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Li-Fi in Vehicle Communication for Traffic Noise Reduction

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***Abstract* - Li-Fi abbreviated as Light Fidelity emphasizes on the idea of transmission of any images or audio/video signals with the help of visible light. Using this very concept, in the past few years, various application-oriented industrial sectors have evolved tremendously or are on the verge of evolving. One such domain that has taken into consideration the concept of Li-Fi and put it into practice is vehicle communication. Li-Fi has successfully made its way in smart vehicle communication resolving problems like road accident, traffic control among many. Working on the same domain as vehicle communication, we intend to address another rigorous problem associated with vehicles that has a huge impact on human lives, that is, noise pollution. Horns built inside every car, when honked, creates excess noise and leads to cacophonous environment. Thus, adhering to the ideology of Li-Fi, we, in this project, make an effort to replace the harsh honking with a simple sound signal that will travel through LED based headlights, that is to say, sound signal will be superimposed on light signal. At the receiver section, a solar panel, speaker and an amplifier is used to obtain the amplified version of original input sound signal. The two incredible properties of Li-Fi due to which the entire proposed system becomes reliable are, one, Li-Fi uses visible light as a source whose availability is in abundance and is harmless and another, the signals received remain confined within the system itself.**

Keywords: Li-Fi, Vehicle Communication, Traffic, VLC, Light, Noise Reduction.

I. INTRODUCTION

Light Fidelity (Li-Fi) as a technology has seen an efficient growth since the time it was first brought into the picture around eight years back in 2011. Within a couple of years the concept of Li-Fi made its way through different sectors where the idea was being put into practice. After its invention and till date various investigation/research/work is being carried out using the concept of Li-Fi so that it can be effectively used in various applications.

Li-Fi for visible light is between 430 THz to 770 THz, whereas radio frequency ranges between 1 Hz to 3 THz, for the sake of simplification, is considered as the advanced version of Wi-Fi, except that, unlike Wi-Fi which uses radio waves (RF) for communication, Li-Fi revolves around the idea of using light as a source for various communication purposes. In reference to electromagnetic spectrum, it uses visible light to make communication possible. This is widely regarded as visible light communication (VLC). The frequency band for visible light is between 430 THz to 770 THz, whereas radio frequency ranges between 1 Hz to 3 THz. Thus the frequency bandwidth of visible light is 400 times more as compared to that of radio frequency, which means more number of bits can be transferred using visible light. Availability of source for transmission can never be a problem in case of Li-Fi since light being naturally present everywhere, it is available in abundance and hence can be effectively used as and when needed. Currently, light as a source is being used with the help of LEDs.

When a communication is to be accomplished using Li-Fi, the data or the message/information signal to be transferred can be in the form of images, video, audio etc. One of the applications where this very ideology is being worked on and includes some past work is vehicle communication. To deal with some of the major concerns like traffic management, reduction in number of accidents, etc communication between vehicles became a need and Li-Fi being introduced almost came as a rescue, solving these problems to a great extent.

Among many, another concern regarding vehicles is the increasing noise level during traffic hours. With the increasing population there is a tremendous increase in private vehicles. This has led to an increase in traffic on roads causing noise pollution. It has been estimated that about 50,000 people die of heart failure every year, the sole cause being the traffic noise. The solution to this is again, making an effective communication possible between two vehicles such that the excessive noise is minimized. This can be implemented using the concept of Li-Fi, where the data/signal will be in the form of audio. The audio signal will be transmitted using LED which will be employed as transmitter and the emitted light will be detected by the receiver.

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The audio signal will be superimposed on the light which will be transmitted using LED source. As the visible light cannot penetrate through the walls/obstacles and it remains confined within, this makes it easier to communicate since the transmitted signal will only be received by the intended recipient.

II. METHODOLOGY

The transmission process is can be sub categorized into three sections as given below:

- Transmission Module
- Receiver Module

2.1 Transmission Module

We can use Light Emitting Diodes as the best source for Optical Transmission since they support a fast modulation and high data rates. We can even use Laser Sources but when we talk about the implementation of the techniques in cars Lasers becomes Impractical to propose as light sources for transmission. LEDs can use different technologies for transmission of white light. When it comes to advancement in the optical technology nowadays more and more cars are supporting LED Headlights and Taillights. And the main reason for the same is because of the advantages of LED lights over conventional Light Sources.

