CHAPTER 1
INTRODUCTION

1.1 INTRODUCTION

In the rapidly evolving landscape of automotive technology, Smart Drive Innovation stands at the forefront, revolutionizing the driving experience with groundbreaking advancements. Our latest innovation combines Li-Fi technology with smart transactions, adaptive lighting, and automated braking to redefine safety, convenience, and efficiency on the road.

As technology has developed, different systems have been integrated to produce more effective and efficient solutions for common problems. One such invention is the idea of Li-Fi-driven intelligent systems, which transform our perception of safety and convenience in drive-through settings by combining the power of visible light communication (VLC) and smart automation. This idea includes several elements that improve safety and simplify the drive-thru experience for both customers and businesses. These features include smart payment, adaptive lighting, and brake automation.

Smart payment systems enable seamless and contactless transactions, streamlining the drive-thru experience and reducing waiting times for customers while also optimizing efficiency for businesses. Adaptive lighting technologies dynamically adjust brightness and focus based on environmental factors and driving conditions, ensuring optimal visibility for drivers and pedestrians alike. Moreover, automated braking systems utilize real-time data and sensors to detect potential hazards and apply brakes with precision, thereby mitigating the risk of accidents and enhancing overall road safety.

Figure 1.1 Drive-Thru

Figure 1.2 Drive-Thru accident

Li-Fi stands for Light Fidelity, which is a wireless communication technology that uses light to transmit data. It is an alternative to traditional Wi-Fi networks as it offers higher bandwidth and increased security. The concept of Li-Fi-driven intelligent systems integrates this technology with smart automation to create a seamless and connected experience for users in drive-thru environments.

1.1.1 Smart Payment

One of the key features of a Li-Fi-driven intelligent system is smart payment, which enables customers to make purchases in a drive-thru environment without the need for physical contact. This is made possible through the use of VLC, where data is transmitted through light waves between an LED light source transmitter and a receiver. By simply standing by the vehicle to the designated area, customers can make secure and contactless payments, eliminating the need for cash or credit cards. This not only speeds up the transaction process but also minimizes the risk of spreading germs, making it an ideal solution in a post-pandemic world.

1.1.2Adaptive Lighting

In addition to smart payment, Li-Fi driven intelligent systems also utilize adaptive lighting. This feature uses sensors to detect the movement of vehicles and adjusts the intensity of the LED lights accordingly. This not only optimizes the use of energy but also enhances safety for drivers and customers by providing adequate and targeted lighting. For instance, when a vehicle approaches the ordering kiosk, the lights will automatically become brighter, allowing drivers to clearly see and navigate through the menu and make their orders. On the other hand, as the vehicle moves towards the pick-up window, the lights will dim, reducing glare and potential distractions for both drivers and customers.

Figure 1.3 Glare caused by opposite vehicles

1.1.3 Brake Automation

The third element of a Li-Fi-driven intelligent system is brake automation. This feature uses Li-Fi technology to send signals from the drive-thru kiosk to the vehicle's brake system, allowing for safer and smoother stops. For instance, if a driver fails to notice a pedestrian crossing in front of the vehicle, the system will detect the individual's movements and send a signal to the car's brakes, bringing it to an immediate stop. In addition, brake automation also facilitates swifter transactions, as the system will automatically detect when a customer has picked up their order and signal the vehicle to move forward.

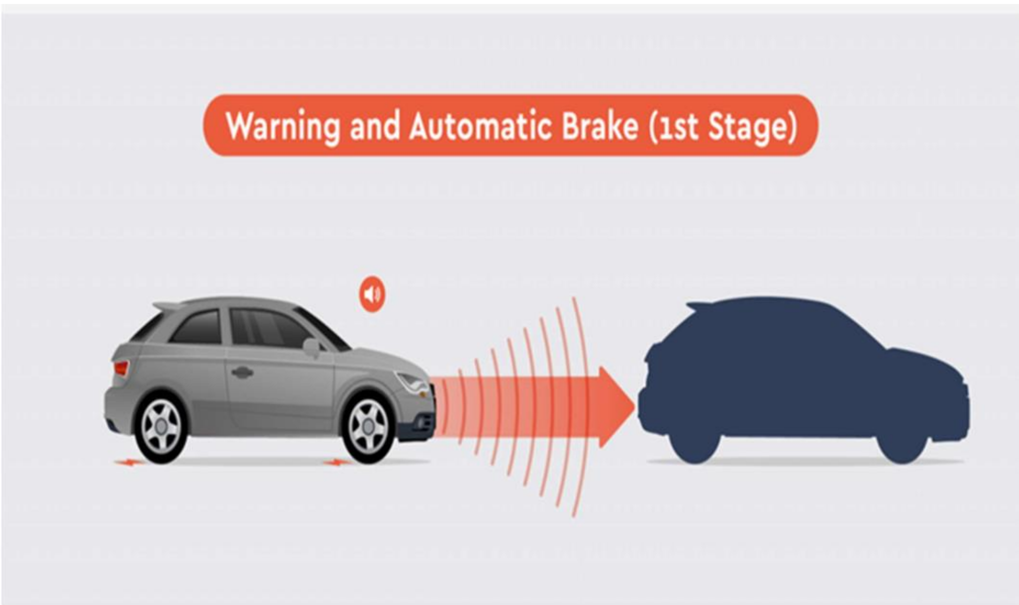

Figure 1.4 Brake Automation

1.1.4 Enhancing Efficiency and Safety in Drive-Thru Encounters

The integration of smart payment, adaptive lighting, and brake automation within Li-Fi-driven intelligent systems promises to transform drive-thru environments fundamentally. By seamlessly merging these technologies, drive-thru operations can streamline ordering and payment processes, significantly reducing wait times for customers. Moreover, this integration enhances safety by minimizing distractions and potential accidents, thus ensuring a secure experience for both patrons and employees. Furthermore, by offering a contactless and efficient solution, these advancements address the evolving needs of consumers in today's fast-paced society. In essence, the convergence of these innovations has the potential to revolutionize the drive-thru experience, making it safer, more efficient, and better aligned with modern consumer expectations.

Furthermore, the integration of these advanced technologies fosters a more seamless and intuitive customer experience. With smart payment systems enabling quick and convenient transactions, adaptive lighting enhancing visibility and ambiance, and brake automation ensuring smooth traffic flow, customers can enjoy a hassle-free journey through the drive-thru. This heightened level of efficiency and comfort not only enhances customer satisfaction but also cultivates loyalty and positive brand perception. As drive-thru establishments continue to evolve with the integration of innovative technologies, they stand poised to redefine convenience and excellence in the realm of fast-food service.

1.1.5 Effect on the Operation of Businesses

The impact of Li-Fi-driven intelligent systems extends beyond customer experience to significantly influence business operations. Through automation of payment and ordering processes, these systems effectively streamline operations, slashing both time and costs traditionally tied to manual transactions. This heightened efficiency not only boosts productivity but also mitigates the risk of errors. Moreover, the integration of adaptive lighting and brake automation further enhances the overall customer experience, fostering a seamless and enjoyable journey through the drive-thru.

Consequently, this heightened satisfaction can translate into increased customer loyalty and repeat business, underlining the transformative potential of these advanced technologies in optimizing business performance and customer relations alike.

Beyond streamlining transactions and enhancing customer satisfaction, the implementation of Li-Fi driven intelligent systems catalyzes broader operational improvements within businesses. With automation at the forefront, tasks such as inventory management, order processing, and employee scheduling can be optimized for greater efficiency and accuracy. Real-time data exchange facilitated by these systems allows for more informed decision-making, enabling businesses to adapt swiftly to fluctuating demand and market trends.

Additionally, the collection and analysis of customer data can provide valuable insights for personalized marketing strategies and product development, further bolstering competitiveness and revenue generation. As a result, the adoption of these innovative technologies not only revolutionizes the drive-thru experience but also positions businesses for long-term success in a dynamic and competitive market landscape.

1.1.6 Challenges and Recommendations

While the potential benefits of Li-Fi-driven intelligent systems are substantial, addressing certain challenges is crucial for successful implementation. A key obstacle is the limited range of Li-Fi technology, which may lead to connectivity issues within the drive-thru environment. To overcome this limitation, businesses should strategically deploy multiple access points to ensure seamless coverage throughout the area.

Additionally, the absence of standardized protocols and regulations for Li-Fi technology usage poses another challenge. Establishing industry standards and regulatory frameworks is essential to prevent interference with other light-based systems and ensure the smooth operation of Li-Fi-driven intelligent systems.

In conclusion, while the concept of Li-Fi-driven intelligent systems holds promise for enhancing safety and efficiency in drive-thru environments, proactive measures are necessary to address implementation challenges effectively. By leveraging the capabilities of Li-Fi technology and smart automation, these systems offer features like streamlined payment processes, adaptive lighting, and automated braking, which enhance the overall customer experience while improving operational efficiency. With continued advancements in technology and concerted efforts to overcome challenges, Li-Fi-driven intelligent systems are poised to revolutionize the drive-thru experience, setting new standards for convenience and innovation in the fast-food industry.

1.2 LITERATURE SURVEY

1. **"Vehicle to vehicle communication using Li-Fi Technology," Author: S. P. Cowsigan, S. Narendhran, B. Nithisree and T. J. Jisshnu Kannan, Year: 2022**

Vehicle-to-vehicle communication has proven to be the most successful method of reducing vehicle accidents. In this study, the suggested application of Li-Fi technology consists primarily of light-emitting diode bulbs as a means of connectivity, with data sent over the spectrum of light as an optical wireless medium for signal propagation. Road accidents can be avoided with the use of this technology, and many human lives can be spared. An ultrasonic sensor to detect distance is employed to communicate between the vehicles travelling in a range of touching distance. Data is exchanged from one car to another via this LI-FI. Any type of data, such as audio, video, or text, can be transferred over LIFI. This idea can be implemented at a minimal cost and maximum efficiency.

Today's day-to-day activities make extensive use of LED-based lighting, which can also be used for communication due to advantages such as fast switching, great power efficiency and safety to human vision. As a result, environmental friendly data communication between vehicles using visible light, which is made up of white LEDs that transfer audio signals to the receiver. VLC has a bright future ahead of it, and it complements current RF communication by increasing efficiency.

2. **"RFID Based Vehicle Toll Collection System for Toll Roads", Author: Piyush Singhal, Rajkumar Sharma, Year: 05 April, 2021**

The RFID-based vehicle collection program is intended to better handle toll operations through technology that aims to streamline the flow of vehicles. The purpose of this work is to plan, introduce and promote the automated operation of the car selection system (VTS). The Vehicle Toll Collection Device in this paper automatically detects vehicles and gathers machine-readable details on tolls for automobiles driving in the toll road. This knowledge is instigated by the modification and installation of at least one vehicle with a moving vehicle detection device. The computerized control device located along the toll line will transmit the registration signal as the car is reaching the registration point and will determine the toll to be debited and transfer the toll electronically to the account of the individual vehicle. This device helps a car to proceed beyond the scan point with no halting, thereby providing commuters with optimum comfort, speeding up traffic movement and reducing the need for human capital on highways.

3. **"Design and Implementation of a Vehicle to Vehicle Communication System using Li-Fi Technology" Author: Noof Al Abdulsalam, Raya Al Hajri, Zahra Al Abri, Zainab Al Lawati, and Mohammed M. Bait-Suwailam Year: 2015**

A small-scale prototype of a vehicle-to-vehicle communication system using light fidelity (Li-Fi) technology, a new technology that was developed in the last few years, which still needs more investigations on its sustainability for outdoor vehicular networks. Vehicle to vehicle communication is the most effective solution that has been used in order to reduce vehicles' accidents. The proposed use of Li-Fi technology in this paper comprises mainly light-emitting diode (LED) bulbs as means of connectivity by sending data through light spectrum as an optical wireless medium for signal propagation. In fact, the usage of LED eliminates the need of complex wireless networks and protocols. Several case studies mimicking the vehicle to vehicle communication are explored in this work. Both numerical simulations using Proteus package and experimental results are also presented, which agree quite well.

