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Electric Vehicle & Green Mobility

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Abstract: *The rapid increase in pollution and depletion of fossil fuels has created a need for sustainable transportation solutions. Electric Vehicles (EVs) and green mobility have emerged as effective alternatives to traditional fuel-based vehicles. This thesis explains the concept of EVs, their types, advantages, challenges, and their role in achieving a cleaner and greener future. It also highlights the importance of adopting eco-friendly transportation systems to reduce environmental impact.*

Keywords: *Electric Vehicles*

I. INTRODUCTION

Transportation plays a vital role in modern life, but it is also one of the major sources of air pollution. Conventional vehicles that run on petrol and diesel release harmful gases like carbon dioxide (CO_2), nitrogen oxides, and particulate matter, which damage the environment and human health.

Electric Vehicles (EVs) are vehicles that use electric motors powered by batteries instead of internal combustion engines. These vehicles are considered environmentally friendly because they produce zero or very low emissions.

Green mobility refers to the use of sustainable and eco-friendly transportation systems such as EVs, public transport, cycling, and walking. The goal is to reduce pollution, save energy, and create a healthier environment.

II. LITERATURE REVIEW

Many researchers and organizations have studied electric vehicles and green mobility as solutions to environmental problems caused by conventional transportation. Reports by the International Energy Agency highlight that the adoption of electric vehicles has increased significantly in recent years due to government policies, technological advancements, and rising fuel prices. According to their studies, EVs play a major role in reducing greenhouse gas emissions and improving energy efficiency.

Research papers published in journals like the IEEE discuss the technical aspects of electric vehicles, including battery management systems, charging infrastructure, and motor efficiency. These studies show that improvements in lithium-ion battery technology have made EVs more practical and reliable.

In the Indian context, policies introduced by the Government of India, such as FAME (Faster Adoption and Manufacturing of Electric Vehicles), have encouraged the use of electric mobility. Several studies indicate that these initiatives are helping to reduce pollution levels in major cities and promote sustainable transportation

III. SYSTEM ARCHITECTURE AND DESIGN

FUNCTIONAL OVERVIEW

The functional operation of an Electric Vehicle (EV) is based on the conversion of electrical energy into mechanical energy to drive the vehicle. Unlike conventional vehicles, EVs do not use an internal combustion engine. Instead, they rely on a battery system and an electric motor for propulsion.

The main component of an EV is the battery pack, which stores electrical energy. This energy is supplied to the controller, which manages the flow of electricity based on the driver's input such as acceleration and braking. The controller then sends power to the electric motor. The motor converts electrical energy into mechanical energy, which rotates the wheels and moves the vehicle

