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Vehicle to Vehicle Imparting System using Wireless Technology

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Abstract— ***The project titled "Vehicle to Vehicle Imparting System Using Li-Fi" is centered around enhancing vehicle control and accident detection. This innovative project harnesses Light-Fidelity (Li-Fi) technology to manage the speed of oncoming vehicles. The receiver circuit embedded in the headlight employs a silicon photodiode, while the transmitter circuit within the taillight utilizes a white LED for transmission. Additionally, a Light Dependent Resistor (LDR) is integrated to regulate the headlight's intensity during night time conditions. The project also incorporates a Radio Frequency communication speed control mechanism, aimed at regulating vehicle speeds in densely populated areas like school zones and college campuses. An ultrasonic sensor plays a crucial role in managing the speed of vehicles coming from the opposite direction, contributing to safer driving practices. To detect accidents, an accident sensor is integrated, triggering a buzzer system to alert relevant parties. project showcases an innovative fusion of Li-Fi technology, optical communication, and various sensors to enhance vehicle control, accident detection, and traffic management. This amalgamation of technologies promises safer and more efficient driving experiences in diverse environments.***

Keywords--- VLC, Li- Fi, Ultrasonic sensor, Silicon Photo Diode, LDR, PIC 16F877.

I. INTRODUCTION

The "Li-Fi Enabled Vehicle-to-Vehicle Communication System for Accident Prevention" project focuses on enhancing accident detection and control mechanisms. The central concept of this project involves utilizing Light-Fidelity (Li-Fi) technology to regulate the speed of approaching vehicles. The vehicle's front end incorporates a receiver circuit housing a silicon photodiode, while the rear end features a transmitter circuit employing a white LED as the signal transmitter. During nighttime conditions, a Light Dependent Resistor (LDR) is employed to adjust the headlight's brightness. In addition to Li-Fi, the project integrates Radio Frequency (RF) communication for managing vehicle speeds in densely populated zones like school and college areas. For collision avoidance, an ultrasonic sensor is deployed to modulate the speed of oncoming vehicles. To detect accidents, an accident sensor triggers a buzzer alert system. Li-Fi technology utilizes light signals to transmit data, leveraging high-intensity light-emitting diodes (LEDs) that can toggle between transmitting digital 1s and 0s at rapid rates beyond human perception. This concept was coined as "Li-Fi" by Harald Haas during his TED Global talk on Visible Light Communication, representing an optical counterpart to traditional Wi-Fi. At its core, this technology employs high-brightness LEDs for swift switching between 1s and 0s, enabling the encoding of data in light signals. The rapid modulation of LED intensity remains imperceptible to the human eye, ensuring consistent output. Advanced techniques hold the potential to significantly augment the data transfer rate of Visible Light Communication (VLC).

II. LITERATURE SURVEY

Li-Fi Enabled Bidirectional IoT Communication

It reveals a growing interest in enhancing energy efficiency and data transmission capabilities. Researchers have turned to non-orthogonal multiple access (NOMA) as a potential solution, coupled with optimal power allocation (OPA) strategies to ensure quality-of-service (QoS) guarantees for both downlink and uplink channels. To optimize user-channel pairing, an adaptive approach considers individual channel gains and QoS requirements. By evaluating these parameters jointly, researchers aim to create effective matches between users and channels. It also emphasizes performance evaluation, particularly regarding energy efficiency (EE) and user outage probability (UOP) for both downlink and uplink channels within the Li-Fi-enabled IoT context. Comparative analyses between NOMA with OPA, orthogonal multiple access (OMA), and NOMA with conventional power allocation methods highlight the superior performance of NOMA with OPA.

Vehicle-to-Vehicle Optical Wireless Communication

It shows convergence of cutting-edge automotive lighting technologies consolidated within a unified automotive light entity termed the "Smart Corner." This research paper delves into the intricacies of the optical wireless communication (OWC) system integrated into the third-generation Smart Corner, prominently featured at the 2019 Consumer Electronic Show (CES). The core of this system rests upon an orthogonal frequency division multiplexing (OFDM)

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modulation technique, which synergizes with channel estimation and bit loading strategies. The potential significance of the OWC system as a reliable and redundant communication conduit within various automotive scenarios.

