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Design and development of visible light spotlighting system for location identification

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ABSTRACT: With advent of various technologies of communication a person can access the whole world at one go. The impact of internet on our day to day life has been so huge that we could not think of a day without it. It has become a fundamental requirement in our daily lives. Survey reports show that nearly 46% of homes throughout the world have access to the internet. And the percentage is growing each day. With such a high rising demand there has been a looming crisis of Radio Frequency spectrum, which paved the way of the invention of the new technology:-LI-FI.

LI-FI, acronym of light fidelity, is a modern wireless technology which has the ability to provide high speed internet connection within localized environment. Till today we are familiar with WI-FI which has been using radio frequency spectrum for its communication. Even though it gives a speed of nearly 150mbps (as per IEEE802.11n), it isn't sufficient to satisfy all users. On the other hand LI-FI uses spectrum which comprises a wide range of frequencies, from the infrared through visible, down to the ultraviolet spectrum for communication which has the ability to produce a theoretical speed of 10Gbps. Actually this technology comprises of sub- gigabit and gigabit-class communication speeds for short, medium and long ranges, as well as has the option of unidirectional or bidirectional data transfer using line-of-sight or diffuse links, reflections and much more. It is not only confined to LED or laser technology or to any specific receiving technique, LI- FI is a framework for all those technologies which provides new ways to all present as well as future services or applications.

Keywords: WI-FI, LI-FI, VLC, LED, Optical wireless, Line of Sight (Los).

I. INTRODUCTION

In a very lucid language we can define LIFI as LIGHT based WIRELESS TECHNOLOGY (WIFI). The only difference of LIFI with WIFI is that instead of radio waves it takes the help of visible light spectrum to communicate and instead of modems, LED lamps are used which are fitted with transmitter as well as receiver. We are involved with light for millions of years but it has a very little or no impact on heath issues. For this reason as well as the confinement of the previous technology i.e. WIFI, has paved the way for the discovery of this technology. Data can be encoded in light, at a speed in which LEDs flicker. When it is off 0 is transmitted and when on 1 can be transmitted through it- thus giving rise to digital signals. The modulation intensity is so rapid that human eyes cannot detect it and LED appears to be constantly glowing. Li-Fi, has already achieved lightning fast speed in the

laboratories. Scientists at the Heinrich Hertz Institute situated in Berlin, Germany, have been able to obtain a data transfer speed rate of over 500 megabytes per second where they used a white-light LED for their experiment. Herald Haas, who is known to be the father of this technology, has set up a firm which sells a consumer visible light communication (VLC) transmitter. It has the ability to transmit data at about 100 Megabytes per second which is much faster than most UK broadband connections.

Prof. Harald Haas, a pioneer in the field of optical wireless communications at the University of Edinburgh was the first person to demonstrate this technology. He has been able to show how a light-emitting diode bulb (LED) combined with signal processing technology successfully streamed a video to the computer. He was the first person to coin the term "LIGHT FIDELITY" or LI-FI. With the help of this technology, a one-watt white LED bulb has the ability to provide internet connectivity to four computers simultaneously. At the same time LI-FI holds the potential of providing a future where data for smart phones, tablets and laptops will be transmitted via light in a room.

LIFI TECHNONLOGY

Li-Fi can be considered as a Wi-Fi which uses light. That is, light is used in lieu of electromagnetic waves to broadcast data and instead of Wi-Fi routers, Li-Fi would use lamps as transceivers that can light a hall and simultaneously transmit and receive information. Since light bulbs are simple and can be used almost anywhere, it is feasible to have a high number of access points [9]. Li-Fi differs from Wi-Fi in the type of modulation that is used. For Li-Fi, direct modulation is used avoiding the addition of extra components like intermediate frequencies as done in radio frequency systems.

