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Li-Fi Based A New Home Automation System

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Abstract — *This paper presents a design and system implementation of new home automation system that uses Li-Fi technology as a network infrastructure. The proposed system consists of two main components; the first part is the web server, which presents core that controls, manages and monitors users home. The Users and administrator can locally or remotely manages and controls system code. The next part is hardware interface module, which provides appropriate interface between the sensors and the actuator of home automation system. Unlike most of existing home automation system in the market, the proposed one is scalable that a server can manage many hardware interface modules as long as it exists on Li-Fi network coverage. The proposed system is scalable, flexible and low of cost than the commercially available home automation systems.*

Keywords— *Home automation, Optical Wireless LAN, Li-Fi, Micro-Controllers.*

I. INTRODUCTION

The light-emitting diodes act as a medium for Light based communication system to high speed Li-Fi or Light Fidelity refers to 5G visible communication in a similar manner as Wi-Fi. Nowadays where internet has become a major demand, all are in search of Wi-Fi hotspots. Li-Fi, the Life of data communication is the best alternative to Wi-Fi in wireless communication. This paper is about a survey on Li-Fi Technology. In visible regions, it has more capacity in terms of bandwidth, so it will not stab the nose for other communication which uses RF (radio frequency) range, without taking its frequency bands. It is thousand times faster than Wi-Fi and provides high security as the visible light cannot penetrate through the walls of the home, which leads to a new generation of optical wireless communication [2]. The concept of Li-Fi data communication on fast flickering of light is not detected by the eye of human, but it is detected on a photo detector which is used to convert the on and off state into binary digital data such as 0's and 1's.

II. Li-Fi

Li-Fi using visible light instead of gigahertz radio waves. Nowadays approximately 5 million mobile phones are transmitted higher than 600 terabytes of data in every month and currently there are 1.4 billion base station available that inherent more energy and there should be less than 5 percent of efficiency, this all explains that usage of wireless has been achieved maximum utility. It is free of wires and there will be no box installed as Wi-Fi. The binary numbers should be transmitted into light pulse. It can be through tiny LED bulbs on and off a million of times per second. The explorers of data transmission through blinking of LED which translates upto 10 Gbps with the help of wireless internet [10] . These gain come at a five-fold transits currently offering fiber optics, Luminous router is used to get the maximum gain of this technology, that have the capacity to emit the binary signals. Li-Fi is not visible to eye so it won't ever replace Wi-Fi, but it could overcome it nicely. It will be very easy in our house where every light will act as a wireless network bridge, instead of trying to find the perfect Wi-Fi router.

A. Construction Of Li-Fi System

Compared to Wi-Fi, Li-Fi is a cheap and fast optical technology. Visible Light Communication (VLC) is the basis for Li-Fi. VLC is a data communication media, which depends on visible light between 400 THz (780 nm) - 800 THz (375 nm). It acts as an optical carrier for data transmission and illumination which uses fast signals of light for transmission without wires.

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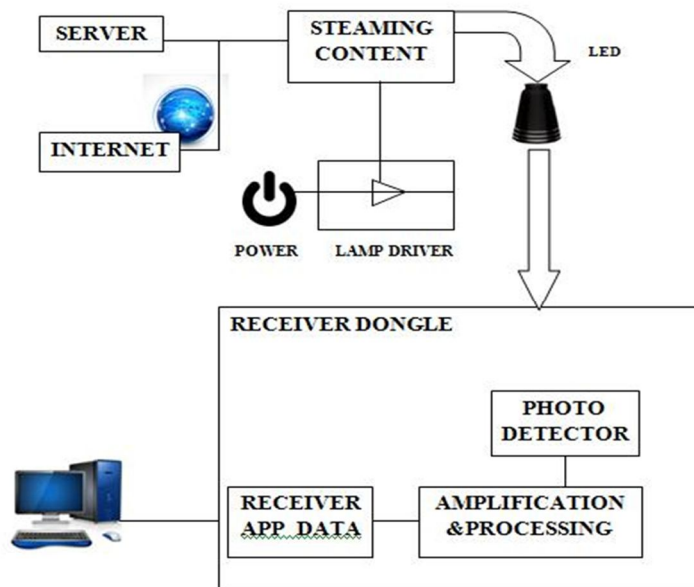