4. **"Prevention of Road Accidents by Interconnecting Vehicles using LiFi and LoRaWAN Technologies", Author: G. Raj Suriyan, K. Rahul, S. Rajesh, C. Dhanalakshmi and G. Udhayakumar, Year: 2023**

Road accidents remain a global issue, causing countless injuries and fatalities every year. While several measures have been implemented to prevent such accidents, there is a need for more effective and innovative solutions. In today's world, Vehicle to Vehicle (V2V) communication is essential for any form of activity, to prevent accidents. Light Fidelity (Li-Fi) and LoRaWAN(Low Power Wide Area Network) are two emerging wireless communication technologies that offer unique advantages over traditional wireless communication technologies like Wi-Fi and cellular networks.Li-Fi uses light waves to transmit data, while LoRaWAN uses radio waves to communicate over long distances. The performance of these technologies is evaluated and compared with communication range, data rate, and power consumption. Additionally, the discussed technologies were examined for potential applications and their associated challenges. This system combines both technologies which makes it work on long and short ranges.

5. **"Contactless payment systems based on RFID technology", Author: Izabela Lacmanovic, Biljana Radulovi, Dejan Lacmanovic, Year: May 2010.**

Contactless payment systems represent cashless payments that do not require physical contact between the devices used in consumer payment and POS terminals by the merchant. Radiofrequency identification (RFID) devices can be embedded in the most different forms, such as the form of cards, key rings, built into a watch, or mobile phones. This type of payment supports the three largest payment system cards: Visa (Visa Contactless), MasterCard (MasterCard, PayPass), and American Express (ExpressPay).

All these products are compliant with the international ISO 14443 standard, which provides a unique system for payment globally. Implementation of contactless payment systems is based on the same infrastructure that exists for the payment cards with magnetic strips and does not require additional investments by the firm and financial institutions, other than upgrading the existing POS terminals. Technological solutions used for the implementation are solutions based on ISO 14443 standard, Sony FeliCa technology, RFID tokens and NFC (Near Field Communication) systems. This describes the advantages of introducing contactless payment system based on RF technology through pilot projects conducted by VISA, MasterCard and American Express Company in order to confirm in practice the applicability of this technology.

6. **"Li-Fi based Safety technique for Vehicle to Vehicle communication", Author: P. G. Surya, G. Sankar, R. Sivanesan and A. A. Rai, Year: 2021**

The most powerful approach that has been used to minimize vehicle injuries is vehicle-to-vehicle contact. In this paper, we present the designs and prototype of a device for vehicle-to-vehicle communication (v2v) using Light Fidelity (li-fi) technology, known as Visible Light Communication (VLC), which is here used for vehicle data communication. The proposed device also involves the prevention of turning point incidents with an ultrasonic sensor. The Buzzer indicator in a vehicle with Li-Fi technology. Li-Fi includes the use of the spectrum of visible light as a contact medium. High-speed data transfer, secure, efficient and environmentally friendly, is provided by Li-Fi technology.

7. **"Vehicle-to-Vehicle Communication using LI-FI Technology", Author: Buvaneswari S, Tanishka Raghu, Saranraj S Year: 2020**

Wireless communication has become a basic utility in our day-to-day life such that it becomes fundamental in our lives and this communication uses the radio spectrum for data transfer. There are issues in using the radio spectrum they are capacity, efficiency, availability, and security. The usage of Wi-Fi also causes damage to the ecosystem such as flora and fauna.

The defects of the Wi-Fi technology has given birth to the concept of Li-Fi (Light Fidelity) technology. Li-Fi is an advanced technology. This project is concise to vehicle-to-vehicle communication for avoiding road accidents. We use the ultrasonic sensor, gas sensor, vibration sensor, LCD display, LiFi transmitter and receiver. In case of an abnormal condition in the front vehicle, the vehicle at the back will be intimated and will stop on the second.

For future enhancement, Li-Fi can be implemented in class rooms where data stored in the server is transmitted through LED lights attached in the ceilings of the classroom and the data can be received through Li-Fi receiver (dongle) which is present with each student in the classroom.

8. "Vehicle to Vehicle Communication Using Li-Fi Technology by Android System", Author: B.Shanmuga Priyan, R.Gowthamraj, G.Dineshwar, Mr.J.T.ArunRaghesh Year: 2018

A vibration-based approach for automatic detection of potholes and speed breakers along with their coordinates. The communication between the vehicles is based on the Li-Fi technology. It is a wireless technology that uses the visible light to transmit data at high speeds which is 100 times faster than Wi-Fi. A message is sent via Li-Fi whenever the first car is slowed down. Thus received data is used for braking in highways through the activation of automatic braking system. The GPS is used for locking the pot holes on the road. Node MCU provides the Wi-Fi communication with the android devices.

9. “Vehicle To Vehicle Communication Using Li-Fi Technology”, Author: Vishal Mishra, Anand Yadav, Prabhat Singh Rawat, Md. Uzair, Ravi Shankar year: 2022

Vehicle to Vehicle (V2V) Communication is a developing technology which helps make our transportation system intelligent. The system can also avoid accidents and traffic congestion. In this paper, we employ Light Fidelity (Li-Fi) for data communication among vehicles. LiFi falls under the category of Visible Light Communication (VLC). We present initial designs and results of a small-scale prototype using light fidelity (Li-Fi) technology, a new technology that was developed in the last few years, which still needs more systematic inquiry on its sustainability for outdoor vehicular networks.

10. “Wi-Fi for Vehicular Communication Systems”, Author: J. Jansons, E. Petersons and N. Bogdanovs, Year: 2013

Vehicular communication is a popular topic in the academia and the car industry. This growing interest aims to develop an effective communication system for the Intelligent Transportation System (ITS). In this, the model of the wireless base station good put evaluation. It uses the wireless access point model as a queuing system with variable requests and the auto traffic model. The performance of the wireless networks can be impacted by a variety of parameters, such as radio communication range, available bandwidth, and bit rate, the number of clients in the wireless network range, and vehicle speed. The basic parameters were analyzed and presented.

CHAPTER 2

EXISTING SYSTEM

2.1 INTRODUCTION

The drive-through payment process has indeed revolutionized the way customers interact with fast-food and quick-service restaurants, offering unparalleled convenience and efficiency. Initially designed to minimize wait times and provide a seamless experience for on-the-go customers, this system has continuously evolved with advancements in technology, aiming to enhance speed, convenience, and security. One significant aspect of this evolution is the integration of various payment methods, catering to diverse customer preferences and technological capabilities.

Traditional cash transactions have been complemented by card payments, which offer convenience and ease of use. However, the emergence of contactless payment options, such as mobile wallets and NFC-enabled cards, has further expedited the transaction process, allowing customers to simply tap their devices or cards to complete payments swiftly and securely. Moreover, the rise of mobile ordering and payment apps has significantly transformed the drive-through experience. These apps empower customers to place orders in advance, customize their meals, and pay seamlessly from their smartphones before arriving at the restaurant. This not only reduces wait times but also ensures accuracy in orders and enhances overall customer satisfaction.

Additionally, innovations in payment technology have focused on improving security measures to protect customer data and prevent fraudulent activities. Encryption protocols, tokenization, and biometric authentication methods are being integrated into drive-through payment systems to safeguard sensitive information and instill trust among consumers. Furthermore, the integration of artificial intelligence (AI) and data analytics has enabled restaurants to personalize the drive-through experience further. By analyzing customer preferences and past orders, AI-powered systems can suggest tailored menu items and promotions, enhancing upselling opportunities and fostering customer loyalty. Overall, the continuous evolution of technology in drive-through payment processes underscores a commitment to delivering unparalleled convenience, efficiency, and security to customers. As technology continues to advance, we can expect further innovations aimed at refining the drive-through experience and meeting the ever-changing needs of consumers in the fast-paced world of quick-service dining.

2.2 WORKING MODULE

Drive-through payment systems work in a straightforward manner, allowing customers to make payments for their orders without leaving their vehicles. The process typically involves the following steps:

• **Placing an Order:** In a drive-through system, placing an order is an essential first step that establishes the parameters for the whole transaction. It consists of a number of components intended to provide precise and easy communication between the patron and the automated system or restaurant employees. Customers approach the ordering point usually indicated by a speech system or a computerized menu board as soon as they reach the drive-through lane. This space is positioned strategically to give drivers easy access and visibility. Customers view the restaurant's menu selections on a digital menu board at the ordering station. To help with decision-making, this board may have a range of food products, combinations, specials, and promotions together with eye-catching pictures and informative writing. Using the digital interface, customers peruse the menu selections and make their way through the available options. To locate what they're looking for, they may browse through several categories including burgers, sandwiches, sides, drinks, and desserts. Customers may personalize their meals to meet dietary requirements and personal preferences. This might entail asking for special cooking instructions (e.g., no onions, additional sauce), choosing particular components, changing portion proportions, or upgrading the dish. Using an automatic ordering system or a two-way speaker system, patrons may immediately express their requests to the restaurant personnel. They express explicitly what foods and beverages they enjoy, including the amount and any additions or alterations. The restaurant personnel or an automated system verifies the products the client has ordered after receiving the order data. To verify correctness and rectify any possible misunderstandings or discrepancies, they could give the consumer a second chance to place their order. An initial question on the chosen payment method may be part of the ordering process, depending on how the drive-through is configured. This guarantees a smooth transition to the payment window or terminal and enables the restaurant personnel to be ready for the next payment transaction. The customer receives an acknowledgment from the restaurant personnel or an automated system after the order details are verified and any extra instructions are documented. This notifies the consumer that their order placing is complete and gets them ready for the next payment step.

- **Order Confirmation:** An essential part of the drive-through procedure is order confirmation, which guarantees that the customer's order is correctly recorded and comprehended by the automated system or restaurant personnel. By reducing mistakes and inconsistencies, this phase eventually raises customer satisfaction. When the consumer places an order via the automated interface or speech system, the system or restaurant employees begin the process of confirming the order information. To make sure that the order appropriately represents the customer's preferences and specifications, this verification phase is essential. The employee or automated system pays close attention to what the consumer says and either confirms or modifies it. An essential part of the drive-through procedure is order confirmation, which guarantees that the customer's order is correctly recorded and comprehended by the automated system or restaurant personnel. By reducing mistakes and inconsistencies, this phase eventually raises customer satisfaction. When the consumer places an order via the automated interface or speech system, the system or restaurant employees begin the process of confirming the order information. To make sure that the order appropriately represents the customer's preferences and specifications, this verification phase is essential. The employee or automated system pays close attention to what the consumer says and either confirms or modifies it. The employee or the system mentally checks off each item and change that the customer has stated as they transmit the order. To verify correctness and alignment, they evaluate the customer's orders with the menu items and available options. During the verification phase, any requests or modifications like dietary preferences, worries about allergens, or specific preparation instructions—are given further consideration. To effectively meet the needs of the consumer, the staff member or system makes sure that these particular requests are appropriately captured and understood. Following the customer's order communication, a staff member or the system does a last review to verify that all order data are correct. To find any inconsistencies or missing details, they mentally compare the order to the customer's spoken instructions and the menu options. The employee or system gets ready to confirm the order and send it back to the client after looking over the order information. This might entail correctly capturing and communicating all pertinent facts while summarizing the sequence in advance of repeat or confirmation.

