A VISIBLE LIGHT COMMUNICATION FOR SMART FACTORY USING LI-FI TECHNOLOGY

Iswarya Lakshmi Priya.A[1] | Kowsalya Kumar.V[2] | Anand.S[3] | Athithya.B[4]
[1](Dept of ECE, Anna University, Chennai, India, aishlakshpriya@gmail.com)
[2](Dept of ECE, Anna University, Chennai, India, kowsalyakumar95@gmail.com)
[3](Dept of ECE, Anna University, Chennai, India)
[4](Dept of ECE, Anna University, Chennai, India)

Abstract*—In recent years, wireless networks and applications have achieved great successes in government, enterprise, home, and personal communication systems. The desired features of wireless communications draw lots of attention to the industrial communication and expected to bring benefits such as reduce deployment and maintenance after employed. However, the industrial communication system required real-time communication, which means the control systems in the factory are required accurate control and rapid communication, such as the industrial motion control system. In this type of application, the communication system performance and efficiency will be evaluated to ensure it applicable to the industrial network. However, there are a few original issues in the wireless communication, such as fading, multipath propagation and interference problems which will affect the reliability and performance of industrial communication system operation. Therefore, we proposed a connection protection mechanism that cooperates with wireless network and visible light communication to achieve reliability and performance in industrial communication network. We will consider implementing this mechanism by using industrial wireless Ethernet in the near future.*

Keywords—Smart Factory; Internet-of-Things; Visible Light Communication; Wireless Networking; Industrial Communication Network

1. INTRODUCTION

Harald Haas was coined the term LI-FI and promoted LI-FI in his 2011 TED Global talk by giving demonstration of an LED light bulb to transmit a video with the speed more than 10 Mbps. German scientists succeeded in 2011 to creating an800Mbps (Megabits per second) capable wireless network by using nothing more than normal red, blue, green and white LED light bulbs, thus the idea has been around for a while and various other global teams are also exploring the possibilities. In simple terms, LI-FI can be thought of as a WI-FI based on light as it uses light instead of radio waves to transmit information. Instead of WI-FI modems or routers, LI-FI uses transceiver-fitted LED lamps that can be used as a light or for transmission of the data communication through internet [4]. This technology uses a visible light communication spectrum and has not major ill effect as we know that the light is very much part of our life. Moreover in this spectrum 10,000 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 [3][5].

A. Working Technology

LI-FI is implemented using white LED light bulbs which used for illumination by applying a constant current. However, by fast variations of the current, the light output can be made to vary at extremely high speeds. If the LED is on, it transmits a digital 1otherwise it transmits a digital 0. The LEDs can be switched on and off quickly to transmit the data that can't be detected by a human eye [7].

There are also some enhancement could be made, like using an array of LEDs for parallel transmission, or using amalgamation of basic three colors i.e., red, green, and blue LEDs as different frequency with each having a different data channel. To further get a grasp of LI-FI consider an IR remote. It sends a single data stream with 10–20 kbps speed. Now if we replace the IR LED with a large LED array then that can be capable of sending thousands of such streams ata very fast rate.

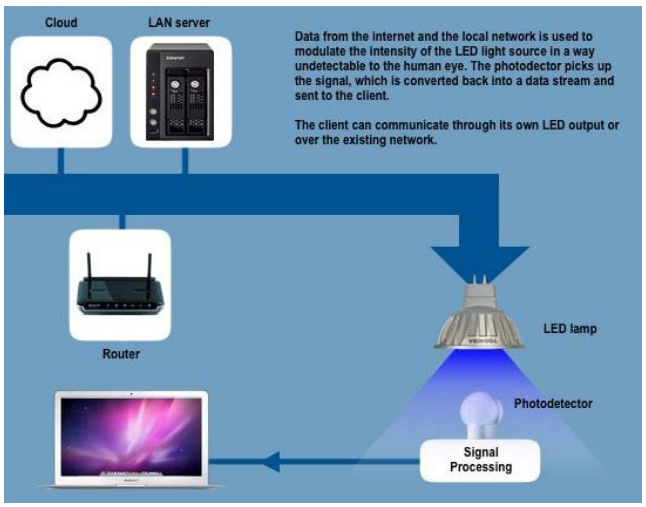

Fig. 1.1 Working principle of Li-Fi

B. Data Transmission using Li-Fi

This system, Fig. 1.2 is capable of sending thousands of such streams at very fast rate. Light is inherently safe and can be used in places where radio frequency communication is often deemed problematic, such as in aircraft cabins or hospitals. So Visible Light Communication (VLC) not only has the potential to solve the problem of lack of spectrum space, but can also enable novel application. The visible light spectrum is unused. It's not regulated, and can be used

for communication at very high speeds. The University of Strathclyde in the UK has created a research center aimed at turning the constant flicker of LED lights into a way to transmit internet communications using visible light, as opposed to radio waves (Wi-Fi, cellular) or via cables.