Figure 1.1 System Architecture

The major components of Li-Fi system are as follows: The transmission source for Li-Fi is the high brightness LED (white). b) A silicon photodiode with proper response to visible light as the receiving node. LEDs can be switched on and off to produce digital strings of different combination of 1s and 0s. To produce a new data stream, data can be encoded in the light by changing the flickering rate of the LED. The lamps can be used as a sender or source, by transmitting the data with the LED light as a signal. The LED results as a constant to the human eye by virtue of the fast flickering rate of the LED [1]. Normal communication rate greater than 100 Mbps is possible by using multiplexing techniques with the help of high speed LEDs and the VLC data transfer rate can be raised by parallel data transmission with the help of LED(array manner) in which tie every LED sends the various data sets. The Li-Fi emitter system consists of four basic sub connections a) Bulb b) RF power amplifier circuit (PA c) The electrical inputs and outputs of the PCB controls will be enclosed and the various lamp functions should be managed by the microcontroller. The solid-state PA is used to generate the RF(radio-frequency) and with the it is processed into the electrical field . In the bulb center, the contents of the bulb will be vaporizing into the plasma state with the help of maximum concentration energy in the electrical field.

B. Comparison between Li-Fi & Wi-Fi

Li-Fi is the name given to high speed wireless communication, where visible light plays a vital role. The name is derived from similarity to Wi-Fi. Wi-Fi works well within buildings, [6] and Li-Fi is unique for high density data coverage areas or rooms and for avoiding radio interference issues. Table 1.1 shows a comparison of Wi-Fi and Li-Fi technologies that are used for connecting the end users. Wi-Fi provides higher data rates, IEEE 802.11.n in maximum implementations which provides up to 150Mbps practically, but the speed is low.

C. Problems in Wi-Fi

The basic issues with radio signals are given as follows:

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Characteristics	Wi-Fi	Li-Fi
Frequency	2.4 Ghz-5Ghz	No Frequency for light
Range	100 meters	Based on LED light falling
Primary application	WLAN	Where ever light is available
Data transfer rate	11 Mbps	>1 Gbps
Power consumption	Medium	Medium
Cost	Medium	Low
Security	Medium secure	High Secure
Primary devices	Notebook computers, desktop computers, servers, latest mobiles, iPods, etc.	Mobile phones, PDAs, consumer electronics, office and industrial automation devices, Notebook computers, desktop computers, servers, latest mobiles, iPods, and other latest devices with Li-Fi.
Primary users	Corporate campus user and homes, flats, public places.	Travelling employees, corporate campus users and home, flats, public places and industrial areas, power plants, hospitals.
Usage location	Within range of WAN infrastructures, usually inside the building	Anywhere where light is available like roads, public places, home, office, etc.
Standard	IEEE 802.11b	IEEE 802.15
Operating band	RF band	Visible light band
Maximum members	Number of devices connected depends on bandwidth availability	Number of receivers present under light.
Development started	1990	2011
Working concept	Various topologies	Direct binary data serving

Table A: Comparison between Wi-Fi and Li-Fi

1) *Capacity*: Wireless data is transmitted through radio waves which are short and high of cost. In a rapidly developing world, and also the developing technologies like 3G and 4G, it have only the limited bandwidth. we are running out of spectrum.

2) *Efficiency*: There are 1.4 million mobile radio base stations that consume maximum energy. This energy is used for cooling process for the base station instead of transmission. Therefore efficiency of such stations is only 5%.

3) *Availability*: Availability of radio waves is a big thing. In aero planes and the places like petrol pumps and petrochemical plants, the mobile can't be able to use, because it is not safe at all.

4) *Security*: Radio waves can pass through walls and can be intercepted. If somebody has knowledge and bad intentions, they can misuse easily. This causes a main security concern for Wi-Fi.

5) *Advantages of Li-Fi*: For transferring the data, the Li-Fi usually uses the LED or some other light sources. The transfer of the data can be possible with the help of light, no matter which part of the spectrum they belong. The ultraviolet, the visible or invisible part of the spectrum are fits in light [5]. The speed of the communication is more sufficient for download of movies, games, music and all in fraction of time.

a) *Capacity*: Compared to radio signals, the bandwidth of light is 10000 time wider. The light sources are already installed so that Li-Fi has got best capacity and the equipments are already available.

b) *Efficiency*: The data transmission using Li-Fi is very cheap, less energy and highly efficient.

c) *Availability*: All over the place, the light source is present so availability is not an issue. In worldwide there will be numerous light bulbs available and they are needed to be replaced with LEDs for proper transmission of data.

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d) *Security*: Light waves do not penetrate through walls and they can't be intercepted and misused. With the help of Li-Fi, it is not mandatory to be in a region that is Wi-Fi enabled to have connected to the internet. So anyone standing under any form of light can browse the internet as the connection is made with the help of lights.

