IJCSE International Journal of Computer Sciences and Engineering Open Access
Review Paper Vol.-7, Issue-1, Jan 2019 E-ISSN: 2347-2693

Potential of Li-Fi (Light Fidelity) Technology for Internet Penetration in Rural India

W.Akram[1*]

[1]Department of Computer Applications, GDC Mendhar, Poonch (J&K)

**Corresponding Author: wasimmir143@gmail.com Mobile: +91-7051388383*

Available online at: www.ijcseonline.org

Accepted: 14/Jan/2019, Published: 31/Jan/2019

***Abstract*-** Li-Fi stands for Light-Fidelity. Li-Fi is a data transfer technology that uses visible light as the medium of transfer rather than the radio waves that are used currently in the Wi-Fi technology [1]. This technology is cheaper, cleaner, greener, faster and secure than the Wi-Fi technology. Digital India is a much celebrated and much discussed programme of Indian Government that focuses on internet penetration in the remotest corners of India. This paper presents a survey of the applications, advantages, disadvantages and standardization of Li-Fi. It also focuses on the research challenges in VLC. In this paper, a study on how Li-Fi Technology can be used in rural areas for the transformation of India into a Digital India by using Li-Fi enabled Solar Panels has been carried out. In this paper we cover every aspect of implementation of Li-Fi Technology in rural India. During this paper we explain how this emerging technology will empower the rural areas in a broad way.

***Keywords*:** Li-Fi, Radio Waves, Wi-Fi, Digital India, Internet, Rural Areas, VLC, Solar panels.

I. Introduction

Li-Fi stands for light fidelity and it is a data transfer technology that uses visible light as the medium of transfer rather than the radio waves that are used currently in the Wi-Fi technology. The setup used in this technology is much simpler and cheaper than that which is used in Wi-Fi system. It thus, requires a transceiver-fitted LED lamp instead of a Wi-Fi modem , which can transmit the data and can lit the room as well. The Li-Fi technology is thus, cheaper, cleaner, greener, faster and secure than the Wi-Fi technology. It uses visible light communication technology (VLC) as a medium of data transfer that was developed by a group of scientists including Gordon Povey, Harald Haas and Mostafa Afgani at the university of Edinburgh[1].

The introduction of the paper is given in Section I and Section II describes the History of Li-Fi Technology, Section III describes the working of Li-Fi Technology, Section IV explains the implementation of Li-Fi, Section V explains the various advantages of using Li-Fi, Section VI explains the various disadvantages of using Li-Fi, Section VII describes the need of Li-Fi Technology, Section VIII describes the applications of Li-Fi in various areas, Section IX describes the working of Li-Fi enabled Solar Panels , Section X describes the future scope and Section XI contains the Conclusion.

II. History of Li-Fi Technology

Prof. Harald Haas, from the University of Edinburgh in the UK, is extensively renowned as the original founder of Li-Fi. He invented the term Li-Fi and hold the Chair of Mobile Communications at the University of Edinburgh and is the co-founder of pureLiFi. Prof.Haas proposed this technology in his 2011 TED Global talk and helped start a company to market it. In October 2011, various companies and industry groups formed the Li-Fi Consortium, to promote high-speed optical wireless systems. The earliest Li-Fi Smartphone model was presented at the Consumer Electronics Show in Las Vegas from January 7–10 in 2014.

III. Working of Li-Fi Technology

- The LEDs can be switched on and off very quickly which gives nice opportunity for data transfer in the form of Binary code.

- Switching ON a LED is logical '1', switching off a LED is logical '0'.
- Hence it is possible to encode the data into the LED's by using a controller and we just have to vary at which LED's flicker depending on the data we want to encode to give different strings of 0's and 1's[2].
- UK researches say that using a micro-LED light bulb they have achieved a data transmission speed of 10Gbps using LI-FI.