• **Transaction Completion:** The drive-through payment procedure ends with the consumer receiving a confirmation of their transaction and their payment having been properly completed. This is known as transaction completion. This is an essential step in making sure the consumer has a smooth and positive experience. After the order has been verified, the customer goes to the terminal or payment window to start the payment procedure. The consumer may utilize a self-service payment terminal or speak with a staff member stationed at the payment window, depending on how the drive-through is configured. The consumer chooses their chosen payment method from the available alternatives at the payment window or terminal. Cash, credit/debit cards, mobile wallets, and contactless payment methods like NFC-enabled cards or smartphones are often accepted payment methods in drive-thru. The customer chooses their chosen payment option, then gives the employee or payment terminal the required payment information or shows their payment device.

The consumer has two options for making payments: inserting or swiping their card if paying with cash, or tapping their device on the terminal if using a contactless or mobile wallet. The authorization procedure is started by the payment terminal or a staff person when the payment information has been input or provided. The customer's bank or payment provider is contacted by the payment system to confirm the transaction and make sure there are enough funds available for the purchase. When the payment authorization is successful, the consumer is informed that the transaction has been completed by the payment terminal or a staff person. This confirmation might be given orally, shown on a computer screen, or stated on a paper receipt, based on the drive-through configuration and the preferences of the consumer. The payment terminal or a staff person creates and prints a receipt for the customer upon request for their transaction. This receipt, which contains information on the goods purchased, the payment amount, the transaction ID, and any relevant taxes or discounts, acts as documentation of payment. The customer gets their payment device from the payment terminal or a staff member if they made their purchase using a card or mobile device. Alternatively, if a consumer wants to pay with cash, they provide the cash to the employee, who can make changes if necessary. The employee thanks the customer for their business as the transaction comes to an end. A courteous "thank you" or other expression of gratitude enhances good client relations and gives the conversation a more intimate feel. The consumer can now move to the designated waiting area or the food pickup window after completing the payment. The customer's order is being prepared by the restaurant personnel in the meanwhile, making sure everything is accurate, fresh, and ready for pickup.

- **Order collection:** Order collecting is the last phase of the drive-through procedure, where customers pay and get their cooked meal order. Ensuring that clients receive their chosen things precisely and timely is dependent on this step. The consumer goes to the pickup window or designated waiting area to pick up their purchase after finishing the payment procedure. Usually situated next to the payment window, this area is conveniently reachable by cars using the drive-through lane. To make sure the right person is receiving the order, the client may be requested to prove their identification when they arrive at the pickup window or other specified place. This might be giving the name linked to the order or displaying any receipts or order confirmations obtained during the transaction. In the meantime, the restaurant's order fulfilment employees prepare each customer's order based on the information they were given when placing their order. This include putting the food products together, packing them safely, and making sure that any specific requests or adjustments are appropriately included. A staff member at the pickup window or other specified location gives the customer their order when it's ready. This might entail delivering the bundled order to the client via the window or setting it on a special shelf or counter for them to pick up. Both the consumer and the employee in charge of presenting the order confirm that the products received are accurate as they are being given to them. To make sure that all requested products are included and that any specific requests or adjustments have been appropriately handled, the client may physically examine the order. The client may bring any inconsistencies or mistakes in the order such as missing components or improper preparations to the notice of the employee at the pickup window or other specified location. The employee then moves swiftly to fix the problem, which might include preparing missing products, rectifying mistakes in items, or offering replacements or reimbursements as needed. The employee at the pickup window or other designated location thanks the client for their business as soon as they get their order. A genuine "thank you" or other expression of gratitude personalizes the exchange and promotes good client relations. The employee could additionally wish the client a happy lunch or a wonderful day before leaving. The client feels satisfied after this last exchange, which improves their entire drive-through experience. Employees working in the drive-through guarantee that customers receive their meals precisely and on time, enjoying a satisfactory eating experience, by closely supervising every stage of the order-collecting process. The seamless and delightful drive-through experience for consumers is facilitated by clear communication, meticulous attention to detail, and amiable customer service.

2.3 DRAWBACKS

Drive-through systems have many advantages, yet there may be negative aspects to their operational mechanisms. Compared to dine-in menus, drive-through menus sometimes provide a smaller range of food items. Customers may have fewer alternatives as a result of this restriction, which might cause them to become unhappy or make it impossible to satisfy their dietary needs or limitations. Sometimes outside variables like road noise or bad weather make it difficult for workers and customers to communicate over speaker systems or intercoms. Customers and employees may become frustrated as a result, and there may be miscommunications. Orders can still be incorrectly entered and fulfilled even with thorough verification procedures.

Inaccurate orders may be made as a consequence of miscommunications, technological difficulties, or human mistake, which may cause consumer discomfort. During peak hours, drive-through lanes may get crowded, resulting in lengthy wait times for patrons. These wait periods can be made worse by delays in order placing, payment processing, or meal preparation, which can aggravate and irritate patrons. Drive-thru systems, such as those with digital menu boards, payment terminals, and order management software, are highly dependent on technology. These systems' ability to work can be interfered with by technical issues, internet outages, or power outages, which can cause service disruptions and inconvenience for staff and consumers alike. Ineffective traffic flow can be caused by badly planned drive-through layouts or insufficient traffic management techniques, which can clog up traffic and delay customers who are waiting to make orders or pick up their meals. This may discourage repeat business and have a detrimental effect on the entire consumer experience. Drive-thru businesses may exacerbate environmental issues including trash, noise pollution, and increased vehicle emissions.

While food waste and discarded packaging can contribute to littering and environmental degradation, drive-through lanes can also add to air pollution and carbon emissions from idle automobiles. It is necessary to carefully evaluate operating procedures, technological integration, customer service guidelines, and environmental sustainability projects to address these shortcomings.

CHAPTER 3
PROPOSED SYSTEM

3.1 INTRODUCTION

The integration of Li-Fi technology in vehicles presents a promising avenue for enhancing safety and efficiency in the automotive sector. Li-Fi's utilization of light waves for data transmission offers several advantages over traditional Wi-Fi systems, including faster speeds and increased security. By incorporating Li-Fi into the drive-through experience, alongside other emerging technologies like contactless payments and mobile apps, the potential for improving payment processing speed and security becomes apparent.

Li-Fi's high-speed data transmission capabilities can facilitate swift and secure payment transactions, potentially reducing waiting times at drive-thru. Furthermore, the integration of Li-Fi with sensors and components within vehicles can lead to the development of intelligent driving systems that prioritize safety and efficiency on the road.

One of the primary benefits of integrating Li-Fi technology into vehicles is its ability to support smart payment options. With Li-Fi-enabled systems, customers can make contactless payments seamlessly, enhancing convenience and reducing transaction times. Moreover, Li-Fi's secure data transmission ensures that payment information remains protected from potential cyber threats, bolstering overall transaction security.

In addition to enhancing payment processing, Li-Fi technology can enable adaptive lighting within vehicles, optimizing visibility and comfort for drivers and passengers. By adjusting interior lighting levels based on ambient conditions, Li-Fipowered systems can enhance driving experiences and reduce driver fatigue, ultimately contributing to improved road safety. Furthermore, Li-Fi integration holds the potential to enhance vehicle automation, particularly in areas such as brake automation. By leveraging Li-Fi-enabled sensors and communication systems, vehicles can react more swiftly to changing road conditions and potential hazards, enhancing overall driving safety.

In conclusion, the integration of Li-Fi technology in vehicles represents a significant step toward creating intelligent driving systems that prioritize safety and efficiency. By harnessing Li-Fi's speed, security, and versatility, automotive manufacturers can develop innovative solutions that revolutionize the drive-through experience and enhance road safety for all motorists.

3.2 BLOCK DIAGRAM

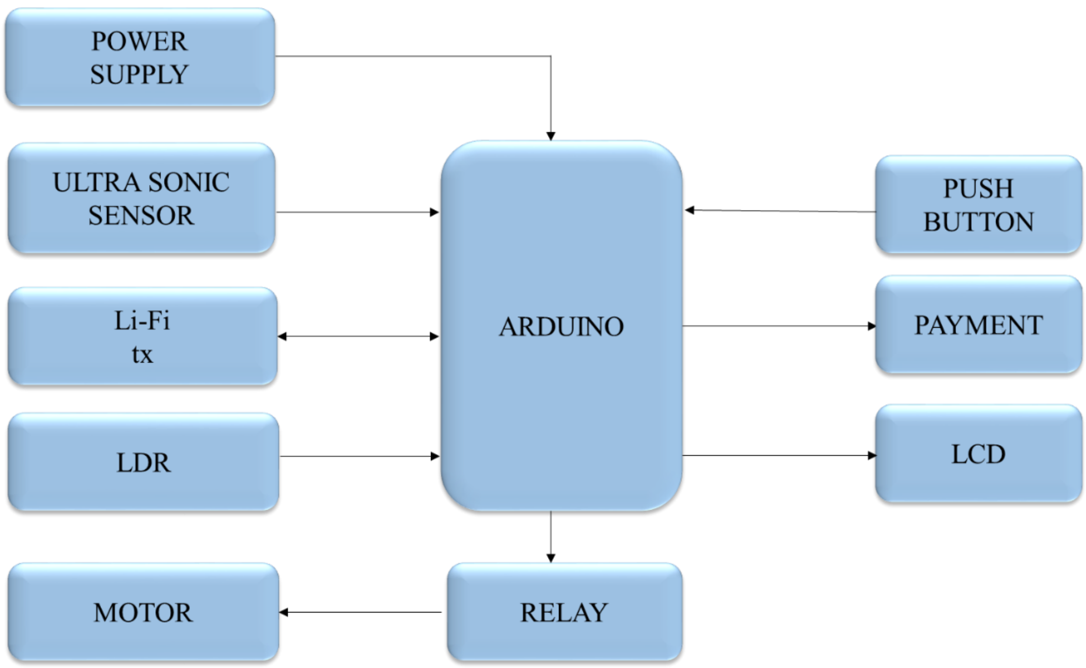

Figure 3.1 Block diagram for Brake automation and Smart payment

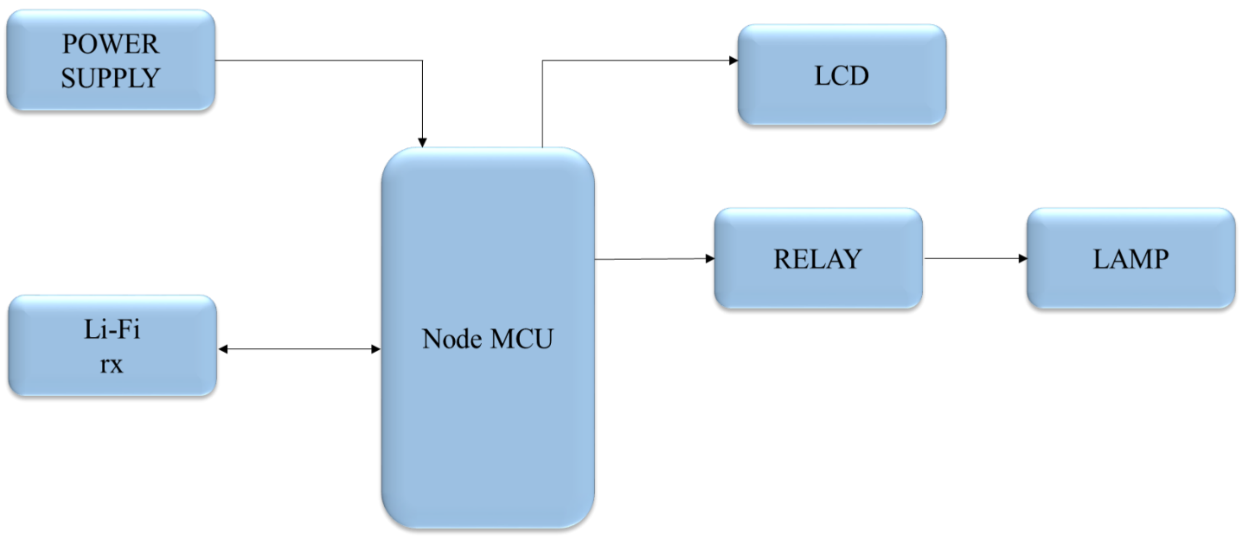

Figure 3.2 Block diagram for Adaptive lighting

3.3 BLOCK DIAGRAM DESCRIPTION:

The system includes several key components such as Li-Fi transmitters and receivers, LDR (Light Dependent Resistor) and ultrasonic sensors, an Arduino controller, and various relays and motors. Each of these components plays a crucial role in the functioning of the system, and their integration allows for a comprehensive solution to enhance the driving experience.

