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Vehicular Communication System Using LI-FI for Collision Avoidance

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Abstract: *Vehicular communication systems are networks in which vehicles and roadside units are the communicating nodes, providing each other with information, such as safety warnings and traffic information. Li-Fi (Light – Fidelity) is a visible light communication (VLC) system that uses Light-Emitting Diodes(LEDs) for data transmission. The existing system provides an alert message to avoid collisions but the drivers will not consider the alert message all the time. The aim of the project is to prevent accidents by controlling the speed of the vehicle and then it is stopped automatically using relay. When a vehicle is jammed at the road, an alert message will be sent to the following vehicles. The distance between the two vehicle is calculated using Ultrasonic Sensor and the information is sent to the corresponding person.*

I. Introduction

Vehicular communication systems are a type of network in which the vehicles can communicate with each other using Li - Fi technology. The distance between the vehicle is transmitted using Li-Fi and it is displayed in LCD.

Overview

Light fidelity is used to transmit data through light source.There are many accidents that we face in our life day to day.To avoid those accidents we developed an automatic vehicle control system that produces an alert message that is given by using buzzer and also the distance between two vehicles is shown in Liquid Crystal Display(LCD).Then the speed of that vehicle is controlled by using relay in order to prevent that vehicle from accident.

Origin Of Project

Now, in our day to day life we face many accidents because of lack of concentration.In order to avoid those accidents due to vehicle collision and to prevent human life we have introduced a Vehicular Communication System using Li-Fi.

In this project, the control and monitoring of end-user can be done through monitoring the distance of the vehicle, then providing an alert messageand there by the speed of the vehicle is controlled.In this the fuel of the vehicle can also be determined.

Its significance can be proved by considering the following specialties of set up designed by us:

- **Reliability:**Reliability is one such factor that every electronic system should have in order to render its services without manufacturing over a long period of time.We have designed our set up using ATMEGA microcontroller which itself very reliable and also operates very effectively under normal condition.

- **Cost:** The design is implemented at a very economical price.The total cost incurred by us in designing this kit is very less.

Vehicle Communication

Vehicle Communication systems are computer networks in which vehicles and roadside units are the communicating nodes, providing each other with information, such as safety warnings and traffic information. They can be effective in avoiding accidents and traffic congestion.

Project Realization

The project started off with a brainstorming session. All ideas about how the vehicle communication should work and what functions it should have were written on a workspace. We discussed all possible solutions and ideas that we had come up with and removed things that were not possible to implement within this project scope (Communicating Li-Fi which is not in line of sight). All that was left on the workspace in the end was divided up into following task areas:

i) Network:
Create a wireless connection between two vehicles. To communicate between the Li-Fi transmitter and receiver is been used in both the vehicles.

ii) Software:
The Embedded C software has to be able to control the communication, send task for vehicle communication and access embedded devices.

iii) Electronics:
This area covers in detail the hardware solutions chosen and how that affected the final prototype. The hardware could be described as three different work areas: controller unit, relay circuit and wireless module (Li-Fi).

iv) Interface:
The interface between the vehicles Li-Fi module which is achieved through hyper terminal. We use hyper terminal, which is used to connect between to Li-Fi transmitter and receiver between the vehicles.

v) Prototyping and construction:
The last focusing area is prototyping the final project. We need to build the product and put it into aesthetic form. The presentation of the project should be done so the visitors understand the final product is supposed to be used. Therefore we have to come up the suitable scenarios to present. Some devices(fuel level) are needed to get a vehicle environment feeling for the presentation.

Light Fidelity

Li-Fi is a technology for wireless communication between devices using light to transmit data and position. In its present state only LEDlampscan be used for the transmission of visible light. In technical terms, Li-Fi is a visible light communication system that is capable of transmitting data at high speed over the visible light spectrum, ultraviolet and infrared radiation.

