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VEHICLE-TO-VEHICLE COMMUNICATION USING LIGHT FIDELITY

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ABSTRACT:- Vehicle-to-vehicle (V2V) communication is pivotal for upgrading road safety, traffic efficiency, and enhancing overall driving experience. Traditional wireless communication technologies such as Wi-Fi and cellular networks have been extensively used for V2V communication. However, these technologies face challenges in terms of limited bandwidth, congestion, and susceptibility to interference in densely populated areas. To overcome these limitations, an emerging technology called Light Fidelity (Li-Fi) has gained significant attention in recent years.

Li-Fi is a wireless communication technology that utilizes visible light spectrum for data transmission. It offers several advantages over conventional radio frequency (RF) technologies, including higher bandwidth, lower latency, and improved security. This makes Li-Fi a promising solution for V2V communication, enabling vehicles to exchange information rapidly and reliably.

Key Words:- Vehicle-to-vehicle communication, V2V, Li-Fi, Light Fidelity, wireless communication, visible light communication, road safety, traffic efficiency, collision avoidance, cooperative adaptive cruise control, traffic management.

1. INTRODUCTION

In this era of smart cities and connected vehicles, Li-Fi holds tremendous potential for revolutionizing V2V communication. With its unique capabilities, Li-Fi can provide significantly higher data rates, lower latency, and enhanced reliability compared to existing wireless technologies. These attributes make Li-Fi an attractive solution for applications requiring real-time and bandwidth-intensive V2V communication, such as collision avoidance, cooperative adaptive cruise control, and traffic management.

This paper explores the concept of V2V communication using Li-Fi and highlights its advantages, challenges, and potential applications. It aims to shed light on how Li-Fi technology can contribute to safer and more efficient transportation systems. Additionally, it discusses the requirements, standardization efforts, and infrastructure considerations necessary for the successful deployment of Li-Fi-based V2V communication.

However, deploying Li-Fi for V2V communication also poses certain challenges. Line-of-sight communication requirements, limitations in range, and the need for standardization and infrastructure development are some of the key obstacles that must be overcome. Efforts are underway to develop efficient modulation techniques, optimize resource allocation, and establish protocols that ensure interoperability between Li-Fi and existing wireless communication technologies.

The utilization of Li-Fi technology for V2V communication holds great promise for transforming transportation systems. With its high data rates, low latency, and enhanced security, Li-Fi can enable vehicles to communicate rapidly and reliably, leading to improved road safety, reduced congestion, and more efficient traffic management. However, further research and development efforts are required to optimize Li-Fi for V2V communication, address implementation challenges, and establish the necessary standards for seamless integration with existing communication systems.

2. PROPOSED SYSTEM

2.1 Block Diagram

Here's a simplified block diagram illustrating the key components and communication flow in a V2V system which is divided into three parts :-

- Part 1 – It consist of block diagram of vehicle no. 1.
- Part 2 – It consist of block diagram of vehicle no. 2.
- Part 3 – It consist of block diagram of school building and street lights.

2.1.1 Part 1

Fig. 2.1.1 Vehicle No. 1

2.1.2 Part 2

Fig. 2.1.2 Vehicle No. 2

2.1.3 Part 3

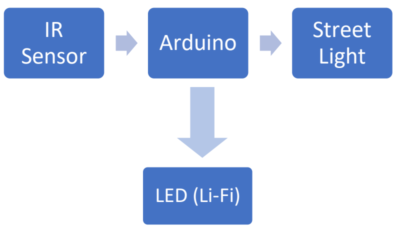


Fig. 2.1.3 School building and street light

2.2 Hardware Components

- Arduino Uno
- LDR
- LED
- IR sensor
- LCD

2.3 Software Used

- Arduino IDE

2.4 Description Of Components

2.4.1 Arduino Uno

The Arduino Uno is a popular microcontroller board based on the ATmega328P microcontroller. It is commonly used in various electronic projects and prototyping due to its simplicity, versatility, and ease of use. Here are some key features and information about the Arduino Uno:

Microcontroller: The Arduino Uno is powered by the ATmega328P microcontroller, which operates at 16 MHz and has 32KB of flash memory for storing the program code, 2KB of SRAM, and 1KB of EEPROM for data storage.

