Li-Fi in data communication

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Chapter 1

1. INTRODUCTION

Light Fidelity (Li-Fi) is a technology based on Visual Light Communication (VLC) that uses light emitting diodes (LEDs) to a wireless system completely connected to the network. Allows the electronic device to connect to the Internet without using a cable. To establish a communication line between the node, the Li-Fi device needs a transceiver to transmit and receive data. Li-Fi can be used for various applications, this document focuses on in-depth studies of Li-Fi applications and on their comparison. Different applications that require a Li-Fi communication system are used in hospitals to monitor children, vehicle-vehicle communications, aircraft to provide high-speed Internet, underwater, where radio frequencies (RF) are hard to reach, load balancing and sensitivity areas, in which the radio frequency can be easily disturbed. This document also focuses on how these applications work and how Li-Fi makes a difference when they are not in the picture. Li-Fi is a good replacement for Wi-Fi as technology evolves, technology-related applications are moving forward. Because all technologies have advantages, there are also some disadvantages. This document will discuss the advantages and disadvantages of Li-Fi and where exactly this technology is used in real-time applications and how it helps us improve our lives. Images are shown below because Li-Fi is used in real-world applications.

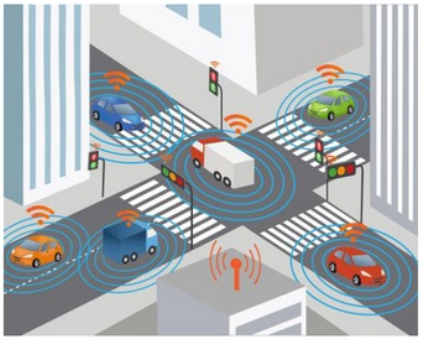


Fig 1.1: Vehicle to Vehicle Communication using Li-Fi

Fig 1.2: Li-Fi in airplanes

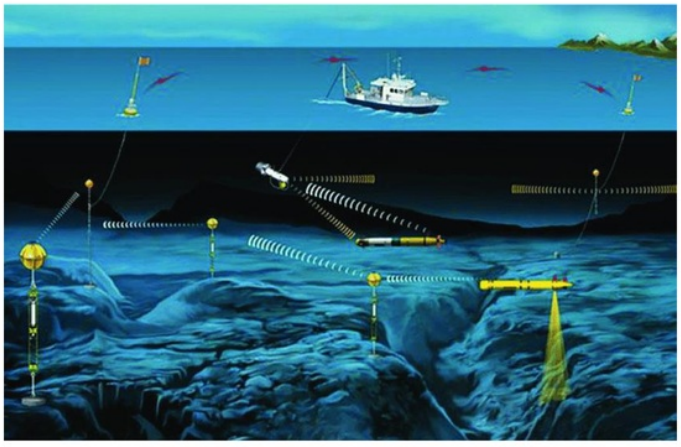


Fig 1.3: Use of Li-Fi Underwater

1.1 What is Li-Fi

According to Figure 1.1.1, Li-Fi technology consists of an LED bulb as a media transmission and a photodetector as a receiver of transmitted information. The lamp driver is required for the LED to function appropriately. While amplification and processing are responsible for managing the signal from the photodetector.