Architecture Of Li-Fi System

Li-Fi which can be the future of data communication appears to be a fast and cheap optical version of Wi-Fi. Being a Visible Light Communication (VLC), Li-Fi uses visible light of electromagnetic spectrum between 400 THz and 800 THz as optical carrier for data transmission and illumination.It uses fast pulses of light to transmit information in wireless medium. The main components of a basic Li-Fi system contains:

- A high brightness white LED which acts as transmission source.
- A silicon photodiode with good response to visible light as the receiving element.

Switching the LEDs on and off can make them generate digital strings with different combination of 1s and 0s. To generate a new data stream, data can be encoded in the light by varying the flickering rate of the LED. In this way, the LEDs work as a sender by modulating the light with the data signal. The LED output appears constant to the human because they are made to flicker at a phenomenal speed (millions of times per second) and it's impossible for human eye to detect this frequency. Communication rate more than 100 Mbps can be achieved by using high speed LEDs with the help of various multiplexing techniques. And this VLC data rate can be further increased to as high as 10 Gbps via parallel data transmission using an array of LED lights with each LED transmitting a different data stream.

The Li-Fi transmitter system comprises of four primary sub-assemblies:

- Bulb
- RF Power Amplifier Circuit (PA)
- Printed Circuit Board (PCB)
- Enclosure

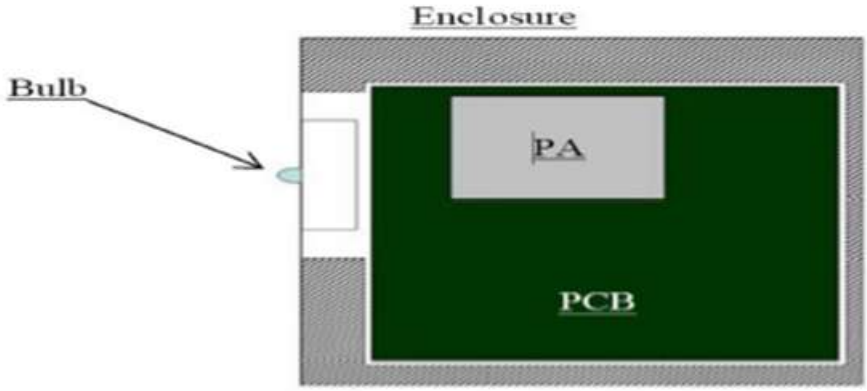


Fig.1 Block Diagram of Li-Fi sub assemblies

The fig.1 shows the Printed circuit board (PCB) controls the electrical input and output of the lamp and the microcontroller used to manage different lamp functions.A Radio Frequency(RF) signal is generated by the power amplifier and is directed into the electric field of the bulb.As a result of the high concentration of energy in the electric field,the contents of the bulb will get vaporized into a plasma state at the bulb's center.And this controlled plasma in turn will produce an intense source of light.All of these subassemblies are contained in an Aluminium enclosure.

Working Of LI-FI

Basic Concept

Light Fidelity (Li-Fi) technology is a wireless communication system based on the use of visible light between the violet (800 THz) and red (400 THz).Unlike Wi-Fi which uses the radio part of magnetic spectrum, Li-Fi uses the optical spectrum i.e. visible light part of the electro-magnetic spectrum. The principle of Li-Fi is based on sending data by amplitude modulation of the light source in a well-defined and standardized way. LEDs can be switched on and off faster than the human eyes can detect since the operating speed of LEDs is less than1 microsecond.This invisible on-off activity enables data transmission using binary codes.If the LED is on, a digital '1' is transmitted and if the LED is off, a digital '0' is transmitted.lso these LEDs can be switched on and off very quickly which gives us a very nice opportunity for transmitting data through LED lights, because there are no interfering light frequencies like that of the radio frequencies inWi-Fi.Li-Fi is thought to be 80% more efficient, which means it can reach speeds of up to 1Gbps and even beyondLi-Fi differs from fiber optic because the Li-Fi protocol layers are suitable for wireless communication over short distances (up to 10 meters).This puts Li-Fi in a unique position of extremely fast wireless communication over short distances.