Li-Fi is a category of Visible Light Communication; an LED light flickers at speeds undetectable to the naked eye to transmit data. In fact, it's been demonstrated that information can be transmitted at as much as 224 gigabits per second [10], the equivalent of 18 movies of 1.5 GB each being downloaded every single second in lab conditions. In an office setting, speeds up to 100 times faster than average Wi-Fi speeds were achieved. The LED lights require so little energy; they can be powered by a standard Ethernet cord. It was suggested by Harald Haas who invented Li-Fi that the smart light bulbs could be energized by cell based charging batteries. In addition, Li-Fi does not cause harm to humans, unlike Wi-Fi that uses electromagnetic waves which cause interference, meaning it could have important applications in sensitive locations like healthcare facilities. A light node can send in real-time the magic world of the very far deep underwater and underground. Light nodes enable divers to readily communicate among themselves and with dolphins and other protected sea life. A light node can send data about petrol reservoirs and nuclear reactors from some kilometers deep. A Li-Fi node can be embedded in security access cards to allow persons to access secured gates/areas.

Astronauts can share information using light node that makes it possible in free space gravity through light and sends data to outer Li-Fi nodes which in turn send it to earth through satellites networks in a reliable and secure manner.

While the light enables eyes to see in the dark, the Li-Fi node uses the light to enable internet users to communicate anytime anywhere in a secure and energy efficient way than ever before. Li-Fi communication and networking technology is, therefore, a true candidate of the Internet of Things and ubiquitous communications.

VISIBLE LIGHT COMMUNICATION

With the invention of LED (Light Emitting Diode), the idea of victimisation light-weight as a communication medium has started once more. VLC uses white Light Emitting Diodes (LED), which send knowledge by flashing light-weight at speeds undetectable to the human eye. One major advantage of VLC is that we will U.S.A.e the infrastructure around us while not having to create any changes thereto. LEDs' ability to transfer information signals over light-weight (lightweight that is between 400THz to 800THz of frequency and whose wavelength is between 400nm to 700nm) makes it a terribly sensible communication medium. Now the light-weight tends to use in our way of life can't solely be used for providing lightweight however conjointly for communication. Upon detailed investigation of VLC analysis, it was found that not lots of research has been done to develop this technology for commercial use. But as a result of analysis into VLC is comparatively new, the possibilities ar wide open. A lot of analysis is being done to create this technology out there for business use in varied fields, including web access and vehicleto-road communication victimisation traffic signal lights. From our review of the literature, it became evident that work should be done to appear into the chance of planning a replacement model that would work the current infrastructure for indoor applications.

II. EXISTING SYSTEM

In existing system, uses RF based communication, so the inference and noise of the signal is high.Power consumption of existing system is high compared to proposed system.And also in this system we can send only text type of data.

III. PROPOSED METHOD

In the proposed the process of voice communication through the visible light on the transmitter side voice is used as the input signal. This signal is converted to an electrical signal through a condenser or microphone. This electrical signal is amplified by the amplifier circuits and fed into the power LED.

The light signal from the LED varies according to the intensity of the voice signal. The louder is voice the glow of the LED will be more.

2.1 DESIGNING A LI-FI BASED SYSTEM

A LIFI product is mainly an assembly of four primary sub-components:

- Bulb
- Radio Frequency Power Amplifier (RFPA) circuit
- Printed Circuit Board (PCB)
- An enclosure

The function of the Printed Circuit Board is to control all the electrical signals of the lamp and also contains the microcontroller which manages the different functions of the lamp. The solid-state Power Amplifier generates a radio frequency signal which is converted into an electric field. Due to high concentration of energy in the electric field the contents of the bulb gets transformed to a plasma state at the center of the bulb. This controlled plasma is responsible for the generation of an intense source of light. All these subcomponents are contained in an enclosure made up of aluminum

2.2FUNCTION OF THE BULB SUB-ASSEMBLY

The centre of a LIFI system consists of a bulb sub- assembly, in which a sealed bulb which is inserted in a dielectric material. This particular design is much more reliable than other well-known light sources which usually use degradable electrodes inside the bulb. The dielectric material has two functions; primarily it acts as a waveguide for the radio frequency energy radiated by the Power Amplifier and secondly it also helps in concentrating the electric field thus focusing energy in the bulb. This energy from the electric field is responsible for heating the material in the bulb readily and transforms it to a plasma state that has the power to emit light of high intensity.