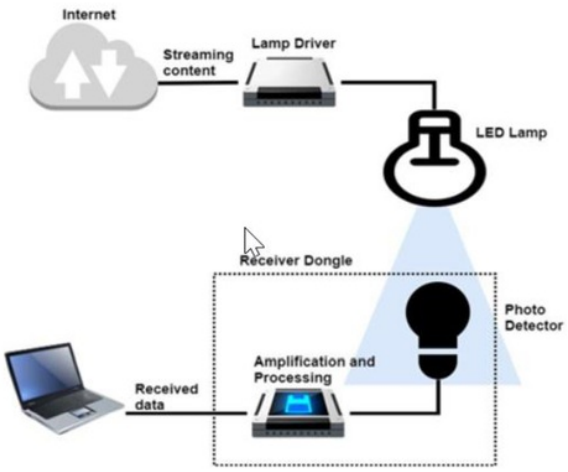


Fig 1.1.1: Basic Concept Diagram Li-Fi

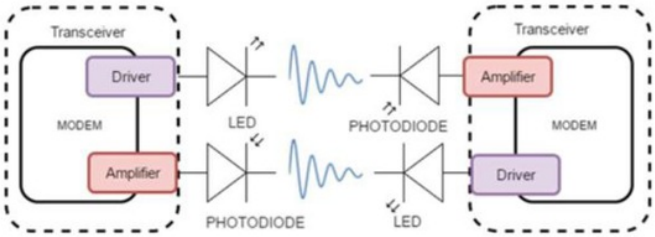


Fig 1.1.2: Transceiver Li-Fi based on Visible Light Communication

The basic concept of operating principle in Li-Fi technology is transceiving and receiving signaling as a multimedia transmission. Figure 1.1.2 is the basic conceptual block diagram for Li-Fi. This basic concept indicates duplex communication. The Li-Fi speed is 14 Gb / s with three available laser diodes (red, blue and green) and provides a speed up to 100 Gbps, when the entire visible spectrum is used. According to Li-Fi and Visible Light Communication (VLC), a medium is used, such as data transfer, which is light. The difference between Li-Fi and VLC is that the VLC has unidirectional point-to-point light communication at low data rates. While Li-Fi technology is completely connected to the network, wireless communication is bi-directional and fast.

1.2 Working of Li-Fi

Li-Fi is a two-way, fast, mobile data transmission network through light. Li-Fi consists of many light bulbs forming a network that is wireless.

When electricity is supplied to the LED, a light current (photons) is emitted from the bulb. LED bulbs are semiconductor devices, which means that the brightness of the light passing through them can be changed at extremely high speeds. This allows us to send a signal that modulates light at different speeds. The signal can be received by a detector that interprets changes in light intensity (signal) as data.

The human eye cannot see the intensity modulation, so communication is as perfect as other radio systems, which allows users to connect to where the Li-Fi lighting is on. Thanks to this technique, data can be sent from a fast LED bulb.

1.3 Problem Statement

The main challenge for existing technologies is low data, transmission speed, high energy consumption and limited bandwidth. Despite continuous improvements in wireless communication systems, e.g. 2G, 3G, 4G etc., an upcoming crisis is expected due to the lack of enough radio frequency resources, this bandwidth limitation cannot support the increase in demand for high data rates and large number of communication systems, in the band from 300 kHz to 4 GHz. This is known as "Spectrum Crunch". Although the spectrum overload is decreasing when higher frequencies are used for data transfer, this is not a practical solution because this part of the spectrum requires complex equipment and creates high-cost systems.

1.4 Limitations of the Current Work

Every technology has negative and positive aspects that are highly important to discuss before implementation. The Li-Fi system will be able to properly function when there is no light. In the sunny day sunlight may interfere in the communication which can lead to the generation of error messages. Also, other light sources, such as light bulbs, may also interrupt the communication.

1.5 Objectives

1. To investigate that Li-Fi is better in vehicle-to-vehicle communication than other existing technologies.
2. To explain how exactly communication between vehicles is carried out using Li-Fi technology.
3. Examination of existing systems and comparison with Li-Fi technology.

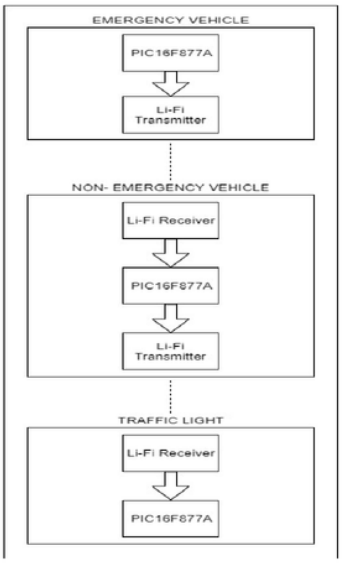
Chapter 2

2. LITERATURE SURVEY

1.