- **Li-Fi Transmitters and Receivers:**

The primary component of the proposed system is the Li-Fi transmitters and receivers. These devices utilize light waves to transmit and receive data, making them an ideal choice for efficient and secure data transmission. These devices can be installed in various locations, such as toll booths, fuel stations, and drive-through restaurants, to facilitate data exchange between the vehicle and the establishment.

- **LDR and Ultrasonic Sensors:**

In addition to Li-Fi technology, the proposed system also includes LDR and ultrasonic sensors. These sensors are responsible for detecting and measuring light and distance, respectively. The LDR sensors are used to detect the intensity of light, while the ultrasonic sensors measure the distance between the vehicle and the surrounding objects. These sensors provide essential data inputs for the system, enabling it to adapt and respond to changing driving conditions.

- **Arduino Controller:**

The Arduino controller acts as the brain of the system, responsible for processing the data from the sensors and transmitters, and controlling the various relays and motors. This microcontroller is equipped with various inputs and outputs, making it suitable for the integration of different sensors and their components. It is programmed to interpret the data received from the sensors and take appropriate actions, such as adjusting the lighting or activating the brakes.

3.1.1 Relays and Motors:

To ensure the smooth functioning of the proposed system, several relays and motors are integrated. These components are used to control the various functions of the vehicle, such as the headlights, brake lights, and brake system. These functions are automatically adjusted based on the data received from the sensors and processed by the Arduino controller. For example, if the ultrasonic sensors detect an obstacle in front of the vehicle, the motors will activate the brakes to prevent a collision.

3.1.2 LCD Display:

The proposed system also includes a user-friendly LCD that provides real-time monitoring and control. This display can be installed on the dashboard or near the steering wheel for easy access by the driver. The display shows important information such as the distance from surrounding objects, payment options, and system status. It also allows the driver to manually control certain functions, such as adjusting the lights or making a payment.

3.1.3 Push Button:

A push button for activating a payment code in Arduino can be implemented as part of a system that triggers a specific action (in this case, activating a payment code) when the button is pressed.

The code would continuously monitor the state of the button, and upon detecting a change (i.e., a button press), it would trigger the sequence of actions related to the payment code generation or activation.

3.2 WORKING PRINCIPLE:

The working principle of this concept is based on the principles of Li-Fi technology and the integration of various components to create an intelligent system for driving. Li-Fi technology uses light signals to transmit data, making it faster and more secure than traditional Wi-Fi technology. In this system, Li-Fi transmitters are placed along the driving route, emitting light signals that carry information about the road conditions and other necessary data. As the heart of this system is an Arduino controller, which acts as the brain and is responsible for receiving and processing the data from the Li-Fi transmitters.

The controller is also connected to LDR (light-dependent resistor) sensors, which detect changes in light intensity and send signals to the controller. Ultrasonic sensors are also used in this system to detect nearby objects and obstacles, providing real-time data on the distance and speed of other vehicles. This data is also transmitted to the controller for further processing.

The controller then uses this data to adjust the vehicle's speed and braking system, ensuring a smooth and safe driving experience. In case of any sudden obstacles, the system can automatically apply the brakes to prevent accidents. The system also includes various relays and motors that control the vehicle's lighting and payment options. Adaptive lighting is achieved by using sensors to detect the ambient light conditions and adjusting the vehicle's headlights accordingly.

The payment option is also integrated into the system, allowing for seamless and contactless transactions. Users can simply connect their payment method to the system, and their payment will be automatically processed as theydrive through the designated areas. All of these components and functionalities are displayed and controlled through an LCD, making it user-friendly and easy to monitor. The display also provides real-time feedback on the vehicle's speed, distance, and other important data.

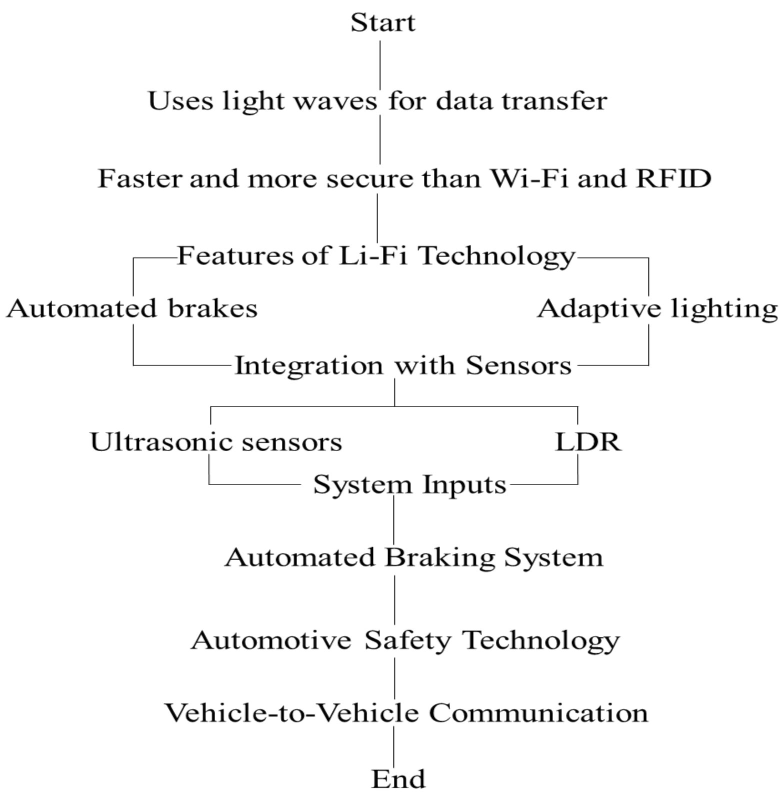

Figure 3.3 Working flowchart

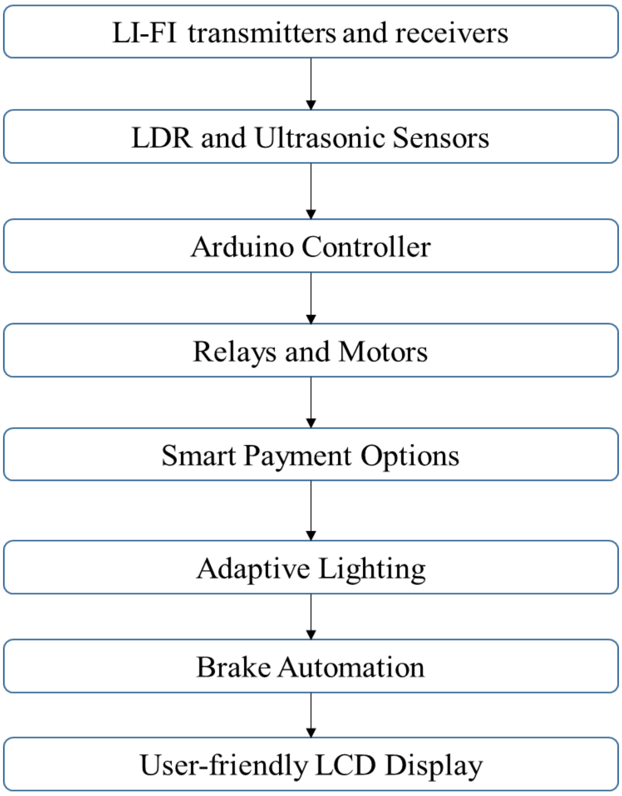

Figure 3.4 Flowchart of the proposed system

3.3 SYSTEM DESIGN:

The system consists of two main parts: the vehicle unit and the drive-thru unit. The vehicle unit will be installed in the customer's vehicle, while the drive-through unit will be installed in the drive-thru lane of the destination.

Vehicle Unit: The vehicle unit will contain all the necessary components, including the Li-Fi receiver, LDR and ultrasonic sensors, Arduino controller, and LCD. The Li-Fi receiver will be connected to the Arduino controller,which will receive data from the sensors and process it. The processed data will be displayed on the LCD display for real-time monitoring.

Drive-thru Unit: The drive-thru unit will contain the Li-Fi transmitter and the relays for enabling smart payment in the drive thru lane. The Li-Fi transmitter will be connected to the Arduino controller, which will transmit data to the vehicle unit and process the payment system accordingly.

Data Transmission: The Li-Fi technology uses light waves to transmit data, which makes it faster and more secure than traditional Wi-Fi. The Li-Fi transmitter in the vehicle will send data to the receiver in the drive-through lane, and vice versa.The Arduino controller will process this data and use it to control the various components of the system.

Data Processing: The data collected by the LDR and ultrasonic sensors will be sent to the Arduino controller, which will process it in real time. The LDR sensor will measure the ambient light intensity, and if it detects a decrease in light, it will send a signal to the Arduino controller. The ultrasonic sensor will be used to detect any obstacles in the drive-through lane, and if it detects an obstacle, it will send a signal to the Arduino controller. The controller will use this data to calculate the distance between the vehicle and the obstacle and control the braking system accordingly.

Adaptive Lighting: The adaptive lighting system is designed to adjust the vehicle's headlights based on the ambient light intensity and the distance from other vehicles. The LDR sensor will measure the ambient light intensity and send the datato the Arduino controller. The controller will then use this data to adjust the brightness of the vehicle's headlights to ensure proper visibility for the driver.

Brake Automation: The system also includes a brake automation feature that uses the data from the ultrasonic sensor to control the braking system. If the sensor detects an obstacle in front of the car, the controller will send a signal to the relays, whichwill activate the brakes to reduce the vehicle's speed or bring it to a complete stop if necessary.

Smart Payment Options: The Li-Fi technology can also be used for smart payment options in the drive-through lane. Customers can make payments through their vehicle using the Li-Fi connection. The Li-Fi transmitter in the drive-through unit will transmit the payment data and transfer it to the Arduino controller, which will then complete the payment process.

Real-time Monitoring and Control: The system includes a user-friendly LCD in the vehicle, which will provide real-time monitoring and control of the system. It will display the data collected by the sensors and the current status of the braking and lighting system. Additionally, the LCD can also be used tochange settings and control the system manually.

Integration of Components: The integration of all the components mentioned above is crucial for the proper functioning of the system. The sensors, Arduino controller, relays, motors, and LCD will all be connected and programmed to work together seamlessly.

Testing and Calibration: Before deploying the system, it is essential to test and calibrate all the components to ensure they are functioning correctly. The LDR and ultrasonic sensors will be tested for their accuracy in detecting light intensity and obstacles, respectively. The Li-Fi connection between the vehicle unit and the drive-thru unit will also be tested for its speed and reliability. Additionally, the braking and lighting systems will be tested for their responsiveness and accuracy.

