LI-FI (LIGHT FIDELITY) DATA COMMUNICATION

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Abstract— Li-Fi stand for light fidelity. It is bidirectional, high speed and fully wireless network technology which is similar to Wi-Fi. This technology related to visible light communication offer many key advantages and effective solutions. It is based on LED light between the violet (800 THz) and red (400 THz) to transmit data wireless. It has broader spectrum compare to conventional methods of wireless communication of data transmission. Li-F provide us better capacity, efficiency, availability and security than Wi-Fi .Li-Fi could lead to the Internet of Things, which are electronic being connected to the internet, with the LEDs light on the electronic being used for internet access points-fi assures to solve the issues like shortage of radio frequency bandwidth and eliminates the drawback of Radio communication technologies/Li-fi provide us the faster speed and better bandwidth rather than the Wi-Fi. This paper focus on Li-Fi, its applications, features of Li-Fi and comparison with existing technologies.

Index Terms— Wi-Fi, Radio Frequency, LED (light emitting Diode) Light Fidelity, and Visible Light Communication (VLC).

1 INTRODUCTION

Basically Light Fidelity is a visible light communication system running wireless communications travelling at very high speed. The function of data communication is to transfer the information between user's terminal and application programs. The simplest form of data communication is that when two devices are connected together by some point-to-point transmission network.

Transformation of data from one place to another is a important activity now a days. When multiple devices are connected, current wireless networks that connect us with the internet are very slow. Because the access of internet by through devices is rapidly increasing day by day which ultimately effect the speed of internet. This is cause because of the fixed bandwidth. Wi-Fi technology is widely used in all area, also the usage time is increasing exponentially every year, and the system capacity is limited since the limitation of Radio Frequency (RF) resource.

The basic ideology behind this technology is that the data transmission is done by the LED light whose intensity is varies even faster than the human eye. Transmission of data take place through the light emitting diodes, the amount is small. In times, is also known as Optimized version of Wi-Fi. In simple term, Li-Fi can be thought of as a light-based Wi-Fi? Li-Fi would use transceiver-fitted LED lamp which can light a room, transmit and receive information as well. Day-by-day the signals are being clogged up due to this there is a need of an error transmission free technology and the solution of that problem is Li-Fi.

The principle of Li-Fi is sending data through amplitude modulation of light source in a consistent and well defined way. Li-Fi basically solve the problem of low bandwidth, faster transfer speed and security as compare to Wi-Fi. Light is very much part of our lives for millions of years and does not have any major ill effetely-Fi technology uses 300 THz license free and unused optimal spectrum for wireless communications, Li-Fi is a green communication method as it reuses thee existing lightning infrastructure for communications. Data is transfer by the rapid subtle changes light intensity that is unnoticeable by the human eye. It is potential candidate for other applications such as underwater communication, intelligent transportation system, indoor positioning, and the Internet of Things (IoT) [1].

In indoor setting, hybrid integration of Wi-Fi and Li-Fi is expected to improve both the system throughput and the user's quality of services. One of the most important advantage of Li-fi is that it does not cause interference to exiting RF communication system, because it use different part of the electromagnetic spectrum .Li-Fi offers a much wider spectrum than RF, it is not restricted like RF-restricted, Recent research show that by using a single LED, Li-Fi is capable of offering high speed data transmission in the Gbps range.

Visible light communication (VLC) is a new way of wireless communication by visible light. Typical transmitters used for visible light communication which are visible light LEDs and receivers are photodiodes and image sensors. Light-emitting diode lamps act as access points (Aps), and light is used as a medium to carry informations bits via intensity modulation and direct detection. We present a new technology which will be made possible by visible light communication application technology. In this system, these devices are not only used for illuminating rooms, but also for an optimal wireless communication system. By leveraging the minimum-cost nature of LEDs and lighting units there are many opportunities to exploit this medium. From public internet access though street lamps to auto-piloted cars that communicate by their headlights. Haas envisions a future where data for laptops, smart phones and tablets will be transmitted through the light in a room.

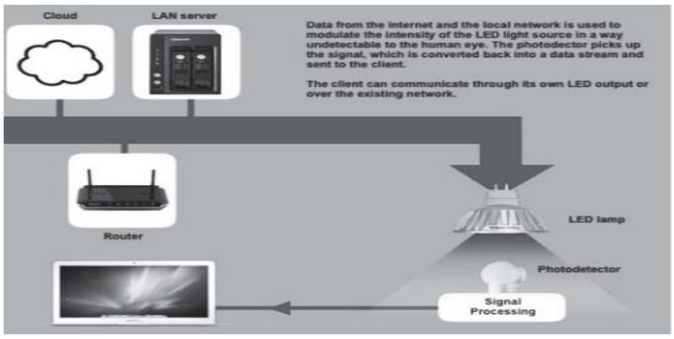


Fig. 1 Magnetization as a function of applied field.
Note how the caption is centered in the column.

2 RELATED WORK

In an indoor Li-Fi system the transmitter is an LED bulb. The most likely candidate for front-end transmitter devices is incoherent solid-state lighting LEDs due to their lowest cost. Multiple LED of different color like red, blue, and green, orange, yellow can be used in Li-fi communication system. About if we talk about high data dates, 1 Giga bits per second has been reported using phosphor-coated white LEDs [3] and 3,4 Giga per second has been red-green-blue (RGB) LEDs[4], the high speed that has ever been reported from a single color incoherent LEDs is 3.5 Giga bits per second.
Mostly LED luminaire use white light to perform both the function of illumination and communication. One way for producing white light is to use blue LED with yellow phosphor coating. When a beam of blue light passes through yellow phosphor coating layer it becomes a white light. Another way is to use a combination of red, green and blue (RGBs) LEDs, when red, green and blue light properly mixed together it become white light .As the light emitted by LEDs are incoherent in to optical signal of instantaneous power. Signal receive at receiver by using Direct Detection (DD) method. In Direct detection (DD) a photodiode is used to convert the optical signal power into a proportional current.