Implementation

An emergency vehicle consists of a Li-Fi transmitter that is implemented using its lighthouse. When entering a traffic-congested lane, it issues a warning message as "EMERGENCY VEHICLE". If there is a non-emergency vehicle in front of it, the non-emergency vehicle transceiver will receive the alarm message. When the non-emergency vehicle receives the warning message, the vehicle driver will be informed using the vehicle's infotainment system. At the same time, it will transmit the warning message to a vehicle, if it is present in the front or to the road sign control. The signal control, after receiving the warning message, will turn green. The warning message can be skipped through any number of vehicles until it reaches road sign control. Therefore, despite the length of the traffic, the warning message will reach the traffic signal control in a short period of time.



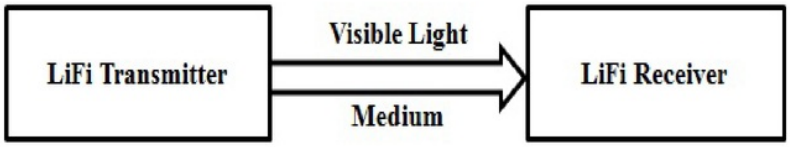
Limitations

1. The vehicle head and tail lights need to be kept ON even during the day for Li-Fi to work but the intensity can be maintained at a minimum level.
2. Li-Fi works efficiently when the transmitter and receiver are placed in Line of Sight. Any deviation from this position can lead to miscommunication.
3. During the day, intense sunlight may interfere in Li-Fi communication. Also, other light sources, such as normal light bulbs, may also interrupt the communication.

2.

Implementation

The proposed system comprises a transmitter and a receiver section. The background lights of vehicle A act as a transmitter and send pulses of 0 and 1. The flashing of the LEDs must be performed very quickly so that it cannot be visualized by the human eye. A photodiode placed in front of vehicle B receives the data transmitted in the form of current. The system is applicable to the scenario in which the vehicle A is braking, the rear lights transmit the brake warning to the vehicle B to avoid the collision. Block diagram of the transmitter and receiver, respectively.



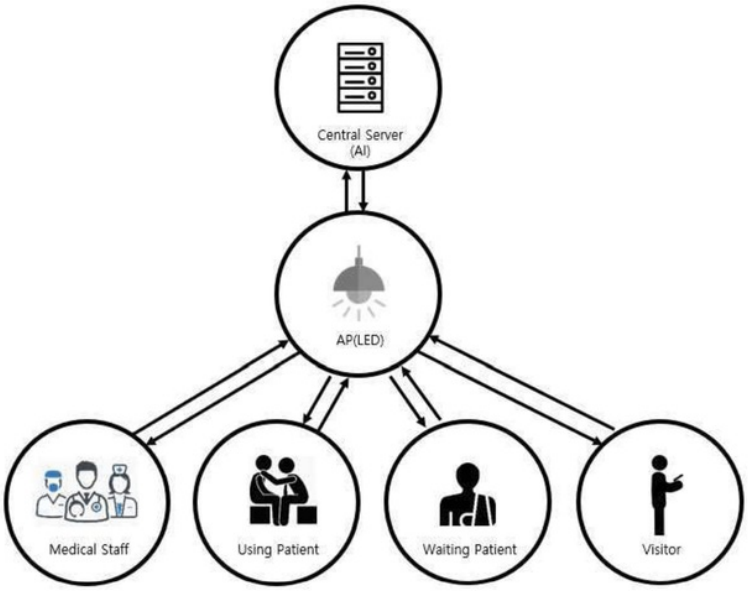
Limitations

Reliable property and network coverage are serious problems to be considered because of the interference from external light sources like sun bulbs, light and opaque materials in the path of transmission results in a disturbance in the communication.

3.