Working Model

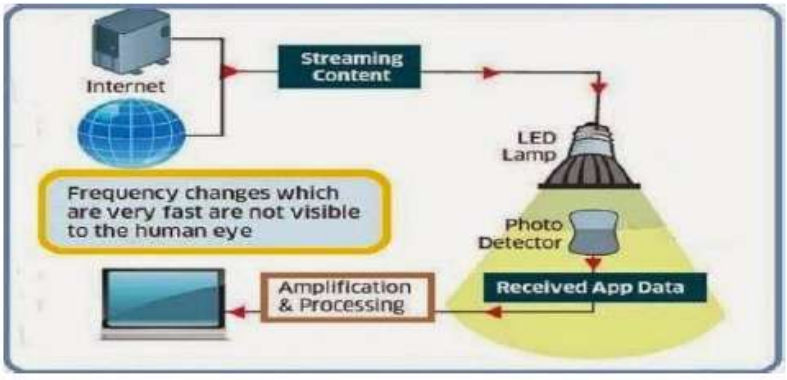


Fig.2Block diagram of Li-Fi Sub System

The working model of Li-Fi is explained in fig.2. The working of Li-Fi is very simple. There is a light emitter on one end i.e. an LED transmitter, and a photo detector (light sensor) on the other. The data input to the LED transmitter is encoding to the light (technically referred to as Visible Light Communication) by varying the flickering rate at which the LEDs flicker 'on' and 'off' to generate different strings of 1s and 0s. The on off activity of the LED transmitter which seems to be invisible (The LED intensity is modulated so rapidly that

human eye cannot notice, so the light of the LED appears constant to humans), enables data transmission in light form in accordance with the incoming binary codes: switching ON a LED is a logical '1', switching it OFF is a logical '0'. By varying the rate at which the LEDs flicker on and off, information can be encoded in the light to different combinations of 1s and 0s.

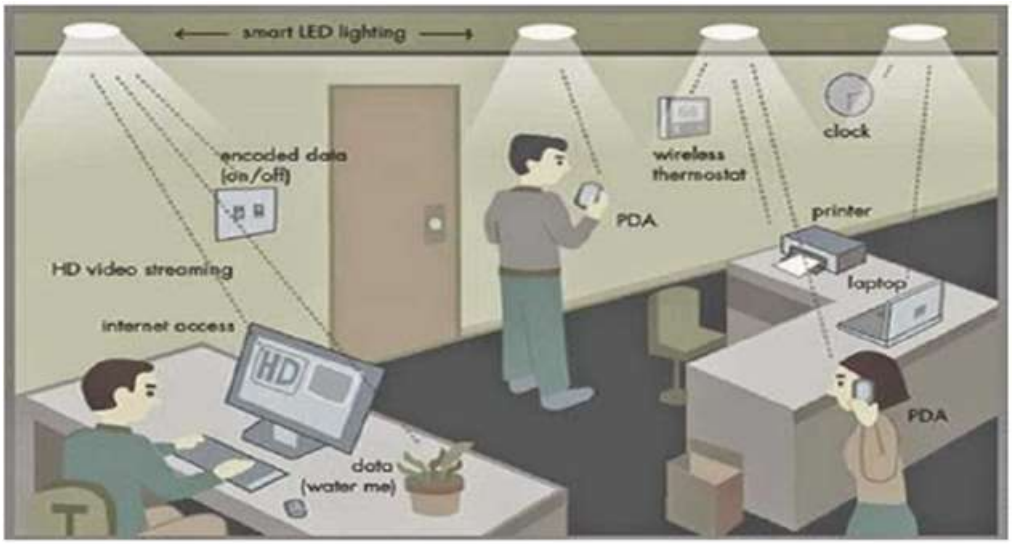


Fig.3 Li-Fi system connecting devices in a room

The fig.3 shows working/deployment of a Li-Fi system connecting the devices in a room. In a typical setup, the transmitter (LED) is connected to the data network (Internet through the modem) and the receiver (photo detector/light sensor) on the receiving end receives the data as light signal and decodes the information, which is then displayed on the device connected tothe receiver. The receiver (photo detector) registers a binary '1' when thetransmitter (LED) is ON and a binary '0' when the transmitter (LED) is OFF. Thus flashing theLED numerous times or u sing an arrayofLEDs(perhaps of a few differentcolors) willeventually provide data rates in the range of hundreds of Mbps.

