Drive Secure: Advanced Arduino Car Safety

Abdulla Al Samir
Department of Computer Science and Engineering
United International University
asamir192039@bscse.uiu.ac.bd

Md Abdul Quddus Sagor
Department of Computer Science and Engineering
United International University
msagor192047@bscse.uiu.ac.bd

***Abstract*—This project aims to enhance vehicle safety using an Arduino-based system. The system integrates various sensors and components such as hall effect sensors, ultrasonic sensors, temperature sensors, LEDs, and a motor controller. Through real-time monitoring and control, the system ensures seat belt usage, prevents collision through distance detection, manages speed, and alerts the driver in case of potentially hazardous conditions like alcohol detection and high temperature. The project highlights the integration of these technologies to create a comprehensive car safety solution, demonstrating the potential of embedded systems in enhancing road safety.**

I. Project Overview

The project focuses on leveraging Arduino-based technology to enhance the safety features of a vehicle. This project addresses the critical aspects of modern vehicle safety, such as seatbelt usage, collision prevention, speed management, and driver alerts for potentially hazardous conditions. By integrating a variety of sensors, actuators, and control mechanisms, the project showcases the potential of embedded systems to create a comprehensive car safety solution.

The primary objective of this project is to design and implement an intelligent safety system that not only ensures the basic adherence to seatbelt usage but also incorporates advanced features to prevent collisions and manage the vehicle's speed. To achieve this, the project employs a range of components, including hall effect sensors, ultrasonic sensors, temperature sensors, LEDs, a motor controller, a buzzer, and a liquid crystal display (LCD).

The system operates by continuously monitoring various parameters. The hall effect sensors detect the presence of a magnetic field, allowing the system to determine seatbelt usage and monitor wheel rotation for distance calculation. Ultrasonic sensors are employed to measure distances from obstacles, contributing to collision avoidance. The temperature sensor provides real-time temperature readings, which can help in identifying potential issues like engine overheating. The system also integrates a potentiometer to control motor speed and a push button to initiate braking.

Through careful integration and programming, the Arduino-based system takes autonomous actions to ensure safety. If any critical condition arises—such as unfastened seatbelts, proximity to obstacles, alcohol detection, high temperature, or low distance from an obstacle—the system responds by stopping the motor, activating an alert buzzer, and illuminating LEDs to visually warn the driver. Furthermore, the system incorporates an LED push button that, when pressed, illuminates white LEDs to enhance visibility and road presence during low-light conditions.

The project's significance lies in its ability to provide a holistic car safety solution that goes beyond conventional seatbelt reminders. By combining multiple sensors and actuators, it addresses a range of safety concerns and hazards, ultimately contributing to the overall road safety ecosystem. The project demonstrates the potential of embedded systems to enhance vehicle safety and highlights the importance of integrating technology for a secure driving experience.

In conclusion, the project showcases the power of innovation in addressing real-world challenges. By developing an intelligent safety system using Arduino, this project contributes to creating safer roadways and emphasizes the role of technology in promoting responsible driving practices.

II. Component List

1) Arduino Uno R3
2) MQ-3 Alcohol Detector Gas Sensor
3) A3144 Hall Effect Sensor
4) HC-SR04 Ultrasonic Distance Sensor
5) LM35 Temperature Sensor
6) 16x2 I2C LCD Module Display
7) L293D Motor Driver Shield
8) DC Geared Motor
9) Plastic Mag Wheel
10) 100K Potentiometer
11) Active Buzzer
12) Push Button
13) White & Red LED
14) 220 Ω Resistor
15) 3000mAh 3.7v Battery

A. Arduino Uno R3

The Arduino Uno R3 serves as the central nervous system of the project, playing a pivotal role in coordinating various sensors, actuators, and components to ensure a safe and secure driving experience. As an open-source microcontroller board, the Arduino Uno R3 provides an accessible and versatile platform for developing and implementing a wide range of projects, making it an ideal choice for this car safety application.

Fig. 1. **Arduino Uno R3**

Key Features:

- **Microcontroller:** At the core of the Arduino Uno R3 is the ATmega328P microcontroller, which boasts a clock speed of 16 MHz. This microcontroller offers sufficient processing power to handle sensor data processing, motor control, and user interactions effectively.
- **Digital and Analog I/O Pins:** The Arduino Uno R3 is equipped with a diverse set of digital and analog pins, enabling seamless connectivity with various sensors and actuators. These pins facilitate the acquisition of real-time data from sensors and the execution of precise control signals to actuators.
- **Integrated Development Environment (IDE):** Arduino's user-friendly IDE simplifies the programming process. It supports the C/C++ programming language and provides a library of functions that streamline communication with sensors, motor control, and display output. This simplifies the coding process for both beginners and experienced programmers.
- **Versatility:** The Arduino Uno R3's versatility lies in its ability to interface with a multitude of sensors, motors, displays, and communication modules. This versatility allows it to effectively manage safety features such as alcohol detection, obstacle avoidance, temperature monitoring, and more.
- **Interactivity:** With the inclusion of push buttons, LED indicators, and LCD displays, the Arduino Uno R3 enhances interactivity with the driver. It can provide real-time feedback, warnings, and alerts to ensure driver awareness and safety compliance.

Role in the Project: In the project, the Arduino Uno R3 acts as the project's brain, processing inputs from various sensors like the MQ-3 Alcohol Detector Gas Sensor, A3144 Hall Effect Sensor, HC-SR04 Ultrasonic Distance Sensor, and LM35 Temperature Sensor. Based on these inputs, the microcontroller makes decisions regarding motor control, LED signaling, and alert generation.

For instance, when the Brake Button is pressed or an obstacle is detected by the Ultrasonic Distance Sensor, the Arduino Uno R3 triggers the motors to stop, activates the Alert Buzzer, and illuminates the Alert LEDs to warn the driver. Similarly, it calculates the distance traveled using the Hall Effect Sensor, displays information on the LCD, and manages the interactivity of the LED Button.