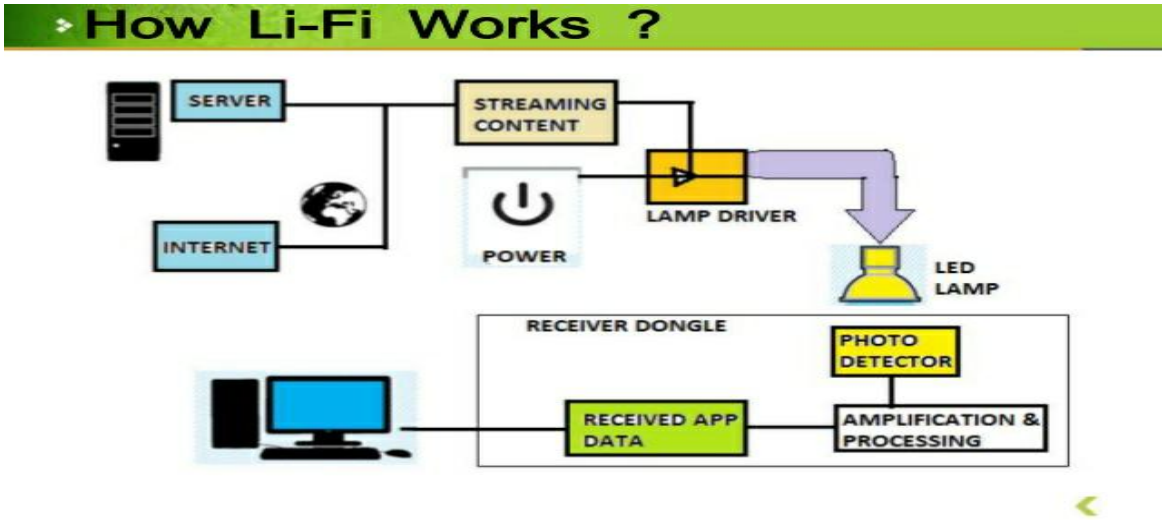

Fig 1: Block diagram of Li-Fi Sub System
(Source: http://www.ijcta.com/documents/volumes/vol5issue1/ijcta2014050121.pdf)

- A **Light Emitting Diode**, which act as a ***communication source***.
- A **silicon photodiode/photo detector** which gives good response to visible wavelength region serving as the ***receiving element.***

IV. Implementation of Li-Fi Technology

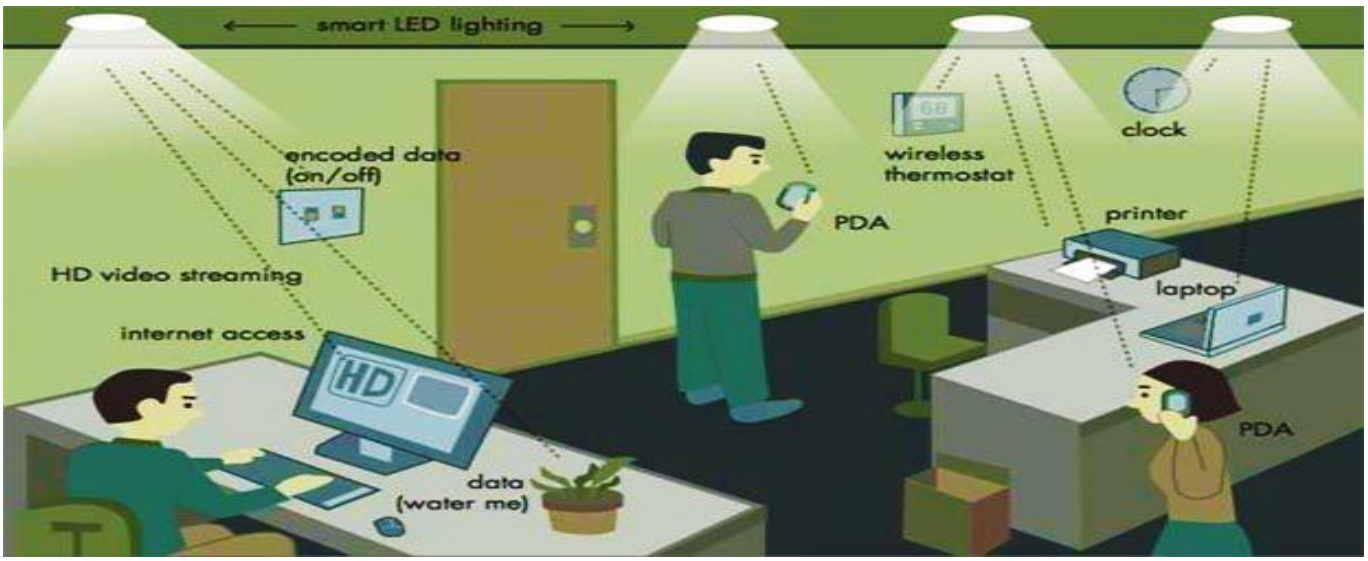

Fig 2: Li-Fi system connecting devices in a room
(Source:http://ijariie.com/AdminUploadPdf/Review_Paper_on_Li_Fi__Light_Fidelity__ijariie2056.pdf)

