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How to Effectively Monitor Highway Traffic in Zambia By the Use of Coexistence of Li-Fi And Wi-Fi

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Abstract
This paper we suggest the use of Visible light communication (VLC)technology combined with Wi-Fi technology to monitor highway traffic in Zambian roads where LED will transmit data of the speedometers of vehicles, the gross weight, the vehicle details and the proprietors to the highway agencies. Visible light communication (VLC) is a new way of wireless communication using visible light. The idea behind this technology is that light emitting diode (LED) bulbs that vary in intensity encode the data in the light by varying the light at which the LED blinks on and off to give different strings of 1's and 0's when synchronize Wi-Fi and Li-Fi in data transmission . It plays an important role of using a diverse spectrum to provide high quality of service (Qos).

As vehicular accidents in Zambia has become one of the worrying and growing concerns to most Zambians in recent times. This is as a result of the tremendous negative effects of road traffic accidents on human lives, properties and the environment.

As the need for highway traffic monitoring grows, public appreciation of the problems in this area remains poor. In general, the public believes that monitoring should be relatively easy and does not understand either the importance or the cost. Because public perception drives legislative decisions, the lack of support has created a crisis in highway agencies across the nation as staff resources are constrained. Although the burden to build new highways lessens, highway agencies are desperately trying to maintain the existing infrastructure in a safe condition and at the same time provide the level of service that highway users have come to expect. None of these things can be accomplished without understanding how highways are used. Therefore, close monitoring of the usability of the highway users should be analyzed by the highway agencies in the country in order to reduce abuse of the use of the road and prevent accidents on human lives, properties and the environment.

The research is looking into the effectiveness of monitoring highway traffic in Zambia by the use of coexistence of LI-FI and Wi-Fi in order to curb abuse of the road and prevent accidents on human lives, properties and the environment. The findings may help the government to cut expenses on issues that can be effectively prevented.

Keywords-*LiFi, Visible light communication, Wi-Fi, Li+WiFi*

1. Introduction

Vehicular accidents in Zambia have become one of the worrying and growing concerns to most Zambians in recent times. This is as a result of the tremendous negative effects of road traffic accidents on human lives, properties and the environment.

Many researchers have come out with the causes, effects and recommendations to vehicular accidents, which include drunk driving, machine failure and over speeding just to mention a few. Yet every year there seems to be an un-ending situation with regard to road accidents in Zambia.

As the need for highway traffic monitoring grows, public appreciation of the problems in this area remains poor. In general, the public believes that monitoring should be relatively easy and does not understand either the importance or the cost. Because public perception drives legislative decisions, the lack of support has created a crisis in highway agencies across the nation as staff resources are constrained. Although the burden to build new highways lessens, highway agencies are desperately trying to maintain the existing infrastructure in a safe condition and at the same time provide the level of service that highway users have come to expect. None of these things can be accomplished without understanding how highways are used. Therefore, close monitoring of the usability of the highway users should be analyzed by the highway agencies in the country in order to reduce abuse of the use of the road and prevent accidents on human lives, properties and the environment.

This paper suggests the used of Visible light communication (VLC)technology combined with Wi-Fi technology to monitor highway traffic where LED will transmit data such as the speed at which the vehicle is moving at, the weight of the vehicle while on the road, the details of the vehicle and the proprietor's details to the highway agencies. Visible light communication (VLC) is a new way of wireless communication using visible light. Typical transmitters used for visible light communication are visible light LEDs and receivers are photodiodes and other sensors.

Hema Patel (ud) explains that LiFi will offer the possibility of car-to-car communication using LED, allowing development of anti-collision systems and exchange of information about driving conditions between vehicles. Traffic lights that already use LED lighting can also be used so it provides the opportunity to manage traffic systems. This would also enable car systems to download information available on the network regarding optimal routes to take, and update the network regarding conditions recently experienced by individual vehicles.

Global view of road traffic accidents

About 1.2 million people die and 50 million others are injured on the world's roads each year. An estimated average of 3,242 people die daily from road accidents (WHO, 2004). The same report has ranked the worldwide leading causes of death by age as follows; 0-4-year olds (14th), 5-14-year olds (2nd), 15-29-year olds (1st), 30-44-year olds (3rd), 45-69-year olds (8th), and 70 + year olds (20th). These data suggest that globally, the leading cause of death is road traffic accidents is among 5-29-year olds. Official statistics from police reports suggest that in 2005 alone, 41,600 people were killed and over 1.5 million were injured in road traffic crashes in the European Union member countries (ETSC, 2007).