Maintenance and Upgrades: Regular maintenance and upgrades are essential to ensure the smooth functioning of the system. The sensors and other components should be checked and calibrated regularly to detect and fix any malfunctions. Upgrades can also be made to the software to improve the system's performance and add new features.

3.4 FUNCTIONING OF THE PROPOSED SYSTEM:

The proposed system functions as follows:

Smart Payment Options: As the vehicle approaches the drive-through restaurant, the Li-Fi transmitters and receivers communicate with each other to establish a connection. The vehicle's details are transmitted to the establishment, and the driver can make a payment through their vehicle, eliminating the need for physical cash or card transactions.

Adaptive Lighting: The LDR sensors continuously detect the light intensity around the vehicle, and the information is processed by the Arduino controller. Based on this data, the system can automatically adjust the vehicle's headlights and taillights accordingly to provide optimal visibility for the driver and other motorists.

Brake Automation: The ultrasonic sensors measure the distance between the vehicle and surrounding objects. If the distance is reduced to a predetermined threshold, the Arduino controller activates the motors to apply the brakes. This automation ensures timely braking to prevent collisions and improve safety on the road.

Real-Time Data Collection and Processing: The integration of various sensors and components allows for real-time data collection and processing. This enables the system to adapt and respond to changing driving conditions, ensuring a smooth and efficient driving experience.

3.5 BENEFITS OF THE PROPOSED SYSTEM:

Enhanced Safety: By utilizing Li-Fi technology and various sensors, the proposed system can effectively enhance safety on the road. The automation of brakes and adaptive lighting reduces the chances of collisions, making driving safer for both the driver and other motorists.

Improved Efficiency: This system can also improve driving efficiency by facilitating quick and secure payments and reducing the time spent at toll booths, fuel stations, and drive-thru. This can lead to a smoother and faster drive-through experience, saving both time and fuel.

Integration with Existing Technology: The proposed system can be easily integrated with existing technology such as smartphones and vehicle systems. This makes it a cost-effective solution that does not require major changes to the vehicleor infrastructure.

Eco-Friendly: With the reduction of physical transactions and more efficient driving, this system can also contribute to a cleaner environment by reducing carbon emissions

CHAPTER 4

HARDWARE IMPLEMENTATION

4.1 INTRODUCTION

This proposed system aims to utilize the advantages of Li-Fi technology and integrate it with various sensors and components to create an intelligent driving system that enhances safety and efficiency on the road. The Arduino Integrated Development Environment (IDE) is a software application used to write, compile, and upload code to Arduino microcontroller boards for developing projects.

The Arduino software is easy to use and includes a powerful Integrated Development Environment (IDE) that can be used to create custom projects from scratch. The IDE includes a text editor and a compiler, which can be used to create and debug code for the Arduino platform. The IDE also includes a library of code examples and tutorials that can be used to quickly create projects.

4.2 HARDWARE COMPONENT DESCRIPTION

The description of the various hardware used in the project is as follows,

4.2.1 ARDUINO

Arduino is an open-source electronics platform based on easy-to-use hardware and software. It can receive and send information to most devices, and even through the internet to command the specific electronic device. Technically, 1‟s (LED on) and 0‟s (LED off) are modulated and then transmitted at very high speed.

Arduino Li- Fi Transfer from one source to another through visible light without flickering effect. Arduino boards are built around microcontrollers from the Atmel AVR family, although newer versions also utilize ARM-based chips. These boards typically include digital and analog input/output pins, USB connectivity, power connectors, and various other components to facilitate interfacing with sensors, actuators, and other electronic devices.

Arduino has a large and active community of users and developers who contribute to the platform by sharing code, tutorials, and project ideas. This vibrant ecosystem has led to the development of countless libraries, shields (expansion boards), and accessories that extend the capabilities of Arduino boards for various applications. One of the key principles of Arduino is its open-source nature. Both the hardware designs and the software are freely available for anyone to use, modify, and distribute under the terms of the GNU General Public License (GPL) or Creative Commons Attribution-Share Alike license.

Arduino boards can be expanded using shields, which are add-on boards that provide additional functionality such as Wi-Fi connectivity, motor control, GPS, and more. These shields can be stacked on top of the Arduino board, allowing users to easily customize and extend their projects.

While the official Arduino boards are widely used, there are also many compatible boards available from other manufacturers. These boards are typically compatible with the Arduino IDE and libraries, allowing users to choose the hardware that best suits their needs. Overall, Arduino is a powerful yet accessible platform for creating interactive electronic projects, making it an ideal choice for both beginners and experienced makers alike.

Figure 4.1 Arduino

4.2.2 LCD

LCD (Liquid Crystal Display) is a type of flat panel display that uses liquid crystals in its primary form of operation. When an electric current is applied, the crystals align to control the amount of light passing through them, creating the image you see on the screen. It can be connected to the Arduino using a parallel bus, when there are available ports, or a serial bus, using the I2C module. Those alert messages can be displayed through the LCD in the vehicle.

LCDs work on the principle of manipulating light through liquid crystal molecules. Liquid crystals are substances that exhibit properties of both liquids and solids. When an electric current is applied, the orientation of liquid crystal molecules changes, altering the passage of light through them. A typical LCD consists of several layers sandwiched between two transparent electrodes. These layers include a backlight (in most cases), polarizing filters, glass substrates with electrodes, liquid crystal material, color filters, and a top polarizer.

Polarizing filters are placed on the top and bottom layers of the LCD panel. They help to control the direction of light passing through the liquid crystal layer. The orientation of the polarizers determines the orientation of the liquid crystal molecules and thus affects the display of images. The liquid crystal layer is the heart of an LCD. It is made up of long, rod-shaped molecules that can align themselves in specific orientations when subjected to an electric field. These molecules twist and untwist to control the passage of light through the display. In color LCDs, color filters are used to produce a full range of colors. Each pixel on the screen typically consists of three sub-pixels, each with a color filter corresponding to red, green, or blue (RGB). By adjusting the intensity of light passing through each sub-pixel, a full spectrum of colors can be displayed.

Most LCDs require a backlight to illuminate the display. This backlight can be fluorescent tubes (older technology) or light-emitting diodes (LEDs) in modern displays. The backlight provides the necessary illumination for the liquid crystal molecules to modulate and produce visible images.

Advantages:

- Low power consumption compared to other display technologies like CRT (Cathode Ray Tube).
- Thin and lightweight, making them suitable for portable devices.
- Can be produced in various sizes and resolutions to meet specific application requirements.

Disadvantages:

- Limited contrast ratio compared to some other display technologies like OLED (Organic Light-Emitting Diode).
- Response times may not be as fast as other display technologies, leading to motion blur in fast-moving images.
- Limited flexibility, as LCD panels are rigid and cannot be bent or curved like OLED or AMOLED displays.

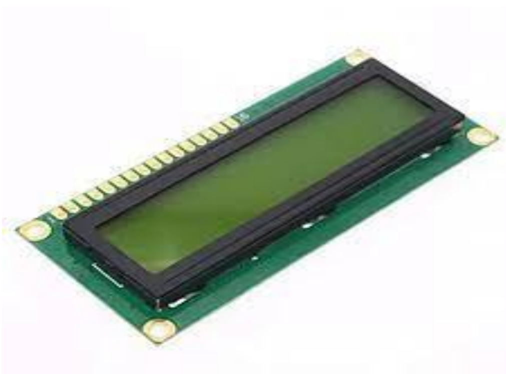

Figure 4.2 LCD

4.2.3 RELAY

Relays are electrically operated switches that open and close the circuits by receiving electrical signals from outside sources. They receive an electrical signal and send the signal to other equipment by turning the switch on and off. It’s an electromagnetic device that is used to isolate two circuits electrically and connect them magnetically. Relays are electromechanical switches used to control the flow of electricity in a circuit.

Relays are widely employed in various applications where electrical isolation or high-power switching is required. Here's a deeper exploration of relays. Relays operate on the principle of electromagnetism. They consist of a coil of wire (the electromagnet), an armature (movable contact), and one or more sets of stationary contacts. When a current flows through the coil, it generates a magnetic field that attracts or repels the armature, causing it to move and make or break connections with the stationary contacts.

Electromechanical Relays (EMRs): These are the most common type of relays and utilize an electromagnetic coil to control the switch mechanism. EMRs come in various configurations, including single-pole single-throw (SPST), single-pole double-throw (SPDT), double-pole single-throw (DPST), and double-pole double-throw (DPDT).

Solid-State Relays (SSRs): SSRs use semiconductor devices such as thyristors or MOSFETs to perform switching instead of mechanical contacts. They offer advantages like faster switching speeds, longer lifespan, and reduced electromagnetic interference (EMI), but they may not handle as much current as EMRs and typically have higher initial costs.

Reed Relays: These relays use a small electromagnet to control the movement of a reed switch enclosed in a glass tube. Reed relays offer high reliability, low contact resistance, and fast operation, making them suitable for applications requiring precise switching.

Latching Relays: Latching relays have two stable states and remain in their last switched position even after power is removed. They are commonly used in power-saving applications where continuous power consumption is undesirable.

Protective Relays: These relays are designed to detect abnormal conditions such as overcurrent, overvoltage, or faults in electrical systems and trigger protective actions, such as opening circuit breakers or disconnecting power sources, to prevent damage to equipment or personnel.

Operation: When the coil of a relay is energized, it creates a magnetic field that attracts the armature, causing the contacts to close (or open, depending on the relay type). When the coil is de-energized, the magnetic field collapses, and the contacts return to their default position due to spring tension or other mechanisms. Relays play a critical role in numerous electrical and electronic systems, providing reliable and flexible switching solutions across a wide range of industries and applications.

Applications:

- Control of high-power loads such as motors, heaters, lights, and solenoids.
- Automation and process control systems.
- Electrical distribution and protection in power systems.
- Remote control and signaling applications.
- Automotive and marine electronics.
- Safety systems and emergency shutdown circuits.

Features:

- **Electrical Isolation:** Relays provide isolation between the control circuit and the switched circuit, offering protection against voltage spikes and electrical noise.
- **Versatility:** Relays can switch a wide range of voltages and currents, making them suitable for diverse applications.
- **Longevity:** Mechanical relays can endure millions of switching cycles, while solid-state relays have no moving parts and can last even longer.
- **Coil Ratings:** Relays are available with various coil voltage ratings to suit different control circuitry requirements.

Figure 4.3 Relay

4.2.4 CAPACITOR

Capacitor is an electronic component that stores electrical charge and is commonly used to smooth out power fluctuations or filter out unwanted noise in an electronic circuit. In such times, a 1000µF 16V Electrolytic Capacitor is ideal for low-frequency signals, to reduce the effects of ripples, surges as well as sudden drops in current.

In electronics used to store and release electrical energy. They are found in a wide range of applications, from simple circuits to advanced electronic devices. Here's a deep dive into capacitors.

Basic Principle: A capacitor consists of two conductive plates separated by a dielectric material. When a voltage is applied across the plates, an electric field is created in the dielectric, causing positive and negative charges to accumulate on the plates. This creates an electric potential difference (voltage) between the plates, storing electrical energy in the form of an electric field.

Construction:

- **Conductive Plates:** Typically made of metal, such as aluminum, tantalum, or ceramic materials. These plates provide the surfaces for charge accumulation.
- **Dielectric Material:** The dielectric is an insulating material placed between the plates to prevent direct electrical contact and increase capacitance. Common dielectric materials include ceramic, paper, plastic films, and electrolytes.
- **Terminals:** Capacitors have two terminals that connect to the conductive plates. These terminals allow the capacitor to be connected within an electrical circuit.