TABLE I
METHOD TO GENERATE WHITE LIGHT

White light production method	Advantages	Disadvantages
Blue light with yellow phosphor coting	Easy to implement and cost effective	Phosphor coating limit the speed at which Led can switches to a few MHz
RGB light	Easy to modulate the data using three different color wavelength LEDs	Not cost effective

3 ARCHITECTURE OF LI-FI

Li-Fi which can be the future of data communication seems to be a fast and cheap optical version of Wi-Fi. Being a Visible Light Communication (VLC), Li-Fi uses visible light of electromagnetic spectrum between 400 THz and 800 THz as optical carrier for data transmission and illumination. It uses quick pulses of light to transmit information in wireless medium. The main elements of a basic Li-Fi system might contain the following:
a) A highly bright white LED which acts as transmission source.
b) A photodiode of silicon with good response to visible light as the receiving element. Turning the LEDs on and off can make them generate digital strings with different combination of 1s and 0s. To come up with a new data stream, data can be encoded in the light by varying the flickering rate of the LED. In this way, the LEDs work as a transmitter by modulating the light with the data signal. The LED results appears constant to the human because they are made to flicker at a phenomenal speed (millions of times per second) and it's impossible for human eye to detect this frequency. Communication quite more than 100 Mbps can be achieved by using high speed LEDs with the help of various multiplexing techniques. And this VLC data rate can be more increased to as high as 10 Gbps via parallel data transmission using an array of LED lights with each LED transmitting a different data stream .The Li-Fi transmitter system consists of four primary subassemblies
·Bulb
·RF Power Amplifier Circuit (PA)
·Printed Circuit Board (PCB)
·Enclosure

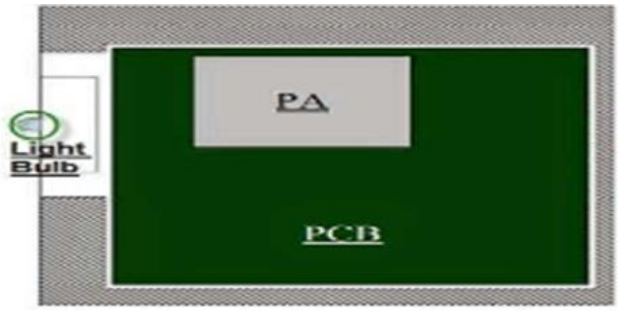


Fig. 2 Block Diagram Li-Fi sub-assemblies.
(Source:http://www.ijcta.com/documents/volumes/vol5issue1/ijcta2014050121.pdf)

The (PCB) Printed circuit board handle the electrical inputs and outputs of the lamp and houses the microcontroller used to manage different lamp functions. A Radio Frequency (RF) signal is produced by the Power Amplifier and is directed into the electric field of the bulb. It give us high concentration of energy in the electric field, the contents of the bulb will get vaporized.

4 WORKING MECHANISM

The working procedure is very simple, if the light is on then

transmit a digital 1: if it's off transmit a 0, The LEDs can be switched on and off very quickly which give nice opportunities for transmitting data as shown in Fig.2 [5]

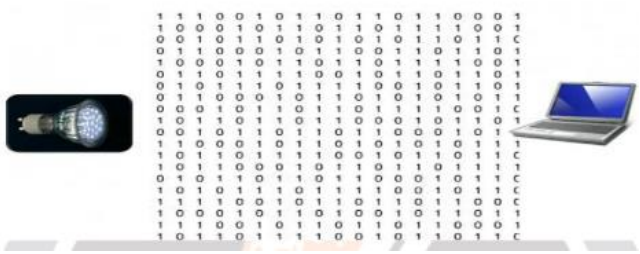


Fig. 3 Data Transmission

Hence LEDs and a controller that a code data into those LEDs. All one has to do is to vary the rate at which the LED flicker depend on the data want to encode. Further enhancement can be made in this method, like using array of the LEDs for parallel data transmission, or using mixture of red, green and blue LEDs to alter the light's frequency with each frequency encode a different data channel.

- Li-Fi is implemented using white LED.
- On one end the data in the internet will be streamed to a lamp driver when the LED is turned on the microchip it convert the digital data in the supervision of light.
- A receiver dongle then converts the small changes in amplitude into an electrical signal, which convert back into data stream and transmitted to a computer or mobile device.

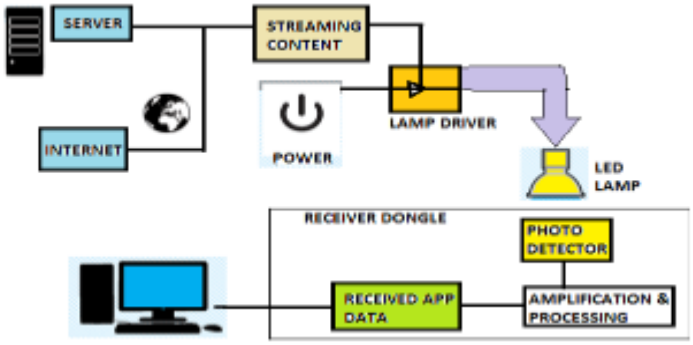


Fig. 4 Working Of Li-Fi Communication

If LED shifting data at a sluggish rate, so many millions of LEDs with one micron size are installed with the bulb. The reduction of size of LEDs doesn't shortage, its ability to shift data on the opposite it increases the efficiency of a single lightweight bulb to transmit the data at a suddenly higher rate. The Figure 4 shows a brief connection of internet [8] with LED and information retrieved on the Tab. Moreover, these micro-LEDs are ultimately simply pixels and at one micron, these LEDs would be a load lesser than those in your Smartphone's retina show. You could have a large array of these LEDs that double up as a room's light source of illumination display and provides networking ability on the side. The model of Li -Fi LED crustal rectifier lightweight light shows in Figure 6.

