with an LED bulb to transfer a video of a conference in Edinburgh, since 12th July 2011.

Orthogonal Frequency Division Multiplexing or OFDM is a modulation format that is being used for many of the latest wireless and telecommunications standards. OFDM has been adopted in the Wi-Fi arena where the standards like 802.11a, 802.11n, 802.11ac and more. It has also been chosen for the cellular telecommunications standard LTE / LTE-A, and in addition to this it has been adopted by other standards such as WiMAX and many more. Orthogonal frequency division multiplexing has also been adopted for a number of broadcast standards from DAB Digital Radio to the Digital Video Broadcast standards, DVB. It has also been adopted for other broadcast systems as well including Digital Radio Mondiale used for the long medium and short wave bands. A light-emitting diode (LED) is a two-lead semiconductor light source. It is a p–n junction diode that emits light when activated. When a suitable current is applied to the leads, electrons are able to recombine with electron holes within the device, releasing energy in the form of photons. This effect is called electroluminescence, and the colour of the light is determined by the energy band gap of the semiconductor. LEDs are typically small and integrated optical components may be used to shape the radiation pattern.

II. LI-FI DESIGN

Li-Fi structural design consists of a number of LED bulbs or lamps including many wireless devices such as Mobile Phones, Laptops and Personal digital assistant. The following factors should be taken into concern while designing Li-Fi:

1. Existence of light.
2. Line of sight (LOS).
3. for improved performance use Fluorescent light and LED.
4. A photo detector received data.
Hence all that is required is some LEDs and a controller that will code data into those LED switch [11][12][13].

III. LI-FI IMPLEMENTATION

Li-Fi is characteristically implemented using white LED light bulbs at the downlink transmitter. The LEDs are used for enlightenment only on applying a constant current to them. However, by rapid and delicate variations of the current, the optical production can be made to vary at tremendously high speeds. This especially in terms of optical communication current is used in Li-Fi technology arrangement. It’s operation is very straightforward as when the LED is on then a logic “1” is transmitted and when the LED is off then a logic “0”is transmitted. This so happens at a very swift rate iridescent of LED which is not noticeable to the human eye [14]. Further enhancement can be made in this method, like using a collection of LEDs for parallel data transmission, or using mixture of red, green and blue LEDs to alter the light’s frequency with each frequency encoding a different data channel. Such advancement promise a hypothetical speed of 10Gbps – meaning one can download a full high-definition film in just 30 seconds.

IV. VISIBLE LIGHT COMMUNICATION

Former the radio waves were used but they were costly and less sheltered. Infrared, can only be used with low power as for the sake of eye safety. Gamma rays cannot be used as they can prove to be dangerous. Ultraviolet light is good for position which is liberated from humans otherwise can be very harmful to the humans. Since visible light has no harmful effects, it can be safe to use and is also having a larger bandwidth. VLC is a data announcement medium, which uses visible light in the range of 400THz to 800THz as optical carrier for transmission and illumination.

FEATURES OF LI-FI

A) Data density

Li-Fi can bring about 1000 times the data density of Wi-Fi, as visible light can be well controlled in the light elucidation but in case of RF it suffer from meddling.

FEATURES OF LI-FI

B) Bandwidth

The visible light spectrum is plentiful, much more than RF and also is free to use [15].

C) High speed

A very high velocity of data access can be achieved from Li-Fi as it is free from intrusion and also is having a very large bandwidth [16].

V. APPLICATIONS

With an extensive use of data broadcast these days, Li-Fi has proved to be more beneficial than the present day technology of Wi-Fi. There are many fields where Wi-Fi and many technologies have failed but Li-Fi has proved its superiority [17].

Mobile Connectivity:

Various devices such as Laptops, Mobile Phones, Tablets and other devices can be interrelated directly by using Li-Fi. It gives very elevated data rates and also provides security.

Hazardous Environments:

Li-Fi is a secure substitute as compared to radio waves as in radio waves the electromagnetic meddling takes place in environments such as mines and petrochemical plants.

Underwater Communication

To use radio frequency in underwater, communication can be unfeasible due to strong signal absorption in water. Li-Fi provides an undue benefit in this case [18].

Spectrum Relief:

With the increase of mobile phone users, the presented bandwidth is inadequate and can lead to over loaded circumstance. This problem can be solved by Li-Fi which uses the visible spectrum for communication.

<table>
<thead>
<tr>
<th>Modulation scheme</th>
<th>Working</th>
<th>Advantage</th>
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<tbody>
<tr>
<td>On-off keying (OOK)</td>
<td>OOK is a dimming based modulation scheme which transmits data by sequentially turning the LED on and off.</td>
<td>OOK provides a good trade-off between system performance and implementation complexity</td>
</tr>
<tr>
<td>Pulse Width Modulation (PWM)</td>
<td>In PMW signal pulses carry The modulated signal in the form of a square wave and the widths of the pulses are adjusted based on the desired level of dimming</td>
<td>PMW achieves the dimming without changing the intensity level of pulses.</td>
</tr>
<tr>
<td>Pulse position modulation (PPM)</td>
<td>PPM allows one pulse per symbol duration .The symbol duration is divided into time slots of equal duration and a pulse is transmitted in one of the time slots.</td>
<td>PPM is more power-efficient as compare to OOK.</td>
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VI. RELATED WORK

