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The Next Generation of Wireless Communication in Navigation System Using Light Fidelity Technology

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ABSTRACT: This paper presents a smart navigation system by using Li-Fi technology. The light fidelity technology refers to visible light communication (VLC) that uses light as a medium to deliver high-speed data in a manner that is much greater than that of Wi-Fi. Over here we demonstrate a hardware prototype that is developed using the Arduino microcontroller platform to explore the possibilities of using Li-Fi in routing. The transmitter and receiver sections contain atmega328p which is programmed by using Arduino IDE. High-intensity LEDs are used in the transmitting section for delivering high-speed data to moving vehicles. In the receiver end, the LDR module is used to detect the signal generated by the LEDs. According to the received signal, the information of current location and further diversions is displayed on the LCD installed at the receiver. We wish to reduce the dependency on GPS devices and make Li-Fi a commonly used technology for the future. Thus, this technology is more useful for automatic navigation in rural areas.

KEYWORDS: Visible light communication (VLC), light-fidelity (Li-Fi), light emitting diodes (LEDs), photo-detector, Wireless communication.

I.INTRODUCTION

Wireless-fidelity, and many other wireless communication technologies used meanwhile, operate in the radio frequency (RF) band. However, due to the crisis of the over- crowded RF band, which ranges from interference, limited bandwidth to fear for human safety, exploring efficient alternatives is a must. The Radio-frequency band is only a small portion of the electromagnetic spectrum available for data transfer. A German physicist Harald Haas proved the possibility of using visible light for data transmission. He introduced the technology of light-fidelity, which is based on visible light communication (VLC) technology. It is a short-range wireless communication system where the light generated by a light- emitting diode (LED) acts as the medium for the data transmission. Light-Fidelity can contribute much more than the existing technologies. It is an emerging technology with high data transmission rates, safety for human use, and security. Moreover, the illumination from the same source reduces the infrastructure complexity. Recently, the Li-Fi technology has attracted the research community, addressing the promising potential of the integration of Light fidelity into basic lightings. The Li-Fi products have experienced mark able improvements in the market, and several products are being sold with increasing data rates and easy installations. VLC is a version of data communication systems that uses visible light for communication. The band range varies from 380 nm to 750 nm in the electromagnetic spectrum, which corresponds to a frequency spectrum of 430–790 THz. Since the visible light spectrum is 10,000 times larger than the RF spectrum, VLC is regarded as a solution to Radio Frequency bandwidth limitations.

II.LIGHT FIDELITY TECHNOLOGY

The Li-Fi technology overcomes several inefficiencies of the current wireless communication (WC) technologies using the RF band (e.g., Wi-Fi, IrDA, and Bluetooth). One of the biggest struggles of the RF band is ‘‘spectrum crunch’’, which is the incapability to keep up with the huge demand of wireless communication (WC) and high data rates due to the limited bandwidth. Moreover, low data rates, security and human safety concerns are other significant downgrades

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of the RF band. Thus, an alternative is a must, and Li-Fi proves to be a suitable candidate for this purpose. It can be seen as a preceding technology when compared with other wireless technologies from the following viewpoints:

Capacity: Since Li-Fi works with the visible light spectrum, it provides 10,000 times more license-free bandwidth of the entire Radio Frequency spectrum.

Speed: Light Fidelity can transmit data at a high speed of more than 1 Gbps, which reaches up to 10 Gbps, due to low visible light interference, exceeding all current Radio Frequency technologies (Wi-Fi range of 150 Mbps and Bluetooth range of 3 Mbps). It should be mentioned that the traditional Shannon framework is not applicable for computing the transmission of data rate.

Efficiency: The core technology of Li-Fi is LEDs, and hence, it is more efficient in terms of energy consumption and construction cost.

Availability and Safety: Light Fidelity is an environment-friendly technology that does not possess any health concerns since it uses VLC as the medium, unlike RF technologies, which has safety as a major concern. In hospitals prohibit using Wi-Fi in some areas such as operation theaters, as it interferes with other devices, blocking the monitoring equipment's signals.

Security: ''If you can't see the light, you can't able to access the data!''. Light waves are incapable of penetrating walls, which makes them invulnerable to interception and misuse of data.