At present, road traffic fatalities are the 9th leading cause of death and disability in the world.

The World Health Organization (WHO) has described them as 'hidden epidemics' and has forecast that they will be the 5th leading cause of death worldwide and the 2nd leading cause of disability-adjusted life year losses in many developing countries by 2030 (Murray and Lopez, 1996). These projections are expected to bring about 2.4 million fatalities annually. Also, the International Federation of Red Cross and Red Crescent has observed that the road traffic burden is "a worsening global disaster destroying lives and livelihoods, hampering development and leaving millions in greater vulnerability" (Cater & Walker, 1998; cited in Ameratunga et al., 2006, p. 1533).

Zambian view of road traffic accidents

According to (RTSA 2012), accidents in the country have greatly gone up in the recent years.
They further explain that in the second quarter of the year 2011, the country recorded 5,402 road traffic accidents in which 399 people died. In the third quarter of the same year, the figure had gone up to reach 5,975.
A total number of 450 people died which reflected an upward percentage of 51 compared to the second quarter figures of the same year.

Therefore, we have suggested a system which can mitigate this problem by use of synchronizing LiFi with Wi-Fi in monitoring traffic in Zambian highways.

Working of Li-Fi

According to Subarna Panda et al (2013) Li Fi Technology utilizes the principles of VLC (Visual Light Communication). Here, the working logic is very simple, if the Bulb is turned ON then Digital 1 is transmitted otherwise if Bulb is turned OFF then Digital 0. The LED can be turned ON and OFF very frequently causing a flickering signal that is used for transmitting signal across devices. In a Li Fi model one end consist of the light emitter (LED) and on the other end that's receiver's end, we should have light detector (Photodiode). The Photodiode gains a binary 1 when LED is ON and Binary 0 if it is OFF. To have a data rate of hundreds of megabytes per seconds, different colored LEDs are used. Encoding and Decoding the data involve in communication while transmitting/ receiving it, is one of the most important steps that need to be follow to accomplish an error free transmission. Therefore, we can use various Encoding/Decoding techniques like 4B/5B, NRZ, Manchester, Differential Manchester, etc. with dedicated quantization bit. To accomplish this, we just need a microcontroller and a transceiver. By this we can theoretically achieve the speed of 10 Gigabytes per second. Just like the Encoding and Decoding, Modulation and Demodulation techniques are also very important for the signal that is involved in communication.

The LED flickers at very high speed. Its high enough that the data is transmitted and human eye can't even come to know about it. It appears constant glowing to human eye. Various Multiplexing techniques can be used to achieve a communication rate or transmission speed of more than 100 Megabytes per second. Parallel Transmission of data can be achieved by the array of LEDs where each LED will be transmitting a different stream of data.

Wi-Fi

Wi-Fi - is a short name for Wireless Fidelity, and this system was released during 1990 with standard IEEE 802.11. This technology was designed to provide wireless connectivity to devices that require

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a quick installation, such as portable computers PDAs or generally mobile devices inside a WLAN network.

IEEE 802.11b enjoys international acceptance, as the 2.4-GHz radio frequency band is almost universally available and no license is needed 802.11b hardware can transmit data at speeds of up to 11 megabits per second.

Hybrid LI-FI WI-FI

WI-FI and LI-FI coexistence in this scenario is the utilization of WI-FI on the external transmission of data using the internet and the LIFI shall be use on inter vehicle communication and internal communication within the vehicle. Because luminaries are distributed throughout our living spaces, it is often possible to "see" more than one at a time. This fact can be exploited using a multichannel receiver. Imagine that the lighting infrastructure is potentially enabling MIMO transmission using a multi-detector user devices (UD). However, reconciling the optimal link or links involving one or more luminaries in the presence of multiple UDs is challenging. Multiple luminaries can send signals to multi-detector UDs to serve these multiple users in parallel. Note that such parallel transmission is common in RF communications, while multiple-source, multiple-access schemes, also including multi-color luminaries are only just emerging from early lab prototypes. The handover mechanism may also involve information about UD location, which can be realized using both technologies, while LiFi is probably more precise.