Conclusion: The Arduino Uno R3 serves as the brainpower behind the project. Its processing capabilities, versatile I/O options, and user-friendly programming environment contribute to creating a sophisticated safety solution that enhances driver awareness, prevents accidents, and promotes responsible driving practices.

B. *MQ-3 Alcohol Detector Gas Sensor*

The MQ-3 Alcohol Detector Gas Sensor is a critical component within the project, contributing to the project's overarching goal of ensuring safe and responsible driving practices. This sensor is specifically designed to detect the presence of alcohol vapors in the surrounding environment, playing a vital role in preventing drunk driving incidents.

Fig. 2. **Alcohol Detector Gas Sensor**

Key Features:

- **Sensitive Alcohol Detection:** The MQ-3 sensor is designed to detect a wide range of alcohol vapors, including those emitted from alcoholic beverages and other sources. It utilizes a sensitive semiconductor material that changes its electrical resistance when exposed to alcohol fumes.
- **Analog Output:** The sensor provides analog output voltage that varies in proportion to the concentration of alcohol vapors detected. This analog signal can be read by the Arduino Uno R3's analog pins, enabling accurate quantification of alcohol levels in the vicinity.
- **Fast Response Time:** The MQ-3 sensor offers a rapid response time, allowing it to detect alcohol presence almost instantaneously. This quick response is crucial in alerting the driver and initiating safety measures promptly.
- **Integration Possibilities:** The analog output of the MQ-3 sensor can be easily interfaced with the Arduino Uno R3, enabling real-time monitoring of alcohol levels. The sensor's compatibility with the project's microcontroller allows for seamless integration into the overall safety system.

Role in the Project: The MQ-3 Alcohol Detector Gas Sensor plays a pivotal role in preventing impaired driving, which is a significant contributor to road accidents. By integrating this sensor into the project, the system can detect the presence of alcohol vapors in the driver's immediate environment. When the alcohol concentration exceeds a predefined threshold, the Arduino Uno R3 responds by activating safety measures.

For example, if the sensor detects elevated alcohol levels, the system can trigger the Alert Buzzer, illuminate the Alert LEDs, and display a warning message on the LCD screen. These actions are designed to raise the driver's awareness of their impaired state and discourage them from operating the vehicle.

Importance and Impact: The inclusion of the MQ-3 Alcohol Detector Gas Sensor underscores the project's commitment to road safety and responsible driving. By integrating this sensor, the project contributes to reducing the risk of accidents caused by drunk driving. This proactive approach aligns with global efforts to curb road accidents, promote awareness about the dangers of impaired driving, and prioritize the safety of both drivers and pedestrians.

Conclusion: The MQ-3 Alcohol Detector Gas Sensor is a vital element within the project, working hand in hand with other components to create a comprehensive safety solution. By detecting alcohol vapors and initiating appropriate alerts, the sensor empowers the system to intervene in potentially dangerous situations, promoting safe and responsible driving practices and ultimately saving lives on the road.

C. A3144 Hall Effect Sensor

The A3144 Hall Effect Sensor, a fundamental component of the project, serves as a critical magnetic sensing device that contributes to the project's overarching goal of ensuring enhanced vehicle safety and driver awareness.

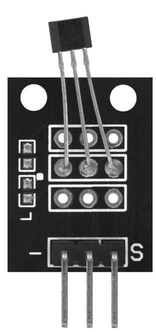

Fig. 3. **Hall Effect Sensor**

Key Features:

- **Hall Effect Principle:** The A3144 sensor operates based on the Hall effect, a fundamental physics phenomenon. When exposed to a magnetic field, the sensor generates a voltage output that is proportional to the strength of the magnetic field. This makes it an ideal choice for detecting the presence of magnets in its vicinity.
- **Digital Output:** The A3144 sensor provides a digital output signal that indicates the presence or absence of a magnetic field. It operates as a switch, toggling between two states based on the presence of a magnet.
- **Non-Contact Sensing:** One of the sensor's key advantages is its non-contact sensing capability. It can detect magnets without requiring direct physical contact, making it suitable for applications that demand reliable and non-intrusive magnetic field detection.
- **Compact Size:** The compact and robust design of the A3144 sensor allows for easy integration into various systems and environments, including vehicles.

Role in the Project: The A3144 Hall Effect Sensor plays a vital role in various safety-related aspects of the project. It is strategically placed in key locations within the vehicle to sense the rotation of vehicle components, such as wheels or gears, as well as to detect the presence of magnets. In the context of the project, it is particularly employed for two primary functions:

- **Distance Traveled Calculation:** By attaching a magnet to a rotating wheel, the sensor detects each revolution of the wheel. The Arduino Uno R3 interprets these signals to calculate the distance the vehicle has traveled. This information is displayed on the LCD screen, enabling the driver to monitor their journey's progress.
- **Magnet Detection:** The sensor is utilized to detect the presence of magnets associated with various safety mechanisms, such as seat belt fastening or vehicle door closure. It contributes to ensuring that essential safety protocols are adhered to, thereby minimizing risks to the driver and passengers.

Importance and Impact: The integration of the A3144 Hall Effect Sensor underscores the project's commitment to leveraging advanced sensor technology for enhancing vehicle safety. By accurately calculating the distance traveled and detecting critical safety conditions, the sensor contributes to reducing the likelihood of accidents, ensuring driver compliance with safety measures, and promoting overall road safety.

Conclusion: The A3144 Hall Effect Sensor stands as a testament to the project's dedication to employing innovative solutions for improving vehicle safety. Its ability to accurately detect magnetic fields and translate them into meaningful data plays a pivotal role in calculating distances, enhancing safety protocols, and fostering responsible driving habits. In combination with other project components, the sensor contributes to creating a holistic safety system that aims to protect drivers, passengers, and pedestrians alike.

D. HC-SR04 Ultrasonic Distance Sensor

The HC-SR04 Ultrasonic Distance Sensor, a cornerstone of the project, serves as a crucial component that empowers the project's mission of enhancing vehicle safety and ensuring optimal driving conditions through accurate distance measurement.