III.WORKING PRINCIPLE

The significant concept behind the Li-Fi technology is wireless data transmission through visible light. The working principle of Li-Fi is quite similar to that of Wi-Fi, as both transmit and receive data wirelessly. In general, to obtain a working Li-Fi system, there should be a transmitter on one end (i.e., LED light) and a receiver on the other end (i.e., photodetector) for the data transmission. LED selection plays essential role as the data rate in a Li-Fi system can be related to LED. Parameters like ON-OFF speed and the number of LEDs can affect the data of the communication. If the ON-OFF speed of LED is fast, then data can be transmitted at high rates in the form of 1's and 0's. Higher the number light intensity with a maximum flickering of LED's in a system results in more transmission of data.

Transmitter

Encoding data into the light for transmission is achieved by varying the light intensity of the LED, which causes the LED to flicker ON and OFF at a very high speed. These flickers represent the data being transmitted. When the LED is switched ON, it logically represents the transmission of a ''1,'' and when it is switched OFF, it transmits a ''0.'' A combination of 1s and 0s generates different data strings. However, the flickering speed is so high that the LED appears to be constant to the human eye, causing no harm to it.

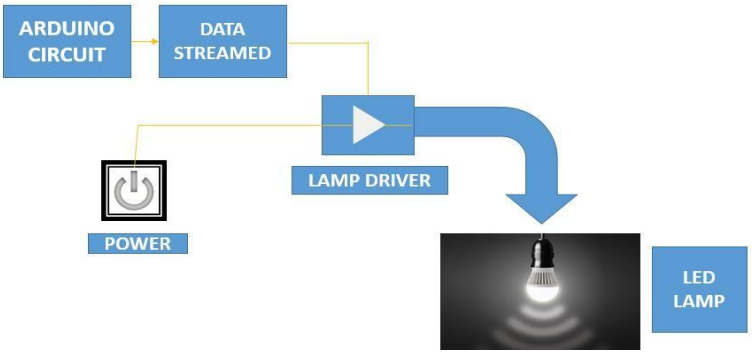

Fig. 1 Transmitter section

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Receiver

Data reception is the function of the dongle, or more specifically, the PD within. A PD detects the light source and converts the changes in its intensity into an electrical signal. When the LED flickers ON, the PD registers a binary 1; otherwise, it registers a binary 0. Then, the received data are amplified, processed, and forwarded to the user.

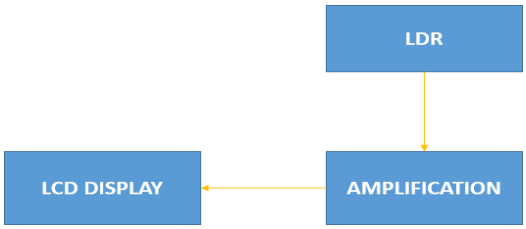

Fig. 2 Receiver section

IV.LIMITATIONS AND PREVIOUS STUDIES

Li-Fi is a promising technology, but like any other emerging technology, it has its downsides. Following are the major limitations of Li-Fi.

1) It requires a perfect line-of-sight to receive data.

2) Light cannot pass through objects; thus, if the receiver is blocked by an opaque object, then the signal is immediately cut out.

3) There is interference from other light sources such as sunlight and normal bulbs. However, most new Li-Fi products have overcome this limitation, since Li-Fi depends on detecting the fast changes in light intensity and not on the slowly varying levels caused by natural disruptions in daylight or sunlight. A team from Pure Li-Fi Company has tested the company's Li-Fi receivers outdoor under 77,000 Lux of sunlight.

4) It is a short-range wireless communication system. However, Professor Harald Hass has mentioned that huge improvements in data rates, ranges and coverage have been reported.

Year	Author	Main Contribution
2006	Prof. Harald Haas, Dr. Mostafa Afgani, Hany Elgala, and DietmarKnipp	Working on the idea that data can be transmitted through LED bulbs. Demonstrating that it is possible to turn commercially available (LED) light bulbs into wireless transmission system.
2010	Prof. Harald Haas, Dr. Mostafa Afgani and Dr. Dr. WasiuPopoola	The D-Light project's objective was achieved successfully with 102.5 Mbps data transmission measured under normal lighting condition.
2011	Prof. Harald Haas	Introduced the term Li-Fi to the world in a TED global talk. Companies and industry groups formed the Li-Fi alliance.
2012	Group of researchers from the universities of Edinburgh, St. Andrews, Strathclyde, Oxford and Cambridge.	Research project called UP-VLC. Achieved record data transmission speeds of 10 Gbps.