Li-Fi is the use of light-emitting diodes (LEDs), a rapidly spreading lighting technology which is expected to become dominant over the next 20 years. Imperceptibly, LEDs flicker on and off thousands of times a second: by altering the length of the flickers, it is possible to send digital information to specially-adapted PCs and other electronic devices, making Li-Fi the digital equivalent of Morse code.

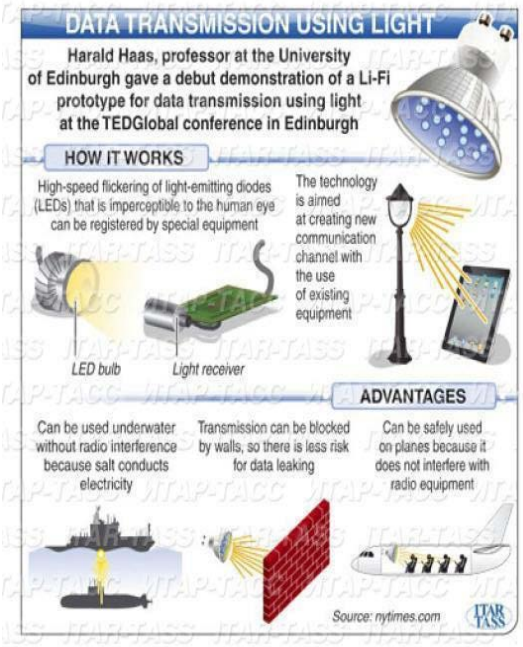

Fig. 1.2 How Li-Fi works

This would make them easier for the electromagnetic spectrum available for internet communications, easing pressure on the increasingly crowded parts of the spectrum currently being used. Instead of researching Li-Fi LEDs around 1mm2 in size, the EPSRC-funded team is developing tiny, micron-sized LEDs which are able to flicker on and off 1000 times quicker than the larger LEDs. This would allow them.

2. VISIBLE LIGHT COMMUNICATION

VLC 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. Fast pulses are used for wireless transmission. Communication system components are:

- A high brightness white LED which acts as a communication source.
- Silicon photo diode which shows good response to visible wavelength region.

LED illumination can be used as a communication source by modulating the LED light with the data signal. The LED light appears constant to the human eye due to the fast flickering rate. The high data rate can be achieved by using high speed LEDs and appropriate multiplexing techniques. Each LED transmits at a different data rate which can be increased by parallel data transmission using LED arrays. Many different reasons exist for the usage of LED light in spite of fluorescent lamp, incandescent bulb etc which are available. Visible light does not penetrate thick materials such as walls and partitions, which can be a security advantage. Visible light usually poses no health hazards to human body and eyes. Visible light also has many advantages over infrared communication technologies.

Visible light can be literally visible so that human notices where the data is transmitted from. In addition, since LED lighting has recently become part of a building infrastructure, making visible light communication infrastructure is fairly easy by adding communication function to LED lighting.

3. COMPARISON BETWEEN LI-FI AND WI-FI

Li-Fi is the name given to describe visible light communication technology applied to obtain high speed wireless communication. It derived this name by virtue of the similarity to Wi-Fi. Wi-Fi works well for general wireless coverage within buildings, and Li-Fi is ideal for high density wireless data coverage inside a confined area or room and for relieving radio interference issues. It shows a comparison of transfer speed of various wireless technologies and comparison of various technologies that are used for connecting to the end user. Wi-Fi currently offers high data rates.

A. Disadvantages of Wi-Fi

The following are the basic issues with radio waves:

Capacity: Wireless data is transmitted through radio waves which are limited and expensive. It has a limited bandwidth. With the rapidly growing world and development of technologies like 3G, 4G and soon we are running out of spectrum.

Efficiency: There are 1.4 million cellular radio base stations that consume massive amount of energy. Most of the energy is used for cooling down the base station instead of transmission. Therefore efficiency of such base stations is only 5%.

Availability: Availability of radio waves is a big concern. It is not advisable to use mobile phones in aero planes and at places like petrochemical plants and petrol pumps.

Security: Radio waves can penetrate through walls. They can be intercepted. If someone has knowledge and bad intentions, they may misuse it. This causes a major security concern for Wi-Fi.

B. Advantages of Li-Fi

Some of the future applications of Li-Fi are as follows:

1) Education systems:

Li-Fi is the latest technology that can provide fastest speed internet access. So, it can replace Wi-Fi at educational institutions and at companies so that all the

people can make use of Li-Fi with the same speed intended in a particular area.