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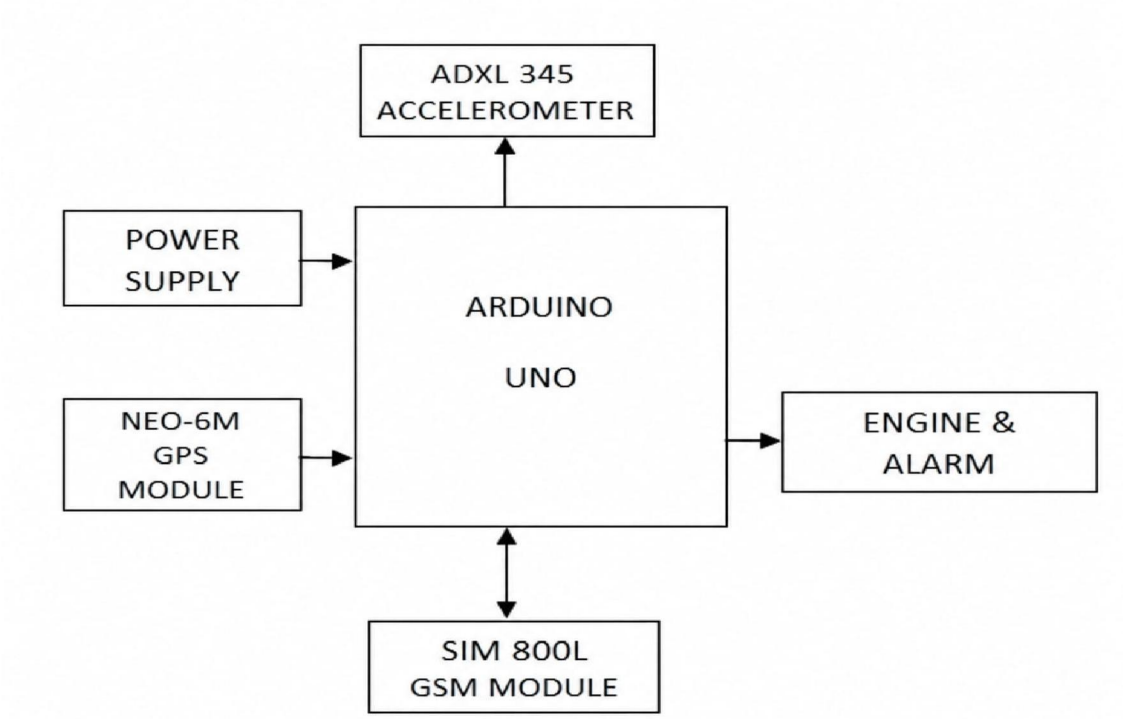
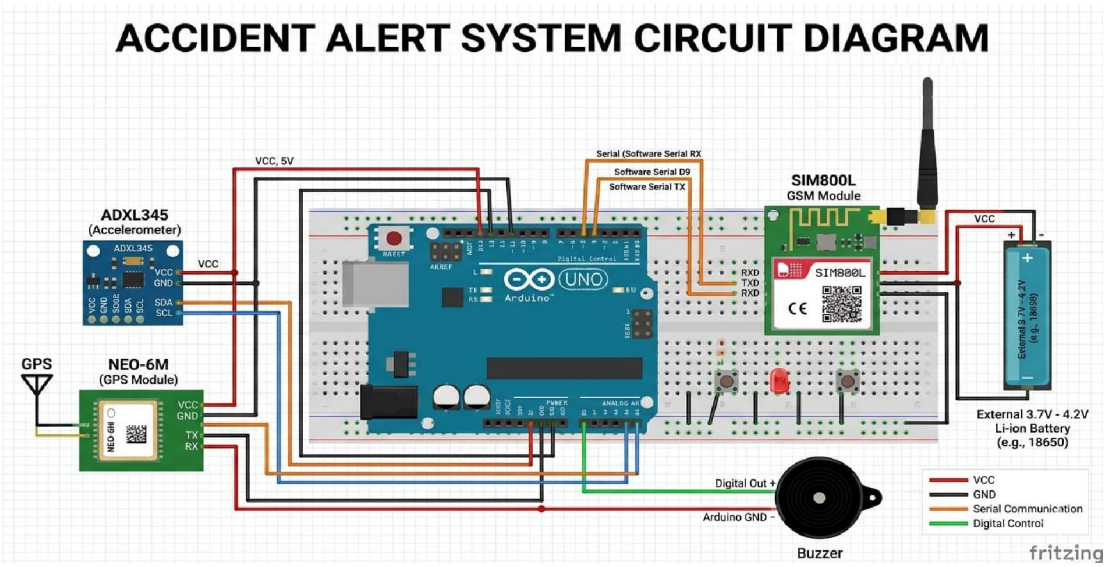
BLOCK DIAGRAM DESCRIPTION





The block diagram of an electric vehicle shows the main components such as the battery, controller, inverter, motor, and wheels. The battery supplies electrical energy to the controller, which regulates power flow based on driver input.The inverter converts DC power from the battery into AC power for the motor.Finally, the motor drives the wheels, and regenerative braking helps to recover energy back to the battery.