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2014	Fujitsu Laboratories	Developed a technology that can modulate the color of the light emitted by the LED's in a way that it can embed ID data in the light that is cast on the object.
2016	Zubin Thomas, Nikil Kumar and D. JyothiPreshiya.	Developed an automatic billing system using Li-Fi mobile 2010.

V. RESULT AND DISCUSSION

In this project we received the following results on the poles used by us.

Current Location	Previous Location	Upcoming Location
Pattabiram	Avadi	Jaya College

In fig. 3 the light source is transmitting the stored data by fluctuating the intensity of it, in the form of 0's and 1's.

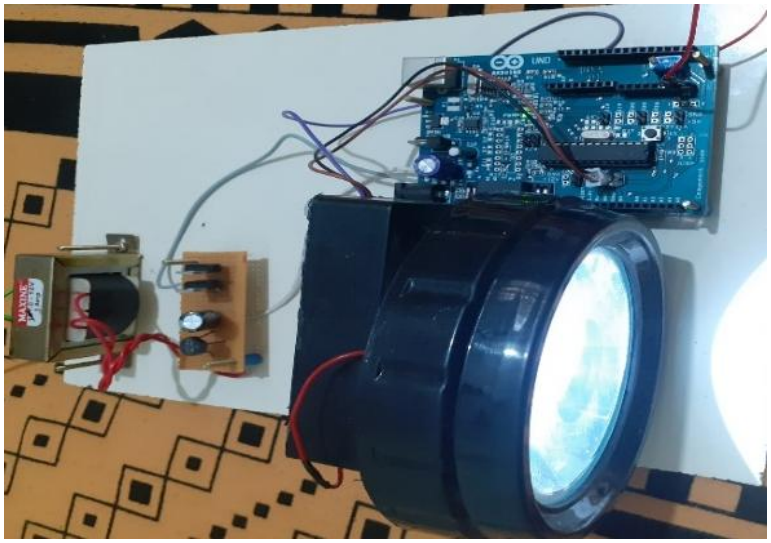

Fig. 3 Transmitter section

In fig. 4 the fluctuating light as been captured by the LDR and using the LCD the retrieved data is been displayed.

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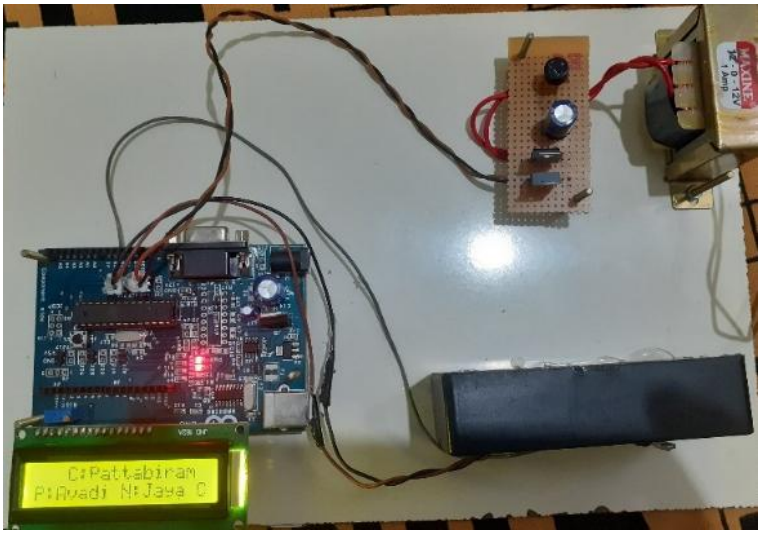

Fig. 4 Receiver section

VI.CONCLUSION

The Light Fidelity technology is spreading exponentially because of its faster data transmission, secure content transmission and increased capacity than Wi-Fi. Transmission and Reception of information takes place in form of visible light energy which issued for navigation through street light. The transmission of pre-determined data using the visible light spectrum allows light to modulate at high data rate. So,that the data can be picked by receivers which are equipped with light sensors at very high speed of hundreds of megabytes per second, enabling the visible light source to transmit data. The utilization of Li-Fi technology provides agreat chance to replace RF-based wireless technologies. This technique could result in extremely beneficial in managing traffic and user friendly for the travelers, there by setting a smart city.