Capacitance: Capacitance (C) is the measure of a capacitor's ability to store electrical charge per unit voltage. It is determined by the surface area of the plates, the distance between them, and the properties of the dielectric material. Capacitance is measured in farads (F), although capacitors typically have capacitance values ranging from picofarads (pF) to farads (F).

Types of Capacitors:

- **Electrolytic Capacitors:** These capacitors use an electrolyte solution as the dielectric and are polarized, meaning they have a positive and negative terminal. They offer high capacitance values and are commonly used in power supply circuits and filtering applications.
- **Ceramic Capacitors:** Ceramic capacitors use ceramic material as the dielectric and are non-polarized. They are widely used due to their small size, low cost, and stability over a wide range of temperatures and frequencies.
- **Film Capacitors:** Film capacitors use a thin film of plastic or metal oxide as the dielectric and are available in both polarized and non-polarized configurations. They are used in applications requiring high precision and low losses.
- **Tantalum Capacitors:** Tantalum capacitors use tantalum metal as the anode and a thin oxide layer as the dielectric. They offer high capacitance density and are often used in compact electronic devices.
- **Supercapacitors:** Also known as ultracapacitors, supercapacitors have a much higher capacitance density than traditional capacitors and can store and release energy rapidly. They are used in applications requiring high-power bursts, such as hybrid vehicles and regenerative braking systems.

Applications:

- Energy storage in electronic circuits, such as power supplies and filters.
- Timing circuits and oscillators.
- Signal coupling and decoupling.
- Motor start and run capacitors in electric motors.

- Tuning and filtering in radio frequency (RF) circuits.
- Energy storage in renewable energy systems and electric vehicles.

Behavior:

- **Charging and Discharging:** When a voltage is applied to a capacitor, it charges up as electrons accumulate on one plate and leave the other plate. When the voltage source is removed, the capacitor discharges, releasing stored energy.
- **Impedance:** Capacitors exhibit impedance to the flow of alternating current (AC), with higher impedance at lower frequencies and lower impedance at higher frequencies. This property makes capacitors useful for filtering and frequency-selective circuits.
- **Time Constants:** Capacitors exhibit time constants, which determine the rate at which they charge and discharge in response to changes in voltage or current.

Capacitors are essential components in electronics, providing energy storage, signal filtering, and voltage regulation capabilities critical for the operation of electronic circuits and devices. Their diverse types and applications make them indispensable in modern technology.

Figure 4.4 Capacitor

4.2.5 POWER SUPPPLY BOARD

The power supply board is a basic essential interface for regulating and supplying power to the connected components. The power supply controls the amount of current or voltage getting into the PCB. The power can be either direct (DC) or alternating (AC). It produces constant power for lamp driver. The female barrel jack connector on the power supply board acts as the input terminal and the terminal block on the board enables you to connect to the components using the male bread board wires.

A power supply board, also known as a power supply unit (PSU) or power supply module, is an essential component in electronic devices and systems. Its primary function is to convert electrical energy from a source (such as an outlet or battery) into a form suitable for powering the various components of the device. Here's a deeper look into power supply boards.

Basic Functionality:

- **Voltage Regulation:** Power supply boards regulate the voltage output to ensure a stable and consistent supply of power to the connected components.
- **Current Limitation:** They also limit the amount of current delivered to prevent damage to the device in case of overloading or short circuits.
- **Filtering:** Power supplies often include filters to reduce noise and ripple in the output voltage, ensuring clean and reliable power delivery.

Components:

- **Transformer:** In AC-to-DC power supplies, a transformer is used to step down or step up the voltage from the input power source.

- **Rectifier:** Converts AC voltage to DC voltage. This can be done using diodes or bridge rectifiers.
- **Filter Capacitors:** Capacitors are used to smooth out the rectified DC voltage, reducing ripple and noise.
- **Voltage Regulator:** Integrated circuits or discrete components regulate the output voltage to maintain a constant level, even with changes in input voltage or load.
- **Protection Circuitry:** Power supplies often include protection features such as overvoltage protection (OVP), overcurrent protection (OCP), and short-circuit protection to safeguard both the power supply and connected devices.

Types of Power Supply Boards:

- **Linear Power Supplies:** These power supplies use linear regulators to regulate the output voltage. They are simple and offer good voltage regulation but are less efficient and generate more heat.
- **Switched-Mode Power Supplies (SMPS):** SMPS use switching regulators to regulate the output voltage. They are more efficient, lighter, and smaller than linear power supplies but may introduce more noise into the system.
- **Uninterruptible Power Supplies (UPS):** UPS systems include a battery backup to provide power in case of a mains power failure. They ensure uninterrupted operation of critical devices and systems.
- **DC-DC Converters:** These power supplies convert one DC voltage to another DC voltage. They are commonly used in devices with multiple voltage requirements, such as computers and communication equipment.

Applications:

- **Consumer Electronics:** Power supply boards are used in devices such as televisions, computers, gaming consoles, and audio amplifiers.
- **Industrial Equipment:** They power various types of machinery, automation systems, and control panels in industrial settings.
- **Telecommunications:** Power supplies are essential for providing power to communication equipment, including base stations, routers, and switches.
- **Medical Devices:** Power supplies are used in medical equipment such as ultrasound machines, MRI scanners, and patient monitoring systems.
- **Renewable Energy Systems:** Power supply boards are used in solar inverters, wind turbines, and other renewable energy systems to convert and regulate power from renewable sources.

Design Considerations:

- **Efficiency:** Efficiency is a critical factor, especially in devices that operate for extended periods. Higher efficiency means less energy wasted as heat and lower operating costs.
- **Size and Form Factor:** Power supply boards need to fit within the device's enclosure while providing the required power output.
- **Reliability:** Reliability is essential to ensure the continuous operation of devices, particularly in mission-critical applications.
- **Safety:** Power supplies must comply with safety standards and regulations to protect users and equipment from electrical hazards.

In summary, power supply boards play a crucial role in providing reliable and regulated power to electronic devices across various industries and applications.

Their design and features are tailored to meet the specific requirements of different devices, ensuring optimal performance and longevity.

Figure 4.5 Power Supply Board

4.2.6 Node MCU

Node MCU is a Low-Cost Open source IOT platform. It initially included firmware which runs on the ESP8266 Wi-Fi SoC from the Systems, and hardware which was based on the ESP-12 module. It can be used to build smart home devices, remote sensors, data loggers, and other internet-enabled devices.

Node MCU is an open-source IoT (Internet of Things) platform based on the ESP8266 Wi-Fi module. It consists of both hardware and software components designed to facilitate the development of IoT projects and applications. Here's a deeper look into Node MCU.

Hardware:

- **ESP8266 Module:** Node MCU is built around the ESP8266 Wi-Fi module, which integrates a microcontroller (usually an ESP8266 chip) with Wi-Fi connectivity. The ESP8266 provides GPIO (General Purpose Input/Output) pins, analog-to-digital converters (ADC), SPI (Serial Peripheral Interface), I2C (Inter-Integrated Circuit), UART (Universal Asynchronous Receiver-

Transmitter), and other interfaces for interfacing with sensors, actuators, and other electronic components.

- **USB-to-Serial Converter:** Node MCU boards typically include a USB-to-Serial converter chip, allowing easy programming and communication with the ESP8266 module via USB.
- **Voltage Regulator:** Node MCU boards often include a voltage regulator to provide a stable power supply to the ESP8266 module and other components.
- **Headers:** Node MCU boards usually feature headers for easy connection of jumper wires, sensors, and other peripherals.
- **LEDs and Buttons:** Some Node MCU boards include built-in LEDs and buttons for status indication and user interaction.

Software:

- **Firmware:** Node MCU firmware is based on the Lua scripting language and runs on the ESP8266 module. It provides a high-level API (Application Programming Interface) for interacting with GPIO pins, Wi-Fi, TCP/IP networking, timers, and other functionalities of the ESP8266.
- **Programming Environment:** Node MCU can be programmed using the Lua scripting language, which is interpreted directly by the ESP8266 module. Alternatively, it can be programmed using the Arduino IDE or other development environments by flashing custom firmware onto the ESP8266 module.

Features:

- **Wi-Fi Connectivity:** One of the key features of Node MCU is its built-in Wi-Fi connectivity, which enables IoT applications to connect to the internet and communicate with other devices and servers.

- **GPIO Pins:** Node MCU boards provide multiple GPIO pins for interfacing with sensors, actuators, displays, and other electronic components.
- **OTA (Over-The-Air) Updates:** Node MCU supports OTA updates, allowing firmware to be updated wirelessly over Wi-Fi without the need for physical access to the device.
- **Low Cost:** Node MCU boards are relatively inexpensive compared to other microcontroller platforms, making them accessible for hobbyists, students, and IoT enthusiasts.
- **Community Support:** Node MCU has a large and active community of developers and enthusiasts who contribute libraries, tutorials, and resources to support the platform.

Applications:

- **Home Automation:** Node MCU can be used to build DIY home automation systems for controlling lights, appliances, thermostats, and security cameras.
- **IoT Prototyping:** Node MCU is widely used for prototyping IoT devices and projects, such as environmental monitoring systems, smart agriculture solutions, and wearable devices.
- **Remote Sensing and Monitoring:** Node MCU can be deployed for remote sensing and monitoring applications, such as weather stations, water quality monitors, and asset tracking systems.
- **Industrial Automation:** Node MCU can be integrated into industrial automation systems for monitoring equipment status, controlling machinery, and collecting data for predictive maintenance.

In summary, Node MCU is a versatile and affordable IoT platform based on the ESP8266 Wi-Fi module. It offers both hardware and software components that enable the rapid development of IoT applications and projects for a wide range of industries and use cases.

Figure 4.6 Node MCU

4.2.7 I2C

I2C Protocol is a synchronous protocol that allows a master to initiate communication with a slave device.I2C protocol is a master-slave communication where the master provides the clock which becomes the data transfer rate or clock frequency. A slave may not transmit data unless it has been addressed by the master.

I2C, which stands for Inter-Integrated Circuit, is a widely used serial communication protocol developed by Philips Semiconductor (now NXP Semiconductors) in the 1980s. It is commonly used to connect low-speed peripherals to microcontrollers, microprocessors, and other integrated circuits within electronic devices. Here's a deeper look into I2C.

Basic Principle:

- **Master-Slave Architecture:** In the I2C protocol, communication typically occurs between one master device and one or more slave devices. The master device initiates data transfer and generates clock signals, while the slave devices respond to commands from the master.
- **Serial Communication:** I2C is a serial communication protocol, meaning that data is transmitted one bit at a time over a shared bus. It uses two wires for communication: a serial data line (SDA) and a serial clock line (SCL).

Physical Connection:

- **SDA (Serial Data Line):** SDA is used for bidirectional data transfer between the master and slave devices. Both the master and slave devices can drive the SDA line, allowing them to send and receive data.
- **SCL (Serial Clock Line):** SCL is a unidirectional clock signal generated by the master device. It synchronizes the data transfer between the master and slave devices.

Key Features:

- **Multi-Master Support:** I2C supports multiple master devices on the same bus, allowing for more complex communication topologies.
- **Addressing:** Each slave device on the I2C bus is assigned a unique 7-bit or 10-bit address. The master device initiates communication by addressing a specific slave device.
- **Clock Synchronization:** All communication on the I2C bus is synchronized to the clock signal generated by the master device. This ensures that data is transferred at the correct timing.

