

## Highway Navigation System Using Li-Fi

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### ABSTRACT

Light is present everywhere as street lamp and traffic light. Imagine that all these light bulbs are high speed wireless transmitter that connects either human to human or systems with systems. In recent times the using of internet is rapidly increase which leads to radio waves being widely used. Long distance data transmission makes use of this spectrum. It has become difficult to keep up with the demand for the high speed connectivity as the number of users is increasing. An alternative and advantageous replacement can be visible light communication (VLC). In this paper, Li-Fi technology is used to build the highway navigation system. The Li-Fi technology based on the visible light communication and it is one of the applications of VLC. Frequently we have to navigating one place to another place. The major issues faced by drivers are navigating at night. Low battery of mobile phone or network connectivity issues are the major problems to use the Gmap. This paper proposes a system which aims to provide efficient and secure communication between vehicles and the street light. To improve safety and reduce accidents in roads at night we are using this system. In this system, LED lights embedded in the highway street light that act as a data transmitter and the receiver are installed on vehicles like car, truck to receive and process the data without using internet. The received information is then displayed on a display screen in the vehicle, such as current location and future diversions. This system is alternate solution for the road navigation board system. In this system the Arduino UNO is used in the transmitter and receiver portions, and it is programmed using the Arduino IDE. The overall the highway navigation system using Li-Fi technology to improve traffic safety and efficiency while reducing the environmental impact of transportation.

**Keywords:** Wireless communication; VLC; Li-Fi; Arduino UNO; Photodetector; Data transmission; LED; LCD.

### 1. Introduction

The radio wave band has been in use by a lot of people and with the increase in the population, the band is being overused. Nowadays, people depend on the internet for their necessities whether it is for learning or communicating. They wish to have a quicker internet connection for their work. In the current scenario, fast internet connection might not be great issue but in the future when there will be increase in the population, the large broadband would be missed [1].

One of the solutions to the problem of less bandwidth can be solved by the Light-Fidelity. The Li-Fi is analogous to Wi-Fi, the difference lies in the medium of data transmission. The Li-Fi uses the light waves to transmit the data while Wi-Fi uses the radio waves [2]. One of the important merits of using the Li-Fi is the large frequency bandwidth that the light waves offer. The project presents use of the Li-Fi in the navigation of roads inside a city or town during the night time. Usually for navigation we make use of the Google maps or other such navigation applications which make use of internet connection via the microwaves or radio waves. Navigation during the night is a difficult task and a map makes it quite easier [3].

This project makes use of Li-Fi to transmit the map on a device screen such as smartphone screen or a tablet. Various commonly used photo detecting devices available have been studied. Some of these include PIN, LDR (Light Dependent Resistor), APD (Avalanche Photodiode), SPAD (Single Photon Avalanche Diode) and solar panel. SPAD is efficient option in case of applications using Optical-OFDM (Orthogonal Frequency Division Multiplexing) as compared to other conventional photo diodes [4].



**Figure 1.** General structure of LI-FI communication

## 2. Literature Survey

M.Thanigave (2013) proposed Li-Fi or optical Wi-Fi, Li-Fi Technology is another milestone in the history of wireless communication. This technology comes to be ten times cheaper than the Wi-Fi and also much safer, because regardless of access control systems and passwords.

The system demonstrated in Devanshu Jhal, Chiragdeep Singh Malhotra, Abhishek Nanda (2017) - Nowadays, we use mobiles for communications on the go, whether that is through calling over the network, messaging, or using the internet services available to us [5]. Every time we try to connect to the internet via our home wireless router in every router and fail to do so, one tends to blame it on the company. Li-Fi works on the same ideas as Wi-Fi except, it uses light to transmit data instead of radio waves [6].

Nowadays, the highways have navigation boards. As per the direction and distance, the driver takes decision wherever he wants to go. The benefit of the proposed work is it maximizes the vehicle utilization, and also reduces the fuel cost, it improves route planning and helps to get real-time information to improve the time management. Li-Fi is a wireless communication technology which utilizes light to transmit data and position between devices. It allows high-speed transmission in both uplink and downlink simultaneously.