Hence all that is required,is some or an array of LEDs and a controller that controls/encodes data into those LEDs.All one has to do is to vary the rate at which the LEDs flicker depending upon the data input to LEDs. Further data rate enhancements can be made in this method by using array of the LEDs for parallel data transmission or using mixtures of red, green and blue LEDs to alter the light's frequency, with each frequency encoding a different data channel.

Advantages Of LI-FI

- Energy consumption can be minimized.
- Itprovide high data rates i.e. 1 Gbps or even beyond.
- It is cheaper.
- One main advantage of Li-Fi is security.
- Li-Fi technology has a great scope in future.

Implementation

The block diagrams in Figure 1 and 2 describes the algorithm used in this technology.

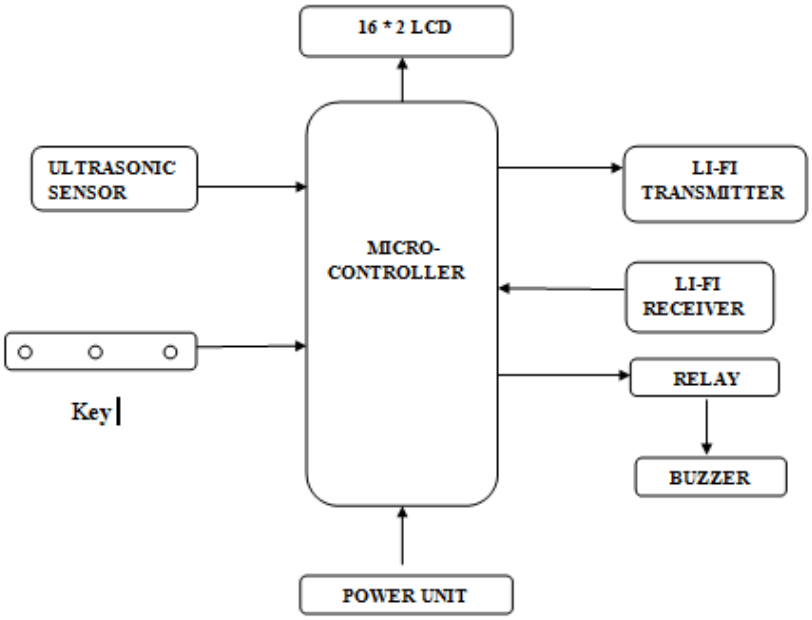


Fig 1 Transmitter Block Diagram

The block diagram of transmitter circuit. Power is supplied to the microcontroller using 12V dc power supply. The signal from the environment is sensed by using ultrasonic sensor and then it is also fed to the microcontroller. Based on the sensed signal the microcontroller sends the information to Li-Fi transmitter and in turn it sends the signal to receiver circuit. The relay in the transmitter side is used to control the speed of the vehicle.Buzzer produces an alert message to the person who drives the vehicle. The distance and the alert message is displayed in LCD.