Fig. 5 Connection Between Led And Tab

Fig. 6 The Model Of Li-Fi Led Light

5 The TX and Rx in LI-FI

Let's begin with TX and RX in different words Transmit and Receive. Adding the x is a shorthand. The data are crossing or traveling over a cable or through the signal in the air. Li-Fi is transmission of data via illumination of the LED by taking the fibre out of the fibre optics by causing data via the LED light bulb that varies in intensity, intense than the human eye can follow. If the LED is ON, the user can transmit a digital string of 1, if it's OFF then the user will transmit a string of 0. It will be switched ON and OFF very speedily, which provide instant favourable moment for transmitting data. It is believable to encode data in the light by varying the rate at which the LEDs flicker ON and OFF to move on dissimilar strings of 1s and 0s. Actually, this technology transfers many thousands of streams of data at the similar instant in parallel in maximum speed with the help of the specific modulation technique using a unique signal processing technology. The light used to send the data is called D-light by Herald Hass, the inventor of Li-Fi [4]. The TX side will transmit the data. It is connected to LEDs which are connected serially via which data is transferred. This data will be received by the receiving side (Rx) side

shows in Figure 7. The receiver side will receive the data that is transmitted via the led panel. These LEDs can be displayed to the Hyper Terminal on the PC by connecting a serially.

Fig. 7 The Li-Fi TX And RX

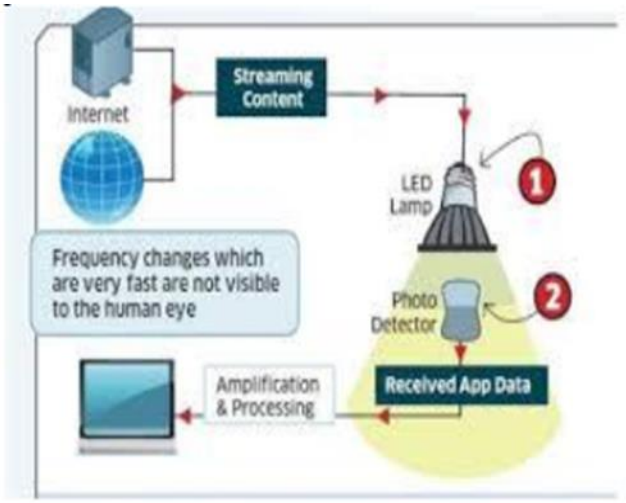


Fig. 8. Function of the Bulb

6 Visible Light Communication

1. Li-Fi is a faster and cheaper version of Wi-Fi, it is based on visible light communication (VLC).
2. The visible light communication is a data communication technique using visible light the range between this is 800 THz and 800 THs as an optical carries for data transmission.

WHY WE USE VLC?

- Gamma rays, X-rays, Ultraviolet rays are harmful for the human body.
- Infrared are also harmful for the human eye.
- Radio wave are expensive but they are less secure. Hence we are left with only the Visible Light Spectrum, it is not harmful for humans.
- It can be used in all locations like infrared, Bluetooth, Wi-Fi and internet services.
- 10000 times the frequency spectrum of radio.
- Unimpeded by radio interference.
- Eliminates neighbouring network interference
- Does not create interference in sensitive electronics, making it better for use in environments like hospitals and aircraft.

7 Function Of Bulb Sub-Assembly

At the heart if Li-Fi, bulb is sub-assembly where a sealed bulb is embedded in a dielectric materials. This design is more reliable than conventional light source that insert degradable electrodes into the bulb. Dielectric material use for following two purpose, waveguide for the RF energy transmitted by the PA and an electric field concentrator that focuses energy in the bulb. The energy which emit the electric field rapidly heats the material in the bulb to plasma state which emit light of high intensity and full spectrum.

8 Modulation Techniques for Li-Fi

In this section, generally we discuss the modulation techniques used for Li-Fi are summarized, and some special issue and requirement are discussed. In Li-Fi principle, it relay on electromagnetic radiation for information transmission. Therefore, typically used modulation RF communication can also be applied to Li-Fi with necessary modification. Due to the use of visible light for wireless communication, Li-Fi also provides a number of unique and specific modulation formats. , it can inherently provide dimmingsupport.1As specified in IEEE802.15.7 [7]

A. Single-Carrier Modulation (SCM)

SCM methodology for Li-Fi include on-off keying (OOK), pulse position modulation (PPM) and pulse amplitude modulation (PAM), that are studied in wireless infrared communication system [6].It provides a good trade-off between system performance and implementation complexity. Dimming through refining the ON/OFF levels of the LED can maintain the same data rate, however, the reliable communication range would decrease at low dimming levels. On the other way, dimming by symbol indemnification can be achieved by inserting additional ON/OFF pulses, whose duration is determined by the desired dimming level. As to achieve the maximum data rate which is done with 50% dimming level assuming equal number of1and0s on average, increasing or decreasing the brightness of the LED would cause the data rate to decrease. SCM novel strategy which named as optical spatial modulation [13], the principle of this spatial modulation, demonstrate to be both power- and data transmission for indoor optical wireless correspondence. As a variant of quadrature amplitude modulation (QAM) for single carrier systems, carrier-less amplitude and phase modulation [14] uses two orthogonal signals, in place of the real and imaginary parts of the QAM signalling format ,for spectrum-efficient signal transmission in Li-Fi network.