## 3. Proposed System

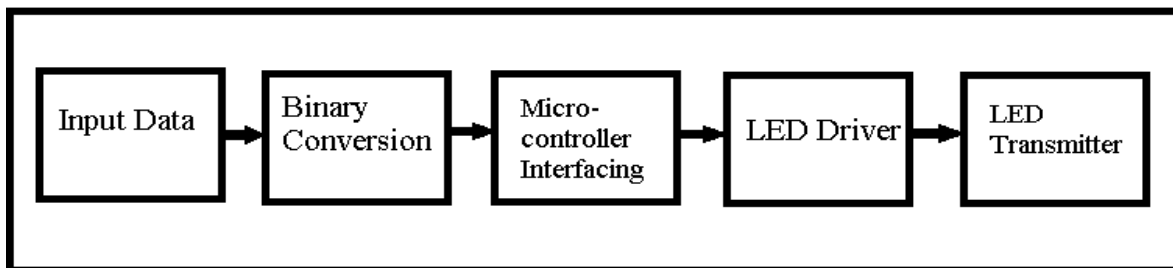
In our proposed system, the navigating system present at junction point which sends navigation information to all the vehicles via visible light. Used LIFI Technology for vehicle navigation which is better than IR. The navigating information received and shown in vehicle's display. This proposed system is an alternate solution for the existing system like GMaps, GPS, etc. Proposed system is having the following benefits.

- Traffic congestion will not take place.
- Driver gets navigating details before junction.
- Driver won't get confused when travelling in a complex junction highway.

#### 4. Design Methodology

##### Hardware Unit - Transmitter Section

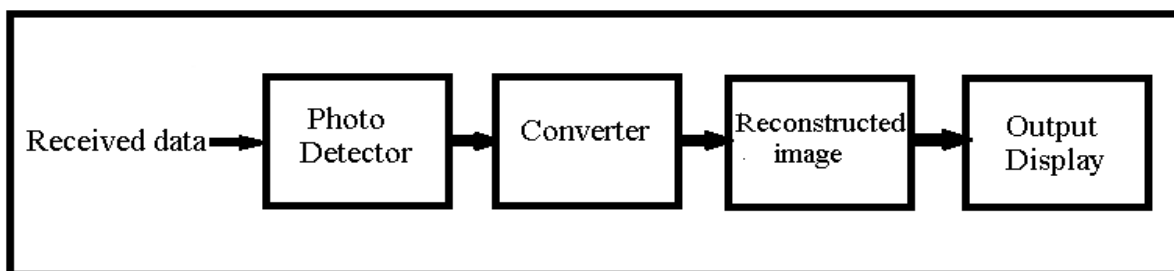
The system architecture consists of a transmit section and a receive section. The transmit section consists of the data input which is then fed into a switching control system. Based on the data, the switching control generates a stream of 1s and 0s also known as Intensity modulation (IM) thereby encoding 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 [7],[8]. This ON-OFF modulation of the LED light transmits the data.



**Figure 2.** Li-Fi Navigation system Transmitter section

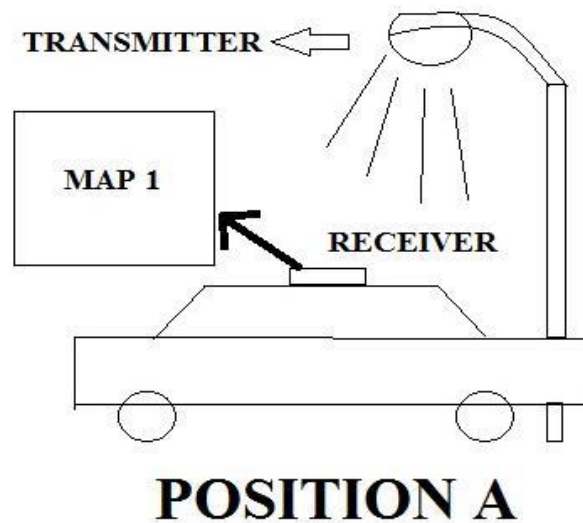
##### Receiver Section

The receiver section consists of solar panel as a receiver having high sensitivity. Photo detector such as LDR (Light Dependent Resistor) can also be used for same purpose. LDR detects the incoming received signal. Based on the sequence of 1s and 0s the signal is decoded. Then the decoded signal is sent to a signal conditioning unit, it is then fed to the microcontroller, which decodes that signal and then given to an output device such as a LCD Display.



**Figure 3.** Li-Fi Navigation system Receiver section

Arduino Uno comes with a built-in LED which is connected through pin 13. Providing HIGH value to the pin will turn it ON and LOW will turn it OFF.  $V_{in}$ . It is the input voltage provided to the Arduino Board. It is different than 5 V supplied through a USB port. This pin is used to supply voltage. If a voltage is provided through a power jack, it can be accessed through this pin. LCD is an electronic visual display which uses light modulating properties of liquid crystals as they do not emit directly. It is capable of displaying fixed and flat images. The LCD used is 2x16 grids in dimension. It displays the data of highway routes from the microcontroller into readable form by parallel communication. The Photo Detector is a sensor of light and electromechanical energy. It works in forward bias by absorbing light. In this paper the photo detector absorbs light from the light emitting diode. The photo detector picks up the signal which is converted back into a data stream and sent to the client. The client can communicate through its own LED output or over the existing network.