Key Features:

- **Ultrasonic Technology:** The HC-SR04 sensor operates on ultrasonic technology, utilizing sound waves that travel

Fig. 4. **Ultrasonic Distance Sensor**

in the form of pulses. By measuring the time it takes for the sound waves to bounce off an object and return, the sensor calculates the distance between the sensor and the object.
- **High Precision:** Known for its high precision and accuracy, the HC-SR04 sensor is capable of providing distance measurements with millimeter-level accuracy. This makes it suitable for applications where precise distance calculations are essential for safety and navigation.
- **Non-Contact Sensing:** The sensor's non-contact nature allows it to measure distances without physical interaction, ensuring that the vehicle's surroundings remain undisturbed while accurate measurements are obtained.
- **Compact and Cost-Effective:** The HC-SR04 sensor's compact form factor and affordable cost make it a popular choice for a wide range of projects and applications, including vehicle safety systems.

Role in the Project: The HC-SR04 Ultrasonic Distance Sensor plays a critical role in enabling accurate and real-time distance measurement in various aspects of the project, contributing to the enhancement of vehicle safety and driver awareness. Its key functionalities include:
- **Obstacle Detection:** Positioned strategically around the vehicle, the sensor detects nearby obstacles, pedestrians, or other vehicles. By measuring the distances to these objects, the sensor helps the driver avoid collisions and navigate safely, especially in tight or crowded spaces.
- **Parking Assistance:** During parking maneuvers, the sensor assists the driver by providing precise distance measurements between the vehicle's rear and any obstacles. This aids in preventing collisions and ensuring smooth parking operations.
- **Alert Generation:** The sensor's data is utilized to trigger alerts, such as activating the alert buzzer and LED indicators, when the vehicle approaches an object too closely. This ensures that the driver is promptly notified of potential dangers, allowing for quick corrective actions.

Importance and Impact: The integration of the HC-SR04 Ultrasonic Distance Sensor aligns with the project's overarching goal of leveraging advanced technology for safer driving experiences. By providing accurate distance measurements and enabling proactive obstacle detection, the sensor enhances the driver's situational awareness, reduces the risk of accidents, and promotes responsible driving practices.

Conclusion: The HC-SR04 Ultrasonic Distance Sensor stands as an integral component of the project, embodying the project's commitment to using cutting-edge technology for improving vehicle safety. Its ability to provide accurate distance measurements and enable timely alerts underscores its role in fostering safer driving conditions, preventing collisions, and ultimately contributing to the well-being of drivers, passengers, and pedestrians. In conjunction with other project elements, the sensor embodies the essence of modern vehicle safety systems that prioritize precision, reliability, and innovation.

E. *LM35 Temperature Sensor*

The LM35 Temperature Sensor, a pivotal component within the project, plays a crucial role in maintaining a safe and comfortable driving environment by providing real-time temperature measurements. This sensor is integral to the project's mission of enhancing vehicle safety and passenger well-being through advanced sensing technology.

Fig. 5. **Temperature Sensor**

Key Features:
- **Linear Output:** The LM35 sensor is renowned for its linear output characteristic, where its voltage output changes linearly with temperature variations. This feature simplifies the conversion of analog temperature readings into meaningful temperature values.
- **High Precision:** The LM35 offers impressive accuracy and sensitivity, making it suitable for applications where precise temperature measurements are essential. It can detect even minor temperature fluctuations, providing reliable data for environmental monitoring.
- **Compact and Low-Power:** Its compact design and low-power consumption make the LM35 sensor an efficient choice for battery-powered applications, such as the project, where optimizing energy usage is important.

Role in the Project: The LM35 Temperature Sensor assumes a vital role in the project by continuously monitoring the vehicle's interior temperature and contributing to safety and comfort enhancement:

- **Climate Control:** By monitoring the cabin temperature, the LM35 sensor aids in regulating the vehicle's climate control system. It ensures that the cabin remains at a comfortable temperature range for passengers, optimizing driving conditions.
- **Alert Generation:** The sensor can trigger alerts if the temperature exceeds predefined thresholds. For example, if the cabin temperature becomes too hot, the sensor's data could initiate actions such as activating the air conditioning system or alerting the driver to take corrective measures.
- **System Protection:** Monitoring temperature is essential for the proper functioning of critical vehicle systems. If the engine, brakes, or other components become excessively hot, the sensor can provide early warnings, preventing potential malfunctions and damage.

Importance and Impact: The integration of the LM35 Temperature Sensor underscores the project's commitment to utilizing advanced sensor technology for both safety and passenger comfort. By accurately measuring temperature and contributing to climate control, the sensor enhances driving experiences and ensures optimal conditions for both drivers and passengers.

Conclusion: The LM35 Temperature Sensor, with its accuracy, simplicity, and energy efficiency, stands as a cornerstone of the project. By providing real-time temperature data and enabling timely responses to temperature changes, the sensor contributes to a safer, more comfortable driving environment. In synergy with other project elements, the LM35 sensor exemplifies how technology can be harnessed to enhance vehicle safety, optimize driving conditions, and elevate the overall driving experience.

F. 16x2 I2C LCD Module Display

The 16x2 I2C LCD Module Display, a key component of the project, serves as the primary interface between the vehicle's electronic system and its occupants. This display empowers drivers and passengers with essential information, contributing to a safer, more informed, and user-friendly driving experience.

Fig. 6. **I2C LCD Display**

Key Features:

- **Compact Design:** The 16x2 I2C LCD module is designed with a compact form factor, making it easy to integrate into various projects without consuming excessive space.
- **High Visibility:** Featuring a 2-line by 16-character configuration, the display offers a clear and concise representation of information. The high contrast of the characters ensures visibility under different lighting conditions.
- **I2C Communication:** The I2C interface simplifies the connection and communication between the display and the Arduino board, requiring fewer pins and streamlining the wiring process.
- **Backlight Control:** The built-in backlight allows visibility in low-light environments, and its controllable nature enables energy-efficient usage.