M. Rubaiyat Hossain Mondal and Rumana Binte Faruqueet al. [19] presented Orthogonal Frequency Division Multiplexing (OFDM) based light fidelity (LiFi) scheme provides the opportunity of high speed data transmission along with room illumination. This paper proposes Hybrid Diversity Combined OFDM (HDC-OFDM) for LiFi by combining the aspects of existing diversity-combined asymmetrically clipped optical OFDM (DACO-OFDM) and direct current biased optical OFDM (DCO-OFDM). The proposed HDC-OFDM has the benefits of power efficiency of DACO-OFDM and the dimming flexibility of DCO-OFDM. In HDC-OFDM transmitter, the lower subcarriers are modulated with DACO-OFDM, and the higher subcarriers with DCO-OFDM. In order to remove the impact of DCOOFDM clipping noise on DACO-OFDM component, a high DC bias is applied on DCO-OFDM. On the other hand, the effect of DACO-OFDM clipping noise on DCO-OFDM element is reduced by estimating the DACO-OFDM clipping noise and then deducting the noise from the received signal of DCO-OFDM. In order to obtain the optimum bit error rate performance of HDC-OFDM, the percentage of subcarriers and the ratio of power levels for DACO-OFDM and DCO-OFDM components are varied. Simulation results show that the dimming flexible HDC-OFDM is 5 dB better than DCO-OFDM and only 1.5 dB inferior to DACO-OFDM in terms of optical power efficiency. Yusuf Perwej et al. [20] presented a demonstration on a close-up view about Li-Fi Technology. This technology we can obtain the data rate greatly speedier than 10 Mbps, which is a lot greater than our LAN (Local Area Network). Li-Fi is very remunerative over Wi-Fi as it uses VLC by which we can make use of the maximum 60 GHz spectrum. Li-Fi confer transmission of data via LED bulb whose intensity change in an excessively faster speed that it could not be able to be explored by the human eye. Li-Fi is confined to the illuminated area, endure a tremendously controllable environment. The signals cannot travel via walls and are fully secure essentially disassemble the threat of data being hacked remotely. Ashish Parnami, Prof. Sanjiv Kumar et al [21] presented a technology based Li-Fi that is light fidelity is one of the future technologies in wireless communication sector. It is a bidirectional, with a very high speed and is a fully networked communication which is wireless technology similar to Wi-Fi. It was developed by the German Physicist Harald Hass who has come up with an idea of sending and receiving data through LED (Light Emitting Diode) light bulb that varies the intensity faster than the human eye. According to Hass, one can use this technology in mobile phones, tablets & laptops and it would be highly secured that is if you can’t see the light that you can’t access the data. It uses light instead of radio waves to transmit information. Instead of Wi-Fi Modems, Li-Fi uses transceiver which has fitted led lamps which can glow a room as well as send and receive information. It is 100 times faster than Wi-Fi reaching at a speed of 224 gigabits per second. Padmini Mishra, Jyoti Poddar, Sonu Priya, Minu Kumara et al. [22] showed that the speed of internet is a major issue and everyone be it business, institutions, organizations, entrepreneurs is thrust for getting right information at the right time and right place. This requires fast internet connectivity, technology and large spectrum of channels. Present paper reflects the Future of Communication (Li-Fi) which may affect all lives. It is a technology that may provide theoretically a speed of upto 10Gbps, cost effective and more robust and useful than Wi-Fi. Li-Fi is not expected to completely replace Wi-Fi, but the two technologies could be used complementarily to create more efficient, green and future-proof access networks. The inventor of Li-Fi, Harald Haas a German physicist and professor has come up with this technology which he calls “data through illumination”. It is a wireless technology that makes use of visible light in place of radio waves to transmit data at terabits per second speeds—more than 100 times the speed of Wi-Fi. This technology has immense possibilities, from public internet access through street lamps to auto-piloted cars that communicate through their headlights. Farooq Aftab, Muhammad Nafees Ulfat khan, Shahzad Ali et al. [23] looked at the different aspects of the Li-Fi based indoor communication system, summarizes some of the research conducted so far and we will also proposed a Li-Fi based communication model.

VII. TECHNOLOGY REPLACEMENT

This technology doesn’t use the radio frequency so it can be used in the place where the technologies like Wi-Fi, Bluetooth, and Infrared etc. are banned. Li-Fi provides a best replacement for such technologies

**Figure 3: Example of Four Wave Mixing in highly nonlinear fibre**

It has various benefits such as:

1. A very ample spectrum of operation over the visible range of electromagnetic spectrum.
2. Extremely high color fidelity.
3. Secure access.
4. Easy terminal management.
5. Instant startup time.

So, in nutshell Li-Fi technology is far better than the modern technology and can be used in those areas where other technologies fail.

VIII. CONCLUSION

With the constant increase in the cellular networks, the most recent technology of Li-Fi has confirmed to be a landmark in communication systems. It uses the visible spectrum of light which is far superior than the RF as it is prone to meddling. With the use of LEDs the information can be transmitted at very high rates with just the simple turning on and off of the LEDs. This technology is not only free to use but also provides a safe and protected access.

REFERENCES

[1] www.lificonsortium.org