**Figure 4.** Receiver side of the proposed system

## 5. Working Principle

Project highway navigation is based on LI-FI. Two basic components of any project are its transmitter and receiver. The transmitter we have used here is a smart pole [8],[9]. It has many components such as LED which is a high glow white light emitting diode, crystal oscillator which is working at 11.085 MHz to provide constant frequency so as to maintain constant clock pulse, voltage regulator, which is giving a constant voltage of 5V by stepping down the supply voltage from transmitter and receiver.

The microcontroller present is a common component in both transmitter and receiver. The microcontroller has the data of highway routes fed in. It is data programmed in it. It also contributes in interfacing. The receiver in the project is a moving vehicle or any ordinary car which has photo detector.

The photo detector absorbs the incoming light from the LED's and passes onto the microcontroller which intercepts the light into data to visible on the LCD in the vehicle. The data is received by the photo detector. To summarize, the project is basically a transmission and reception of information and data in form of light energy which is used for navigation [10],[11].

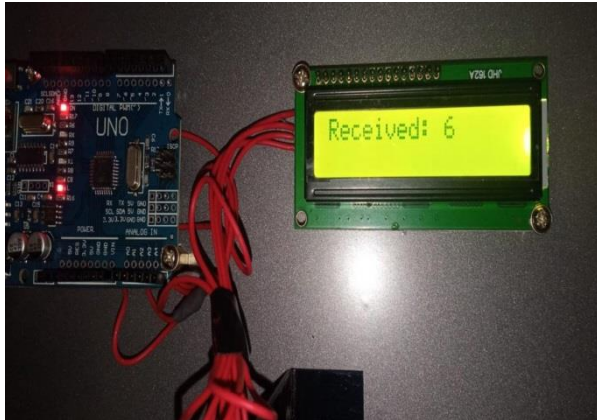
## Software Section

The Arduino IDE is an open-source software, which is used to write and upload code to the Arduino boards. The IDE application is suitable for different operating systems such as **Windows, Mac OS X, and Linux**. It supports the programming languages C and C++. Here, IDE stands for **Integrated Development Environment**. The program or code written in the Arduino IDE is often called as sketching. We need to connect the Genuino and Arduino board with the IDE to upload the sketch written in the Arduino IDE software. The sketch is saved with the extension '.ino.'

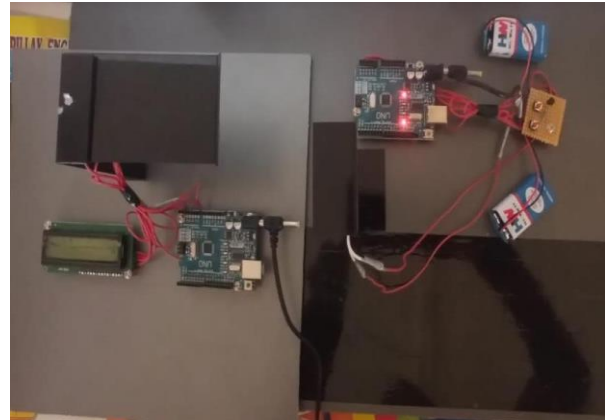
## 6. Results and Discussions

In this system, we are using Arduino for controlling all the elements in this system, and then upload a appropriate program to ATmega. We use light energy as a source, the transmitter is fixed at the light lamp and the received at

car panel the required information at transmitting street light, when the light is focused into the receiving part of the car, current location of the car will be displayed on the screen, from the above picture the received message is “Received 6”. If we need location then we updated it with some required information.



ON condition state



OFF condition state

## 7. Conclusion

The possibilities of Li-Fi application are numerous and can be further explored. The transmission of the proper image of the map using the proposed system depends highly on the light source intensity and the distance between the transmitter and receiver. Another factor which affects the proper transmission is the type of LED light source used in the system. The transmitter and the channel have been tested and the results vary as the distance between the streetlights and the vehicle increase and with the presence of any obstacle between the two. The delay needs to be varied according to the distance between any two street lights for proper image display. The implementation of this system would help drivers navigate, especially at night. It can act as a useful resource.

### Declarations

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#### Competing Interests Statement

The authors declare no competing financial, professional, or personal interests.

#### Consent for publication

The authors declare that they consented to the publication of this research work.

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