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A REVIEW ON LI-FI

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ABSTRACT

This Paper explores a new wireless communication method known as Li-Fi or Light Fidelity which was proposed by Harald Haas. It is used for illumination for data transmission or light as a medium of communication. It uses normal LED lights having variation in its intensity which has speed, a human eye cannot follow. As this technology spectrum which comprises a wide range of frequencies, from the infrared through visible, down to ultraviolet spectrum for communication can produce a theoretical speed of 10 Gbps. So, it's a much more better technology for data transmission compare existing Wi-Fi. Further research has to be done for better outcome.

KEYWORDS: Visible Light Communication, Wireless Communication, Indoor communication.

INTRODUCTION

Li-fi is the one of the latest prototype suggested by Dr. Harald Haas of University of Edinburgh, UK, which overcomes the shortcomings of Wi-Fi like limited bandwidth. It is an optical wireless technology which provides an excellent connectivity in a local environment. Data rates faster than 10Mbps can be transmitted through LED light with visible light as the carrier [1]. It can be very easily explained. If the LED is ON, we are transmitting a digital 1; and if the LED is off we transmit a digital 0. As the LEDs intensity is modulated so rapidly that eyes can't notice, so the output in the form of light appears constantly & offers a permanent connectivity. Teams at University of Oxford, The University of Edinburgh are working on parallel data transmission by using multiple LEDs or array of LEDs. [2] This technology has no major ill effect as we know that the light is very much part of our life. In this spectrum nearby 10000 times more space is available and it also multiplies to 10,000 times more availability as a light bulb and street bulbs are available already. To further get a grasp of LI-FI consider an IR remote. It sends a single data stream with 10-20 kbps speed. If we replace the IR LED with a large LED array then that can be capable of sending thousands of stream at a very fast rate [3]. The current wireless networks that connect us to the internet are very slow when multiple devices are connected.

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When the number of devices Increases which will access the internet, the fixed bandwidth available makes it difficult to enjoy high transfer data rates and connect to a secure network [3-4]. Professor Haas highlighted the following key problems of Wi-Fi that is needed to overcome in future like capacity, efficiency, availability, security, etc. Frank Deicke, a leader of Li-Fi development at Fraunhofer Institute for Photonic Microsystems in Dresden, Germany, has said that Li-Fi can achieve the same data rates as USB cables which is challenging for wireless technologies such as Bluetooth and Wi-Fi. Another advantage of Li-Fi being that the latency of Li-Fi is in the order of microseconds where as that of Wi-Fi is in the order of milliseconds [5]. With the above benefits encouraging us to adopt this new technology, the actual need for Li-Fi can be confirmed from Cisco's Visual Network Index which suggests that user demand is increasing faster than gains in spectral efficiency. By 2015, traffic from wireless devices is expected to exceed that from wired devices. Such increases in network traffic require significant changes in how we think of wireless communication and Li-Fi may be the change that we need [2, 6] Li-Fi is no longer a concept or an idea but a proven technology, although it is still at its infancy. At the University of Strathclyde, researchers have begun outstanding efforts at bringing this new technology to market. Their biggest accomplishment to date is the development of LEDs that are a thousand times smaller than the smallest commercial LED. Dubbed micro-LED or micron-sized LEDs, these newer models are merely 1µm2 (square micrometers) in size. This means that 1,000 more lights could be fit into the same space as a typical LED. In addition to its size, micro-LEDs can flicker 1,000 times faster than commercial LED. Thus, in theory, a bank of 1,000 micro-LEDs flashing 1,000 times faster could transmit data a million times faster than that of an average LED [16, 18]. At the moment, the potential advantage of micro-LEDs for Li-Fi use is staggering [3, 7]. Whereas Li-Fi technology by itself is already incredible, having increased its data transfer speed that is comparable to fiber optics is what makes this new technology a major issue. The Li-Fi technology uses the visible spectrum between 400 THz (780 nm) and 800 THz (375 nm) as a optical carrier for data transmission and illumination [13]. Imagine having a light source that not only provides light but also networking capability at astonishing speeds. Or a home television that communicates with every other gadget around, including the ability to project your smart phone's display onto it for easy presentation to large groups [20]. Or highways lighted by Li-Fi, providing motorists with real-time traffic and weather news as well as internet access to all devices inside. The possibilities seem endless, and the potential is much broader than at first thought. With all the support pouring in, it won't be long now before Li-Fi becomes an everyday technology. Professor Haas has founded a company called Pure LIFI to carry on work in the field of this new technology. The company's mission statement is: "Pure Li-Fi seeks to resolve the global struggle for diminishing wireless capacity by developing and delivering technology for secure, reliable, high speed communication networks that seamlessly integrate data and lighting utility infrastructures and significantly reduce energy consumption."