Role in the Project: The 16x2 I2C LCD Module Display plays a pivotal role in the project by presenting crucial information to users in real-time and enabling interactive engagement:

- **Traveled Distance:** The display provides real-time updates on the distance traveled by the vehicle, allowing passengers and drivers to stay informed about their journey's progress.
- **Temperature Readings:** By showcasing the current cabin temperature, the display contributes to passenger comfort and climate control. This information can help passengers adjust settings to ensure a comfortable environment.
- **Alerts and Notifications:** The display can relay alerts related to factors like alcohol detection, temperature anomalies, and proximity warnings from the ultrasonic distance sensor. This enables prompt responses to potential safety hazards.
- **Status Indicators:** LED status indicators for seat belts, brake button, and LED button can be paired with the display to provide an at-a-glance overview of the vehicle's status and safety features.

Importance and Impact: The 16x2 I2C LCD Module Display serves as the bridge between the car's internal systems and its users. By providing real-time information, alerts, and status updates, the display enhances safety awareness, encourages responsible driving behavior, and ensures passenger comfort. Its role extends beyond conveying data; it empowers users to make informed decisions based on the information at hand.

Conclusion: The 16x2 I2C LCD Module Display is an integral part of the project's commitment to advancing vehicle safety and user experience. By presenting essential information, enabling interaction, and facilitating prompt responses to alerts, the display amplifies the impact of the project's comprehensive safety features. In essence, the display embodies the project's objective: to leverage technology for a safer, more secure, and enjoyable driving journey.

G. L293D Motor Driver Shield

The L293D Motor Driver Shield, a fundamental component of the project, serves as the central hub for motor control, enabling precise manipulation of the vehicle's motion. By providing efficient and reliable motor control capabilities, this shield enhances the project's core objective of ensuring a secure and controlled driving experience.

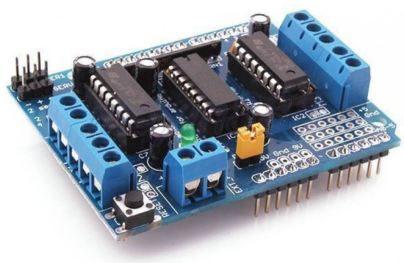

Fig. 7. **Motor Driver Shield**

Key Features:

- **Dual H-Bridge Configuration:** The L293D Motor Driver Shield incorporates two H-bridge motor driver circuits, enabling control over two separate motors independently. This dual configuration supports differential movement, steering, and various driving maneuvers.
- **High Current Handling:** Capable of handling currents up to 600mA per channel and 1.2A peak current, the shield ensures that the motors receive sufficient power for smooth and responsive motion.
- **Built-in Protection:** The shield features built-in flyback diodes that protect the circuit from voltage spikes generated during motor operation, safeguarding the connected components and the Arduino board.
- **Ease of Integration:** Designed as a plug-and-play solution, the shield mounts directly onto the Arduino Uno R3, eliminating the need for complex wiring and external connections.

Role in the Project: The L293D Motor Driver Shield assumes a pivotal role within the project, enabling precise and controlled motor operation:

- **Motor Control:** The shield controls the DC geared motors responsible for driving the vehicle. It translates control signals from the Arduino into appropriate voltage levels, regulating the speed and direction of the motors.
- **Responsive Maneuvering:** The dual H-bridge configuration facilitates differential motor control, allowing the vehicle to execute complex maneuvers such as turning, reversing, and forward motion with high precision.
- **Safety Integration:** The shield's ability to halt motor operation and release the motors ensures that the vehicle can be swiftly stopped in response to safety triggers, such as the brake button or proximity alerts from the ultrasonic sensor.

Importance and Impact: The L293D Motor Driver Shield is a cornerstone of the project's mission to provide comprehensive vehicle safety. By facilitating seamless motor control and enabling dynamic motion, the shield directly influences the project's ability to ensure controlled driving behavior and respond promptly to safety hazards. Its robust design and current-handling capabilities make it an ideal choice for applications demanding reliable and responsive motor control.

Conclusion: The L293D Motor Driver Shield serves as the project's kinetic link, enabling precise control over the vehicle's movement. Its role in motor control and safety integration underlines its significance in shaping the project's impact. By providing the means for controlled acceleration, deceleration, and maneuvering, the shield brings together the technical intricacies required for a secure and advanced driving experience, aligning with the overarching objective of "Drive Secure: Advanced Arduino Car Safety."

H. DC Geared Motor

The DC geared motor is an integral component within the project, serving as the driving force behind the vehicle's locomotion. Engineered for efficiency, control, and adaptability, this motor plays a pivotal role in realizing the project's goal of achieving secure and dynamic movement.

Fig. 8. **DC Geared Motor**

Key Features:

- **Gear Reduction Mechanism:** Equipped with a geared reduction mechanism, the DC geared motor optimizes torque and speed output. This allows the motor to deliver higher torque while maintaining manageable speed, enabling the vehicle to navigate different terrains and perform various maneuvers.
- **High Precision:** The precise gearing and consistent rotational motion of the motor provide accuracy in controlling the vehicle's speed and direction. This level of control is crucial for executing intricate driving commands and ensuring safe navigation.
- **Compact Form Factor:** Despite its power and performance, the DC geared motor's compact size

allows for seamless integration into the vehicle's chassis, ensuring efficient utilization of space.
- **Low Power Consumption:** The motor's design emphasizes energy efficiency, making it suitable for battery-powered applications like the project's Arduino-based car.

Role in the Project: The DC geared motor plays a fundamental role in enabling controlled motion and driving dynamics within the project:

- **Propulsion:** By converting electrical energy into mechanical motion, the motor drives the wheels of the vehicle. This propulsion mechanism is essential for achieving movement in response to user commands.
- **Speed Control:** The geared design of the motor, combined with the L293D Motor Driver Shield, allows for precise control over the speed of each wheel. This enables the vehicle to achieve varying speeds for smooth acceleration, deceleration, and turning.
- **Maneuverability:** The motor's torque output and precision enable the vehicle to execute intricate maneuvers, such as turning at specific angles and navigating around obstacles. This capability enhances the overall safety and agility of the vehicle.

Importance and Impact: The DC geared motor is a cornerstone of the project's functionality, serving as the catalyst for the vehicle's motion. Its ability to provide controlled movement, precise speed adjustments, and responsive navigation underpins the project's objective of developing a safe and advanced driving experience.