Position and Context Detection using V2v Communication

"Position and Context Detection Using V2V Communication" underscores the rising significance of Vehicle-to-Vehicle (V2V) communication in bolstering vehicle safety systems beyond their intrinsic sensor capabilities. This technology exhibits the potential to encompass a wider spectrum of collision scenarios, thereby enhancing warning timing and overall road safety. Presented within this paper is an innovative solution named Geo+NN, which embodies the fusion of neural network and geometric modeling. This intelligent system capitalizes on the combined prowess of these methodologies to facilitate precise position and context detection. The system employs an analytical geometric model to extract salient geometric attributes. These attributes are subsequently fed into a neural network, which is meticulously trained using authentic V2V signals sourced from real-world settings. This neural network adeptly assimilates the acquired knowledge to effectively extrapolate and forecast the behaviors of distant vehicles.

Brake Failure Detection with Braking System

This study embarks on the creation of an electronically controlled automatic brake failure indicator, underpinned by the integration of an IR Sensor. Central to this endeavor is the formulation of an automatic brake failure indicator, harmonized with an auxiliary braking system. The architecture encompasses three fundamental components: the IR sensor circuit, the control unit, and the frame. The pivotal role of the IR sensor circuit is to discern the presence of the brake wire, thereby triggering a control signal to activate the alarm unit. Moreover, the auxiliary braking system plays an instrumental role by augmenting vehicular control. Seamlessly integrated with the wheel frame, the auxiliary brake system exerts braking force when invoked, effectively halting the vehicle.

III. PROPOSED METHOD

The proposed system finds its ideal application within the domain of smart traffic transportation systems, offering an ingenious solution that integrates a transmitter and a receiver. This innovation capitalizes on Vehicle to Vehicle (V2V) communication, seamlessly transmitting data through visible LED light, effectively harnessing Li-Fi technology. Remarkably, the system boasts of remarkable cost-effectiveness in terms of installation, while minimizing potential environmental impacts. The significance of this approach is underscored by its potential to substantially reduce accidents, a pressing issue that frequently graces headlines. Each Li-Fi module is an expansive light emitting diode (LED) lamp, encompassing multiple low-power LEDs. Correspondingly, each user is equipped with a photo detector (PD), oriented orthogonally to the vehicle's trajectory. The receiver module entails a photodiode, such as a silicon photo detector or an Infrared germanium cylindrical detector. In its role as a demodulator, the photo detector meticulously interprets the incoming signal, deciphering the sequence of binary data (1s and 0s). Subsequently, this demodulated signal undergoes filtering to eradicate unwanted noise, refining its quality. In essence, the proposed system is an embodiment of forward-thinking engineering that meets the demand for enhanced traffic management. Through the ingenious merger of V2V communication and Li-Fi technology, this system presents a promising approach to curbing accidents and reshaping vehicular communication paradigms, all while offering an economically viable and environmentally conscious solution.

IV. BLOCK DIAGRAM

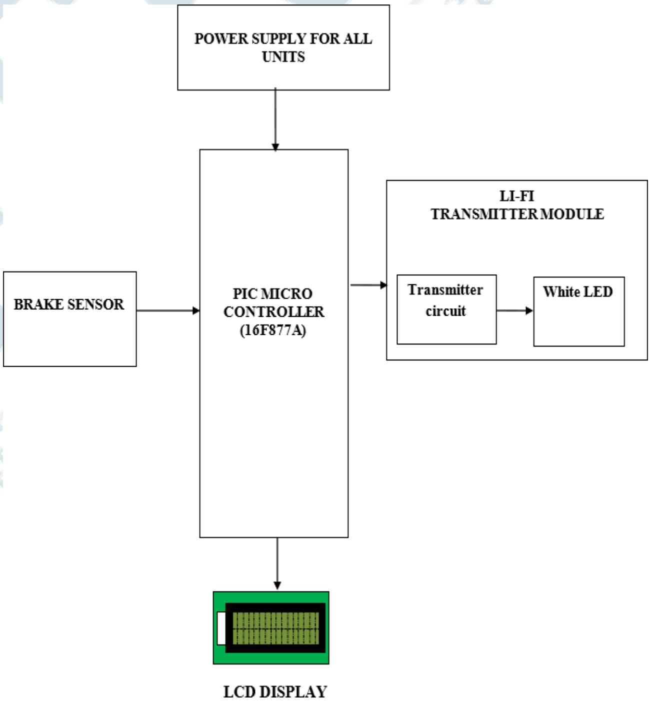

Fig. 1 Transmitter Vehicle Unit

In Fig. 1 shows that, initially, the incoming data undergoes conversion into binary format via an Analog-to-Digital Converter (ADC). Subsequently, the processed binary data interfaces with a LED driver circuit, orchestrating its functions under the governance of a signal processor. The LED driver circuit operates on the principle of On-Off Keying modulation. As a result of this modulation, the LED, characterized by its high luminosity, rapidly alternates between illumination and non-illumination, akin to blinking.