Proposed System for Smart Navigation

To implement the system proposed in this document, first, information on the user's location is collected. The user's LC device sends the beacon signal to the LED (AP) and transmits the patient's current position. AP transmits user location information to the central server. The central server uses the patient's location information to map the patient's location information. In the patient location information map, the user is divided into Use patient, Waiting for patient and Visitor. Patients who have entered the patient's symptoms using the LC device are classified as using patients and waiting for patients and others are classified as visitors. Patient use is a patient who is currently using a clinic. The waiting patient is a patient who expects to use the clinic. The visitor is a patient who has not yet received it or a visitor who has visited the hospital.



4.

This system is proposed for children to monitor health parameters such as heart rate and oxygen level. MAX30100 used to monitor baby's heart rate and oxygen level. Here they propose a compact system that can be installed in the child's bag. This system includes portable sensors and portable microcontrollers for children's physical flexibility.

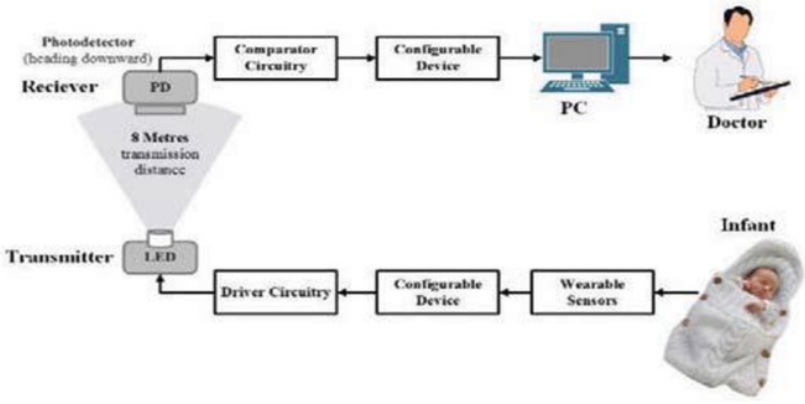


Fig 2.4: Architecture of the Health Monitoring System

5.

Working Principle

This proposed system has two scenarios. The first scenario: when vehicle 1 is braking, the speed meter in the vehicle will detect that the current speed is lower than the previous speed. Therefore, the information will be sent through the transmitter that is placed in the taillights to the vehicle 2. The information will be received by the vehicle two using the photodiode which is in the front of the vehicle. A warning of (decrease in speed) will be displayed on the second vehicle using an LCD screen. The second scenario: when the first vehicle is in the T-intersection, it will continue to send speed information to the second vehicle using the LED on the headlights. Speed information will be received by the photodiode in the second vehicle and will be compared to the second speed of the vehicle. If the second vehicle is about to cross the crossing while the vehicle is moving for the first time at high speed, the driver will be advised to check the other vehicle in the area.

6.

Working Principle

The IR and RF transmitter are positioned in front of the driver and both receivers are positioned behind the vehicle. The receivers are connected to a PIC microcontroller which takes the transmitted signal sent by the transmitters and reads the signal to reproduce the messages. An LCD screen is used to display reception messages and a buzzer is also used to attract the driver's attention. The circuit uses an RF transmitter and receiver to send and receive messages on the left and right side of the vehicle and uses a TSOP1738 IR receiver module on the back of the vehicle to receive the 38 kHz IR frequency pulses from the IR transmitter that sends a message on the side. front of the vehicle.