LITERATURE SURVEY

Instead of using radio waves which acts as a data carrier we can use LI-FI as an alternative method for wireless communication in the modern era of technology. Due to its optical wireless communication technology it provides undisturbed communication. It can achieve up to 10GBPS speed. It is cost efficient. As it cannot penetrate human body unlike radio waves it is not harmful chances of cell mutation is less [1].Airlines companies are soon going to use LI-FI instead of WI-FI due to its high speed. Nuclear and atomic power plants are choosing LI-FI to monitor the temperature and grid connectivity of

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the power plants. Underwater Rovers are using LI-FI as it cost efficient and due to its wireless connectivity. It also helps us to detect accurate GPS location using LI-FI [2]. More Than 2000lumens of white light can be produced with a single source of LI-FI. Unlike radio waves LI-FI cannot be intercepted as it does not require a medium like wall to past through it. Unlike hotspot and WI-FI, Li-Fi does not require a certain area or range to pass the data to the user [3]. The process of transferring data from one source to another is one of the most important day to day activities. LI-FI provides a large range of frequency than any other wireless communication devices. With the means of LI-FI many lives can be saved during the time of natural disasters due to its fast wireless communication technology. It can be used in certain areas where other means of wireless communication is banned. It is not harmful to humans [4]. WI-FI which are transmitted by the means of radio waves are expensive so they can be easily replaced by LI-FI which are cost efficient. As there is a shortage of radio frequencies LI-FI can be used. Modern devices like phones, laptops, tablets etc. can be interconnected easily using LI-FI. It can also be used for hidden communication purpose for the military. The VLC spectrum of a LI-FI is 10000 times more than that of radio waves and is also faster [5]. Due to overload of wireless communication the bandwidths which are present are insufficient so the use of LI-FI can solve this problem. With the use of LI-FI laptops, phones etc. can be connected. In mines and power plants LI-FI can be used as an alternate for WI-FI. It has high speed data transfer due to its large bandwidth. LI-FI can be used underwater as radio waves cannot reach their due to the high absorption power of water [6]. Due to its high efficiency and durability the use of LED is increased. LI-FI has become a potential solution to the wireless communication shortage. The transmission source of the LI-FI can be a high brightness LED. As operation theatres do not allow WI-FI, LI-FI can be used. Due to the large scale development of education system the use of LI-FI can be increased due to its high speed. LI-FI can be used in aero planes due to its low cost [7]. Organic LEDS can be used to provide a faster link between two users. As LIFI uses light it is much faster than WIFI. Airplanes will not get affected due to the use of LIFI. Due to the shortage of radio frequencies LIFI can be used. It is highly secure for hidden communications for secret services [8]. With the use of new wireless communication through LEDS LI-FI is formed. Specific places where various radio waves cannot be used LI-FI can be used in those areas. LED can be replacing bulbs to form a faster communication service. The shorted of radio waves can be solved with th use of LI-FI [9]. Due to the high use of internet communication in different areas the bandwidths are getting slow so they can be replaced by LI-FI for a faster mode of communication. It does not get any obstacles as it does not need any medium to pass through it. It can be used in GPS navigation system. It provides a safe communication for the defense organizations [10]. The bandwidth spectrum of LIFI is high than that of WIFI so it can be easily used in a large region. It is very fast compared to WIFI and can access within a large area. Radio waves are harmful compared to that of LIFI as they are harmful to birds and humans as causes less effect to them. As they are produces by LEDS they have a better communication range [11]. LIFI is easily accessible is all those areas where it is restricted. All the street light bulbs can become a LIFI zone and interconnect with each other once it gets connected. It is less harmful to living organisms and doesn't affect them. Accidents will occur less once cars are replaced by LED lights as they will react faster with LIFI embedded within them[12]. The speed of LIFI is about a 1000 times faster than that of a WIFI. It is very much cost efficient and can easily reach up to a speed of 10 GBPS and can be easily accessed due to its large bandwidth. LIFI can be replaced by WIFI in all educational institutes due to its low cost and high