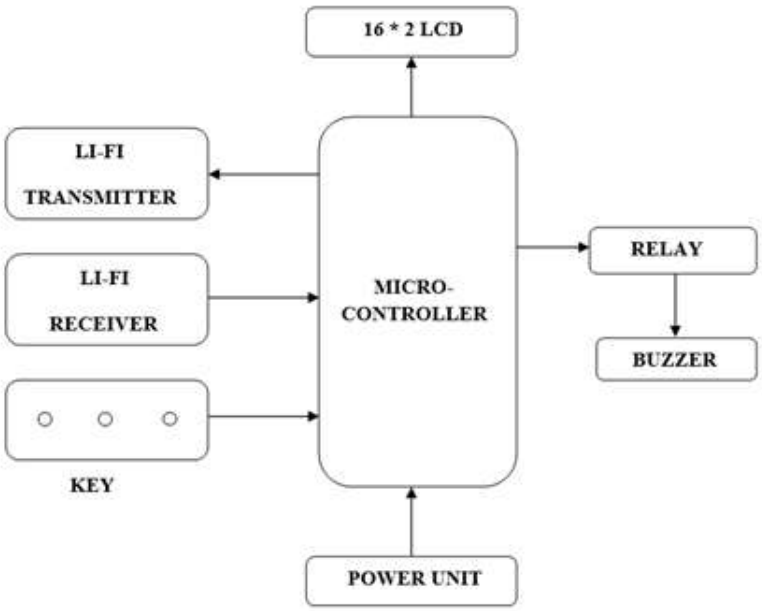
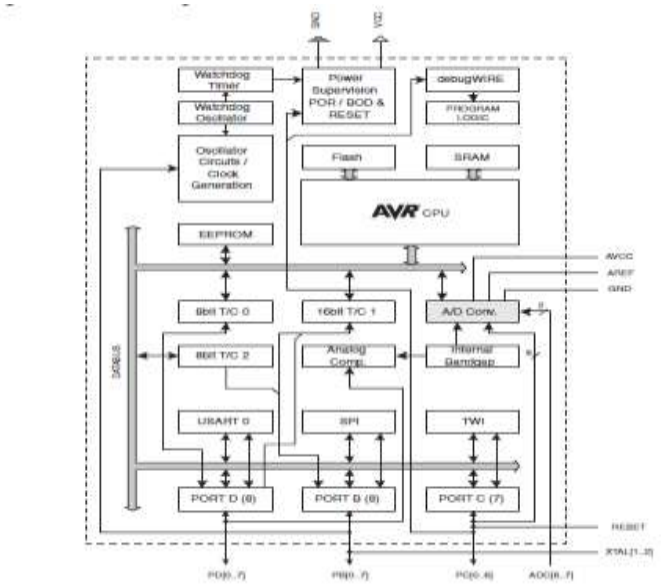
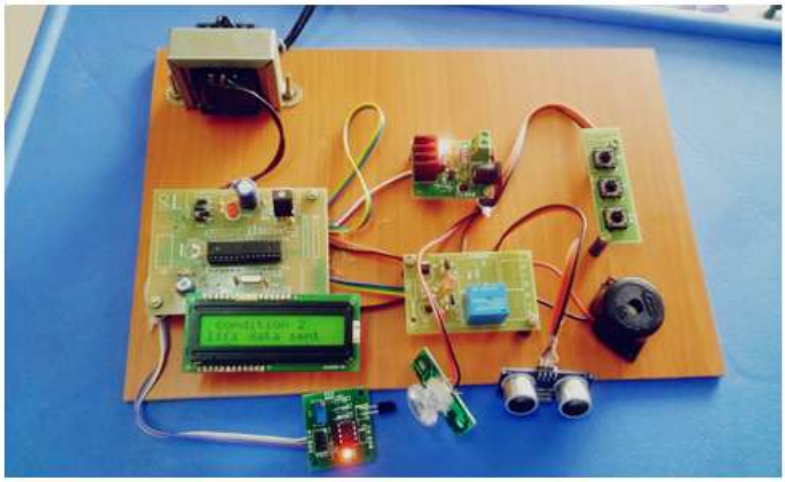


Fig 2 Receiver Block Diagram

The block diagram of receiver circuit is shown. The signal from the transmitter is received in Li-Fi receiver at the receiver end of the module. Then the signal is transferred to Micro-controller based on the signal sensed the distance between the vehicles is displayed on the LCD. An alert message is provided to the LCD display based on the distance between the vehicles that is under the control of micro-controller. At a times the alert message will not be noticed by the persons so buzzer sound is produced and then the vehicle speed is reduced and then stopped using relay.



II. Screen Short



III. Conclusion

After successful completion of project we conclude that a very reliable, efficient and less cost product has been developed which can make our life more comfortable and securable. This project does not require any hard installation and can be easily installed in old installations. Since the project is wireless based and thus doesn't require any extra cost of installing conductors. This project will prove to be efficient for many automobile