TRANSMITTER SECTION: The system architecture consists of a transmit section and a receive section. The transmit section consists of the data input which is then fed into a switching control system. Based on the data, the switching control generates a stream of 1s and 0s thereby encoding the data in binary. The output of this control is given to the array of LEDs which turn OFF and ON at extremely high speeds. This ON-OFF modulation of the LED light transmits the data. LED is the choice for light source since it consumes very less power when compared to fluorescent lamp or a light bulb. LEDs are also fast switching with good visibility. Transmitter section shown in fig.1

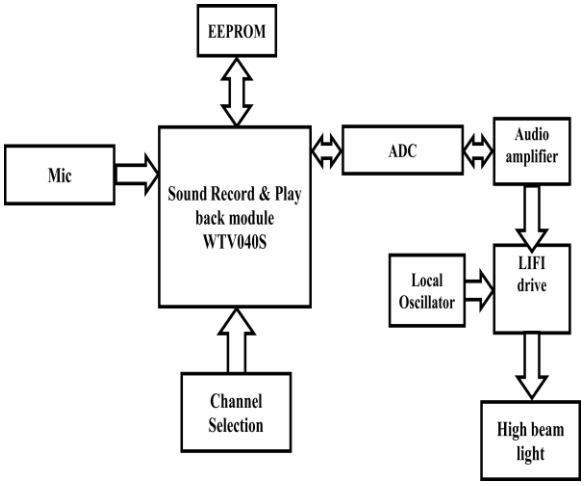

Fig. 1 Block Diagram of Transmitter

Receiver Section: The receive section consists LDR as a receiver having high sensitivity. We can also use the photo detector for same purpose. LDR decode the incoming demodulates the incoming received signal based on the sequence of1s and 0s. The demodulated signal is then sent to a signal conditioning unit than fed to PIC microcontroller, which decode that signal and then given to an output device such as an LCD display. Receiver section shown in fig.2

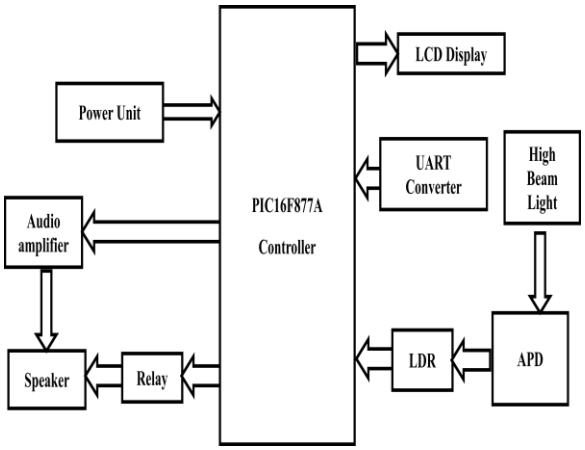

Fig.2 Receiver Section

Steps for sending a message:

1. First a connection is established wherein the transmitter is connected to the computer using USB to TTL adaptor.

2. Similarly the receiver is switched on the and plugged to the other computer.

3. Respective port setting are done in the „Devices Manager".

4. Now we run the program and an window appears where again the ports need to be configured.

5. Once this is done we are ready to send a message. 6.A message is typed in a particular field which is as shown

7. If the connections are done properly then we will receive the same message on the other device.

III RESULTS AND DISCUSSIONS

Experiment is performed on various medical image to check the proposed method for imperceptibility and robustness.

Why only VLC?

Visible Light Communication(VLC) is a data communications medium using visible light between 400 THz (780 nm) and 800 THz (375 nm). Using visible light is less dangerous for high-power applications because humans can perceive it and to protect their eyes from damage.

- Gamma rays can't be used as they could be dangerous.
- X-rays have similar health issues.
- Ultraviolet light is good for place without people, but otherwise dangerous for the human body.
- Infrared, due to high safety regulation, can only be used with low power.