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speed. Internet can be accessed in each and every corner of the globe once it is replaced with LIFI [13]. LEDS can be served as a data transmission medium for LIFI and can be accessed all around. It cannot be intercepted or traced easily and can be used for various government and defense unit purposes as it is a safe mode of data transmission. Even the street LED lights can become an access point. Traffic accidents can also be controlled if the cars are replaced with LIFI LED'S and can prevent a major accident [14]. LIFI can be produced with a single band spectrum of white light and can connect easily with our day to day gadgets. LEDS are cost efficient and can use less amount of energy. As rays of light cannot penetrate through walls it is a very secure mode of communication. It is 10000 times faster than radio waves and is cost efficient [15].For transmission of Li-Fi some kind of modulation is needed. So, for indoor Li-Fi transmission OOK, PWM, OPPM, VPPM, PPM, OSM these type of single carrier based schemes are used to achieve higher data rate OFDM, ACO-OFDM, DCO-OFDM. There are other modulation scheme for like CSK (Color Shift Keying) for encoding the transmitted signals [16]. Li-Fi can be used as secure data transmitter, where data only transfer to a legit receiver and no one other than legit device can only decode the data just like security used in Wi-Fi [17].

Li-Fi technology can be used to transmit data wirelessly. It's way more capable than a Wi-Fi in terms of bandwidth capacity. It can transfer a 10 times more bandwidth than the conventional wireless technology [18]. Li-Fi and Wi-Fi both are going towards the 5G concept, it is possible to achieve a data rate in gigabits for an individual person. So, using Li-Fi technology a person can use multiple applications at same with a smooth experience [19]. Using Li-Fi technology we can communicate deep underwater areas where RF signals cannot reach. It also energy efficient compare to RF equipment as it uses regular Led lights which are uses household [20].