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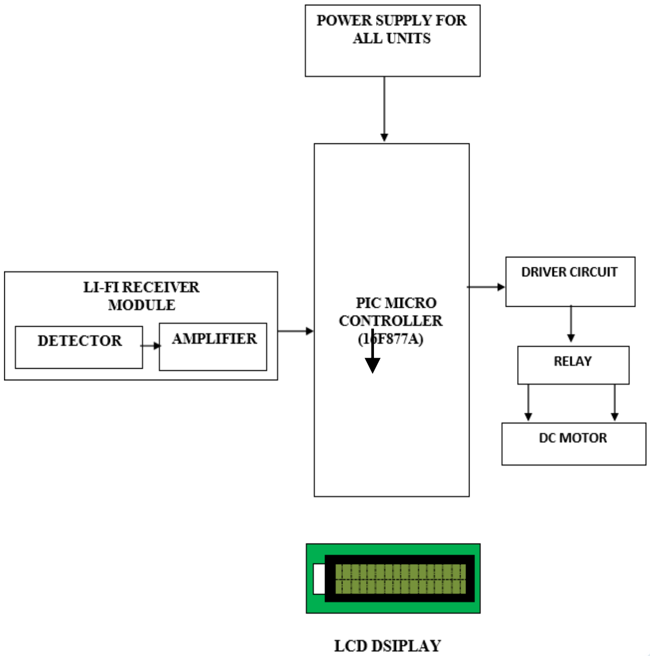

Fig. 2 Receiver Vehicle Unit

In Fig. 2 encapsulates the intricate orchestration of events at the receiver end of the vehicle communication system. By decoding optical pulses into electrical signals, amplifying, and restoring them to binary data, and incorporating a networked LED light infrastructure, this framework epitomizes the dynamic interplay that facilitates effective and accessible vehicular data communication.

V. WORKING

Visible Light Communication (VLC) exploits the spectral range between 400 THz (780 nm) and 800 THz (375 nm) for both data transmission and illumination. This technology employs swift light pulses to facilitate wireless information exchange. Central to VLC's architecture is a high-intensity white LED, functioning as a communication source, and a silicon photodiode, well-responsive to visible wavelengths, as the receiving component. The LED, endowed with the ability to alternate between on and off states, becomes a conduit for generating binary sequences of 1s and 0s, thus encoding data. This data encoding takes shape by manipulating the flickering rate of the LED, ultimately embedding information within the emitted light. Through this modulation, the LED's light emission transitions into a medium for communication. The rapidity of the flickering rate surpasses human perception, ensuring a consistent LED output to the human eye. The potential for high data rates is a hallmark of VLC, reaching 100 Mbps or more through the integration of high-speed LEDs and efficient multiplexing methods. Furthermore, data rate augmentation is achievable via parallel data transmission with arrays of LEDs, each transmitting distinct data streams. Although numerous illumination sources exist, LEDs shine as the preferred choice due to their rapid switching capabilities, aligning seamlessly with the demands of data transmission. The binary transmission is as simple as transmitting 1s when the LED is on and 0s when it's off. This swift on-off mechanism unlocks possibilities for robust data transmission. By altering flickering patterns, data encoding within light becomes feasible, resulting in diverse sequences of 1s and 0s. Due to the rapid modulation, the human eye perceives a stable output, while the technology holds untapped potential for even higher data rates through sophisticated techniques. Leading academic institutions such as the University of Oxford and the University of Edinburgh are actively exploring advanced strategies like parallel data transmission using LED arrays. Each LED concurrently transmits a unique data stream, promising to further elevate VLC's data transmission capacities.