Conclusion: In the realm of vehicle dynamics, the DC geared motor emerges as the project's powerhouse, responsible for translating electronic signals into mechanical action. Its unique combination of torque, precision, and compactness makes it an indispensable element of the project. Through its contributions to propulsion, control, and maneuverability, the DC geared motor empowers the vehicle with the capability to navigate its environment safely and efficiently, aligning seamlessly with the project's overarching vision.

I. Plastic Mag Wheel

The plastic mag wheel is a pivotal component within the project, offering both functional and aesthetic value to the vehicle's design. As a critical element in the vehicle's locomotion system, the mag wheel not only facilitates smooth movement but also contributes to the project's overall visual appeal.

Key Features:

- **Sleek Design:** The mag wheel's design is characterized by its sleek and modern appearance. The combination of plastic material and the distinctive pattern mimicking traditional alloy wheels lends an eye-catching and futuristic aesthetic to the vehicle.
- **Lightweight:** Crafted from lightweight yet durable plastic, the mag wheel minimizes the overall weight of the vehicle. This not only enhances energy efficiency but also reduces the load on the DC geared motors, contributing to longer battery life.

Fig. 9. **Plastic Mag Wheel**

- **Low Friction:** The wheel's smooth surface and low-friction properties promote effortless rolling on various surfaces, ensuring efficient movement with minimal resistance.
- **Easy Maintenance:** Plastic mag wheels are easy to clean and maintain, making them a practical choice for projects like the Arduino-based car.

Role in the Project: The plastic mag wheel serves a dual role in the project, fulfilling both functional and visual requirements:

- **Movement Facilitation:** The mag wheels are affixed to the axles of the DC geared motors, enabling the vehicle's movement. By rotating smoothly and evenly, they work in conjunction with the motors to ensure consistent and controlled motion.
- **Aesthetics:** Beyond their functional role, the mag wheels contribute to the overall appearance of the vehicle. The inclusion of mag wheels adds a modern and dynamic touch to the car's visual design, enhancing its overall appeal.

Importance and Impact: The plastic mag wheel stands as a testament to the project's attention to detail, combining practicality and aesthetics in a single component:

- **Performance:** The lightweight and low-friction properties of the mag wheels contribute to the efficiency of the vehicle's movement. Their ability to reduce rolling resistance enhances energy efficiency and prolongs battery life.
- **Design Elegance:** The mag wheels elevate the project's visual aesthetics, transforming the vehicle into a sophisticated and attention-grabbing piece of technology. The modern design language aligns with the project's focus on advanced car safety.

Conclusion: The plastic mag wheel emerges as an essential building block within the project, delivering both functional and visual value. By facilitating smooth movement and enhancing the car's appearance, these wheels encapsulate the project's emphasis on practicality, innovation, and style. In the realm of vehicle design and performance, the plastic mag wheels embody a harmonious fusion of form and function, contributing to the project's success in realizing its ambitious vision of an advanced and secure Arduino-based car.

J. 100K Potentiometer

The 100K potentiometer, a fundamental component in the project, plays a crucial role in controlling the speed of the vehicle's DC geared motors. With its adjustable resistance, this versatile electronic component allows precise speed modulation, enabling users to fine-tune the car's movement characteristics.

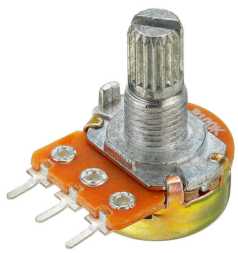

Fig. 10. **100K Potentiometer**

Key Features:

- **Variable Resistance:** The potentiometer is designed with a variable resistance mechanism. By adjusting the knob or slider, users can change the resistance along the potentiometer's track, which in turn influences the motor speed.
- **Linear or Logarithmic Response:** Depending on the type of potentiometer used (linear or logarithmic), the change in resistance can produce either a uniform or gradual change in motor speed as the knob is turned.
- **Easy Integration:** With three terminals—two outer terminals connected to the ends of the resistance track and a central terminal connected to the slider—the potentiometer can be seamlessly integrated into the project's circuit.
- **Compact Size:** The compact size of the potentiometer allows for convenient placement within the project, minimizing space requirements and promoting efficient usage.

Role in the Project: The 100K potentiometer is integral to the project, serving as a means to adjust and regulate the speed of the DC geared motors:

- **Motor Speed Control:** The potentiometer is connected to the Arduino's analog input pin. As the knob is turned, the resistance changes, and the analog value read by the Arduino varies accordingly. This value is then used to control the speed of the DC geared motors.

Importance and Impact: The inclusion of the 100K potentiometer enriches the project's functionality and user experience in several ways:

- **Speed Customization:** By manipulating the potentiometer, users can customize the vehicle's speed according to their preferences or specific requirements. This fine-tuning ability is particularly valuable for scenarios that demand varying levels of speed control.
- **Precision:** The potentiometer's sensitivity allows for precise adjustments to the motor speed, ensuring the vehicle's movement aligns with the intended speed parameters. This accuracy contributes to the overall efficiency and performance of the project.

Conclusion: The 100K potentiometer emerges as an essential component in the project, offering users the ability to regulate motor speed with precision. Its versatility, easy integration, and compact size make it an invaluable tool for creating a dynamic and customizable driving experience. As an embodiment of user control and technological adaptability, the potentiometer encapsulates the project's commitment to combining advanced safety features with user-friendly design, fostering a sense of engagement and empowerment for users interacting with the Arduino-based car.

K. Active Buzzer

The active buzzer, a significant component in the project, serves a crucial role in providing audible alerts and warnings to users. As an acoustic signaling device, the active buzzer plays a vital part in enhancing the safety features of the Arduino-based car.

Fig. 11. **Active Buzzer**

Key Features:

- **Sound Generation:** The active buzzer is designed to generate sound when an electric current passes through it. It produces an audible tone with a fixed frequency when activated.
- **Self-Contained:** Unlike passive buzzers, which require an external oscillating signal to produce sound, active buzzers generate sound independently when supplied with power.
- **Compact and Lightweight:** Active buzzers are typically small and lightweight, making them easy to integrate into various projects without occupying excessive space.