Digital I/O Pins: The Uno has 14 digital input/output (I/O) pins, among which 6 can be used as pulse width modulation (PWM) outputs. These pins can be used to connect to various sensors, actuators, and other electronic components.

Analog Inputs: It has 6 analog input pins, labelled A0 through A5, which can be used to read analog voltages from sensors or other devices. The analog inputs have a 10-bit resolution, providing 1024 different voltage levels.

Power Supply: The Uno can be powered through a USB connection, an external power supply, or a 9V battery connected to the power jack. It also has a built-in voltage regulator, which allows it to operate at a wide range of voltages (typically 7-12V).

Programming: The Arduino Uno can be programmed using the Arduino Software (IDE), a cross-platform development environment. The programming language is based on C/C++, and there is a vast library of pre-written functions and examples available to simplify the coding process.

The Arduino Uno is widely used by hobbyists, students, and professionals for a wide range of projects, including robotics, home automation, data logging, interactive art, and prototyping. It provides an accessible entry point for learning about microcontrollers and electronics.

Fig. 2.4.1- Arduino Uno

2.4.2 LDR Sensor

An LDR (Light-Dependent Resistor) sensor, also known as a photoresistor, is an electronic component that changes its resistance based on the amount of light falling on its surface. LDRs are passive components, which means they do not require an external power supply to operate.

The resistance of an LDR decreases when exposed to more light and increases when exposed to less light. This property makes LDRs useful for detecting and measuring light levels in various applications. They are commonly used in automatic lighting systems, camera exposure controls, light meters, and burglar alarm systems.

LDRs are typically made of a semiconductor material such as cadmium sulphide (CdS) or lead sulphide (PbS). The material's conductivity changes with the intensity of light, altering the resistance of the LDR. When light falls on the sensor, more photons interact with the semiconductor, generating more electron-hole pairs and decreasing the resistance.

LDRs are simple and inexpensive sensors that can detect a wide range of light levels. However, they are not suitable for precise light measurements or applications where fast response times are required. Additionally, LDRs have a nonlinear response to light, meaning the resistance change is not linearly proportional to the light intensity.

To use an LDR sensor in a circuit, it is often connected in a voltage divider configuration with a fixed resistor. The output voltage across the LDR can then be measured and used to determine the light level. By calibrating the sensor and using appropriate circuitry, you can achieve different light-based functionalities in your projects.

Fig 2.4.2- LDR Sensor

2.4.3 LED

LED stands for Light-Emitting Diode. It is a semiconductor device that emits light when an electric current passes through it. LEDs are widely used in various applications due to their energy efficiency, long lifespan, compact size, and durability. LEDs can produce monochromatic light (single colour) or multicoloured light depending on their design.

LEDs work based on the principle of electroluminescence. When a forward voltage is applied across the semiconductor junction of the LED, electrons and holes recombine, releasing energy in the form of photons (light). The energy bandgap of the semiconductor material determines the colour of the emitted light.

LEDs are used in a wide range of applications, including residential and commercial lighting, automotive lighting, displays (such as TVs and monitors), indicators and status lights, signage, backlighting for screens and keyboards, and many more. They are also commonly used in combination with sensors and microcontrollers for various electronics projects.

Fig. 2.4.3- LED

2.4.4 IR Sensor

An IR (Infrared) sensor, also known as an IR detector or IR receiver, is a device that detects and responds to infrared radiation. Infrared radiation is a type of electromagnetic radiation with longer wavelengths than visible light but shorter than radio waves.

IR sensors work based on the principle of detecting the heat emitted by objects in the form of infrared radiation. They typically consist of an IR-sensitive element, which could be a photodiode, phototransistor, or an integrated circuit, along with appropriate electronic circuitry.