PIC Micro-Controller:

The selected microcontroller for this project belongs to the PIC series, renowned for its pioneering use of RISC architecture and CMOS fabrication. Distinctive in its approach, the PIC microcontroller adopts separate buses for instructions and data, allowing concurrent access to program and data memory. This fusion offers a unique synergy, particularly in terms of power efficiency. By harnessing the strengths of CMOS and RISC, this microcontroller manifests low power consumption, culminating in a compact chip size and minimal pin count. The inherent advantages of CMOS, such as its robust noise immunity, further contribute to the efficacy of the PIC microcontroller. In particular, the PIC16F877A variant boasts 40 pins distributed across 5 distinct ports. Each of these ports accommodates 8 pins, which seamlessly operate as bidirectional input/output pins. This architectural arrangement not only facilitates data manipulation but also enhances the versatility and applicability of the microcontroller within the project's context.

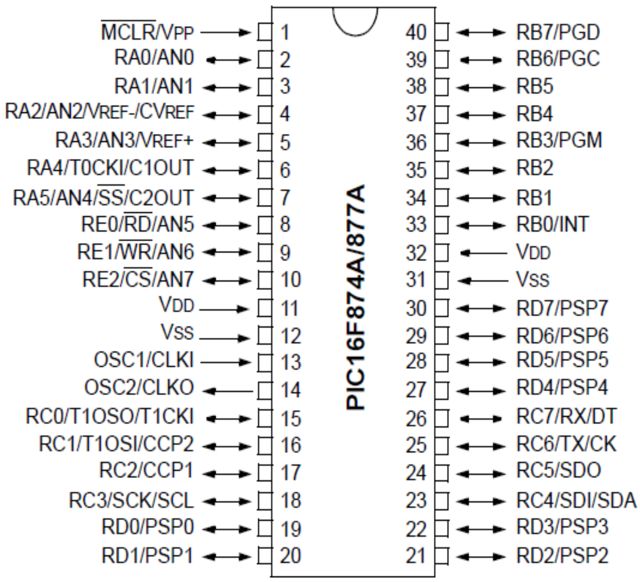

Fig. 3 Pin diagram of PIC 16F877

LCD Display:

Liquid Crystal Cell Displays (LCDs) find application akin to LEDs in a range of scenarios. These applications typically encompass the presentation of numeric and alphanumeric characters through dot matrix and segmental displays. LCDs are classified into two main types: Dynamic Scattering Type and Field Effect Type. Liquid crystal materials, which exhibit crystalline optical traits despite retaining a liquid state, are vital components. Positioned between glass sheets, these materials are embedded with transparent electrodes on their internal surfaces. The resultant configuration shapes a Liquid Crystal Display (LCD), a slim, planar device comprising an assortment of monochrome or color pixels, strategically aligned before a backlight or reflector. LCDs offer particular advantages, notably in battery-powered electronics due to their minimal energy consumption. The composition of LCDs amalgamates the characteristics of both liquids and crystals. Unlike substances with distinct melting points, liquid crystals possess a temperature range where molecules exhibit fluid-like mobility while maintaining an ordered arrangement similar to crystals. LCDs operate as a pivotal electronic modulator, offering flexibility in the presentation of visual content. This versatility is underscored by their capacity to be engineered into compact and energy-efficient structures, making them a preferred choice across diverse applications.

Fig. 4 Liquid Crystal Display

Toggle Switch:

Toggle switches are versatile components, featuring handles crafted from materials like metal, black nylon, or clear nylon. These switches cater to varied contexts, providing both sealed and unsealed actuator options to suit specific requirements. With a robust performance capacity, these toggle switches can handle up to 20 A at 12V DC. Particularly noteworthy are the extra heavy-duty toggle switches, characterized by their formidable die-cast bodies. These switches are engineered to withstand substantial stress, delivering reliable functionality even in demanding scenarios. Their rugged construction ensures durability and resilience, making them a fitting choice for applications demanding enhanced durability.

Fig. 5 Toggle Switch

Dip Switch:

A Dual In-Line Package (DIP) switch comprises a collection of manual electric switches enclosed within a standardized DIP housing. These switches are purposefully grouped together and are intended for integration onto a printed circuit board (PCB), alongside other electronic elements. This integration facilitates the tailoring of an electronic device's functionality to suit scenarios or requirements. The DIP switch configuration is commonly employed to personalize the operation of electronic devices, enabling customization without necessitating intricate circuit alterations. This adaptability enhances the device's versatility and accommodates diverse applications. DIP switches provide a viable alternative to jumper blocks, offering a more accessible means to configure and adjust circuitry. Their integration within PCB layouts streamlines the process of modifying device behavior, contributing to a more efficient and dynamic electronics ecosystem.