Role in the Project: The active buzzer is integrated into the project to provide audible alerts in response to certain conditions:

- **Safety Alerts:** When specific safety conditions are met, such as braking or encountering obstacles, the active buzzer is activated to alert the user audibly.

Importance and Impact: The inclusion of the active buzzer enhances the project's safety measures and user experience in the following ways:

- **Alerting Mechanism:** The active buzzer acts as an effective alerting mechanism, drawing the user's attention to critical safety situations. Audible alerts are particularly valuable in scenarios where visual cues may be insufficient or overlooked.
- **Immediate Feedback:** The buzzer's sound feedback provides instant acknowledgment of safety conditions, enabling users to respond promptly and appropriately to potential hazards.
- **User Engagement:** Audible feedback engages users at a sensory level, creating a more immersive and interactive experience with the Arduino-based car. This engagement fosters a stronger connection between the user and the project.

Conclusion: The active buzzer stands as a pivotal component within the project, contributing to the overall safety and usability of the vehicle. By providing audible alerts, it ensures that users are promptly informed of critical situations, allowing them to take timely actions to mitigate risks. The active buzzer's role in combining advanced safety technology with human-centered design principles exemplifies the project's commitment to creating a secure, engaging, and interactive experience for users interacting with the Arduino-powered car.

L. Push Button

In the context of the project, the push button serves as an essential user interface component, enabling direct user interaction and control over various aspects of the Arduino-based car's operation.

Fig. 12. **Push Button**

Key Features:

- **Momentary Contact:** A push button, also known as a momentary switch, is a simple electromechanical component that completes an electrical circuit when pressed and breaks the circuit when released.
- **Physical Interface:** The push button provides a physical interface through which users can manually trigger actions or events in the project.
- **Versatile Use:** Push buttons can be used for a wide range of functions, from starting and stopping the vehicle to activating safety features or toggling between modes.

Role in the Project: The push button plays a crucial role in enabling users to directly control and interact with the Arduino-powered car. Its functions within the project include:

- **Brake Activation:** The push button can serve as a brake button, allowing users to manually apply brakes and stop the vehicle when needed.
- **User-Initiated Actions:** Users can use the push button to initiate specific actions, such as enabling or disabling certain safety features, toggling between operational modes, or resetting the system.

Importance and Impact: The inclusion of push buttons in the project contributes to user engagement, safety, and control in the following ways:

- **User Empowerment:** Push buttons empower users by giving them direct control over the vehicle's actions and safety features. This hands-on approach enhances the user experience and instills a sense of control.
- **Emergency Response:** The push button's role as a brake button ensures that users have an immediate means of stopping the vehicle in emergency situations, enhancing overall safety.
- **Intuitive Interaction:** Push buttons provide an intuitive means of interaction, as users are already familiar with their operation from everyday devices. This familiarity translates to quick and hassle-free engagement.

Conclusion: The push button's multifunctional nature makes it a valuable component in the project. By allowing users to initiate actions, control safety features, and interact directly with the vehicle, the push button bridges the gap between technology and user experience. Its role in providing a tangible and responsive interface aligns with the project's aim to create a safe, user-friendly, and engaging environment for users to interact with their Arduino-based car.

M. White & Red LED

In the project, Light Emitting Diodes (LEDs) play a crucial role in providing visual feedback, signaling, and enhancing the user interface. LEDs are semiconductor devices that emit light when an electric current passes through them, making them an essential component in electronics for their simplicity, efficiency, and versatility.

Key Features:

- **Light Emission:** LEDs emit visible light when electrically activated, offering a wide range of colors and intensities to suit various applications.

Fig. 13. **LED**

- **Low Power Consumption:** LEDs are energy-efficient and require very low power to produce bright illumination, making them ideal for battery-powered applications.
- **Instantaneous Response:** LEDs illuminate instantly without any warm-up time, enabling rapid signaling and feedback.

Roles in the Project: In the project, LEDs serve various roles:

- **Indicators:** LEDs act as status indicators, providing visual cues to users about the operational state of the car, safety features, and other aspects.
- **Safety Signaling:** Red LEDs can indicate critical situations such as brakes applied, emergencies, or safety warnings.
- **User Interface:** LEDs offer a tangible way for users to perceive the car's actions and responses, enhancing the overall user experience.
- **User Feedback:** LEDs provide instant feedback when a button is pressed, validating user inputs and promoting a responsive interaction.

Importance and Impact: The integration of LEDs into the project significantly enhances user interaction and safety:

- **Safety Enhancement:** Red LEDs acting as brake indicators can alert both the user and surrounding observers that the vehicle is slowing down or coming to a stop.
- **Immediate Feedback:** LEDs offer immediate visual feedback when user-initiated actions are executed, improving user understanding and control.
- **User Engagement:** LEDs engage users by providing a dynamic and responsive environment, making the interaction with the Arduino-based car more enjoyable.
- **Visual Communication:** LEDs serve as a clear and intuitive method of communication, even in low-light conditions, ensuring that users can easily understand the car's status.

Conclusion: LEDs are essential components in the project due to their visual signaling capabilities and contribution to user engagement. By providing real-time feedback, safety indicators, and enhancing the user interface, LEDs create a more interactive and secure experience for users interacting with the Arduino-based car. The project's integration of LEDs exemplifies how these compact semiconductor devices can significantly impact user experience and overall project functionality.

N. 220 Ω Resistor

In the context of the project, the 220 Ω resistor is a fundamental passive electronic component that plays a crucial role in current limiting and circuit protection. Resistors are widely used in electronics to control the flow of electric current, manage voltage levels, and ensure the longevity and reliability of electronic components.

Fig. 14. **Resistor**

Key Features:

- **Resistance Value:** The 220 Ω resistor has a resistance value of 220 ohms, which determines the degree of current flow in a circuit.
- **Color Coding:** Resistors use color-coded bands to indicate their resistance value and tolerance, enabling easy identification and selection.
- **Passive Component:** Resistors are passive components that do not require a power source to function. They rely on the inherent properties of the material to regulate current flow.