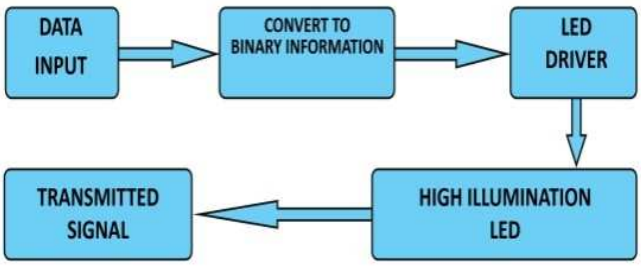

Figure 1.Block diagram of transmitter

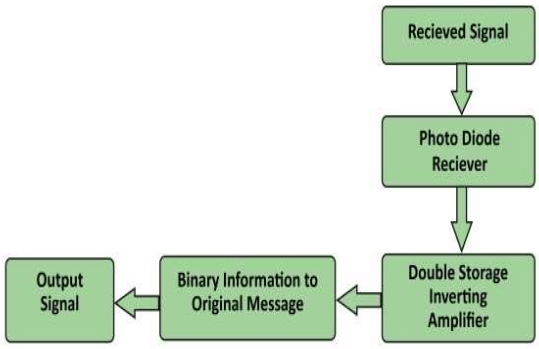

Figure 2.Block diagram of receiver

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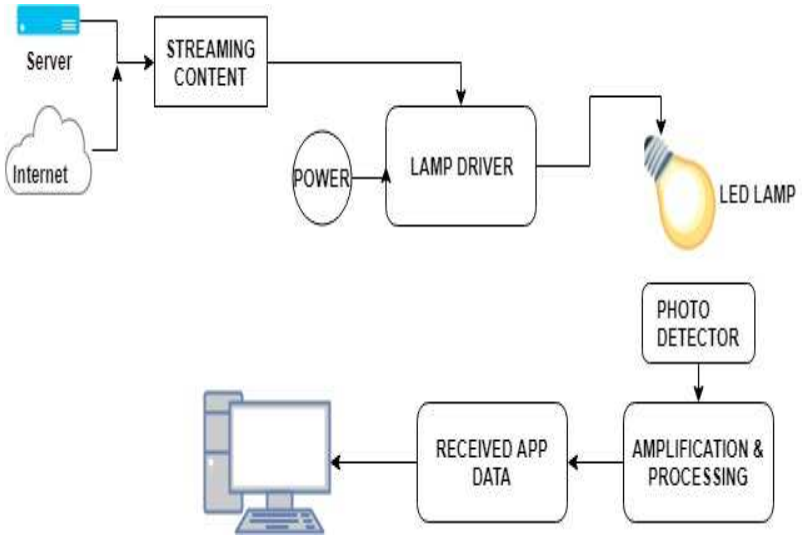

Figure 3.Block diagram of working model

WORKING PRINCIPLE AND RELEVANT DISCUSSION

In Li-Fi technology there is a light source at one end like an LED and a photo detector on the other end as soon as LED starts glowing, photo detector on the other end will detect light and get a binary 1 otherwise binary 0 VLC (visible light communication) is a data communication medium, which uses visible light between 400 THz (780 nm) and 800 THz (375 nm) as optical carrier for data transmission and illumination. The main component of this communication system is a high brightness white LED which acts as a communication source and a silicon photodiode LED can be switched on and off to generate digital strings of 1s and 0s data can be encoded in the light to generate a new stream by varying the flickering rate of LED by modulating LED light with data signal the LED illumination can be used as a communication source a data rate greater than 100 Mbps is possible by using high speed LEDs with approximate multiplexing techniques. standard LED light bulbs are controlled by a driver that turns the LED on and off or dims and brighten it with Li-Fi enabled LED light bulbs, the driver is used to transmit encoded data by controlling the LED light an optical sensor is used to receive the data, which is then decoded the receiver has optics, and is fast enough to see the light dimming and brightening, smart enough to decode the Li-Fi data, and then deliver it to the attached device such as a laptop computer, a receiver dongle converts tiny charges in amplitude into an electrical signal which is then converted back into a data stream and transmitted to a device.

ADVANTAGES OF LI-FI

Availability: light is presence everywhere, for proper transmission of data, just need to replace with LED Lower electricity cost. Security: light waves do not penetrate through the walls, so there is no question for misuse it. It is highly secure. Li-Fi not required license, it has free band. Li-Fi technology cheap in cost. Capacity: light has 10000 times wider bandwidth than radio waves, so it has got large capacity and equipment are easily available. Speed is high as compared to other existing technology. Efficiency: Li-Fi is more efficient because it consumes less energy, but compare with cellular phones for the base stations required large energy. It is used in VLC band which safe for human health. Security: One main advantage of Li-Fi is security. Since light cannot pass through opaque structures, Li-Fi Internet is available only to the users within a room and cannot be breached by users in other rooms or buildings.