When an object emits infrared radiation, the IR sensor detects it and produces an electrical signal proportional to the intensity of the detected radiation. The specific design and sensitivity of the sensor depend on its intended application.

IR sensors offer advantages such as non-contact operation, fast response times, and the ability to detect objects or events in various environmental conditions. They are widely used in consumer electronics, automation, security systems, and industrial applications.

Fig 2.4.4- IR Sensor

2.4.5 LCD Display

An LCD (Liquid Crystal Display) 16x2 is a commonly used alphanumeric display module that can display 16 characters in each of its two rows, resulting in a total of 32 characters. It is widely used in various electronic devices, including calculators, digital clocks, and small embedded systems. Here's a breakdown of the components and connections involved in using an LCD 16x2 display.

Key components and connections of the LCD 16x2 display:

Control Unit (MCU): This refers to the microcontroller or any other device that controls the LCD display. It sends commands and data to the display to control its behaviour and content.

Data Bus: The data bus consists of multiple pins (typically 8 pins) that carry the data from the MCU to the LCD display. These pins are connected to the data pins of the display module.

RS (Register Select) Pin: It is used to select whether the data sent to the display is an instruction or actual character data. When RS is low (0), it indicates that the data being sent is an instruction. When RS is high (1), it signifies that the data being sent is character data.

RW (Read/Write) Pin: The RW pin is used to control the read and write operations of the LCD. When RW is low (0), it indicates a write operation (sending data to the display). When RW is high (1), it signifies a read operation (receiving data from the display). In most cases, the RW pin is connected to ground to enable write operations only.

E (Enable) Pin: The E pin is used to enable the display to latch in the data or execute a given command. A high-to-low transition of the E pin triggers the display to accept the data present on the data bus.

Data Pins: These are the pins (typically 8 pins) that carry the actual data to be displayed on the LCD. The data is sent to the LCD module in 8-bit or 4-bit mode, depending on the configuration.

To use the LCD 16x2 display, the MCU sends commands and data to the display module through the control unit. The control unit sets the appropriate values of RS.

Fig. 2.4.5- LCD Display

2.4.6 Arduino IDE

The Arduino IDE (Integrated Development Environment) is a software application used for programming and uploading code to Arduino microcontrollers. It provides a user-friendly interface for writing, compiling, and uploading code to Arduino boards. Here are some key features and components of the Arduino IDE:

Code Editor: The Arduino IDE provides a text editor where you can write your Arduino code. It supports features like syntax highlighting, auto-indentation, and code completion, making it easier to write and edit your code.

Library Manager: Arduino IDE includes a Library Manager, allowing you to easily search for, install, and manage libraries that provide additional functionality for your Arduino projects. It provides a vast collection of libraries for various purposes, such as sensor integration, communication protocols, and display control.

Serial Monitor: The Arduino IDE includes a built-in Serial Monitor that enables communication between your Arduino board and your computer. It allows you to send and receive data to/from the Arduino board via the serial port, making it useful for debugging and interacting with your projects.

Compile and Upload: The Arduino IDE provides options to compile and upload your code to the Arduino board. It automatically compiles your code into machine-readable instructions and sends them to the Arduino board for execution.

Tools and Preferences: The IDE offers various tools and preferences settings that allow you to configure your Arduino development environment. You can customize settings related to programmer type, serial port selection, and more.

The Arduino IDE is available for Windows, macOS, and Linux operating systems. It is an open-source software, and Arduino IDE has a large and active community, which provides support, tutorials, and a vast collection of code examples to help you get started with your Arduino projects.

3. METHODOLOGY

The proposed system involves the communication of data from one vehicle to another using Li-Fi technology. As it makes life easier by utilising LED lighting. This strategy will assist us in avoiding traffic and accidents. Data transfer via Li-Fi technology is expected to play an important role in the future.