Roles in the Project: In the project, the 220 Ω resistor serves several important purposes:

- **LED Current Limiting:** When connected in series with an LED, the resistor limits the current flowing through the LED, preventing it from getting damaged due to excessive current.
- **Circuit Protection:** By controlling the current, the resistor safeguards other components in the circuit from potential damage caused by overcurrent conditions.

Importance and Impact: The integration of the 220 Ω resistor is vital for ensuring the proper functioning and longevity of LED components in the project:

- **LED Protection:** LEDs are sensitive to overcurrent conditions, and excessive current can lead to permanent damage. The 220 Ω resistor ensures that the LED operates within its safe operating limits.
- **Circuit Stability:** By controlling the current flowing through LEDs, the resistor stabilizes the circuit and prevents voltage spikes that could impact other connected components.

Conclusion: The 220 Ω resistor is a simple yet crucial component in the project, providing current limiting and circuit protection for LEDs. Its presence in the circuit ensures the safe and reliable operation of LEDs by preventing excessive current flow. As a fundamental building block in electronics, the 220 Ω resistor exemplifies how even the simplest components contribute to the overall functionality and longevity of electronic systems.

O. 3000mAh 3.7v Battery

The 3000mAh 3.7V battery is a critical component in the project, providing the necessary power to run the various electronic components and ensure the functionality and mobility of the car.

Fig. 15. **Battery**

Key Features:

- **Capacity:** The battery has a capacity of 3000mAh, which represents its ability to store and deliver electrical energy. Higher capacity allows for longer operating times before recharging is required.
- **Voltage:** The battery has a nominal voltage of 3.7V, which is a common voltage for lithium-ion batteries.
- **Lithium-Ion Chemistry:** The battery utilizes lithium-ion chemistry, known for its high energy density, lightweight nature, and rechargeability.

Roles in the Project: The 3000mAh 3.7V battery serves a central role in powering various components of the project:

- **Motor Power:** The battery supplies the necessary power to the DC geared motors through the L293D motor driver shield, enabling the car to move and respond to user inputs.
- **Sensor Power:** The battery powers sensors such as the MQ-3 alcohol detector gas sensor, A3144 Hall effect sensor, HC-SR04 ultrasonic distance sensor, and LM35 temperature sensor, allowing them to function and provide data.
- **Microcontroller Power:** The Arduino Uno R3 is powered by the battery, enabling it to execute the programmed logic and control the entire system.

Importance and Impact: The 3000mAh 3.7V battery is essential for the project's overall functionality and mobility:

- **Portability:** The battery provides the necessary energy for the car to operate without being tethered to a power source, enabling the project to be used in various environments.
- **Flexibility:** With a significant capacity, the battery can support extended usage sessions before requiring recharging, enhancing the user experience.
- **Reliability:** The battery's lithium-ion chemistry offers a stable and consistent power supply, contributing to the reliable and predictable operation of the project.

Charging and Safety Considerations: Given that lithium-ion batteries can be sensitive to overcharging and discharging, proper charging and use practices are crucial for safety and longevity. Users should follow manufacturer guidelines for charging and storage to prevent any potential risks associated with lithium-ion batteries.

Conclusion: The 3000mAh 3.7V battery is the powerhouse that drives the project, supplying power to motors, sensors, and the microcontroller. Its capacity, voltage, and lithium-ion chemistry combine to provide the necessary energy for the project's operation, making it a key enabler of the project's mobility and functionality.

III. Features

Here's the list of the main features of the project:

1) **Alcohol Detection:** The project incorporates the MQ-3 Alcohol Detector Gas Sensor to detect the presence of alcohol in the vicinity, ensuring that the driver is not under the influence while operating the car.
2) **Seat Belt Detection:** The system includes a seat belt detection mechanism using the hall effect sensor. It promotes safety by alerting the driver to fasten their seat belt before starting the vehicle.
3) **Obstacle Collision Avoidance System:** The HC-SR04 Ultrasonic Distance Sensor helps prevent collisions by measuring the distance to obstacles in real-time. The system triggers automatic braking if an obstacle is detected too close to the vehicle.
4) **Engine Temperature Monitoring System:** The LM35 Temperature Sensor monitors the engine's temperature. If the temperature exceeds a certain threshold, the system alerts the driver and initiates safety measures to prevent overheating.
5) **Odometer:** The Odometer feature utilizes the A3144 Hall Effect Sensor to track the rotation of the car's wheels. This data is then used to calculate the distance traveled by the vehicle.

These key features collectively create a safety-focused environment within the vehicle, ensuring responsible driving practices and enhancing the overall security of the passengers and the car itself.