B. Multi-Carrier Modulation

As the required data rate increases in Li-Fi networks, SCM schemes such as OOK, PPM and PAM start to suffer from unwanted effects, such as non-linear signal distortion at the LED front-end and inter-symbol interference caused by the frequency selectivity in dispersive optical wireless channels. Consequently, for high-speed optical wireless communication, efforts are pinched to multi-carrier modulation (MCM). Differentiate with SCM, MCM is more bandwidth-efficient but less energy-efficient. One and perhaps the most common realisation of MCM in Li-Fi networks is OFDM [15], where parallel data streams are transmitted simultaneously through a collection of orthogonal subcarriers and complex equalization can be omitted. If the quantity of orthogonal subcarriers is chosen so that the data length of the modulated signal is smaller than the coherence data length of the optical channel, every subchannel may be considered as a flat attenuation channel. Method and technique already developed for flat fading channels can therefore be applied. The use of OFDM permits for further adaptive bit and power loading techniques on each sub-carrier so that enhanced system performance may be achieved. An OFDM modulator can be implemented by an inverse discrete Fourier transform block, which can be efficiently realised using the inverse fast Fourier transform (IFFT), followed by digital-to-analogue converter (DAC). As a result, the OFDM-generated signal is complicated and bipolar naturally. So as to fit the IM/DD demand obligatory by commercially available LEDs, necessary modifications to the conventional OFDM techniques are required for Li-Fi. The generally used method for ensuring a real-valued signal output after IFFT is by imposing Hermit Ian symmetry on the subcarriers. Moreover, because the intensity cannot be negative, the Li-Fi signal needs to be unipolar. There are many several strategies to obtain a unipolar time-domain signal. DCO-OFDM uses a positive direct current (DC) bias for unipolar signal generation. This methodology brings a rise within the total electrical power consumption, however while not more loss in spectral potency. Unsymmetrically clipped optical OFDM (ACO-OFDM) is another variety of optical OFDM scheme where, as well as imposing Hermitian symmetry, only the odd subcarriers are used for data transmission and the even subcarriers are set to zero. Therefore, the spectral efficiency of ACO-OFDM is more halved. Since only a minimum DC bias is required in ACO-OFDM, it is more energy-efficient than DCO-OFDM. Asymmetrically clipped direct current biased OFDM (ADO-OFDM) is a combination of DCO-OFDM and ACO-OFDM, where the DCO-OFDM scheme is used on the even subcarriers and the ACO-OFDM scheme is used on the odd subcarriers. In specific scenarios, it is shown that ADO-OFDM outperforms both DCO-OFDM and ACO-OFDM in terms of power-efficiency.

9 The Viewpoint of Li-Fi

Li-Fi technology can be used for many purposes, it matters the data transmission via LEDs thus all the screens which provide light can be served as a platform for data communication. The Li-Fi cloud is a software solution which enable the user to control all the feature within a data centric Li-Fi environment. In Figure 8. Shows how the Li-Fi cloud will get communicated with other electrical devices. The Li-Fi use visible light as an alternative of gigahertz radio waves. At this time there are 1.4 billion base stations, they consume more energy and its competence is less than five percent and we have a total of almost five million mobile phones which transfer more than 600 terabytes [14] of data every month it provide the reality that wireless has become usefulness. The screen of the television, mobile phone bulbs will gesture as a source of light. On the contrary, the receiving platform, the photo detector can be replaced by a camera in mobile phone for scanning and access data. So many applications are Li-Fi for desktops, hospitals, Li-Fi in cities, smart guides, museums, smart card, Li-Fi for schools, hotels, fairgrounds, events, indoor, [15] access control and identification crisis, airport, malls and dangerous environments like thermal power plants. The forerunner of data transmission through the blinking of the LEDs can create wireless internet access with data transmission speeds of close to 10Gbit/s, theoretically, permit a high-definition film to be downloaded in 35 seconds which is 250 times faster than excellent broadband. These advantages come at a quintuple transits currently offering fibre optic lines, [16] to advantage from this technology requires a luminous router which is competent of emitting the binary signal.