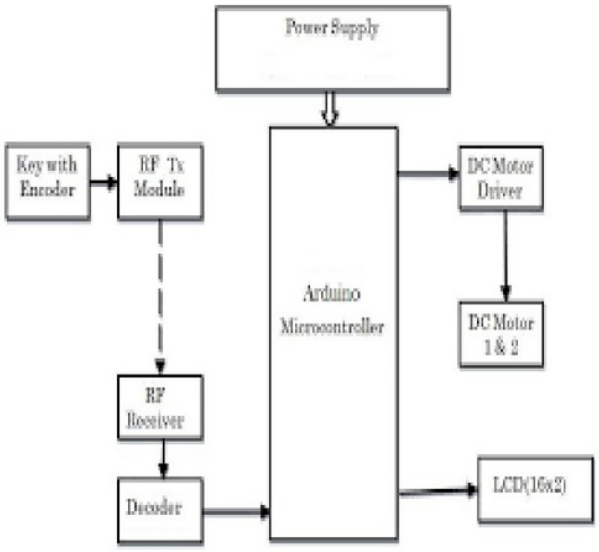


Fig 2.6: Implementation using IF and IR

Chapter 3

3. COMPARATIVE STUDY

1.1 Distance Short Range Communication VS Li-Fi Technology

Short-distance communication is a technology that allows vehicles to communicate with other vehicles. In this type of communication, the distance between two vehicles is short and they communicate with each other using onboard devices (OBU). The DSRC data transmission rate is 54 Mb / s, data transmission above this value is not possible, because as in the case of Li-Fi data, the data transmission rate can be up to Gbps. Instead of using on-board devices, Li-Fi has used Visible Light Communication (VLC), which is larger than DSRC Li-Fi in data transfer technology. Communication between vehicles can be from a long distance compared to DSRC. In Li-Fi, the LED sends a signal that is difficult to trace

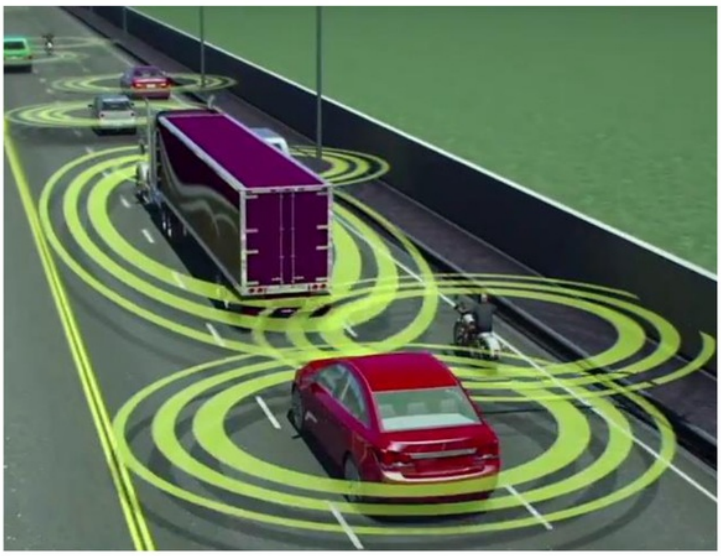


Fig 3.1: DSRC overview in communication between vehicles

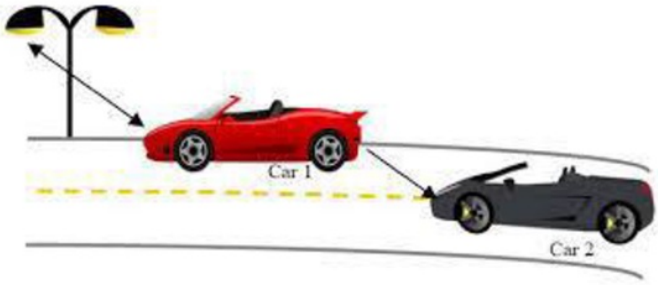


Fig 3.2: Li-Fi review in the vehicle to vehicle communication

1.2 Wi-Fi VS Li-Fi Technology

Li-Fi technology used to describe VLC technology, used for fast wireless communication, is called Wi-Fi, only light instead of the radio. Li-Fi is ideal for transferring high-density wireless data in a limited space or indoors and solving problems with the radio and Wi-Fi is great for the entire range of wireless buildings. The performance of both Wi-Fi data connections only works up to 5% performance; on the other hand, Li-Fi LEDs are characterized by high efficiency and energy consumption. Security, the problem, if you cannot see the light, you cannot access data in Li-Fi, which radio waves that can penetrate the walls, make it want to break the security protocol. The light is easily available compared to Wi-Fi. Li-Fi is a free team that does not require a license. That's why it's cheaper than Wi-Fi.