3 .COMPARISON BETWEEN WIFI AND LIFI

Li-Fi uses Light as a medium to transfer data widely called as Visible Light Communication (VLC), whereas Wi-Fi uses Radio Frequency [RF] spectrum whose range is comparatively less than visible light spectrum. The data transfer speed in Li-Fi is much faster compared to all wireless connection links of about 10Gbits/s. But in Wi-Fi data transfer speed is only upto 150Mbits/s. The spectrum range of visible light is 10,000 times broader in comparison to radio frequency. In turn spectrum range of Radio Frequency spectrum is less than visible light. Li-Fi is comparatively cheaper than Wi-Fi because free band doesn"t need license and it uses light. Wi-Fi is costlier in comparison to Li-Fi because it use Radio Spectrum. Both Wi-Fi and Li-Fi uses PTP [Point-To-Point] network topology. Li-Fi uses hundreds of Tera Hz operating frequency and Wi-Fi uses only 2.4GHz as its operating frequency.

CHALLENGES

1. Li-Fi requires line of sight.
2. Receiving device would not be shift in indoors. 3. A major challenge is how the receiving device will transmit data back to transmitter.
4. Visible light can't penetrate through brick walls.
5. We become dependent on the light sources for internet access. If the light sources break, we lose access to the internet [3].

APPLICATIONS

1.Replacement for other technologies-as compare with other wireless technology Li-Fi have great features, for money applications we can use Li-Fi as a wireless technology.
2. Road Safety and Traffic Management- Li-Fi can be used for communication between the LED lights of vehicles. It can also be implemented in the traffic lights for vehicle to roadside communication to update traffic information.
3. Public internet access through street lamps- Any lighting devices like street lamps, etc. are performed as a hotspot. It means that the any light able to spread internet using visual light communication which helps us to low cost architecture for a hotspot. The hotspot is a limited region in which some amount of device can access the internet connectivity.

4. Auto-piloted cars that communicate through their headlights which is useful to exchange traffic information between heavy traffic.
5. Point to point data communication between no. of devices.
6. Hazardous Environments: Li-Fi is a safe alternative to RF communication in environments such as mines and petrochemical plants which are susceptible to electromagnetic interferences.
7.Underwater Communication- for underwater communication use of radiofrequencies (RF) & use of Sound waves is impractical due to strong signal absorption. Li-Fi can be employed in such cases for underwater communication.

ADVANTAGES

1. Li-Fi has low implementation and maintenance costs.High data transmission rates of up to 10 Gbps can be achieved.
2. It is safe for humans since light, unlike radio frequencies, cannot penetrate human body.
3. Efficiency: Data transmission using Li-Fi is very cheap
4. .A free band that does not need license.
5. Availability: Availability is not an issue as light sources are present everywhere.

Drawbacks:

• It is a one-way connection, permitting download but no upload from the connected device.

• The light cannot get through walls and has a limited field of action.

• The power cord immediately becomes your data stream, so if you have power, you have internet.

Future Scope:

As light is everywhere and free to use, there is a great scope for the use and evolution of LiFi technology. If this technology becomes mature, each Li-Fi bulb can be used to transmit wireless data. As the Li-Fi technology becomes popular, it will lead to a cleaner, greener, safer communications and have a bright future and environment. The concept of Li-Fi is deriving many people as it is free (require no license) and faster means of data transfer. If it evolves faster, people will use this technology more and more. Currently, LBS (location Based Service) or Broadcast solution are commercially available. The next step could be a Li-Fi WLAN for B2B market with high added value on specific business cases and could grow towards mass market. In the long term, the Li-Fi could become an alternative solution to radio for wireless high data rate room connectivity and new adapted service, such as augmented or virtual reality.

CONCLUSION AND FUTURE WORK

The proposed method, With the number of electonic devices increasing every minute, there is a possibility that Li-Fi technology soon becomes reality. On implementation of this technology, every bulb could be then used a Li-Fi hotspot with better transmission rate of data. Implementing this technology will have a direct impact on environment making it cleaner and greener as this technology uses light for transmission of data and light does not have any ill-effects on environments unlike Wi-Fi which makes use of RF waves which are hazardous in nature.

Medical applications is one of the brighter side to this technology as Wi-Fi could not be used for such applications.Also with the increase in number of Wi-Fi users the speed for transmission od data has reduced and price for the service has increases. Thus, Li-Fi can overcome all these problems and can be used cheaply and readily.

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