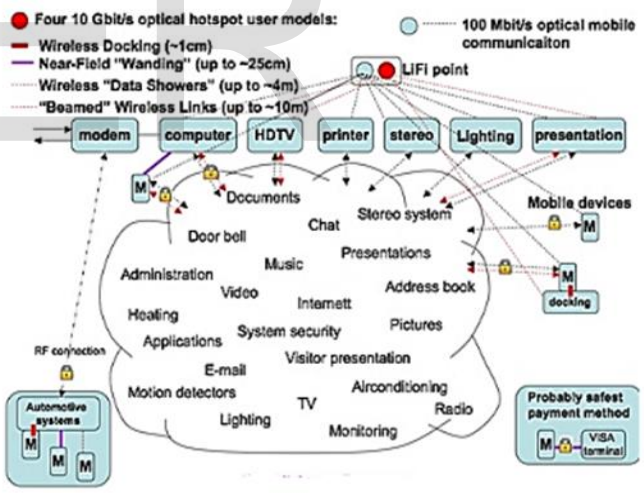


Fig. 9 the Li-fi Communication with other Electronic Devices

10 LI-FI Network

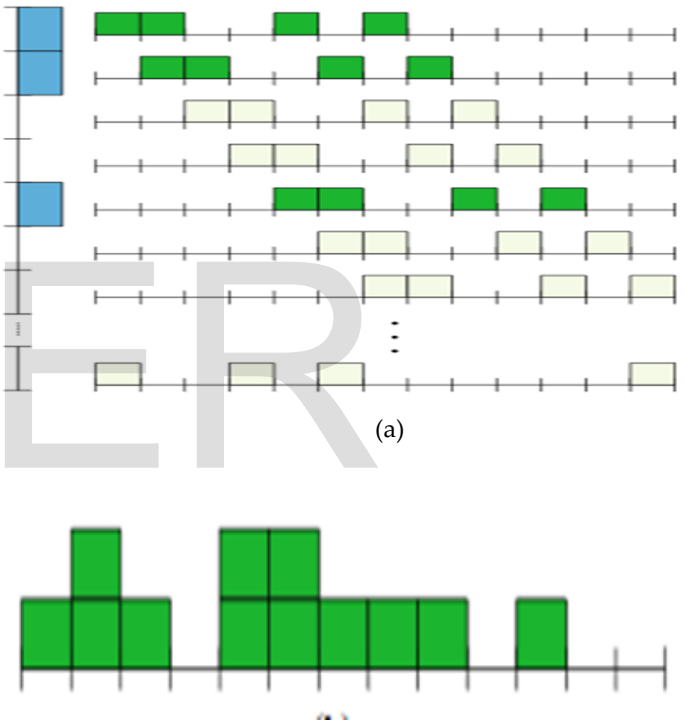
For providing the illumination and seamless communication coverage, attocell architecture has been proposed, which is referred from cellular network as the cell sizes are smaller than in a typical RF femtocell network. Every LED light bulb in attocell Li-Fi network is treated as an access point and an illumination source for covering a limited region or one room. In this context, Li-Fi is shown potentially to provide at least an order of magnitude improvement in the area spectral efficiency (ASE) as compared to the femtocell system. It is due to the

fact that there is no interference from one room to another since light does not propagate through walls unlike RF signals.

A.Multiple Access and Resource Allocation

Based on the attocell architecture, users must be associated with one or some LED lamps for accessing and downlink transmission. In [17], three user access schemes are pro-posed, i.e., the distance-prior (DP), the service aggregation (SA) and the enhanced bandwidth-based (BB) lamp selection schemes. All the users are assumed to be equipped with a position sensor that can provide real-time precise position information to the LED scheduler. In DP protocol, user accesses to the nearest LED lamp, while SA scheme allow multiple LED lamps to serve one user for satisfying the service requirements. However, many LED lamps may carry limited service due to the dispersed signals using DP scheme, which is not economy. Also, SA scheme may not robust when a network with extremely aggregated services. In order to solve these problems, BB scheme, which balances the advantages of DP and SA, has been presented in [17] depending on the percentage of LED affordable bandwidth. In case of little service, the selection result is the same as that of the SA scheme; otherwise, the result is the same as that of the DP scheme. Nevertheless, interference among different LED lamps under the scenario of dense users will increase to degrade the system performances in [17].Similar to OFDMA technology of RF network, effective subcarrier and power allocation design can not only exploit the spatial transmitter diversity but also decrease the interference imposed on the users from the LED lamps. In [18], a heuristic algorithm has been proposed to manage subcarriers reuse among different transmitters and power redistribution between different subcarriers. The interferences can be mitigated if the adjacent LED lamps use orthogonal subcarriers. Different modulation order may be adopted on each assigned subcarrier for satisfying the QoS of different users. In [19], each user are allocated with orthogonal subcarriers, while a user-specific inter leaver is adopted to separate users. However, high peak-to-average power ratio (PAPR) always exists and needs to be can-celled by the amplifier with high dynamic range.

Another multiple access technique, namely optical code-division multiple access system (OCDMA), has been developed to allow simultaneous transmission from a large number of sources by using random optical codes (ROCs) to share the channel [20]. Although the novel preamble bits have been designed, the synchronization among TXs and RXs is still challenging, especially for large number of accessing users. In [21], the multiple access technique using multilevel-expurgated pulse position modulation (EPPM) is proposed. Different with the schemes that discussed above, it can also support the light feature of dimming control by simply changing the generating balanced incomplete block designs (BIBD) code, which is an area of combinatorial mathematics with several communication applications. Fig.10 shows the multilevel symbol generated using a (13, 3, 1) optical orthogonal codes (OOC) code word and a (13, 4,1) BIBD code. In this scheme, every user is assigned a unique OOC and the BIBD codes are used for high order modulation. The number of BIBD codes that allocated to the users can be dynamically adjusted according to their rate requirements. As shown in Fig.10 (b), every bit of the user encoded binary sequence is multiplied by a BIBD code word, and then the OOC-encoded BIBD code words are added to generate a multilevel signal. Optical beam forming, which is considered to be a kind of spatial multiplex technique, has been recently proposed that it can focus LED light on a desired target device .This technology can increase the transmission distance by enhancing optical SNR at a given direction and provide.



(a)

(b)

Fig. 10 Symbol generation for coded-MEPPM using the (110010000000) OOC code word and a (134, 1.1)-BIBD, and b the resulting symbol

Orthogonal multiple user transmission based on spatial separation. Spatial light modulator (SLM), which is a transparent or reflective optical device that can modulate optical phase or amplitude on each pixel, is attached on the LED TX . SLM can be regarded as a dynamic diffractive convex lens controlled by electrical signals . In order to satisfy the multi-user scenario, several direction codes representing different indoor positions are modulated and packed via LED light transmission. When the user detects the direction code, it sends the information to the LED via uplink channels (e.g., Wi-Fi, infrared or Bluetooth and so on). Correspondingly, the modulated light beam can transmit in a particular path to the RX without interfering

with others.