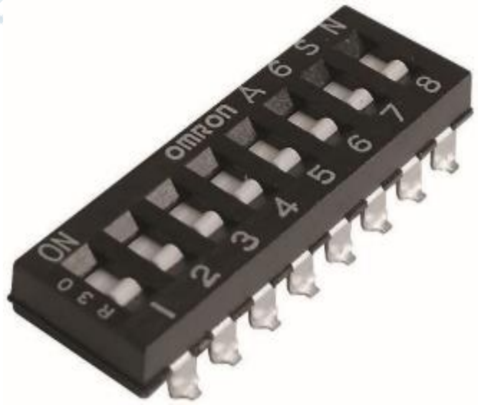

Fig. 6 Dip Switch

Relay:

A relay functions as an electrically operated switch, with its operation centered around the interaction of current and magnetic fields. The relay coil, when subjected to an electric current, generates a magnetic field that exerts a force on a lever mechanism. This mechanical interaction, in turn, triggers a transformation in the state of the switch contacts. The relay's coil current possesses two states: on or off. As a result, relays are equipped with two primary switch positions, often featuring double throw (changeover) switch contacts.

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Vol 10, Issue 9 September 2023

This setup permits the relay to toggle between two distinct electrical paths, allowing one circuit to control or influence the state of another circuit. This interconnection between circuits enhances the versatility and applications of relays. Most integrated circuits (ICs) lack the capacity to supply the current required for the relay coil. To bridge this gap, transistors are commonly employed to amplify the relatively modest IC current to the higher value essential for energizing the relay coil. It is important to note that certain ICs, like the widely used 555 timers, possess a maximum output current of 200mA, rendering them capable of directly supplying relay coils without the need for additional amplification. Typically, relays come in Single Pole Double Throw (SPDT) or Double Pole Double Throw (DPDT) configurations. However, the versatility of relays is demonstrated by the potential for incorporating multiple sets of switch contacts, enabling intricate control over various interconnected circuits.

Fig.7 Relay

MPLAB IDE Software:

MPLAB stands as a proprietary freeware Integrated Development Environment (IDE) meticulously crafted for the facilitation of embedded application development on PIC and dsPIC microcontrollers. The creative force behind this IDE is Microchip Technology, renowned for its contributions to the field. Latest iteration of MPLAB is labeled as MPLAB X, and it's built upon the robust NetBeans platform. MPLAB and MPLAB X collectively cater to a comprehensive range of tasks including project management, code editing, debugging, and programming across Microchip's repertoire of 8-bit, 16-bit, 32-bit PIC microcontrollers. The IDE's compatibility extends to the acclaimed MPLAB ICD 3 and MPLAB REAL ICE devices, which enable the seamless programming and debugging of PIC microcontrollers through personal computers. MPLAB offers support for PICK it programmers, enriching its versatility. Distinguishing the legacy and modern versions, MPLAB 8.X serves as the final iteration of the legacy MPLAB IDE, constructed using Microsoft Visual C++. In contrast, MPLAB X is the culmination of Microchip Technology's latest efforts and is founded upon the open-source NetBeans platform. Notably, MPLAB X introduces cross-platform compatibility, marking a significant departure from its predecessors by extending its operational sphere to encompass Mac OSX and Linux, alongside the conventional Microsoft Windows environment.

