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Highway navigation system using light fidelity technology

Pramod B. N.
pramodbn001@gmail.com
Atria Institute of Technology, Bengaluru, Karnataka

Sumitha B. S.
sumitha.bs@atria.edu
Atria Institute of Technology, Bengaluru, Karnataka

Pavan Angadi
pavanangadi1999@gmail.com
Atria Institute of Technology, Bengaluru, Karnataka

Nitish Nishant
nitishnishant29833@gmail.com
Atria Institute of Technology, Bengaluru, Karnataka

Manu S.
sureshmanvith136@gmail.com
Atria Institute of Technology, Bengaluru, Karnataka

ABSTRACT

This study shows how Li-Fi technology can be used to create a smart highway navigation system. Light fidelity technology is a type of visible light communication that employs light as a medium to transmit high-speed data at a rate far faster than Wi-Fi. Here, the proposed prototype is tested using PROTEUS 8 professional software to see what potential there are for employing LiFi in highway routing. Atmega328 is used in the transmitter and receiver portions, and it is programmed using the Arduino IDE. The transmitter component uses high-intensity LEDs to convey high-speed data to moving cars. The LDR module is also utilised in the receiver section to detect the signal generated by the LEDs. On the receiver's LCD, information about the current location and future diversions is presented based on the received signal. As a result, this technology is better suited to automatic navigation on motorways and wide roads.

***Keywords*:** Li-Fi, Wi-Fi, VLC, LED.

1. INTRODUCTION

Travelers to rural places frequently find it challenging to find their way onto the correct path. The problem worsens at night due to a lack of visibility and GPS failure because mobile networks are not available everywhere on the roadway for navigation [1]. If there is another way to supply the passenger with the correct path and position at that moment, it will undoubtedly lessen anxiety and inspire more people to go on a road trip [2]. As a result, we recommend installing Li-Fi in streetlights to solve this problem. In the field of wireless communication, Li-Fi (light fidelity technology) is a relatively new technology [3]. It's part of the PAN IEEE 802.15.7 standard for visible light communication (VLC) [4]. It is the transport of data via visible light, using LED bulbs that switch quicker than the human eye can detect. Li- Fi is a wireless communication system that is an improved version of Wi-Fi. It differs from Wi-Fi in every way, including data transfer rates, security, high frequency and bandwidth, and so on [5]. We live in an era where we are constantly surrounded by wireless technology such as cell phones, Wi-Fi, IoT, and so on. Everyone nowadays wants most items to be based on wireless technologies. It encompasses the use of radio waves for communication, such as Bluetooth and Wi-Fi, as well as the newer Li-Fi technology. LEDs are used in the Li-Fi technology to transmit data [6]. Li-Fi is rapidly gaining traction in the industry since it is faster and more secure than other wireless technologies and can transport data at a high rate. Many studies are being conducted in these sectors, such as "Li-Fi: The Path to a New Mode of Communication" [7]. Microcontrollers in these units have previously saved data (i.e. direction indications). When a vehicle comes within range of these poles' visible light, the data is transmitted to that vehicle. The available information is presented on the LCD in the car that is connected to the receiver [8]. This Li-Fi-based highway navigation system will also provide travelers with information about their current location and all the divergences ahead, thanks to the LEDs that are employed in streetlights for lighting. This concept has a broad future reach because it can assist in the setup of both outdoor and indoor navigation systems [9]. The major goal of our article is to develop a navigation system for regions such as highways and broad lanes that uses Li-Fi technology to provide autonomous navigation for travelers. This will transform highway routing by providing a superior alternative to GPS systems.

2. AN OVERVIEW OF THE SYSTEM

Figure 1 depicts the steps involved in the system.

3. DESIGN COMPONENT

The transmitter and receiver are the two most important components in this project. The signal is transmitted using LEDs, while the signal is received using LDRs. A white light LED, 16MHz crystal oscillator, buck converter for 5V voltage regulation (LM2596), LED driver circuit, Tip 122 Darlington transistors, LDR module, Microcontroller AT Mega 328, LCD, and Buzzer are used in the design.