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LIMITATIONS OF LI-FI

Internet cannot be used without a light source. This could limit the locations and situations in which Li-Fi could be used. Because it uses visible light, and light cannot penetrate walls, the signal's range is limited by physical barriers. Other sources of light may interfere with the signal. One of the biggest potential drawbacks is the interception of signals outdoors. Sunlight will interfere the signals, resulting in interrupted Internet. A whole new infrastructure for Li-Fi would need to be constructed. Though it draws low power, in order to avail li-fi internet services, lights need to be kept ON throughout day and night. As internet is need of the hour, this will waste energy more than any other internet system. Li-Fi has demonstrated extremely high downlink speeds. There has never been any mention regarding the uplink and any clarity on how it is being implemented. Limited range due to it can't penetrate walls. It needs specialised hardware for implementation which isn't currently available on a large scale.

RECENT RESEARCHES GOING ON

ACHIEVING RECORD SPEEDS WITH NEW MICRO LED DESIGN

Micro-sized Gallium Nitride (GaN) light emitting diodes (micro-LEDs) are strong candidates for VLC (visible light communication) and Li-Fi (light fidelity) due to their high bandwidths. Segmented violet micro-LEDs are reported in this work with electrical-to-optical bandwidths up to 655 MHz An orthogonal frequency division multiplexing (OFDM) based VLC system with adaptive bit and energy loading is demonstrated and a data transmission rate of 11.95 Gb/s is achieved with a violet micro-LED, when the nonlinear distortion of the micro-LED is the dominant noise source of the VLC system. A record 7.91 b/s data transmission rate is reported below the forward error correction threshold using a single pixel of the segmented array when all the noise sources of the VLC system are present [21]

LI-FI MODULATION TECHNIQUES

Li-Fi is cellular wireless networking (re)using lights. Specifically, light emitting diodes (LEDs) are used in Li-Fi as visible light transmitters. This means future lighting systems fulfill two functions: high speed wireless networking and illumination. Li-Fi supports multiuser access and handover to enable mobile services. Since LED lights emit incoherent light only intensity modulation and direct detection can be used. Single carrier modulation techniques are straightforward to implement, but for data rates higher than about 15 Mbps computationally complex equalization techniques are required in frequency selective Li-Fi channels. Moreover, single carrier techniques suffer from DC wander effects. Alternatively, multicarrier modulation techniques offer a viable solution for high speed Li-Fi in terms of power efficiency, spectral efficiency and computational efficiency. In particular, orthogonal frequency division multiplexing (OFDM) based modulation techniques offer a practical solution as they are based on fast Fourier transformations for which very computational effective digital signal processing implementations exist. Li-Fi modulation techniques need to also satisfy illumination requirements. Flickering avoidance and dimming control are considered in the variant modulation techniques presented. This paper surveys the suitable modulation techniques for Li-Fi including those which explore time, frequency and color domains[22].

FUTURE SCOPE

Scope for future enhancement may be affect of interference from non-LED light sources like sun light or any other light and obviously cost reduction is always a criteria. Also using coding techniques the transmitted signals can be encoded, so the data can't be accessed other

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than authorized device or person. As the Li-Fi technology becomes popular, it will lead to a cleaner, greener, safer communications and have a bright future and environment. The concept of Li-Fi is deriving many people as it is free (require no license) and faster means of data transfer. If it evolves faster, people will use this technology more and more.

CONCLUSION

Light is a new technology at its infant stage. It has got waste potential. The main advantage is cleaner and greener technology where mankind will be safe. It is able to solve almost all problems of Wi-Fi like interference, bandwidth, speed, security, cost etc. On-line will become on-light in near future. Many companies are currently working on this concept, which promises to solve the problem of lack of radio spectrum, space and low internet connection speed. The concept of Li-Fi can be used to solve issues such as, shortage of radio-frequency bandwidth and eliminates the disadvantages of Radio communication technologies. Li-Fi is the upcoming and growing technology acting as catalyst for various other developing and new inventions/technologies. Therefore, there is certainty of development of future applications of the Li-Fi which can be extended to different platforms and various parts of human life.

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