VI. RESULTS AND DISCUSSION

In conclusion, the primary objective outlined earlier in this project has been successfully realized through the thorough analysis and implementation of wireless communication technology. This system stands as a significant milestone, offering an efficient and rapid channel for reporting instances of vehicle communication while driving to law enforcement. The system's efficacy is underpinned by its capability to elicit prompt and effective responses from authorities. A noteworthy aspect is the system's seamless integration into existing vehicles, requiring no intricate setup modifications. By addressing critical issues like heavy load or brake failure during driving, the project assumes a role in safeguarding human lives—a value that takes precedence over all else. The urgency of this endeavor becomes evident when contemplating the multitude of lives lost due to accidents on the road. The project's efficacy lies in its ability to bridge the gap in information dissemination during emergencies. Often, accidents occur in critical situations, leaving little room for timely response. Our project emerges as a potential solution, instantly transmitting vehicle and contact information to the police or rescue teams. This proactive approach empowers the police to swiftly locate the source of the distress signal and initiate the necessary actions to mitigate harm. Central to our project's success is the integration of Li-Fi, a revolutionary technology that utilizes visible light for high-speed wireless communication. This technology's resemblance to Wi-Fi, with light replacing radio waves, distinguishes it. Li-Fi excels in densely populated areas and confined spaces, serving as a complement to Wi-Fi and resolving radio interference concerns. In essence, this project has positioned itself as a potential lifesaver on the road. The convergence of wireless communication, rapid response, and innovative Li-Fi technology underscores the potential for reducing accidents and protecting human lives, ultimately contributing to safer and more secure roadways.

The outcomes are systematically presented across three distinct scenarios:

- CASE 1: Upon activating the power supply, the LCD screen promptly exhibits the welcoming message, "WELCOME."
- CASE 2: The intervention of the brake switch prompts the LCD to display the message "BRAKE IS APPLIED," effectively conveying the braking action to the user.
- CASE 3: Subsequently, in response to the reapplication of the brake, the system orchestrates the illumination of the red LED. This illumination signifies the vehicle coming to a halt, as the running of the vehicle is promptly halted.

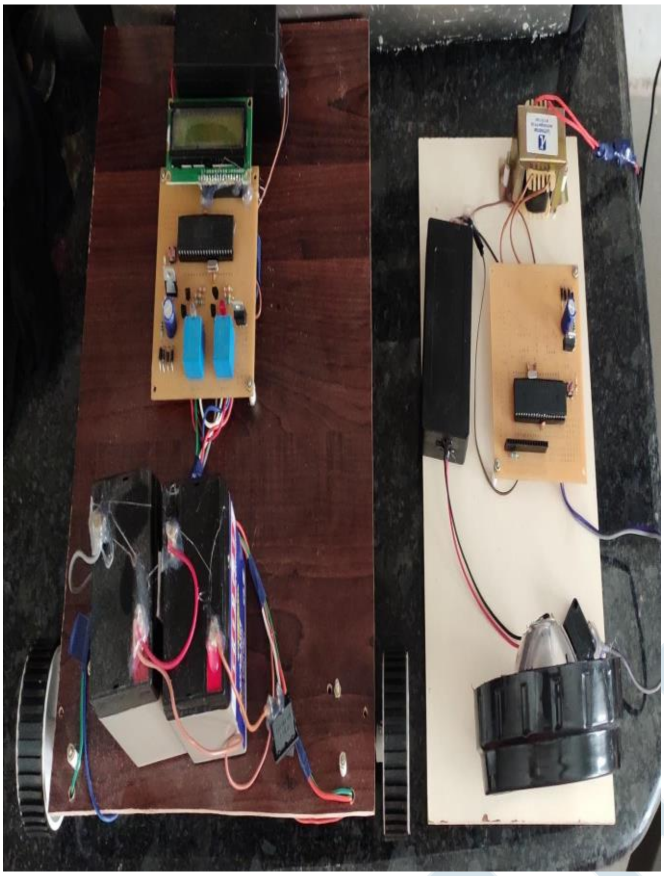

Fig.8 Hardware Setup of Vehicle to Vehicle imparting system using wireless technology