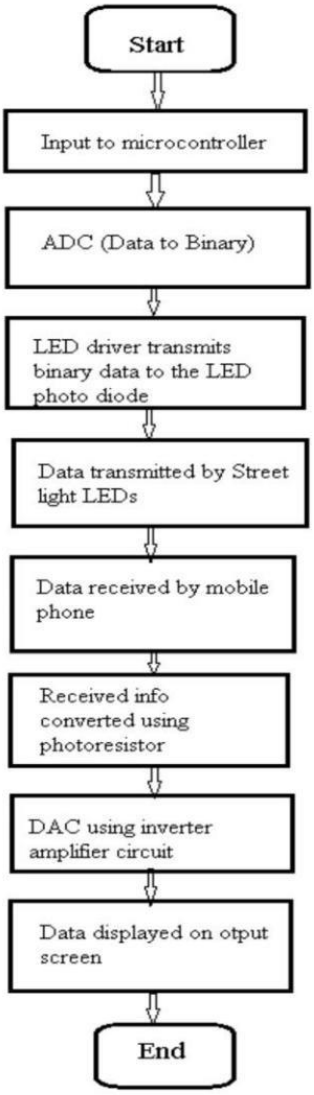

Fig. 1: Flow Chart describing the steps involved

First and foremost, the suggested system is based on PROTEUS 8, a professional software package. After the results have been determined to be satisfactory, hardware is designed. The entire system is divided into two sections: one for the transmitter and another for the receiver.

2.1 Transmitter

The transmitter is made up of the following components, with the circuitry shown in Figure 2.

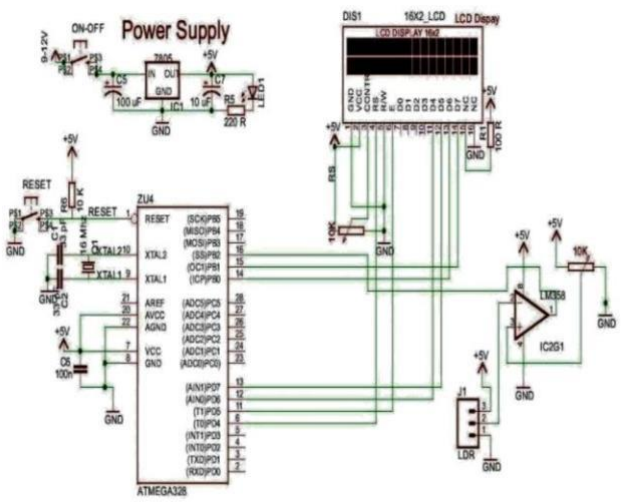

Fig. 2: Transmitter Section

a. Light Emitting Diode (LED)

When a light -emitting diode is turned on, electrons are released and recombine with holes within the device, releasing energy in the form of photons. This phenomenon is known as electroluminescence, and the colour of the light (corresponding to the photon's energy) is determined by the semiconductor's energy band gap. Longer longevity, lower energy usage, increased physical robustness, and faster switching are just a few of the advantages LEDs have over incandescent light sources.

b. Crystal Oscillator

This transmitter's Crystal Oscillator operates at a frequency of 16 MHz. It maintains a regular clock pulse in the circuitry by providing a constant frequency to the circuit.

c. Voltage Regulator

A voltage regulator is used to generate a constant output voltage of a circuit in response to changes in the input voltage. We may have 9V in, but if we only want 5V out, we'll need to use a voltage regulator to step it down (Buck). For voltage regulation in the transmitter, we employed a single trimmer buck converter in our prototype. This shields and protects your electronic circuitry from any possible damage.

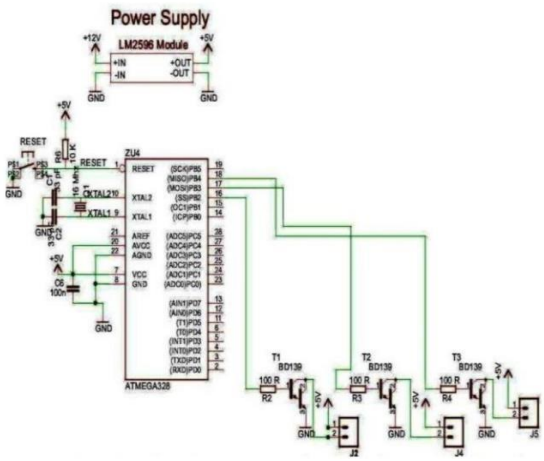

Fig. 3: Receiver Section

2.2 Receiver

The signal is received by the receiver using a photo detector and light flashing. The receiver converts the slight changes in the quick dimming of LED lamps into an electrical signal. It consists of the following components, with circuitry depicted in Figure 3

a. Photo Resistors

A Light Dependent Resistor (LDR) is utilized in this project for the purpose of photo detection. An LDR is a component having variable resistance that changes when the intensity of the light falling on it changes, i.e. it is photoconductive. As a result, light sensor circuits can use LDR.