2) Medical Applications:

Operation theatres (OTs) do not allow Wi-Fi due to radiation concerns. Usage of Wi-Fi at hospitals interferes with the mobile and PC which blocks the signals for monitoring equipment's. So, it may be hazardous to the patient's health.

3) Cheaper Internet in Aircrafts:

The passengers travelling in aircrafts get access to low speed internet at a very high rate. Also Wi-Fi is not used because it may interfere with the navigational systems of the pilots.

4) Underwater applications:

Underwater ROVs (Remotely Operated Vehicles) operate from large cables that supply their power and allow them to receive signals from their pilots above.

5) Disaster management:

Li-Fi can be used as a powerful means of communication in times of disaster such as earthquake or hurricanes. The average people may not know the protocols during such disasters. Subway stations and tunnels, common dead zones for most emergency communications, pose no obstruction for Li-Fi.

6) Applications in sensitive areas:

Power plants need fast, inter-connected data systems so that demand, grid integrity and core temperature (in case of nuclear power plants) can be monitored.

- **Capacity**: Light has 10,000 times wider bandwidth than radio waves. Also, light sources are already installed. So, Li-Fi has got better capacity and also the equipment are already available.
- **Efficiency**: Data transmission using Li-Fi is very cheap. LED lights consume less energy and are highly efficient.
- **Availability**: Availability is not issues as light sources are present everywhere. There are billions of light bulbs worldwide; they just need to be replaced with LEDs for proper transmission of data.
- **Security**: Light waves do not penetrate through walls. So, they can't be intercepted and misused. With the advent of Li-Fi, now it is not mandatory to be in a region that is Wi-Fi enabled to have access to the internet. One can simply stand under any form of light and surf the internet as the connection is made if light is present.

4. APPLICATIONS

Applications of Li-Fi can extend in areas where the Wi-Fi technology lacks its presence like medical technology, power plants and various other areas. Since Li-Fi uses just the light, it can be used safely in aircrafts and hospitals where Wi-Fi is banned because they are prone to interfere with the radio waves. All the street lamps can be transferred to Li-Fi lamps to transfer data. As a result of it, it will be possible to access radiation types are bad for sensitive areas surrounding the power plants. Li-Fi could offer safe, abundant connectivity for all areas of these sensitive locations. This can save money as compared to the currently implemented solutions. Li-Fi can also be used in petroleum or chemical plants where other transmission or frequencies could be hazardous.

A. Replacement for other technologies:

Li-Fi doesn't work using radio waves. So, it can be easily used in the places where Bluetooth, infrared, Wi-Fi, etc. are banned.

B. Traffic management:

In traffic signals Li-Fi can be used which will communicate with the LED lights of the cars which can help in managing the traffic in a better manner and the accident numbers can be decreased. Also, LED car lights can alert drivers when other vehicles are too close.

5. CONCLUSION

If LI-FI technology can be put into practical use, every bulb used to transmit a data and will lead toward the cleaner, greener, safer and brighter future. LI-FI may solve issues such as the shortage of radio-frequency bandwidth and is aimed at creating new communication channels with the use of existing equipment. Currently, the LI-FI concept is attracting a great deal of interest, because it provides an authentic and very efficient alternative to wireless device which used radio spectrum.

6. REFERENCES

[1] N. Kumar, D. Terra, N. Lourenço, L. N. Alves, and R. L. Aguiar, "Visible light communication for intelligent transportationin road safety applications," Proc. 7th Int. Wireless Commun.Mobile Comput. Conf,pp. 1513-1518,2011.

[2] J. Rani, P. Chauhan, and R. Tripathi, "Li-Fi (LightFidelity)-the future technology in wireless communication," International Journal of Applied EngineeringResearch, vol. 7No.11,ISSN 0973-4562,2012

[3] W. Jia-yuan, Z. Nian-yu, W. Dong, I. Kentaro, I. Zensei,and N. Yoshinori, "Experimental study on visiblelight communication based on LED," The Journal of ChinaUniversities of Posts and Telecommunication,vol. 19,Supplement 2,Jan 2012.

[4] M. Goyal, D. Saproo,and A. Bhagashra, "New epoch of wireless communication: light fidelity," International Journal ofInnovative Research in Computer and Communication Engineering,Vol. 1, Issue 2, ISSN (Print): 2320-9798, ISSN (Online): 2320–9801, Jan 2012

[5] J. K. Kim and E. F. Schubert, "Transcending the replacementparadigm of solid-state lighting," Opt. Exp., vol. 16, no. 26, pp. 21835–21 837, Dec. 2008.

[6] J. Park, "Speedup of dynamic response of organic light-emittingdiodes," J. Lightw. Technol., vol. 28, no. 19, pp. 2873–2880, Oct.2010.

[7] Ian Lim, "Li-fi Internet at the speed of light," vol. 2, no. 1, pp.1–39,2011.