V. Advantages of Li-Fi Technology

- **Efficiency:** Li-Fi works on visible light technology. As homes and offices have already LED bulbs for lighting purposes, the same source of light can be used to transmit data. Hence, it is very competent in terms of costs as well as energy. Light must be on to broadcast data, so when there is no need for light, it can be reduced to a point where it appears off to human eye, but is actually still on and working.
- **Availability:** Wherever there is a light source, there can be Internet. Lights are accessible everywhere – in homes, workplaces, shops, shopping centers and planes.
- **Security:** Li-Fi Internet is available only to the users within a room and cannot be breached by users sitting in other rooms or buildings as the light cannot penetrate through the walls.
- **Speed**: Li-Fi provides higher speeds in transmitting and receiving data than Wi-Fi Technology as it has 10000 times the frequency spectrum of radio. Its speed will be about 100 times of the speed of Wi-Fi.
- Prevents piggybacking.
- Eliminates neighboring network interference.
- Unimpeded by radio interference.
- Li-Fi does not create interference in susceptible electronics, making it better for use in environments like hospitals and aircraft.
- It is environmental friendly.

VI. Disadvantages of Li-Fi Technology

- Internet cannot be used without a light source.
- As Li-Fi uses visible light for data transmission, and light cannot penetrate walls, the signal's range is limited by physical barriers.In other words a Li-Fi enabled system will require line of sight and that is a big challenge[3].
- One of the biggest potential drawbacks of Li-Fi is the interception of signals outdoors. The interferences from outdoor light sources like sun, light, normal bulbs, opaque materials.
- One weakness is that how the receiving device will transmit back to transmitter.
- High installation cost of the VLC systems.
- Wastage of energy as light will have to be kept on, even when not needed for lighting purposes.

VII.Need of Li-Fi technology

The present Wi-Fi technology is based on radio waves which form a small part of the electromagnetic spectrum and hence, such a fixed small bandwidth cannot provide a fast, safe and secure system for the transfer of such a huge amount of data that is increasing day by day due to the increasing penetration of the internet in the so far un served remote areas. Li-Fi however, is a technology that is complementary to the Wi-Fi technology and is about 100 times more faster than Wi-Fi and can be even used at places like in the nearby areas of nuclear power plants .It is more secure and safe .Li-Fi will add the so far unutilized bandwidth of the visible light to the currently available radio waves and thus, can share the burden of the over -loaded Wi-Fi system. It is thus a new way for optimum utilization of our already limited electromagnetic spectrum.

VIII. Applications of Li-Fi Technology

Security

In a conference room environment, the access area of each channel is the width of the light pool, and can be accessed by multiple users. Each and every user can receive higher data rates than would be the case for an equivalent Wi-Fi channel. In the Wi-Fi case, each user or group of users directly competes for higher speed and more access to bandwidth[3].The net result is that the more connections there are, the slower the download speeds are for all. As in the case of Li-Fi, with its larger number of available access points/ LED Lamp drivers, each Lamp Driver provides full channel data rates with fewer simultaneous users. In addition to it the light does not pass through the walls. Consequently, with less protection to avoid leakage from windows, etc., security is basically enhanced as compared with Wi-Fi.

Dense urban environments

Dense urban environments by their natural world tend to have complete artificial lighting coverage. This lighting transportation can present always available high data rate access for users as they move through that environment[3]. For example, along a railway station, restaurant corridor or reception hall a large number of users can accept high data rate downloads at any point.

Besides, high speed wireless data would be accessible in every room since the light waves do not propagate through walls. This will achieve fully interference free wireless communication, and spectrum does not have to be shared among a large number of users in the rooms.

Cellular communication
In outside environments of urban cities, the use of Li-Fi enabled street lamps would provide a greater network of internet access points. In cellular communication, the space between radio base stations has come down to about 200-500 metres. So, as an alternative of installing new radio base stations in our cities, street lamps could provide both, lighting during night, and high speed data communication [4]. An additional cost benefit occurs in installing new radio base stations usually comes with huge cost for installation and site lease.

EMI sensitive environments
On airplane, Li-Fi empowered solar lighting will distribute high information rate availability for every traveler. It will permit network constantly, without making electromagnetic impedance (EMI) with sensitive radio gear on the flight deck. The lessening in wiring prerequisite likewise implies a lighter aircraft.

Augmented reality
Shows in exhibition halls and displays are enlightened with particular lighting. Li-Fi empowered lighting can give confined data inside that light[4]. This implies a visitor's camera or cell phone can be utilized to download additional data with respect to the question being seen from the light that enlightens the display.

Localized advertising
By utilizing shop display lighting as a Li-Fi communicate channel, it is conceivable to transmit promoting data on the products being seen, and in addition some exceptional offers and coupons.