Data Transfer:

- **Start Condition:** Communication on the I2C bus begins with a start condition, where the master device pulls the SDA line low while the SCL line is high.
- **Addressing Phase:** The master device sends the address of the target slave device along with a read/write bit to indicate the direction of data transfer.
- **Data Transfer Phase:** Data is transferred between the master and slave devices, with the master device generating clock pulses on the SCL line.
- **Stop Condition:** Communication ends with a stop condition, where the master device releases the SDA line while the SCL line is high.

Applications:

- **Sensor Interfacing:** I2C is commonly used to interface with sensors such as temperature sensors, humidity sensors, accelerometers, and gyroscopes.
- **Memory Devices:** EEPROMs (Electrically Erasable Programmable Read-Only Memory) and other non-volatile memory devices often use the I2C protocol for communication.
- **Peripheral Control:** I2C can be used to control peripherals such as digital-to-analog converters (DACs), analog-to-digital converters (ADCs), and LCD displays.
- **Embedded Systems:** I2C is widely used in embedded systems for communication between microcontrollers and various peripheral devices.

Advantages:

- **Simple Implementation:** I2C is relatively simple to implement and requires only two wires for communication.

- **Flexibility:** The I2C protocol supports multiple devices on the same bus and allows for dynamic device addressing.
- **Low Pin Count:** I2C devices typically require fewer pins compared to other communication protocols, making them suitable for applications with limited I/O resources.

Disadvantages:

- **Limited Distance:** I2C communication is typically limited to short distances due to the capacitance of the bus and signal integrity issues.
- **Lower Speed:** I2C is a low-speed protocol compared to other serial communication protocols such as SPI (Serial Peripheral Interface) and UART (Universal Asynchronous Receiver-Transmitter).
- **Clock Stretching:** Some devices may require clock stretching, where a slave device temporarily holds the clock line low to slow down the master device, which can complicate timing considerations.

In summary, I2C is a widely used serial communication protocol that provides a simple and flexible way to connect multiple devices within electronic systems. Its ease of implementation, multi-master support, and flexibility make it well-suited for a wide range of applications in embedded systems, consumer electronics, and industrial automation.

4.3 Arduino IDE

The proposed system that is going to be described in this phase is done using the Proteus Design suite and Arduino IDE. In order to get the desired output, the simulation circuit has been designed in Proteus Design suite software by using the respective components that is present in the Proteus library. The Arduino Integrated Development Environment (IDE) is a software application used to write, compile, and upload code to Arduino microcontroller boards for developing projects. The Arduino software is easy to use and includes a powerful Integrated Development Environment (IDE) that can be used to create custom projects from scratch. The IDE includes a text editor and a compiler, which can be used to create and debug code for the Arduino platform. The IDE also includes a library of code examples and tutorials that can be used to quickly create projects.

The Arduino Integrated Development Environment (IDE) is a software application used to write, compile, and upload code to Arduino microcontroller boards for developing various electronic projects. While the primary purpose of the Arduino IDE is to create programs for Arduino boards, it's not limited to just Arduino-based projects and can be used for programming other microcontroller platforms.

Here are the key aspects and functionalities of the Arduino IDE for electrical circuits:

Code Editor: The IDE provides a text editor where users can write code in the Arduino programming language. It uses a simplified version of C/C++ to make it easier for beginners to get started.

Code Libraries: It includes a wide range of libraries that provide pre-written code for common tasks, making it easier to interface with various components like sensors, displays, motors, etc.

Compilation and Upload: The IDE compiles the code, turning it into machine language that the microcontroller can understand. It then uploads the compiled code to the Arduino board via a USB cable or other compatible interfaces.

Serial Monitor: It features a serial monitor that allows communication between the computer and the Arduino board. This is useful for debugging and displaying data sent by the Arduino.

Example Codes: The IDE provides numerous examples to help users understand the basics of programming and working with different components. These examples cover various functionalities and can be a great starting point for beginners.

Board Manager: It includes a board manager that allows users to add support for different Arduino-compatible boards. This is beneficial as the IDE supports various Arduino board types, each with its specifications and capabilities.

Integrated Development Environment: The software offers a user-friendly interface that consolidates code writing, compiling, and uploading, providing an integrated environment for developing projects.

Cross-Platform Compatibility: Arduino IDE is available for multiple operating systems, such as Windows, MacOS, and Linux, making it accessible to a broad range of users.

While the Arduino IDE is a popular choice for beginners due to its simplicity and extensive community support, there are also alternative IDEs and text editors available, such as Platform IO, that offer additional features and support for a broader range of microcontrollers.

Overall, the Arduino IDE serves as an excellent starting point for hobbyists, students, and professionals looking to develop projects based on electrical circuits and microcontrollers.

4.4 IMPLEMENTATION STRATEGY:

This technology has the potential to revolutionize the driving experience by providing smart payment options, adaptive lighting, and brake automation. In Smart Payment, it consists of two main parts: the vehicle unit and the drive-through unit. The vehicle unit will be installed in the customer's vehicle, while the drive-through unit will be installed in the drive-through lane of the payment area.

Vehicle Unit: The vehicle unit will contain all the necessary components, including the Li-Fi receiver, LDR and ultrasonic sensors, Arduino controller, and LCD display. The Li-Fi receiver will be connected to the Arduino controller, which will receive data from the sensors and process it. The processed data will be displayed on the LCD display for real-time monitoring.

Drive-thru Unit: The drive-thru unit will contain the Li-Fi transmitter and the relays for enabling smart payment in the drive thru lane. The Li-Fi transmitter will be connected to the Arduino controller, which will transmit data to the vehicle unit and process the payment system accordingly.

The LDR sensors are used to detect the intensity of light, while the ultrasonic sensors measure the distance between the vehicle and the surrounding objects. These sensors provide essential data inputs for the system, enabling it to adapt and respond to changing driving conditions.

An automatic braking system is an important part of safety technology for automobiles. It is an advanced system, specifically designed to either prevent possible collision, or reduce speed of the moving vehicle, before a collision with another vehicle, pedestrian or an obstacle of some sort.

Overall, the suggested technique offers a dependable and effective way to follow the leading vehicle while vehicle-to-vehicle communications are in progress.

CHAPTER 5

RESULTS AND DISCUSSION

5.1 RESULTS AND DISCUSSION

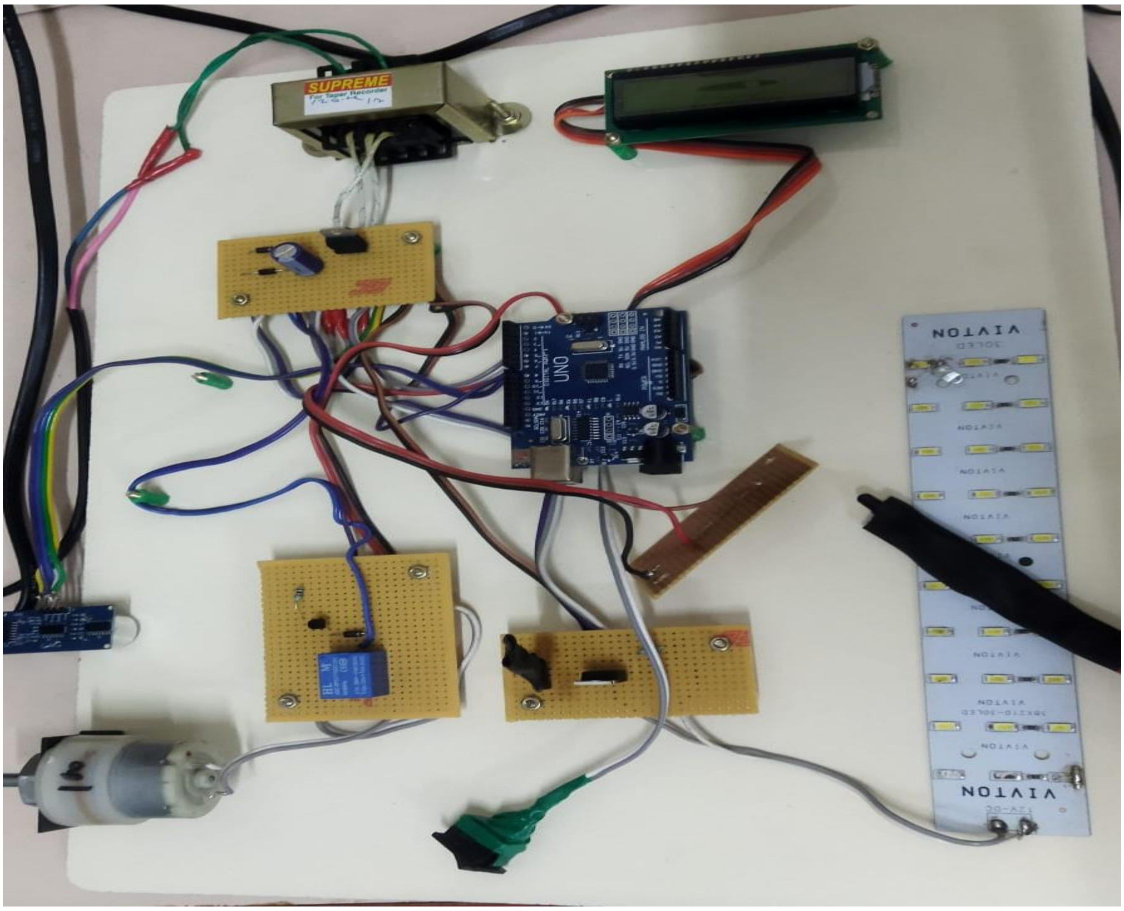

Figure 5.1 Hardware on Smart Payment and Brake Automation

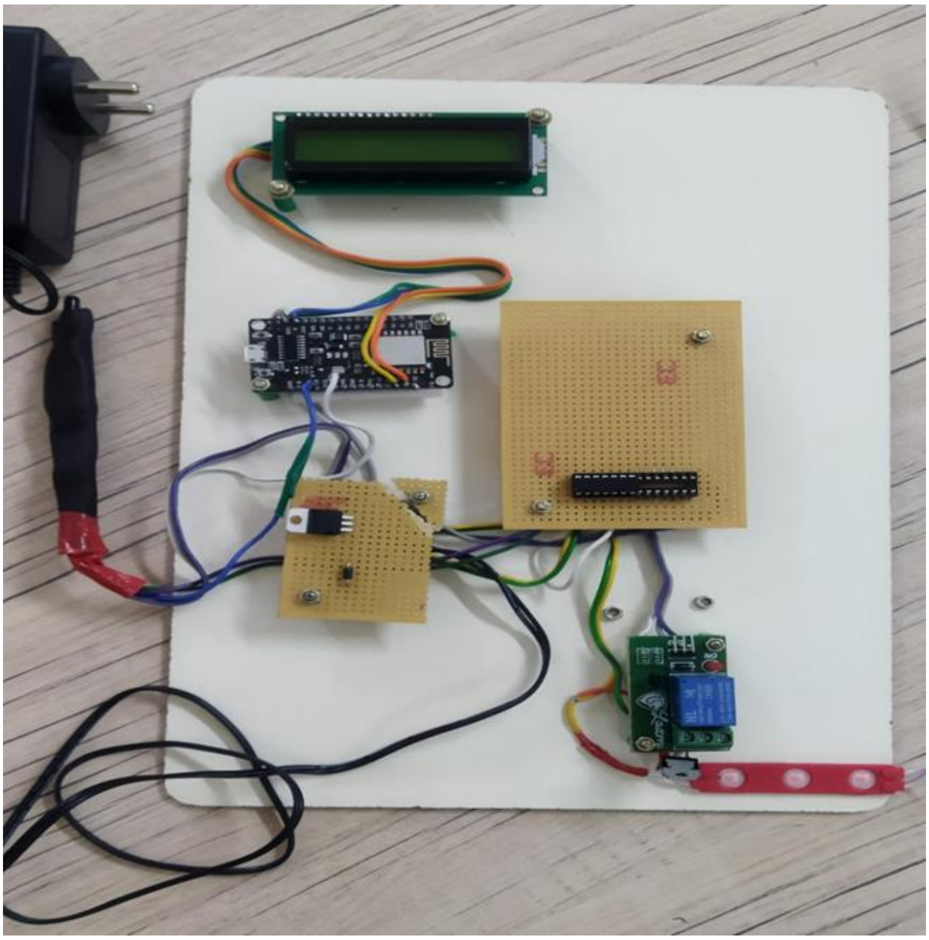

Figure 5.2 Hardware on Adaptive Lighting

The figure 5.1, 5.2 shows that the different characteristic of the proposed system that is the output for brake automation, Adaptive Lighting and payment transaction. One is used to measure the distance between the vehicles and another one is used to sense the intensity of light and that is controlled by MOSFET switch. The motor is used to apply automatic application of brake and that is controlled by relay switch. This system also includes automatic payment, the LCD display is used to indicate the payment process of bill by the using push button that activate the payment code.