B. Interference Management

In attocell Li-Fi architecture like RF cellular network, intercell and intra-cell interference mitigation techniques are indispensable. The most common method is to assign different subbands for neighbouring cells in order to avoid channel interference (CCI).. In this scheme, multicolour white LEDs are implemented, in which one colour is selected to transmit information and others are reserved for illumination. Different wavelength channels assigned to each cell are used to mitigate inter-cell interferences, phase-shifted maximum-length PN sequences are applied to distinguish LEDs sharing the same wavelength channel and the Walsh-Hadamard (WH) code is adopted for user differentiation within a cell to minimize intra-cell interference. This system design is

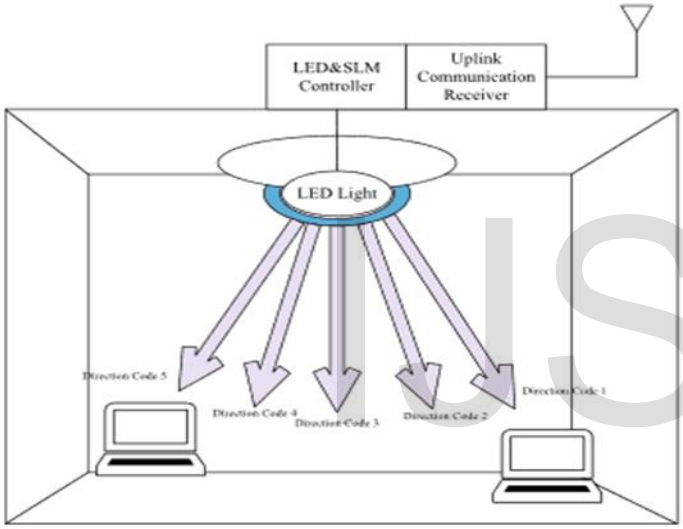


Fig. 11. Optical beam forming system model

11 Application of Li-F

There is very huge necessity for data transfer and by the end of the day every field involve in the uses of new technologies. One such technology is Li-Fi which can have its applications extended in those are where the Wi-Fi technology has lack presence like medical technology, power plants and various other areas where Li-Fi proved it excellence of the undersea awesomeness.

A. Li-fi And Live Streaming

Audience prefer to watch live video from a brand than read a blog and live videos are greater than those which are not live. Because Li-Fi has high speed rates It is avail in everywhere like shopping mall, sport stadium, street lights, airplanes , trains including underground, train stations, airport and hence. It allow any user to consume rich content media like videos as well as live streaming from their smartphones or other mobile devices.

B. Industrial Automation System Of Li-Fi Technology

In industrial manufacturing process, it is very important that process should be completed fast and safely besides product quality. Therefore, the communications across units are developing day by day in nowadays- industrial automation systems. These developments that mostly depending on usage of protocol are shown data transmission rate and security. In industrial applications, while monitoring and control are being done in real time benefiting various network topologies. The efficiency of network is an important factor while this topology is chosen. However, it will be useful to take into consideration; the using network topology is used to recognize devices besides data transmission speed may vary depending on the distance between units. Under these criteria, many industrial automation companies are trying to provide with different communication protocols. It offers sufficient advantages in terms of both cost and speed if data transmission is done wirelessly. Wireless monitoring and control systems are provided a major contribution to the development of the SCADA systems. Wireless communication systems, especially applications are made with web-based or smartphones, has been used successfully. As compared with Wi-Fi, Li-Fi technologies should be preferred because of having high-speed data transmission rate and more secure in wireless communication systems. In current wireless communication system have a security gap because radio waves can pass through the walls. Security gap may be huge disadvantage for industrial automation systems that are operating higher-up security level. Light waves cannot pass through the walls. Therefore, these industrial automation systems are protected by using Li-Fi technology. As mentioned previous chapter, line-of-sight is a big challenge for Li-Fi systems. Some people claim that Wi-Fi is an over light based communication technologies and is not much affected from line-of-sight problem as compared with Li-Fi in a factory environment that includes lots of moving obstacles. Therefore, Wi-Fi systems are more useful than Li-Fi for industrial areas. However, once considering a factory, Wi- Fi connection receivers are positioned in specific locations. The internet connection is delivered to the robotic arms via Ethernet cables. When Wi-Fi systems are replaced with Li-Fi, still receivers are positioned in specific locations and nothing can interrupt light. Therefore, internet connection can be provided without any interruption to the robotic arms or any other devices. Thus, line-of-sight problem are solved. In addition, it can be clearly seen that production process will be faster with using Li-Fi, which is provided high-speed data transmission rate. This system model is shown in Fig. 12.

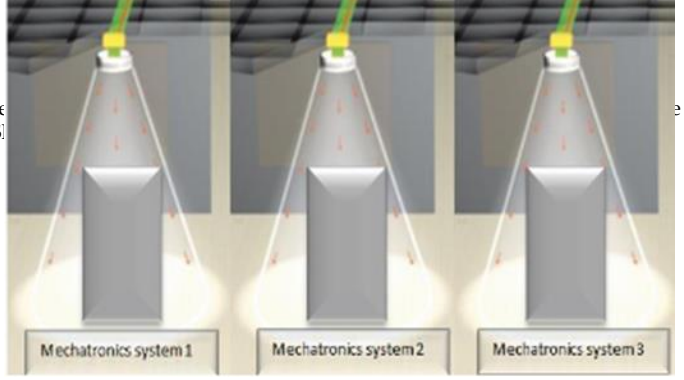


Figure 12. Li-Fi connection system in a factory

A. *Li-fi In The Workplaces*

Li-Fi will not give illumination but secure wireless connectivity in workspaces. As well as thee networking capability, people will be able to take a Skype video conference call and move from one room to another without that conference call being break the continuity .Workers and visitors will have a constant internet speed connection from the Li-Fi network in the workspace. By using light, network access can also be controlled more effectively. Let's see some example, the overhead lighting in an office can provide access to the guest network, desk lamp can provide access to certain parts of a corporate network with access rights assigned on desk-by-desk basis .

