Li-Fi: The Optical Version of Wi-Fi

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Abstract: *Now a days, wireless communications has become fundamental to our lives and we transmit a lot of data every day. The main way we transmit wireless data is by using electromagnetic waves, in particular radio waves. There is an emerging wireless communication with a promising future and which can be a complement of radio waves i.e LI-FI (Light fidelity). This technology describes "Data Through Illumination"—taking the fiber out of fiber optics by sending data through an LED light bulb that varies in intensity faster than the human eye can follow. This paper provides an up-to-date survey of Light fidelity. In addition, relevant topic such as issues regarding radio waves & how VLC can be possible solution to the wireless spectrum shortage.*

Keywords: Li-Fi, VLC, Wi-Fi, LED (Light Emitting Diode), radio waves

1. Introduction

As more and more people and their many devices access wireless internet, clogged airwaves are going to make it increasingly difficult to latch onto a reliable signal. But radio waves are just one part of the spectrum that can carry our data.

What if we could use other waves to surf the internet? Normally we transmit the data through EM waves in the sky. The other part is like EM waves transmission that we use "Data illumination". German physicist, DR. Harald Haas, has come up with an idea of Li-Fi which is a VLC, visible light communication, technology Li-Fi is now part of the Visible Light Communications (VLC) PAN IEEE 802.15.7 standard. Li-Fi is typically implemented using white LED light bulbs. These devices are normally used for illumination by applying a constant current through the LED. However, by fast and subtle variations of the current, the optical output can be made to vary at extremely high speeds. Unseen by the human eye, this variation is used to carry high-speed data. In simple terms, Li-Fi can be thought of as a light-based Wi-Fi. That is, it uses light instead of radio waves to transmit information. And instead of Wi-Fi modems, Li-Fi would use transceiver-fitted LED.Dr. Harald Hass says, it can produce data rates faster than 10 megabits per second, which is speedier than your average broadband connection. He envisions a future where data for laptops, smartphones, and tablets is transmitted through the light in a room. And security would be a snap—if you can't see the light, you can't access the data [5].
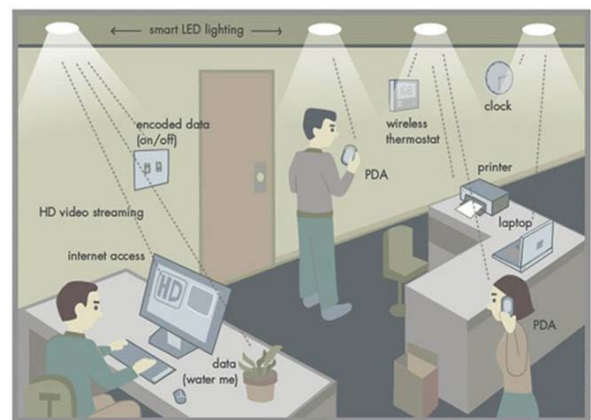

Figure 1: Li-Fi environment

It is possible to encode data in the light by varying the rate at which the LEDs flicker on and off to give different strings of 1s and 0s. The LED intensity is modulated so rapidly that human eyes cannot notice, so the output appears constant.

2. Working Principle

The basic idea behind this communication scheme is transmission of 'Data through illumination'. The intensity of the LEDs is varied by changing the current passed through them at very high speeds. However, the human eye cannot perceive this change and the LEDs appear to have a constant intensity. This ON-OFF activity of LED lights enables data transmission using binary codes i.e., when the LED is ON, logical '1' is transmitted and when the LED is OFF, logical '0' is transmitted [6].This method of using rapid pulses of light to transmit data is called Visible Light Communication (VLC). Fig.2 shows the basic principle of VLC.
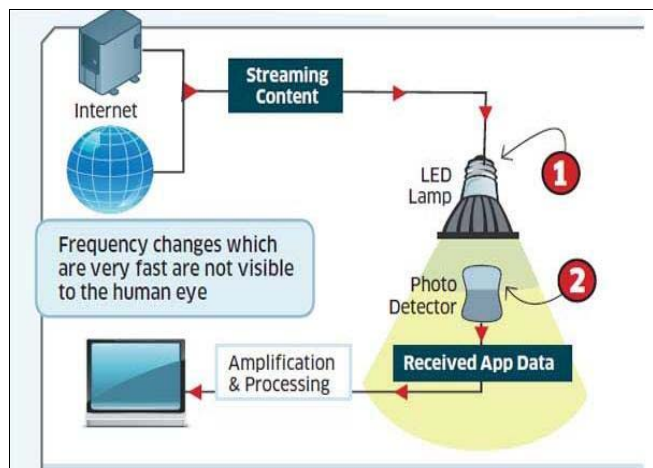
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Figure 2: Working Priciple