IV. Arduino Code

```
#include <Wire.h>
#include <AFMotor.h>
#include <LiquidCrystal_I2C.h>

AF_DCMotor motor1(1);
AF_DCMotor motor2(2);
AF_DCMotor motor3(3);
AF_DCMotor motor4(4);

LiquidCrystal_I2C lcd(0x27, 16, 2);

const int SeatBeltPin = 2;
const int OdometerPin = 3;
const int UltrasonicTrigPin = 4;
const int UltrasonicEchoPin = 5;
const int AlertBuzzerPin = 6;
const int AlertLEDPin = 7;
const int LEDButtonPin = 8;
const int FrontLeftLEDPin = 9;
const int FrontRightLEDPin = 10;
const int BrakeButtonPin = 11;
const int BackLeftLEDPin = 12;
const int BackRightLEDPin = 13;
const int AcceleratorPin = A0;
const int AlcoholGasPin = A1;
const int TemperaturePin = A3;

bool magnetDetected1 = false;
bool magnetDetected2 = false;
int traveledDistance = 0;
const float wheelSizeCm = 6.5;

void setup() {
  motor1.setSpeed(0);
  motor2.setSpeed(0);
  motor3.setSpeed(0);
  motor4.setSpeed(0);
  motor1.run(RELEASE);
  motor2.run(RELEASE);
  motor3.run(RELEASE);
  motor4.run(RELEASE);

  pinMode(SeatBeltPin, INPUT);
  pinMode(OdometerPin, INPUT);
  pinMode(UltrasonicTrigPin, OUTPUT);
  pinMode(UltrasonicEchoPin, INPUT);
  pinMode(BrakeButtonPin, INPUT_PULLUP);
  pinMode(LEDButtonPin, INPUT_PULLUP);
  pinMode(AlertBuzzerPin, OUTPUT);
  pinMode(AlertLEDPin, OUTPUT);
  pinMode(BackLeftLEDPin, OUTPUT);
  pinMode(BackRightLEDPin, OUTPUT);
  pinMode(FrontLeftLEDPin, OUTPUT);
  pinMode(FrontRightLEDPin, OUTPUT);
  lcd.init();
  lcd.backlight();
}

void loop() {
  int seatBeltValue = digitalRead(
     SeatBeltPin);
  int odometerValue = digitalRead(
     OdometerPin);
  int acceleratorValue = analogRead(
     AcceleratorPin);
  int alcoholValue = analogRead(
     AlcoholGasPin);

  int reading = analogRead(TemperaturePin
     );
  float voltage = reading * (5.0 /
     1024.0);
  float temperatureC = (voltage * 100) -
     10;

  int brakeButtonState = digitalRead(
     BrakeButtonPin);
  int ledPushButtonState = digitalRead(
     LEDButtonPin);

  digitalWrite(UltrasonicTrigPin, LOW);
  delayMicroseconds(2);
  digitalWrite(UltrasonicTrigPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(UltrasonicTrigPin, LOW);
  unsigned long duration = pulseIn(
     UltrasonicEchoPin, HIGH);
  float distanceCm = duration * 0.034 /
     2;

  int motorSpeed = map(acceleratorValue,
     1023, 0, 0, 255);
  motor1.setSpeed(motorSpeed);
  motor2.setSpeed(motorSpeed);
  motor3.setSpeed(motorSpeed);
  motor4.setSpeed(motorSpeed);

  if (brakeButtonState == LOW ||
     odometerValue == HIGH ||
     alcoholValue > 500 || temperatureC >
      100 || distanceCm < 10) {
    motor1.run(RELEASE);
    motor2.run(RELEASE);
    motor3.run(RELEASE);
    motor4.run(RELEASE);
    digitalWrite(AlertBuzzerPin, HIGH);
    digitalWrite(AlertLEDPin, HIGH);
    digitalWrite(BackLeftLEDPin, HIGH);
    digitalWrite(BackRightLEDPin, HIGH);
```

```
  } else {
    digitalWrite(AlertBuzzerPin, LOW);
    digitalWrite(AlertLEDPin, LOW);
    digitalWrite(BackLeftLEDPin, LOW);
    digitalWrite(BackRightLEDPin, LOW);

    if (ledPushButtonState == LOW) {
      digitalWrite(FrontLeftLEDPin, HIGH)
          ;
      digitalWrite(FrontRightLEDPin, HIGH
          );
    } else {
      digitalWrite(FrontLeftLEDPin, LOW);
      digitalWrite(FrontRightLEDPin, LOW)
          ;
    }

    if (seatBeltValue == LOW && !
        magnetDetected1) {
      traveledDistance += wheelSizeCm;
      magnetDetected1 = true;
    } else if (seatBeltValue == HIGH) {
      magnetDetected1 = false;
    }

    if (odometerValue == LOW && !
        magnetDetected2) {
      magnetDetected2 = true;
    } else if (odometerValue == HIGH) {
      magnetDetected2 = false;
    }

    motor1.run(FORWARD);
    motor2.run(FORWARD);
    motor3.run(FORWARD);
    motor4.run(FORWARD);
  }

  lcd.setCursor(0, 0);
  lcd.print("Traveled: ");
  lcd.print(traveledDistance);
  lcd.print(" cm");

  delay(100);
}
```

V. Implemented Hardware System

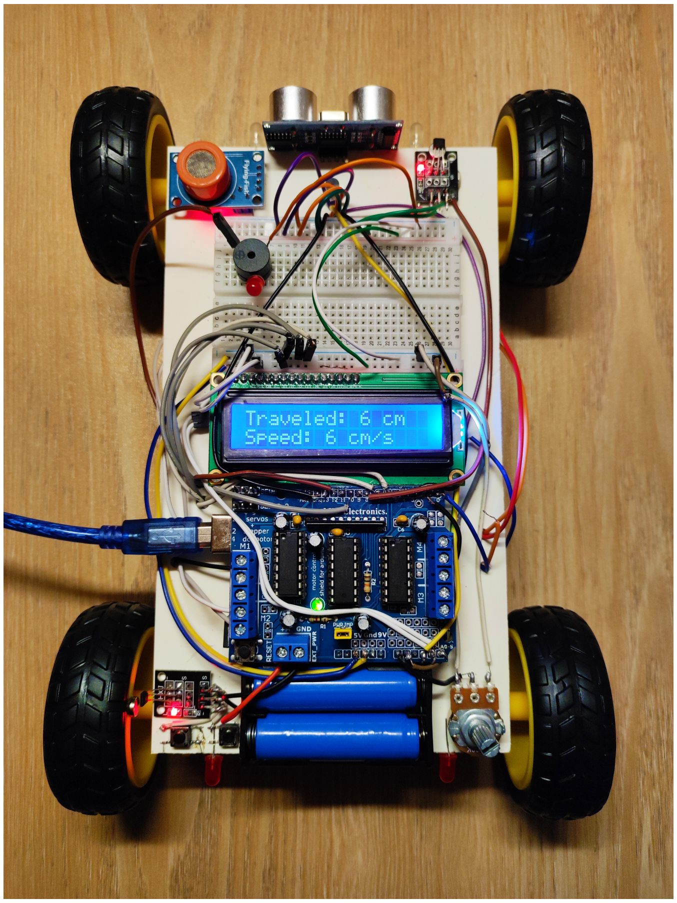

Fig. 16. **Hardware Prototype**

VI. References

1) **GitHub Repository**