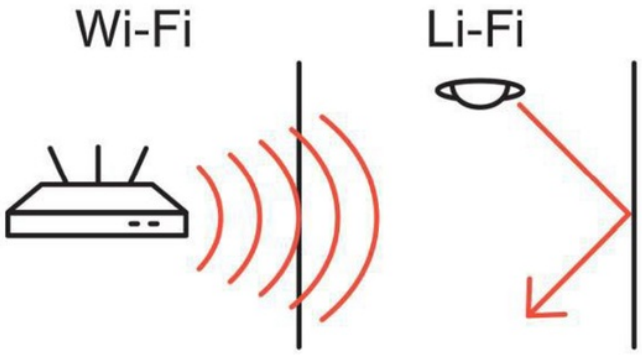


Fig 3.2: Li-Fi and Wi-Fi communication

1.3 Bluetooth

It is the first wireless information exchange technology over short distances. This technology operates in the 2400 MHz and 24833,5 MHz band, including protective bands. This technology operates within a radius of 10 m at a transmission rate of 5 Gb / s.

1.4 WiMax

WiMax stands for global interoperability of microwave access. This technology enables data transfer at a rate of 1 Gb / s.

1.5 Gi-Fi

Gi-Fi technology is Gigabit Wireless Fidelity, which uses a very high frequency of 60 GHz for data transmission, the process of mixing and filtering the signal increases the signal strength, with minimal losses in the medium. Like Bluetooth, this technology uses short-range wireless communication. This feature competes with modern wireless communication technologies; this technology also works within 10 m range, as does Bluetooth technology.

Wireless Transmission					Light Transmission
Feature	**Bluetooth**	**Wi-Fi**	**WiMax**	**Gi-Fi**	**Li-Fi**
Full form	-	Wireless Fidelity	Worldwide interoperability for Microwave access	Gigabit wireless Fidelity	Light Fidelity
Data rate	800Kbps	11Mbps	1Gbps	5Gbps	>10 Gbps
Operating range	10 meters	100 meters	50 Kilometers	10 meters	Inside a confined area or a room or 10 metres
Operating frequency	2.4GHz	2.4GHz	2.3 – 3.5 GHz	57-64GHz	400 THZ to 800THZ
Power consumption	5MW	10MW	~5MW	<2MW	10W LED bulb
IEEE tandard	IEEE 802.15	IEEE802.11	IEEE 802.16	IEEE 802.15.3C	IEEE 802.15.7

Chapter 4

4.1 Advantages of Li-Fi

1 Li-Fi can solve problems related to insufficient radio frequency bandwidth because this technology uses a visible light spectrum that has not yet been used much.

2 High data rates can be achieved up to 11 Gbps.

3 Because light cannot penetrate walls, it provides security and privacy that Wi-Fi cannot.

4 Li-Fi has low implementation and maintenance costs.

5 Li-Fi has its advantages in areas sensitive to electromagnetic factors, such as aircraft cabins, hospitals, nuclear power plants without causing electromagnetic interference.

6 Data transmission is faster and easier.

4.2 Disadvantages of Li-Fi

1 The Internet cannot be used without a light source. This could limit the positions and situations in which the Li-Fi could be used.

2 Li-Fi uses visible light and light cannot penetrate walls, the signal range is limited by physical barriers.

3 Other light sources may interfere with the signal. One of the biggest potential disadvantages is the interception of external signals. Sunlight will interfere with the signals, which will result in an Internet disturbance.

4 It would be necessary to build a completely new infrastructure for Li-Fi.

5 The high cost of installing VLC systems.

Chapter 5

5.1 Future Scope

1 Li-Fi technology is an advanced design approach, which features the best Internet design by significantly reducing the size of the device that transfers data implementation through light bulbs.