Underwater communication
With the use of Light waves it is possible to communicate for larger distance under water instead of radio waves which are quickly absorbed in water, preventing underwater radio communications. Therefore, Li-Fi can enable communication under the water with higher speeds without any interference.

Safety of environments
In explosion and hazard prone environments, the utilization of electrical hardware, including cell phones, is for the most part enormously confined. The utilization of Li-Fi to pass information will improve the setup of information arrangement in such conditions, and can empower new frameworks to upgrade security in these environments.

Intelligent transportation systems
Auto headlights and tail lights are consistently being replaced with LED variants. With the utilization of Li-Fi, the vehicle to-vehicle communication is achievable thus allowing improvement of anti-collision systems and exchange of information on driving conditions between vehicles[5]. This will make it possible for vehicle transportation systems to download information from the network and have real time information on optimal routes to take, and update the network regarding conditions recently experienced by individual vehicles.

Connectivity
Our homes as of now have lighting widely installed. The utilization of Li-Fi gives power to lighting will change the applications that can be imagined, not just the interconnection of gadgets, for example, TVs, PCs and Hi-Fi, but in addition interfacing common local apparatuses, for example; refrigerators, clothes washers, microwaves and vacuums.

Sensitive data
Hospitals are a particular instance of an environment where both EMI affectability and security of information are issues [6]. Li-Fi can empower the better organization of securely arranged medicinal instruments, patients' records, and so forth.

Indoor navigation

By distinguishing each light, it is conceivable to provide a smart means of navigating through urban environments. The distinguishing proof of each code would be connected to a particular area [7]. For instance, light got from the nearest apparatus can demonstrate to a mobile user their correct position as they go along a corridor.

IX. Li-Fi Enabled Solar Panels

When we consider a developed nation, rapid industrialization turns out to be the backbone of the economy. Internet is the building block for giving opportunities to the majority of the rural population of India to make contributions in the development of nation.

Digital India is one such celebrated and much discussed programme of Indian Government that focuses on internet penetration in the remotest corners of India. The programme as stated by its official website "is a flagship programme of the Government of India that aims at transforming India into a digitally empowered society and knowledge economy".

Since electricity is yet a privilege in most of the rural parts of the country, it is not feasible to provide broadband access to each and every one. Moreover in India a village is deemed to be electrified if at least 10 percent of the total number of households and some public places are electrified.

It means providing first the electricity access and then focusing on internet access is not economically viable. we thus need a technology or an idea that is economically viable. The GOI under its UJALA scheme has provided LED bulbs to the households and so Li-Fi becomes a cost effective means of achieving the stated goals of digital India [8].

Li-Fi is a bidirectional, fast and completely optical wireless communications (OWC) technology; similar to Wi-Fi [9]. The improvement by the University of Edinburgh's Li-Fi R&D Center uses a solar panel to get rapid Li-Fi transmitted information while additionally creating electrical power for the operation of the capacity.

"IoT" stands for Internet of Things – an agreement of physical items installed with electronics, software, sensors and network connectivity empowering these gadgets to gather and trade information.. The range of objects is vast; for example, a refrigerator could communicate what food items need to be purchased. Watches could be powered and connected to the internet through light.In addition to this GOI can also launch a similar programme to provide solar panels to each household for energy harvesting. These solar panels can then be used as receivers in Li-Fi technology as said by Harald Hass in an interview with **livemint** last year.

The advantages of using solar panels as means of both sustainable power and internet penetration are:

I. **One Time Investment:** Solar panel need one time investment and then can be used for years and all one needs is installation of solar panel and then continuous exploitation of solar energy for years to come. Now think of a chip which can make the same panel to enable high speed data transfer which will feed on its own energy. Thus the two technologies can be merged to ensure better harvesting at minimum costs.

II. Smart Grams: Like smart cities smart villages can become the reality of day without the need of regulated power supply.

III. Optimum utilization of Electromagnetic Spectrum: The rapid demand of internet and wireless technologies cannot be met only by a limited radio spectrum. Since Li-Fi operates within the visible spectrum it can become an economically viable alternative. It is safe, secure and ensures a larger bandwidth compare to the radio frequency range.

IV. Sustainability: The solar panels use solar energy and are environment friendly. Since the GOI is gradually trying to make a shift towards a green economy, it is the right time to start thinking of merging it with internet penetration.

X. Future Scope

Light is freely available everywhere and thus, Li-Fi can turn every LED bulb in the houses and on the streets into a hotspot for transmitting data. It can be used within the planes, under the water and near the nuclear power plants. It can convert our cities into smart cities and can become the medium of communication between the machines and between human beings and the machines. It can be a harbinger of digital revolution in India. India presently is aspiring to become a digital and cashless economy and Li-Fi has enormous potential to attract the vast population living in remote areas. It can become a cleaner and greener base for delivering public services to the people.