Significance of using LED lights: In case of car headlights three of the most dominant options could be used as light sources. These are the Halogens, HID or high-intensity discharge lights and the LED lights. On comparing their properties, best choice can easily be made for using them in the cars. Efficiency of Halogen headlights is less compared to LEDs. Major form of the charge is lost in form of heat instead of being converted to light. The durability of Halogens is a great concern and hence we need to be replacing them very often.

LEDS have comparatively longer lifespan. Approximately 15,000 hours compared to the 1,000 hours of the halogen bulbs. Though they are expensive, their durability makes them cost efficient. To take a note about the intensity of light source i.e. their brightness, HIDs have the upper hand in the three types of car headlights. However, they have their own weaknesses. They can blind oncoming motorists and their brightness also creates a shadow effect which makes it hard to see other objects when driving. With LEDs we do not have to deal with the problems related to temporary blindness of other motorists. They offer a decent illumination that is far better than the halogens.

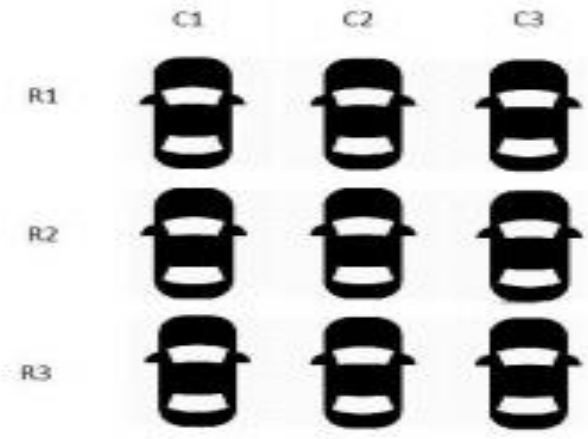

Figure 1: Arrangement of Cars

Consider the arrangement of cars as shown. If the car in row2 column 2 wants to indicate the car in row1 column 2 to clear the way, the only way of indication is through honking. However, this honking causes excessive increase in noise which on a larger scale leads to a numerous problems including hazardous health problems. To avoid this, the phenomenon of light fidelity can be effectively implemented wherein the honk (which is the form of audio) will be superimposed on the light signal and this light signal will be transmitted. During transmission the travelling signal gets modulated which helps in increasing the efficiency of transmission.

2.2 Receiver Module

The prominent component during reception period is going to be the solar panel. The light/input signal (audio signal) from the LED will be transmitted and the signal will reach solar panel. The photo cells present in the solar panel will accommodate this transmitted signal and accordingly demodulation will take place. This demodulation will result in not only getting the carrier less information signal but also help in getting rid of phase errors if any. The output from the solar panel will remain in the analog form and will possess same frequency as that of the input signal.

The demodulated signal obtained from solar panel will need some amplification, thus it will be done by using an audio amplifier. Audio amplifier will be interfaced with the speaker, and after the amplification of the signal, it will pass through the speaker. Thus the message signals (audio) transmitted by superimposing it on the light signal using LED will be successfully received at the receiver end from the speaker.

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2.3 Flow Chart

Accordingly, referring back to Fig.1, after the light signal carrying the audio signal id transmitted, it reaches the receiver section where the audio signal is segregated from the light signal through demodulation. On demodulating the signal, the phase errors if any are conveniently discarded.

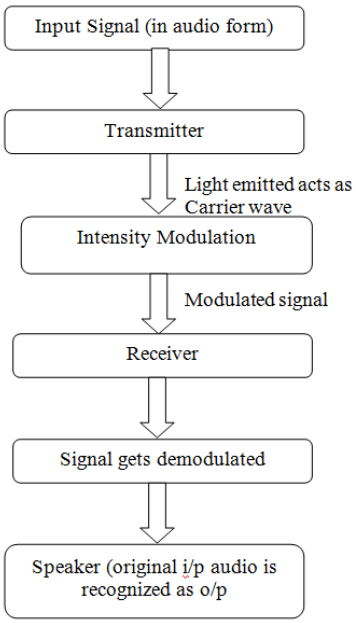

Figure 2: Flow Chart for Schematic Representation

Thus when the car in row 2 column 2 honks as an indication for the car in row 1 column 2 to clear the way, the signal will only be received by the intended car only i.e the car in row1 column 2, thereby minimizing the effect of noise produced due to honking.