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IV. MATHEMATICAL MODELLING AND ANALYSIS

Mathematical modelling of an Electric Vehicle (EV) helps in understanding its performance, efficiency, and energy consumption under different driving conditions. It mainly involves analysing forces acting on the vehicle, power requirements, and battery usage.The total tractive force required to move an EV is the sum of different resistive forces such as rolling resistance, aerodynamic drag, gradient force, and acceleration force. It can be expressed as:

$$F_t=F_r+F_a+F_g+F_{acc}$$

Where,

F_{acc} = Acceleration force

F_t = Total tractive force

F_r = Rolling resistance

F_a = Aerodynamic drag

F_g = Gradient force

Rolling resistance depends on the vehicle weight and road condition:

$$F_r=mgC_r$$

Aerodynamic drag depends on air density, vehicle speed, and shape:

$$Fa=1/2\rho AC_dv^2$$

Where,

ρ = Air density

A = Frontal area

C_d= Drag coefficient

v = Vehicle speed

The power required to drive the vehicle is given by:

$$P=F_t\times v$$

This equation shows that power demand increases with speed and resistive forces.

For battery analysis, the energy consumption of an EV can be calculated as:

$$E=P\times t$$

Where E is energy and t is time.

V. HARDWARE IMPLEMENTATION

In this electric vehicle project, the **Arduino Uno** works as the main controller that manages all components. The **NEO-6M GPS module** is used to track the vehicle's real-time location, while the **SIM800L GSM module** sends SMS or call alerts during emergencies. The **ADXL345 accelerometer** detects sudden movements or accidents and sends signals to the Arduino for action. A **buzzer** provides instant sound alerts in critical situations. All components are powered from the EV battery with proper connections like serial communication and I2C. Overall, this system improves vehicle safety and monitoring by combining tracking, accident detection, and communication features in a simple and efficient way.

VI. SOFTWARE AND ALGORITHM DESIGN

The software design of this electric vehicle project is based on programming the **Arduino Uno** using Embedded C in the Arduino IDE. The program controls all modules such as GPS, GSM, accelerometer, and buzzer by continuously reading sensor data and making decisions in real time. Libraries for **NEO-6M (TinyGPS)** and **ADXL345 (I2C communication)** are used to simplify data handling, while serial communication is used to interface with the **SIM800L GSM module**.

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VII. RESULTS AND PERFORMANCE ANALYSIS

The implemented electric vehicle system with Arduino-based monitoring and safety features showed reliable and efficient performance during testing. The **GPS module (NEO-6M)** was able to provide accurate real-time location data with only minor delays, which is acceptable for tracking applications. The **SIM800L GSM module** successfully sent emergency messages and alerts, although response time slightly depended on network availability.

The **ADXL345 accelerometer** effectively detected sudden movements and impacts. When the acceleration crossed the predefined threshold, the system correctly identified it as a potential accident and triggered the **buzzer** along with sending alert messages. This shows that the accident detection mechanism is responsive and practical for real-world use.

APPLICATIONS

- **Personal Transportation:** Electric vehicles are widely used for daily commuting as they reduce fuel cost and air pollution.
- **Public Transport Systems:** EVs are used in electric buses, metro feeder services, and e-rickshaws to provide eco-friendly mass transportation.
- **Smart City Projects:** Green mobility solutions are implemented in smart cities to reduce traffic congestion and improve air quality.
- **Logistics and Delivery Services:** Many companies use electric bikes and vans for last-mile delivery to save cost and reduce emissions.
- **Industrial and Campus Use:** EVs are used inside factories, airports, and large campuses for internal transportation due to zero emissions.
- **Emergency and Safety Systems:** Integrated systems like GPS, GSM, and sensors help in accident detection, tracking, and quick emergency response.

VIII. CONCLUSION

Electric Vehicles (EVs) and green mobility represent a significant step toward a sustainable and eco-friendly future. This project highlights how EVs can effectively reduce air pollution, dependence on fossil fuels, and overall environmental impact. The integration of technologies such as Arduino-based control, GPS tracking, GSM communication, and accelerometer-based accident detection enhances the safety and reliability of the system.

The study also shows that EV performance depends on factors like resistive forces, power requirements, and battery efficiency, which can be analyzed through mathematical modelling. Although challenges like charging infrastructure and battery cost still exist, continuous advancements in technology and supportive government policies are making EV adoption more practical.

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