6) *Disadvantages of Li-Fi*: One of the major demerits of this technology is that, In walls, the artificial light can't be able to penetrate, and also some of the opaque materials in which the radio waves can do[2]. The Li-Fi permitted end device is not as quick and handy as the Wi-Fi permitted devices which operates in the open air. In direct line of sight only Li-Fi works which is also one of the shortcomings, Still, Li-Fi could emerge as a boon to the rapidly exhausting bandwidth of radio waves. This is the first choice for access the internet at low cost in a confined room.

III. APPLICATIONS OF LI-FI

There are numerous applications for Li-fi technology from internet access through street lamps to automatic cars, which can able to connect the network through these street lamps. Li-Fi is the absolute solution for the power plants, medical technology and some other domains, in which the Wi-Fi is not suitable thing. The Wi-Fi is restricted in hospitals and aircrafts, because they prone to interfere with the radio frequencies, in that areas the Li-Fi should be used safely[3]. All the street lights can be transferred to Li-Fi LEDs to transfer data. As a result, it will be possible to access internet at any public areas. The upcoming applications of Li-Fi is as follows

A. *Education systems*

Li-Fi is the latest technology that can provide faster speed internet access than Wi-Fi. It can be widely implemented at educational institutions and companies so that all the people can make use of Li-Fi with the same speed used in a particular area.

B. *Medical Applications*

Due to radiations of Wi-Fi, it does not allowed in operation theatres. Use of Wi-Fi at hospitals mainly mobiles and pc which blocks the signals for monitoring devices which leads to hazardous conditions to the patient's health. To resolve this condition, OT tech savvy Li-Fi can be used to accessing internet and to control medical functions. For robotic surgery and other automated procedures, this technology is more useful.

C. *Cheaper Internet in Aircrafts*

In aircrafts, the passengers who are travelling will able access only the low speed of internet access frequently. Normally in aircrafts, the Wi-Fi is not used, because in navigational system it gets to interfered. Here Li-Fi can be used for data transmission where it easily provides high speed internet via every light source such as overhead reading bulbs etc. available in the aircraft

D. *Underwater applications*

To obtain the signals from pilots over surface, the underwater ROV (Remotely Operated Vehicles) with the help of large cables. But the tether is not long enough to allow them to explore larger areas. So their wires were replaced with submerged, high-powered light then they would be much freer to explore. They could also use their headlights to communicate with each other, processing data allowing and sending their findings periodically rear to the facade. Even when the Wi-Fi fails to work in particular environment the Li-Fi will be used in that surroundings and thereby throwing an endless chance for military operations.

E. *Disaster management*

Li-Fi can be used as a powerful means of communication during disaster such as earthquake or hurricanes. The common people may not know the protocols during such disasters where tunnels and subways, other dead zones for most frequent communications have no obstacles for Li-Fi. Also, for common periods Li-Fi bulbs could provide less expensive and high-speed Web access to every corner.

F. *Applications in sensitive areas*

Grid integrity and core temperature is needed for inter-connected data systems in power stations. Wi-Fi and other frequency radiation types are bad for sensitive places surrounding the power plants. Li-Fi offers safety and enormous connectivity for all sensitive areas. This can save money as compared to the currently implemented projects and also the pressure on a power station's own reserves could be lessened. It can also be used in petrochemical plants where other radiation or transmission of frequencies

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could be hazardous.

G. Traffic management

In traffic signals Li-Fi can be used with the help of LED lamps of the cars which can manages the traffic in a better manner and the rate of accidents occurring can be decreased gradually. The LED lamps in car can alert drivers when other vehicles are too close.

H. Replacement for other technologies

Li-Fi can be easily used in the places where Bluetooth, infrared, Wi-Fi, etc. are banned, because it doesn't use radio waves other than light.

IV. CONCLUSION

In this paper, we discussed about 5G Li-Fi technology, which is an advanced approach on design, also the best design of internet by largely reducing the size of the device which transfers data and implementation by means of more than 1.4 million light bulbs all over the world which can possibly be replaced by such LEDs can provide feasible access. It has a wide range of applications compared to any other networks in various fields. Likewise there are some drawbacks, but can be eliminated by future research works. Li-Fi has provided the next step of invention in the world of communication, it is safe to all species including humans and progressing towards a greener, less expensive and brighter future of technologies. To provide the new way of communication channels with the help of already existing equipment and also to solve the deficiency of radio frequency bandwidth, the LI-FI should be used. For an proficient alternative to wireless device which make use of radio spectrum, this LI-FI concept will attract the great deal of interest.

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