Vehicle-to-vehicle (V2V) communication using Li-Fi (Light Fidelity) technology involves using visible light to enable wireless communication between vehicles. Li-Fi utilizes light-emitting diodes (LEDs) to transmit data by modulating the intensity of light, providing high-speed communication in a line-of-sight environment. Here's a general methodology for implementing V2V communication using Li-Fi:

Hardware Setup:

a. Vehicle Transmitters: Install Li-Fi transmitters in each vehicle. These transmitters consist of LED arrays capable of modulating light signals to transmit data.

b. Street Light transmitter: A signal transmitting light is setup as a street light which always transmits the information (such as school ahead, hospital ahead so that speed limit should be maintained) in the form of signals to the vehicles crossing through it.

b. Vehicle Receivers: Equip each vehicle with Li-Fi receivers to capture the light signals and convert them back into data. The receivers can include photodiodes or other light sensors.

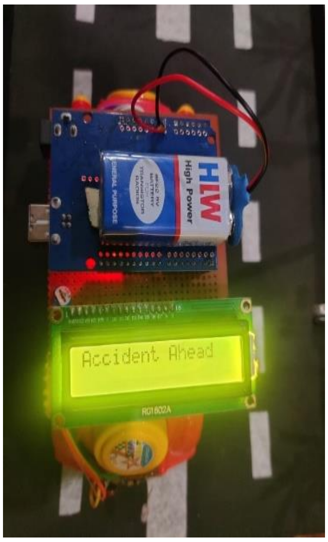


Fig. 3.1 Fig. 3.2

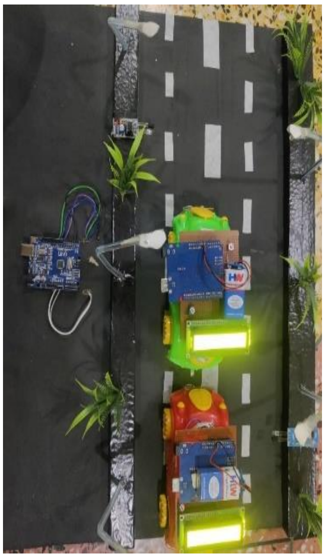
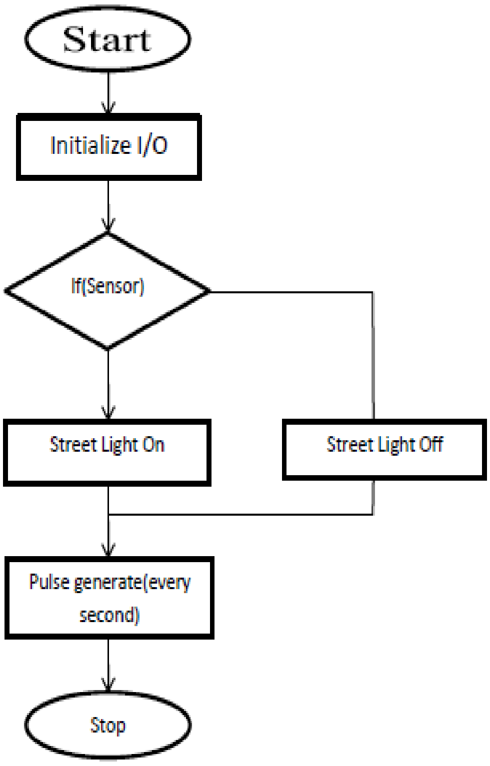


Fig. 3.3 Fig. 3.4

4. Flow Chart



5. RESULT

We have implemented an Inter-Vehicle Communication system consisting of a Li-Fi transmitter and receiver that is targeted at communication between the vehicles; This project aims to propose a cost-effective solution to reduce accidents. Li-Fi can be used to communicate with the LED lights of the cars by utilizing which the number of accidents can be prevented. Li-fi is ideal for high density coverage in a restricted region. It is believed that the technology can yield a speed more than 10 Gbps. It is the fastest and cheapest wireless communication systems which is suitable for communication. Throughout the implementation process, we also make efforts on keeping the implementation cost as low as possible Li-Fi will make all our lives more technology driven in the near future.

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