Inter-vehicle Services

Vehicle-to-vehicle communication can be used to disseminate messages of multiple services generating their content using sensors within the vehicle. These services can include accident warning, information on traffic jams or warning of an approaching rescue vehicle. In addition, information on road or weather conditions can be exchanged. More elaborate inter-vehicle services are direct collision warning or intersection assistance with information on cross traffic.

Services of Road Side Units (RSU)

Communication between vehicles and road side units (RSUs) can also increase safety. Traffic lights or road signs could be equipped with a communication device to actively inform vehicles in the vicinity. Hence, drivers can receive information on traffic flow, road conditions or construction sites directly from the respective RSU. In addition, static hazard areas, e.g. construction sites, could be equipped with an RSU to warn surrounding vehicles. RSU-based services will play an important role during the introduction phase, since they are almost unaffected by the penetration rate. Traffic lights and cars can talk to each other which indeed helps to reduce accidents. So, it gives the opportunity to manage traffic structures. This would also permit vehicle structures to download facts to be had at the network regarding most efficient routes to take, and update the network concerning situations currently skilled with the aid of person automobiles.

Capabilities of the LiFi Transceivers

Li+WiFi has been tested using bidirectional high-speed LiFi transceiver devices that satisfy real-time data delivery and achieve layers 1 and 2 of the OSI protocol stack. The device, the principle of which uses a conventional lighting-grade high-power phosphorus-converted LED (PC-LED) and it realizes both functionalities in parallel, illumination and data transmission. A proprietary LED driver is used to enable an analog modulation bandwidth of up to 180 MHz. At the receiver, a large-area high-speed silicon PIN photodiode is used together with a trans-impedance amplifier (TIA). A plano-convex 1” lens is used at both the LED and the photodiode to concentrate the beam and to enlarge the receiving area, respectively Behind the analog transmitter and receiver circuits, a digital baseband unit (BBU) is used to convert Ethernet packets into DC-biased orthogonal frequency division multiplexing (OFDM) signals and vice versa. The OFDM signals have a bandwidth of 70 MHz. The BBU performs pilot-assisted channel estimation and frequency-domain equalization to reconstruct the received symbol constellations. From the received pilot sequence, the error vector magnitude (EVM) is measured and this information is fed back to the transmitter. Depending on the channel quality as a function of frequency, the bit loading is adapted. The data rate is increased as much as possible so that no errors occur after forward error correction. Thanks to the techniques used in link adaptation, implemented in real-time as a closed-loop, the achievable data rate is realized while avoiding outages due to changing channel conditions such as varying illumination levels. The relation between the data rate and the illumination level is explicitly given in (L. Grobe et al: 2013)

PROPOSED SYSTEM DESCRIPTION

In this section, we have suggested a design a highway Traffic Monitor checker circuit to detect the rash driving and its net weight by using Weigh-In-Motion technology which estimates the weight of a moving vehicle and the portion of that weight carried by each axle with different electronic components such as timer, counter, logic gates, seven segments display and all other components.

Fig.1 shows the typical block diagram of highway Traffic Monitor checker to detect rash driving on highways and its net weight using a Timer which consists of sensors module, logical module, power supply, weight detector, wheel pressure detector, speed detector and display module, as well as a GPS module.

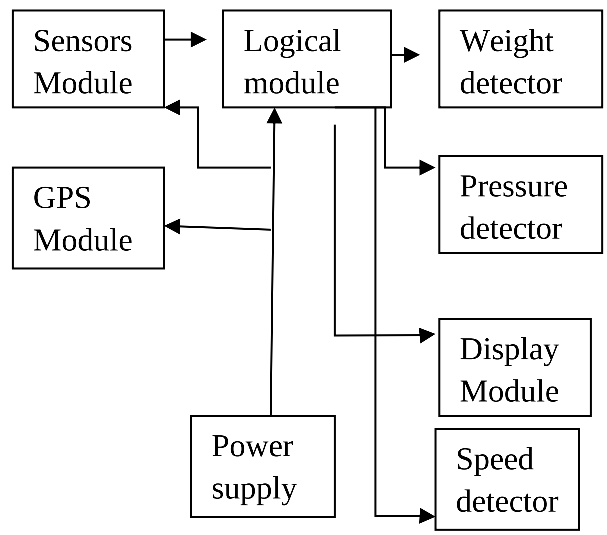

Fig.1 Block diagram of Highway Traffic Monitor Checker Vehicle using Timer

A photodiode can be used as sensor which is a type of photo detector capable of converting light into either current or voltage, depending upon the mode of operation.