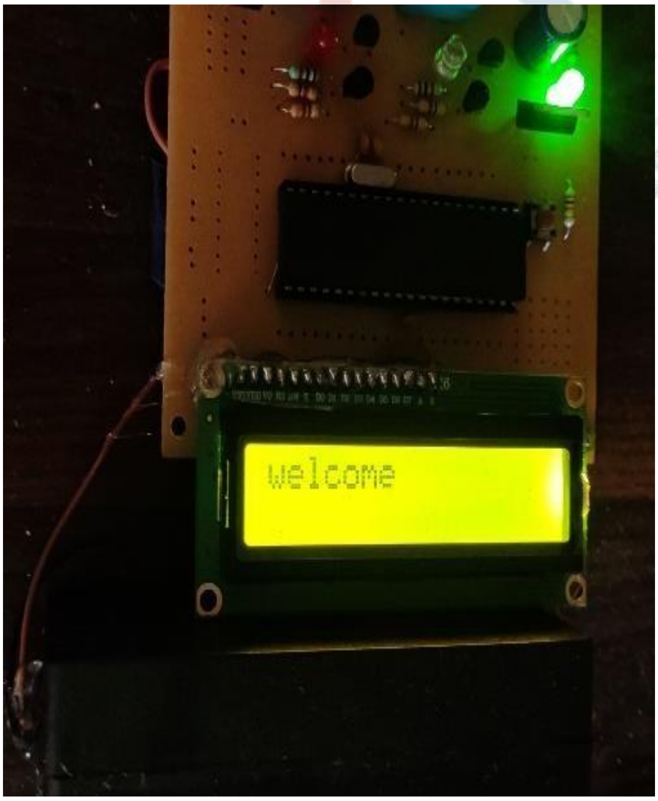

Fig.9 Case 1

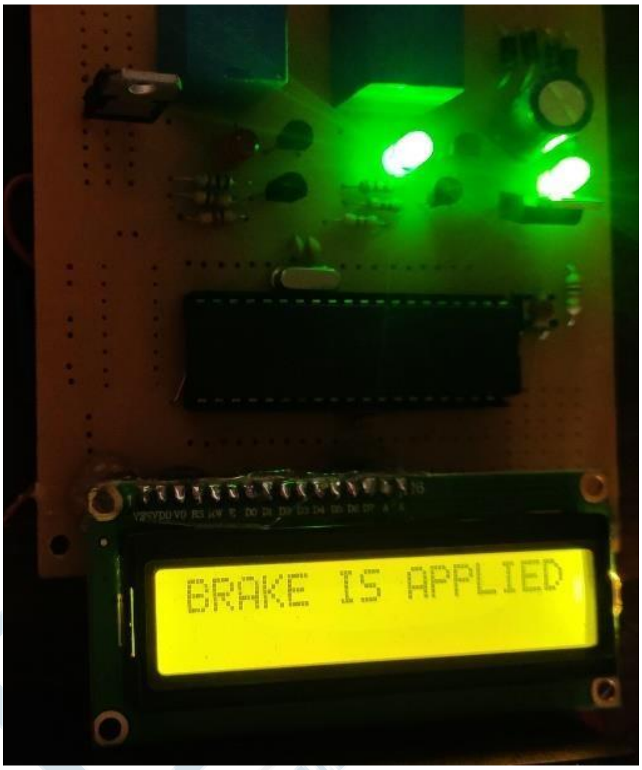

Fig.10 Case 2

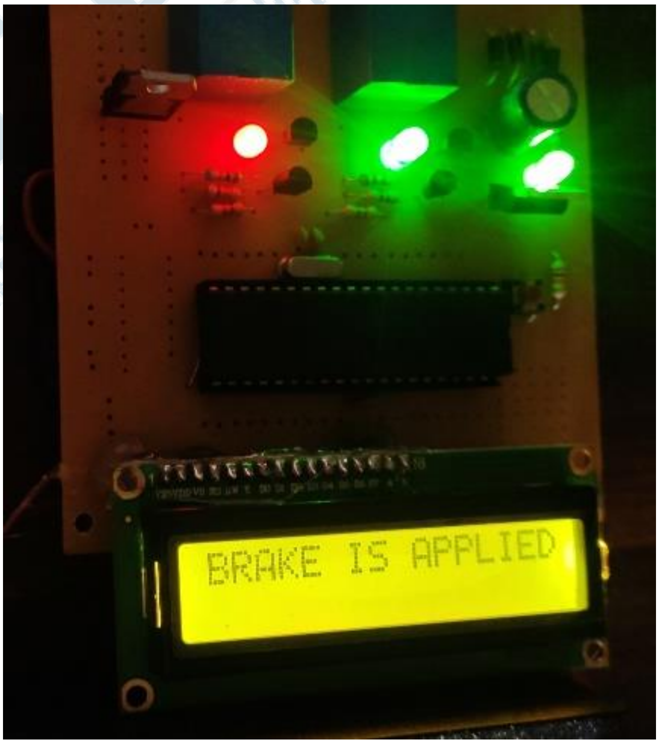

Fig.11 Case 3

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