3. Literature Review and Adoptability of Li-Fi

3.1 VLC: A possible Solution to the global wireless spectrum shortage

Li-Fi is a fast and cheap optical version of Wi-Fi, which is based on Visible Light Communication. VLC is a data communication medium using visible light between 400THz (780nm) to 800THz (375nm) as optical carrier for data transmission and illumination. Data can be encoded in the light to generate a new data stream by varying the flickering rate, to be clearer, by modulating the LED light with the data signal, the LED illumination can be used as a communication source. This is a whole new spectrum of possibilities as compared to the radio waves spectrum and is 10000 times more in size [1]. Visible light is not injurious to vision and are a mandatory part of an infrastructure, therefore abundantly available and easily accessible. Comparing the number of radio cellular base stations (1.4 million) to the number of light bulbs (14 billion) installed already the ratio is coincidently same i.e. 1:10000.
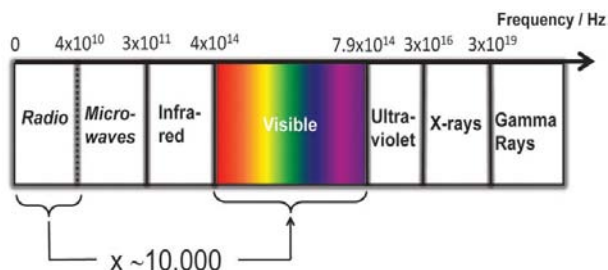

Figure 3: The electromagnetic spectrum and the vast potential of unused, unregulated, safe green spectrum in the visible light part

4. Issues regarding Radio spectrum:

As far as issues regarding radio spectrum are concerned following points can be discussed:

▪ **Capacity:**
  1. We transmit data using radio waves
  2. Cost and expensive
  3. Less Bandwidth compared to other spectrum
  4. Insufficient spectrum for increasing data

▪ **Efficiency:**
  1. Millions of base stations consume huge amount of energy for
  2. Transmitting the radio waves.
  3. To cool the base stations cabins.
  4. 5% efficiency
▪ **Availability:**
  1. Available within the range of base stations.
  2. Limited availability.
  3. Unavailable in aircrafts
▪ **Security:**
  1. Less secure (Passes through the walls)

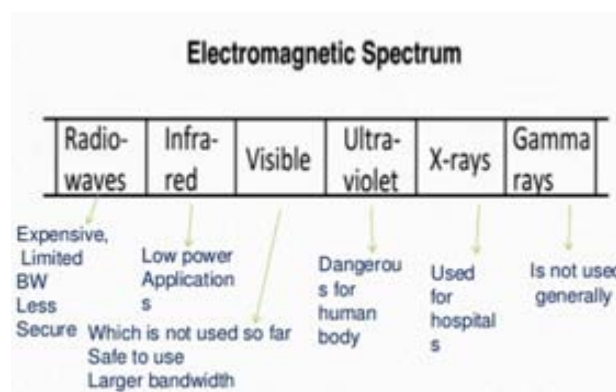## Why Li-Fi?

Why LiFi?

Figure 4: Electromagnetic Spectrum

1. Gamma Rays can't be used as they could be dangerous.
2. X-Rays have similar health issues.
3. Ultraviolet Light is good for a nice suntan, but otherwise dangerous for the human body.
4. Infrared, due to eye safety regulations, can only be used with low power.
5. Hence we are left with only the **Visible Light Spectrum.**

Advantages:
▪ **Capacity:**
  1. 1000 times more spectrum than radio waves.
  2. Light box is present. It contains 1000s of LED making it possible to transfer 1000s of data stream parallel at a very high speed.
▪ **Efficiency:**
  1. LED lights consume less energy, so it is highly efficient.
▪ **Availability:**
  1. It is available at all places where light is present.
▪ **Security:**
  1. Light waves do not penetrate through walls & hence cannot be intercepted & misused by anyone having any bad intension.
Limitations:
▪ The biggest disadvantage is that it needs direct line of sight to transmit data so one wouldn't be able to have a single router in his/her house and the data goes through walls etc..

Applications of Li Fi:

1. In hospitals, it is difficult to lay the optical fiber cables. Li-Fi can be used for modern medical instruments in operation theatre.
2. In traffic signals Li-Fi can be used, which will communicate with the LED light of the cars and thus occurrences of accidents can be reduced.
3. Thousands and millions of street lamps are deployed around the world. Each of these street lamps could be a free access point.
4. Li-Fi can work under sea water where Wi-Fi fails completely, thereby throwing endless opportunities in military/navigation operations.
5. In aircraft Li-Fi can be used for data transmission.
6. It can be used in petroleum or chemical plant where other transmission or frequencies could be hazardous.

5. Conclusion

Li-Fi has great potential in the field of wireless data transmission. It is a promising alternative to conventional methods of wireless communications that use radio waves as data carrier. White led's which can be used for illuminating rooms can be used as optical transmitters for sending data. An interesting property of these devices (in addition to their lightening capabilities) is that they can be utilized for data transmission. Large scale areas that are saturated with radio signals or that don't permit them for security reasons could use Li-Fi as an alternate high-speed wireless network solution. Many enhancements can be made to the existing technology. For example, encoding and decoding can be implemented directly in the transmitter and receiver part of the circuit. This would reduce error in transmission. If this technology is put into full-fledged practical use, every LED can be used like a Wi-Fi hotspot to transmit wireless data. This can lead us to a safer and greener future.

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