The ad hoc network will comprise of two node types: mobile nodes (vehicles) and fixed nodes (Integrated in Traffic lights or road signs) deployed at the roadside. The number of fixed nodes in the network will be small relative to the number of mobile nodes. A subset of these fixed nodes will be connected to external networks. Each public transport will be equipped with a telemetric platform interfaced to on-board systems. Through

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this platform data will be collected and analyzed from on-board sensors.
These sensors may include,

- Weight sensor
- Wheel pressure sensor
- Speedometer sensor

It is proposed that vehicles are going to obtain positional information from on-board GPS receivers.
All nodes are equipped with a processor, memory and digital communication equipment. Nodes organize themselves into a number of local ad hoc networks (or clusters). At this local level, a proactive
routing scheme should be adopted so that communication between nodes in the same cluster is responsive. Vehicles should advertise their presence to their immediate highways agencies by transmitting periodic beacons. These beacons are essentially empty packets with information contained only in the packet header. Information contained in the packet header is summarized in Table 1;

Field Name	Description
Node ID	Unique identifier
Time	Time packet was transmitted.
Destination	ID of destination road
Location	Geographical location of originating vehicle
Velocity	Velocity of originating vehicle
Weight	Net weight of originating vehicle
Heading	Navigational heading of vehicle

Table 1: Summary of packet header

On receipt of a beacon message, the 'node id' of the originating vehicle is added to a list of highways agencies and to neighbouring fixed nodes. The neighbouring fixed nodes regularly scan this list to determine link states. If no beacon message is received from a vehicle in the list, after a given period of time the vehicle is considered broken down. This process enables link-state information to be constructed and maintained for the local ad hoc network.

Conclusion

The coexistence between Wi-Fi and LiFi is a new promising research area. We have discussed the primary characteristics of both technologies and the possibility for them to coexist. We have demonstrated that a close integration of both technologies enables off-loading opportunities for the Wi-Fi network to free resources for more mobile users because stationary users will preferably be served by LiFi. In this way, LiFi and Wi-Fi can efficiently collaborate. We have referred to several similar works which suggest the coexistence of LIFI and WIFI and demonstrate proof-of-concept results, using state-of-the-art LiFi and Wi-Fi frontends, that both technologies together can more than triple the throughput for individual users as well as traffic users and offer significant synergies, yielding a combined solution that can adequately address the need for enhanced communication in highway monitoring in order to reduce traffic road accidents in Zambia .

REFERENCES

[1] J. Rani, P. Chauhan and R. Tripathi, “Li-Fi (Light Fidelity)-The future technology In Wireless communication” International Journal of Applied Engineering Research, ISSN 0973-4562 Vol.7, No.11, 2012

[2] K.S. Kapre (2015), “Road Traffic Management and Safety Using Li Fi Technology”, International Journal of Advanced

[3] L. Grobe, A. Paraskevopoulos, J. Hilt, D. Schulz, F. Lassak, F. Hartlieb, C. Kottke, V. Jungnickel and K.-D. Langer, "High-speed visible light communication systems," IEEE Communications Magazine, vol. 51, no. 12, 2013

[4] Research in Science Engineering & Technology, vol.2, no. 12.

[5] Road Transport and Safety Agency- First Quarter Report (2010), Lusaka

[6] Road Transport and Safety Agency- First Quarter Report (2011), Lusaka

[7] Road Transport and Safety Agency- Second Quarter Report (2012), Lusaka

[8] Rodgers, E.M (1983). Diffusion of Innovations. New York: Free Press

[9] Subarna Panda, MdSoyaib, Dr. A. Jeyasekar” Li-Fi Technology Next Gen Data Transmission through Visible Light Communication International Journal of Innovative Research in Science, Engineering and Technology Volume 4, Special Issue 11, September 2015

[10] United Nations Development Program (1999). Washington DC

[11] Vajpayee, S. Khandelwal and A. Ratawa, “5G Technology using LI-FI (Light Fidelity)”, Journal of Global Research Computer Science & Technology, Vol.-III, Issue-VIII, July 2015.

[12] World Bank- Zambia (2012). Washington DC

[13] World Health Organisation (1994). International Statistical Classification of Diseases and Related Health, 1989 Revision, Geneva