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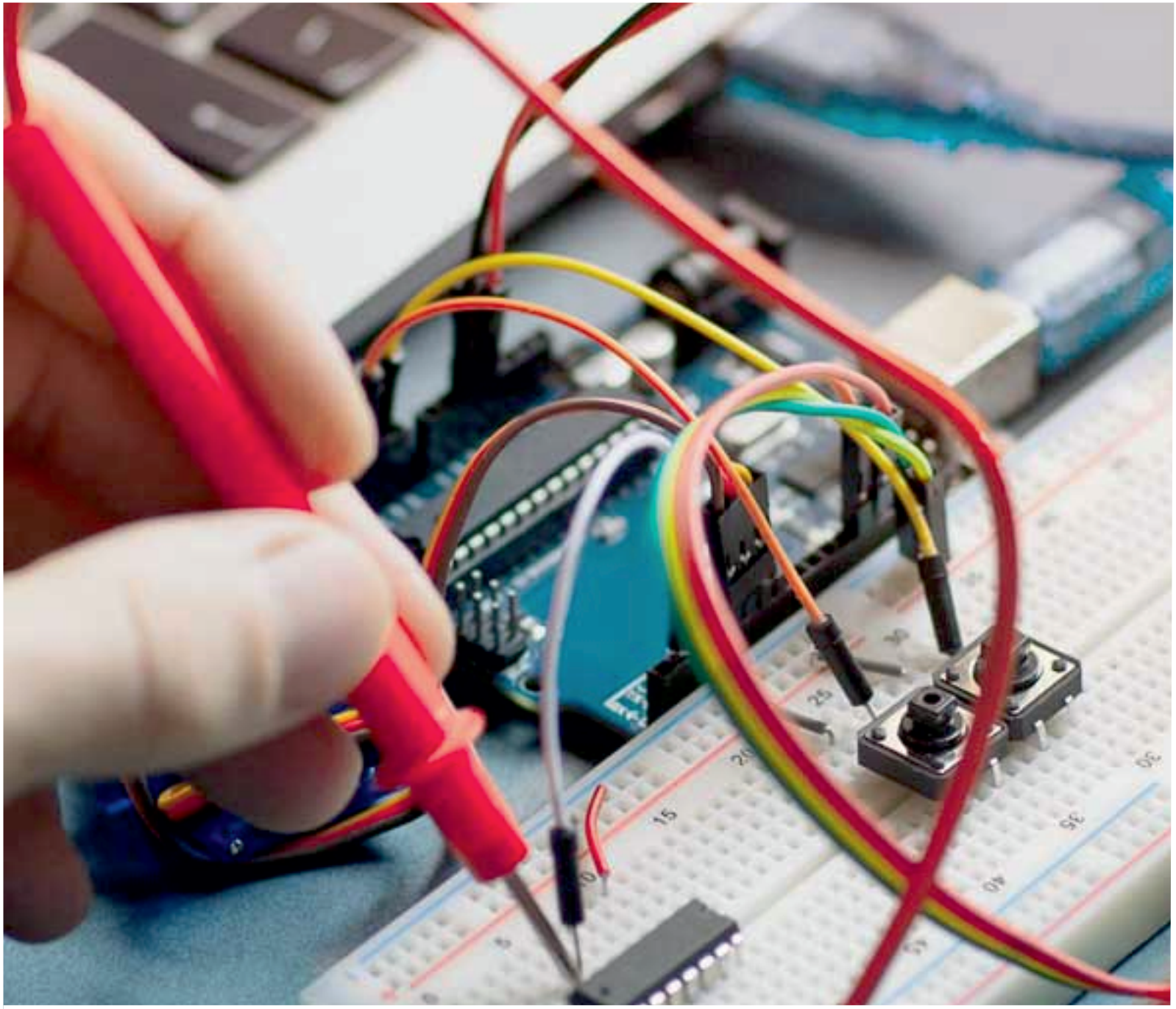

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