B. *Li-Fi Technology In Hospitals*

Li-Fi does not interfere with radio frequency devices, it is safely used in hospital applications. For example, in corridors, waiting rooms, patient rooms and operating theatres, it remove electromagnetic interference issues from smartphones and the use of Wi-Fi in hospitals. It used for real time monitoring and report of patient movement and vital signs without the need of wires.

In hospitals pharmacies and specifically is aseptic manufacturing sites, Li-Fi technology is used by pharmacists for receiving and screening electronically approved prescription directly in the until-fi is used for real-time tracking of drugs which are prescribed to patient Parenteral drugs and centralized intra venous additive services (CIVAS) in the unit , nurses and all the other staff and healthcare professionals from the ward can check the status without the need of calling or going directly to the aseptic until-Fi could use by patient to check the real-time status of the prescription on their Smartphones or pharmacy terminals while waiting to collect their script.

Li-Fi can ensure patient on their beds connecting to internet news, emails, video games and socials media platforms through their smartphones. It is help them to pass the time during their stay .Li-fi enable the tracking and relocation of the position of key devices especially those regularly shared by different departments. Check the below diagram for a summary of the benefit of Li-Fi in hospitals. position of key devices especially those regularly shared by different departments. Check the below diagram Fig 13 for a summary of the benefit of Li-Fi in hospitals. position of key devices especially those regularly shared by different departments. Check the below diagram for a summary of the benefit of Li-Fi in hospitals.

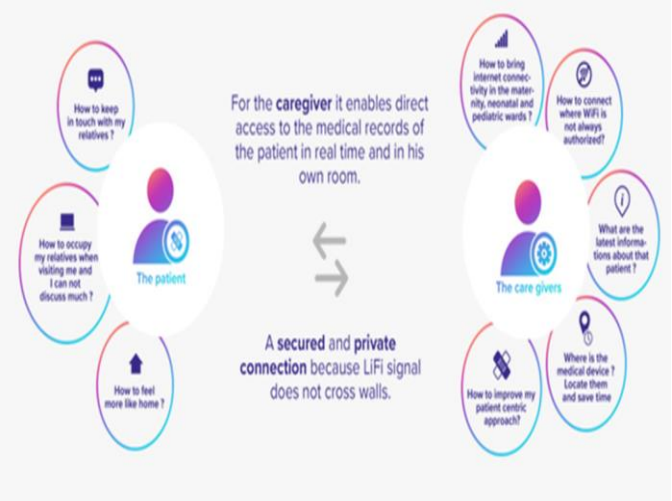


Fig. 13. Li-Fi application to the patient and the care givers

The wireless network is a major component to provide new learning experiences by connecting students and teachers to smart technology, enable learning applications on any mobile device.Li-Fi can also give us seamless network connectivity and security throughout the whole school, from the class room all the way though to university dorms, one schools have even started trailing Li-fi technology in classrooms.

A school called The Hegel-Gymnasium in Stuttgart is currently testing Li-Fi in classrooms to teach a broad range of subjects through information technology. Principal of school's Frank Bäuerle stated that "We are happy that our students are involved with a sensational research project, which is concerned with high-speed data communication without electromagnetic interference. Our students and teaching staff will gather experiences on the level of advanced VLC-modules of Fraunhofer HHI, as well as on which pedagogical concepts make sense with this technology. That's why we will be able to assist in the identification of future technological development."

Fewer days ago, The Kyle academy, In Scotland has also started using Li-Fi in classroom. The Li-Fi project is being run in cooperation with PureLiFi and University of Edinburgh. The installation of pureLiFi's LiFi-XC system consists of eight LiFi-enabled LED light bulbs in the ceiling and students have been given access to LiFi-XC Stations that plug into their laptops enable high-speed connect through the lights.

E. *Managing Traffic*

Li-Fi is used to update traffic information at almost every instant and it ill be easy for traffics police to deal with traffic and catch one whole breaks the rule.When thee rd light signal in on all the vehicle are stopped.But there are some vechicle which do not wish to follow the rules.Li-fi technology can be used to prevent thi violence of traffic signal.Every vechicle can be assigent a unique number and information against this unique numer must be stored I the central datanase. The red , green,yellow,orange traffic light and the head light and tail light must be Li-Fi enabled Led which can transmit and receve data. Whenever there is a red traffic signal the server of that spot sends a signal through the red light to all nearby vehicles to send that unique code and information regarding to the

amount of time they should wait which is received by the head light and tail light of the vehicle. An Arduino microcontroller is used to decode the received data from the red light. Then the vehicles must wait that specified amount of time and a timer is generated. If a vehicle starts running before the particular amount of time then that is sensed by the motion sensor attached with the Arduino microcontroller then it sends an indication to the server through head-light or tail-light to red light whereever complete information about the vehicle is then stored. Traffic police could make use of this information if required and can take necessary action.