b. Buzzer

A buzzer is a small sound generator that is used in electronic circuits to provide audio feedback. It is commonly employed in electronic equipment as an alarm generator. It comes in a variety of styles and sizes to meet your needs. When the buzzer is turned on, the oscillator generates a frequency that causes the element to vibrate, producing the sound. A standard buzzer operates between 3 and 12 volts DC.

c. Liquid Crystal Display

We used a 16x2 LCD panel, which is a basic LCD module, in our project. A 16x2 LCD can display 16 characters per line, and

there are two such lines in a single one. Each character is presented in a 5x7 pixel matrix on this LCD. This LCD features two registers: a Command register (for inserting a particular command into the LCD) and a Data register (for reading data from the LCD) (to insert a data in LCD). A command is a set of data that is used to deliver internal commands to the LCD, such as clearing the screen, moving to the next line, and so on.

3. WORKING

Compared to Wi-Fi, Li-Fi has a number of advantages. In LiFi, LEDs are employed for both illumination and data transmission, whereas in Wi-Fi, data is transmitted through electromagnetic waves. This is a new technology that is being employed in a variety of applications such as security, navigation in metropolitan areas, cellular communication, and so on. Before being sent to the LED driver circuit, the data is transformed into a 0-1 format in this method. In the transmitter, there is a microcontroller that has highway route data loaded in it. Figure 1 shows the proposed design. It is made up of three poles, each of which has an LED as a transmitter for transmitting data. We used an automobile as the receiver, which has an LDR module that absorbs the light from the LEDs. The detected signal is then passed on to the microprocessor, which translates the light into data, and the current location as well as the anticipated divergence are displayed on the LCD in the automobile. Additionally, a buzzer is utilized to sound an alarm.

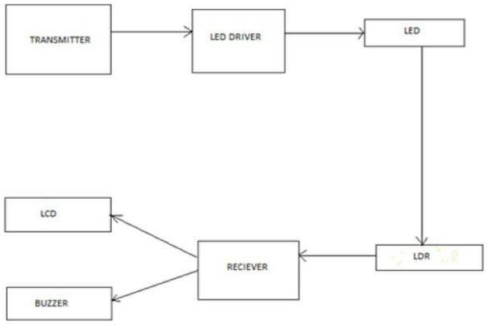

Fig. 4: Flow Chart of the proposed prototype

4. RESULT AND DISCUSSION

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

POLES	POSITION
1	MG Road
2	Malviya Nagar
3	Library

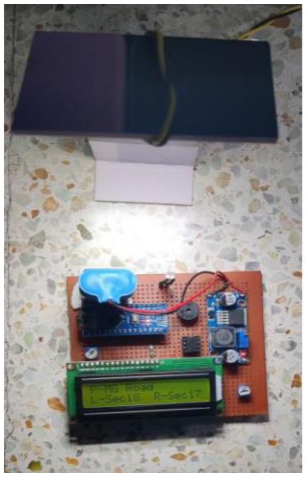

Fig. 5: Pole 1 output (Location - MG Road)

Fig. 6: Pole 2 output (Location – Malviya Nagar)

Fig. 7: Pole 3 output (Location - Library)

5. CONCLUSION

The navigation use of LiFi technology has been effectively described in this study. Li-Fi technology is rapidly gaining traction since it is faster, more secure, and has a higher capacity than Wi-Fi. Information is transmitted and received in the form of light energy, which is used for highway navigation. The concept of transmitting data using visible light allows light to modulate at a fast pace, allowing it to be picked up by receivers equipped with light sensors at speeds of hundreds of gigabytes per second, allowing the light source to communicate data. The use of Li-Fi technology has the potential to completely replace radio-based wireless technologies. This method could be immensely useful in traffic management and, as a result, in the creation of a smart city.

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