III. ADVANTAGES

Li-Fi can be used in easily flammable areas such as Gas berths, planes, etc., as it was interventions in flammable material goods and hazard areas. It can be used for underwater communication systems when light passes through almost all liquid media. Li-Fi provides an electromagnetic wave environment, creating a healthy environment. Li-Fi technology provides secure, fast and efficient communication. An electromagnetic free environment can be created by a Li-Fi technology which can be used in hospital applications.

IV. APPLICATIONS

Security

Unlike radio waves that use Wi-Fi, lights cannot pass through walls and doors. This makes it a safer and an easier to control network access system. As long as transparent materials such as windows are covered, the access to a Li-Fi communication channel is limited to devices within the particular room.

Underwater application

Most remote underwater vehicles (ROVs) are controlled via cable connections. The length of your cabling greatly restricts the range of operation, and can limit other possible factors such as the weight and meaning of the cable. Because light can move in water, Li-Fi-based communications could offer much greater mobility. The usefulness of Li-Fi is limited by the distance that light can enter the water. Significant amounts of light do not exceed 200 meters. The light does not enter after 1000 meters.

Aviation

Effective data communication is possible in air environments such as commercial aircraft with Li-Fi. Use of this light-based data transmission does not affect aircraft equipment that relies on radio waves such as the radar.

Hospital

For many treatments that are becoming more popular, Li-Fi systems may be a better system for communicating patient information. Light waves not only ensure higher speeds, but also have little effect on medical devices and the human body. Using such medical devices, it is possible to communicate wirelessly without having to worry about radio interference that affects the efficiency of the tasks.

Vehicles

Vehicles can communicate with each other through the front and rear lights to increase traffic safety. Street lights and traffic signs can also provide information on the current state of the streets.

Industrial automation

Data needs to be transmitted everywhere in industrial areas, Li-Fi can replace slip rings, sliding contacts and short cables like Industrial Ethernet. Due to Li-Fi's real-time capacity (often required for automated processes), it is also an alternative to common WLAN industrial standards. Fraunhofer IPMS, a German research organization, claims to have developed a highly suitable component for industrial applications with time-critical data transmission.

Advertising

Street lights can be used to display nearby ads or attractions on passing mobile devices. A customer entering a

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store and passing through the store lights can see current sales and promotions on the customer's mobile device.

Education

In a classroom that has Li-Fi enabled the teachers and students can be a part of an active educational community by discussing the study materials. Using smart phones or laptops the students can communicate easily with the teacher, or with them each other and also to create a more efficient learning environment. Teachers and professors were able to collaborate with their students to help them have a better understanding of the class study material.

V. FUTURE SCOPE

Within a couple of years after its invention in 2011, Li-Fi as a technology experienced a rapid growth in various applications. One of the highly evolving application areas that have made use of Li-Fi is vehicle to vehicle communication.

Being a growing technology which needs even further investigation, and if worked on, it will find its way towards numerous applications like V2I and V2P communication. V2I- involves exchange of data related to safety and operations between vehicles and infrastructure, V2P- includes pedestrians and bicyclists.

VI. CONCLUSION

Li-Fi is a growing technology which involves a vast area that still needs to be explored, and when worked on accordingly will give out incredible results given the fact that in the near future, the technological world will have huge demands regarding various aspects and hence working on providing the best and efficient solution will be of much concern. In scenarios like this, invention of a concept like Li-Fi definitely comes as a rescue. Though till date it has been implemented in various sectors, a small effort using the same is being tried to implement in vehicle communication so that a problem of much concern in recent times which is excessive noise during traffic hours shall be minimized using the proposed methodology.

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