12 Li-Fi Attocell

Wireless cellular communications has significantly benefited from reducing the inter-site distance of cellular base stations. By minimizing the cell size, the network spectral efficiency has been increased by two orders of magnitude in the last 25 years. More recently, different cell layers composed of microcells, Pico cells and femto cells have been introduced. These networks are mentioned to as heterogeneous networks. Femtocells are short range, and low transmission power, low cost, plug-and-play base stations (BSs) that are targeted at indoor deployment in order to enhance coverage. They use either cable Internet or broadband digital subscriber line (DSL) to backhaul to the core network of the operator. The deployment of femtocells will increase the frequency reuse, and thus output per unit area within the system since they usually share the same bandwidth with the macro cellular network. However, the uncoordinated and random preparation of small cells also additinalyy cause firther inter-and intra-cell interference that imposes a limit on however dense these little RF can be deployed before interference starts offsetting all frequency reuse gains. The concept of small cell, however, can easily be extended to VLC in order to overcome the high interference generated by the close reuse of radio frequency spectrum in heterogeneous networks. The optical AP is mentioned to as an attocell. Since it operates within the visible light spectrum, the optical attocell doesn't interfere with the macro cellular network. The optical attocell not only give better indoor coverage, but since it does not generate any additional interference, it is able to enhance the capacity of the RF wireless networks. Li-Fi attocells allow for extremely dense bandwidth reuse due to the inherent properties of light waves. The coverage of every single attocell is very limited, and walls prevent the system from suffering from co-channel interference between rooms. This advance deploy is the need of to access multiple points to cover a given space. However, the requirement for illumination indoors are majolry focus, the infrastructure already exists, and this type of cell deployment results in the aforementioned very high, practically interference-free bandwidth reuse. A by-product of this is also a reduction in bandwidth dilution over the area of each access point, which leads to an increase in the capacity available per user. The user data rate in attocell networks are often improved by up to three orders of magnitude.

13 Challenges of Li-fi

The metamorphose of existing devices into Li-Fi enabled ones. Need of line of sight for communication and it also faces interference from external light sources like [15] the sun. Exalted installation costs until it becomes more commercial. The Internet cannot be utilized without a light source. This could limit the locations and circumstances in [22] which Li-Fi could be used. In view of the fact that it uses visible light, and light cannot penetrate walls, the signal's limited range.Li-Fi should need line of sight for effective data transission.Small difference leads to interruption in the transmission.The receving device should not be reallocated inside the hall.The receiving device does not aware to transmit data back to transmitter.Intereference could be caused by external light sources such as normal bulbs,sunlight and opaque objects during data transmission .It leads to decreases reliability.VlC is not able to pierce via brick , thick walls like radio wavers and simply blocked by things human etc.

14 Advantages

A. Capacity:

As we know that light is a voluntarily accessible form of energy so most of the portion of EM spectrum can be covered by it. Spectrum of visible light is 10000 times more than the spectrum of radio wave.

B. Efficiency:

Li-Fi data bits can be transmitted parallel which brings about the expanding efficiency.

C. Availability:

Light is available in every part of the world which makes each individual to work on the internet in airplanes. Light source is everywhere that's availability is not an issue. Wherever the light source is there, there can be Internet. Light bulbs are present almost everywhere –in homes, offices, shops, malls and also in planes, which can be used as a medium for the data transmission. Li-Fi not only requires fewer components for its working, but also uses only a negligible additional power for the data transmission

D. Data rate:

It is possible to get more than 10Gbps, theoretically permit a top quality motion picture to be downloaded in 30sec. This leads to the fast and easy communication.

A. High Speed:

Combination of low interference and high bandwidth and also high-intensity output, help Li-Fi provide high data rates i.e. 1 Gbps or even beyond.

E. Security:

One main advantage of Li-Fi is security. Because light cannot pass through opaque structures, Li-Fi internet is available only to the users within a confined area and cannot be intercepted and misused, outside the area under operation.

F. Cheaper:

Li-Fi not only requires fewer components for its working, but also uses only a negligible additional power for the data transmission

15 Limitations Of Li-fi

As we know that there are many advantages of Li-Fi like any other technology also comes a number of limitations and disadvantages. A big problem is that light cannot pass through objects. If the receiver is inadvertently blocked in any way, then the signal will immediately be cut out. It the light signal is blocked one could switch back over to radio waves. Reliability and network coverage which are the major issues to be considered by the companies while providing VLC services. External source interference like sunlight, normal bulb and opaque materials in the path of transmission will cause interruption in the communication. Reliability and network coverage are the major issues to be considered by the companies while providing VLC services. Interference from external light sources like sunlight, normal bulbs; and opaque materials in the path of transmission will cause interruption in the communication. High installation cost of the systems can be complemented by large-scale implementation of VLC though adopting this technology will reduce further operating costs like electricity charges, maintenance charges etc. We still need Wi-Fi and we still need radio frequency cellular systems. You can't have a light bulb that provides data to a high-speed moving object or to provide data in a remote area where there are trees, walls and obstacles.

16 Conclusion

This paper has presented the study of Li-Fi technology fundamentals, working principle, challenges and application comparing with Wi-Fi technology .Li-Fi is the upcoming and growing technology acting as competent for various other developing and existing technologies. Potentially, Li-Fi is quite energy efficient. The infrastructure of this technology is quite simple and connecting to it might be as simple .Wi-Fi is growing very rapidly but it is not efficient for the transmission of the big amount of data, Li-Fi is more secure than Wi-Fi and it is highly applicable for the big amount of data secure and cost effective. This can solve the issues like the shortage of bandwidth furthermore permit web where conventional radio based remote isn't allowed for example aircraft or hospitals. This technology has the potential to become mainstream and ubiquitous.

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