Presently, location based service (LBS) is commercially available and the next step could be a Li-Fi WLAN for business to business (B2B) and mass market [10]. It can also become an alternative to the radio wave based Wi-Fi system after becoming mature.

XI. Conclusion

The idea of Li-Fi Technology is at present focusing a huge deal of interest, not least since it might offer a genuine and very proficient alternative to radio-based wireless. So, this paper concludes that Li-Fi is the best for high density wireless data coverage in comparatively smaller area (covered by a LED bulb) and to sort out issues rising due to radio frequency.

If we implement Li-Fi technology instead of Wi-Fi Technology, each and every bulb can be used as a Wi-Fi hotspot through which we can transmit data to multiple users at very high speed and it becomes feasible to keep our environment clean, green and safe. Although Li-Fi has various advantages but it cannot be thought as a replacement of technology using radio frequency as light used in this technology cannot be passed through obstacles.

It has a better opportunity to replace the existing Wi-Fi Technology with the latest and emerging Li-Fi Technology to get a reliable, high-speed signal. This idea can resolve a huge number of issues such as the shortage of radio-frequency bandwidth and boot out the disadvantages of Wi-Fi. Li-Fi is one of the latest emerging technologies acting as competent for various other developing and already invented technologies.

Li-Fi Technology in combination with solar panels as receivers offer solutions that could deliver communications and access to the world wide web in a way that the current free space optical (FSO) system on their own cannot do. The use of Li-Fi to control manufacturing processes has enormous potential for introducing efficiencies into existing manufacturing environments as well as the introduction of new 'Smart Li-Fi enabled' robotics and instrumentation. Li-Fi can deliver great advances in both of these diverse application areas. Digital India is one such celebrated and much discussed programme of Indian Government that focuses on internet penetration in the remotest corners of India. India presently is aspiring to become a digital and cashless economy and Li-Fi has enormous potential to attract the vast population living in remote areas. Li-Fi enabled Solar panels can become a cleaner and greener base for delivering public services to the people. Thus Li-Fi becomes a cost effective means of achieving the stated goals of digital India.

References

[1] E. Sarbazi, M. Uysal, M. Abdallah, K. Qaraqe, "Ray tracing based channel modeling for visible light communications", Proc. 22nd Signal Process. Commun. Appl. Conf., pp. 702-705, Apr. 2014.

[2] J. M. Kahn, J. R. Barry, "Wireless infrared communications", Proc. IEEE, vol. 85, no. 2, pp. 265-298, Feb. 1997.

[3] R.R.Sharma, Sanganal, A., Pati, S. (2014). Implementation of a Simple Li-Fi Based System, International Journal of Computing and Technology (IJCAT), Vol. 1 Issue 9, October 2014

[4] S. Chatterjee, Shalabh Agarwal, Asoke Nath, "scope and Challenges in Light Fidelity(Li-Fi)Technology in Wireless Data Communication", International Journal of Innovative Research in Advanced Engineering(IJIRAE), Issue 6, Vol 2, Page 1-9,(June 2015).

[5] S. Dimitrov, H. Haas, "Information rate of OFDM-based optical wireless communication systems with nonlinear distortion", IEEE J. Lightw. Technol., vol. 31, no. 6, pp. 918-929, Mar. 2013

[6] S. Dimitrov, H. Haas, Principles of LED Light Communications: Towards Networked Li-Fi, Cambridge, U.K.:Cambridge Univ. Press, Mar. 2015

[7] S. Rajagopal, R. Roberts, S.-K. Lim, "IEEE 802.15.7 visible light communication: Modulation schemes and dimming support", IEEE Commun. Mag., vol. 50, no. 3, pp. 72-82, Mar. 2012.

[8] S. Vinay Kumar, K. Sudhakar, L. Sudha Rani . Emerging Technology Li-Fi over Wi-Fi ,International Journal of Inventive Engineering and Sciences (IJIES), Vol. 2 Issue 3, February 2014

[9] Annlin Jeba S.V., Gnana King D.R, Combining Trust with Authentication Information for routing in wireless Sensor Networks, International journal of Scientific research in Network security and Communication, Vol.6, Issue.5, pp.38-46, Oct-2018

[10] Akram Waseem, A Study on Positive and Negative Effects of Social Media on Society, International Journal of Computer Science and Engineering, Vol.**5**(**10**), pp: **347-354,** Oct **2017**