2 LEDs can provide feasible access.

3 Applications compared to any other network in different fields that cannot be connected via networks in use.

4 Li-Fi provided a turning point in the development of the growing global hunger communication.

5 This technology is safe for all biodiversity, including humans, and advances towards a greener, cheaper and brighter future than technologies.

5.2 Applications

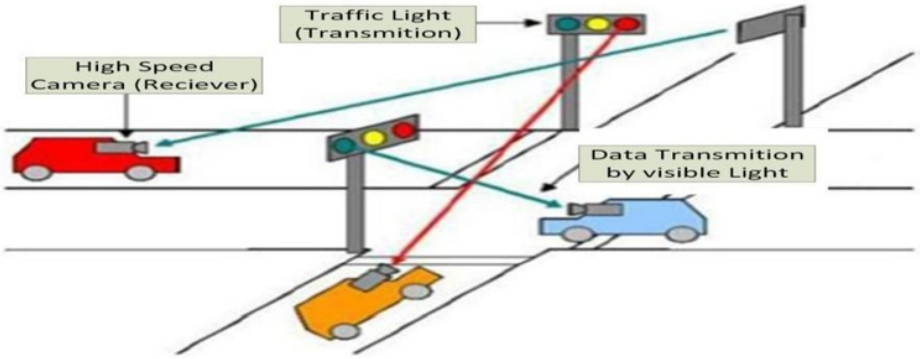
5.2.1 Underwater Communication

The use of RF signals is not practical due to the strong absorption of the signal in the water. Li-Fi offers a solution for short-range communications. Submarines could use their beacons to communicate with each other, process data independently and send their results periodically to the surface in underwater-operated vehicles (ROVs). Another big problem is that the Li-Fi can even work underwater where Wi-Fi completely fails, so it is open to military operations. The seminar's Li-Fi technology shows aquatic vehicles that use light to communicate with each other and transfer data between them.

5.2.2 Traffic Management

Li-Fi can help manage traffic in a better way and the number of accidents can be reduced. Traffic lights can communicate with the car and each other to manage traffic on the road.

The traffic light can play the role of data sender to provide information to the car on the state of the road or the situation of other cars. Furthermore, cars can communicate with each other and prevent accidents during the exchange of information. For example, visible lights can alert car drivers when other vehicles are too close.



5.2.3 Medical Application

One of the most important features of Li-Fi is that it can be used in hospitals and medical facilities that require no RF signals that affect medical equipment. For example, OTs (operative cinemas) do not allow the use of Wi-Fi due to radiation concerns because the use of Wi-Fi blocks the signals to monitor the equipment. This can be dangerous to the patient's health.

5.2.4 Sensitive Areas or Hazardous Environment

Li-Fi ensures secure communication in environments such as mines and petrochemical plants, as it does not cause electromagnetic interference in RF communication. Li-Fi can also be used in oil or chemical plants, where other frequencies can be dangerous. For example, power plants, such as nuclear power plants, require network integrity and station temperature monitoring that require fast, interconnected data systems. Wi-Fi and many other types of radiation are harmful to the sensitive areas surrounding power plants. Li-Fi can offer secure, generous connections for all areas of sensitive locations. In addition, this technology allows us to control plant growth without direct presence.

5.2.5 Smarter Power Plants

Wireless Fidelity (Wi-Fi) and many other types of radiation are harmful to sensitive areas. Like the ones that surround the power plants. However, power plants need fast, interconnected data systems to monitor such factors as demand, network integrity and (in nuclear power plants) core temperature.

Chapter 6

6. Conclusion

The concept of Li-Fi is currently attracting a great deal of interest, that is because, it offers a very efficient and genuine alternative to radio-based wireless. As a growing number of people and their any devices access wireless internet, the airwaves are becoming increasingly clogged, making it more and more difficult to get a reliable, high-speed signal. This technology may solve issues such as the shortage of radio-frequency bandwidth and allow internet where traditional radio based wireless isn‘t allowed such as aircraft or hospitals. One of the shortcomings however is that it only works in direct line of sight.

Li-Fi in data communication

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