Figure 5.3 LCD shows the LDR intensity value and Distance between the vehicles

Figure 5.4 LCD displaying the payment transaction Process

Figure 5.5 LCD displaying High beam Detected

Figure 5.6 LCD Displaying Low Distance Break is ON

Smart Payment: Li-Fi transmitters and receivers facilitate communication as a vehicle approaches locations like toll booths or drive-thru restaurants. The drive-thru unit's Li-Fi transmitter transmits payment data, which is then sent to the Arduino controller to complete the payment process. Thus the LCD Displays the result.

Adaptive Lighting: An LDR sensor to measure ambient light intensity, sending data to the Arduino controller. This data is processed to dynamically adjust the vehicle's headlights based on ambient light and distance from other vehicles, ensuring optimal visibility. With the help of Li-Fi Transmit the data to receiver and control the light intensity.

Brake Automation: The system incorporates brake automation, utilizing data from the ultrasonic sensor. Li-Fi helps to transmit the data to the receiver and by the detection of speed from the vehicle it automatically stop the running of motor in the vehicle.When the sensor detects close proximity to another vehicle, the controller signals the relays to activate the brakes. The Arduino controller triggers the motors to apply brakes promptly, ensuring swift and efficient braking to prevent accidents and enhance road safety.

CHAPTER 6

CONCLUSION

6.1 CONCLUSION

Li-Fi paired with smart systems could be a game-changer for drive-thru, making them a breeze to navigate. Imagine pulling up to a restaurant and your car seamlessly communicating with overhead Li-Fi transmitters. These transmitters, disguised as regular LED lights, would use light signals to send and receive data with a receiver discreetly placed on your vehicle. This invisible conversation between your car and the drive-thru system would create a truly smart and adaptable experience, tailoring itself to your specific needs and preferences.

One big perk is Li-Fi ability to grab and analyse information super-fast, allowing for secure and speedy data transfer. This teamwork between Li-Fi and smart systems paves the way for safer roads by enabling quicker choices based on constantly updated, reliable info. Plus, the system is designed to be user-friendly, so anyone can hop in and use it easily. With Li-Fi constantly getting better, the possibilities for smart driving systems are wide open. This project is talking about a future filled with safer and more efficient ways to get around.

Think beyond drive-thru Li-Fi in smart systems has the potential to completely redefine how we interact with transportation. By harnessing the power of Li-Fi with smart systems, the sky's the limit for improved safety and efficiency in driving. Buckle up because the future of transportation is shaping up to be exciting and dynamic.

6.2 FUTURE SCOPE

The burgeoning future of Li-Fi driven intelligent automotive systems brims with the potential for heightened safety and unparalleled convenience. These systems will usher in an era of real-time communication, fostering seamless interaction between vehicles and their surrounding environment. Imagine streamlined payment processing at drive-thru establishments, facilitated by Li-Fi's secure and rapid data transfer. Furthermore, Li-Fi paves the way for enhanced safety through intelligent features like adaptive lighting that adjusts to weather conditions and automated braking systems that react instantaneously to hazards.

Beyond individual vehicles, Li-Fi offers the potential for high-speed data transfer across entire transportation networks, enabling advanced in-car experiences like real-time traffic updates and personalized entertainment options. This interconnectedness extends to traffic management, optimizing flow and reducing congestion. The environmental benefits of Li-Fi adoption are equally compelling, contributing to sustainability through reduced energy consumption across the transportation sector. These advancements represent a transformative shift within the automotive industry, fostering a future of safer, smarter, and more efficient driving experiences.

Widespread adoption and global implementation of Li-Fi in transportation systems necessitate collaborative efforts. Governments, technology developers, and vehicle manufacturers must work in unison to ensure a seamless and standardized approach to integration. Continued research and development in user interface design and human-machine interaction will be paramount. By prioritizing intuitive interfaces, Li-Fi technology can become more accessible and user-friendly for drivers and passengers alike.

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APPENDIX

```
#include <SoftwareSerial.h>
#include <LiquidCrystal.h>
float potPin1 = A0;
float potPin2 = A1;
//float potPin3 = A2;
float potPin4 = A3;
const int rs = 2, en = 3, d4 = 4, d5 = 5, d6 = 6, d7 = 7;
LiquidCrystal lcd(rs, en, d4, d5, d6, d7);
int pin1 = 8;
int pin2 = 9;
int pin3 = 10;
int pin4 = 11;
//int pin2 = 9;
void setup()
{
pinMode(potPin1, INPUT);
pinMode(potPin2, INPUT);
//pinMode(potPin3, INPUT);
pinMode(potPin4, INPUT);
pinMode(pin4, INPUT);
pinMode(pin1, OUTPUT);
pinMode(pin2, OUTPUT);
pinMode(pin3, OUTPUT);
digitalWrite(pin2, LOW);
digitalWrite(pin1, LOW);
digitalWrite(pin3, LOW);
```

```
lcd.begin(16, 2);
lcd.setCursor(0, 0);
// Print a message to the LCD.
lcd.print("V2V _ comm ....");
lcd.setCursor(0, 1);
// Print a message to the LCD.
lcd.print("BALANCING SYS .. ");
delay(1000);
Serial.begin(9600);
//digitalWrite(pin1, HIGH);    // turn the LED off by making the voltage LOW
delay(100);
}
void loop()                    // run over and over again
{
float sensorValue= analogRead(A0);//TEMP
// Convert the analog reading (which goes from 0 - 1023) to a voltage (0 - 5V):
sensorValue = sensorValue * (100.0 / 1023.0);
// Serial.println(sensorValue);
float sensorValue1= analogRead(A1);//GYRO
// Convert the analog reading (which goes from 0 - 1023) to a voltage (0 - 5V):

sensorValue1 = sensorValue1 * (100.0 / 1023.0);
//   float sensorValue2= analogRead(A2);//O2
// // Convert the analog reading (which goes from 0 - 1023) to a voltage (0 - 5V):
//
//sensorValue2=sensorValue2 * (5.0 / 1023.0);
//p1=sensorValue*sensorValue1*0.5;
```

```
//p2=sensorValue*sensorValue1;
//p3=p1/p2;

lcd.clear();
lcd.setCursor(0,0);
lcd.print("LDR:");
lcd.setCursor(4,0);
lcd.print(sensorValue);
lcd.setCursor(8,0);
lcd.print("DIS:");
lcd.setCursor(13,0);
lcd.print(sensorValue1);
delay (500);
if(sensorValue>60)
{
lcd.clear();
// lcd.init();
// lcd.init();
lcd.setCursor(0, 0);
lcd.print("LOW BAM…. ON ");
digitalWrite(pin2,LOW);
//digitalWrite(D6,LOW);

delay(500);
}
else
{
```

```
lcd.clear();
digitalWrite(pin2,HIGH);
digitalWrite(pin3,HIGH);
delay(500);

digitalWrite(pin3,LOW);
lcd.setCursor(0, 0);
lcd.print("HIGH BAM.... ON ");
delay(500);
}
if(sensorValue1<30)
{
lcd.clear();
// lcd.init();
// lcd.init();
lcd.setCursor(0, 0);
lcd.print("LOW DIS bck...ON ");
digitalWrite(pin1,LOW);
digitalWrite(pin3,HIGH);
//digitalWrite(D6,LOW);
delay(500);
}
else
{

lcd.clear();
```

```
digitalWrite(pin1,HIGH);
digitalWrite(pin3,HIGH);
delay(500);
digitalWrite(pin3,LOW);
lcd.setCursor(0, 0);
lcd.print("DIS NOR bck .... OFF ");
delay(500);
}
if(digitalRead(pin4)==1)
{
lcd.clear();
digitalWrite(pin3,HIGH);
delay(500);
digitalWrite(pin3,LOW);
lcd.setCursor(0, 0);
lcd.print("PAYMENT TRS .. ON ");
delay(500);
}
}
```

LIST OF PUBLICATIONS

[1]. S.Dineshkumar, P. Abinaya, S. Abirami, R. Indhumathi and S. Madhurambiga "SMART DRIVE INNOVATION LI-FI ENABLED SMART TRANSACTION ADAPTIVE LIGHTING AND AUTOMATED BRAKING FOR ENHANCED SAFETY AND DRIVE THRU EXPERIENCE: A Survey" 5th International Conference on Power and Embedded Drive Control (ICPEDC -2024) Sri Sivasubramaniya Nadar College of Engineering, Chennai (Accepted for SPRINGER).

[2]. S.Dineshkumar, P.Abinaya, S.Abirami, R.Indhumathi and S.Madhurambiga "SMART DRIVE INNOVATION LI – FI ENABLED SMART TRANSACTIONS, ADAPTIVE LIGHTING AND AUTOMATED BRAKING FOR ENHANCED SAFETY AND DRIVE THRU EXPERIENCE" 2nd IEEE International Conference on Device Intelligence, Computing and Communication Technologies(DICCT – 2024) organised by Graphic Era(Deemed to be University) during 14th and 15th March 2024. (ACCEPTED FOR IEEE -EXPLORER).

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5th International Conference on Power and Embedded Drive Control

(ICPEDC -2024)

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in

5th International Conference on Power and Embedded Drive Control (ICPEDC - 2024)

organised by the Department of Electrical and Electronics Engineering, SSN College of Engineering, during 17th and 18th January 2024.

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2nd IEEE International Conference on Device Intelligence, Computing and Communication Technologies (DICCT – 2024)


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DICCT 2024

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Certificate of **Participation**

This is to certify that

Abinaya P, Abirami S, Indhumathi R, Madhurambiga S, S.Dineshkumar

have successfully Presented the Paper Entitled

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at the **2nd IEEE International Conference on Device Intelligence, Computing, and Communication Technologies (DICCT-2024)** organised by the Department of Electronics and Communication Engineering, Graphic Era (Deemed to be University) Dehradun, India held on **15-16 March, 2024.**

Dr. Abhay Sharma	Dr. Mridul Gupta	Dr. Chandni Tiwari	Prof. (Dr.) Md. Irfanul Hasan
Convener	Convener	Convener	Conference Chair

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Li – Fi Driven Intelligent System For Enhanced Safety And Drive – Thru Revolution

Presented at TECHgium®.

Date: 26 Dec 2023

Amit Chadha

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CEO & Managing Director

L&T Technology Services Limited


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