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Semi-Autonomous smart electric vehicle using AI based Driving assistance

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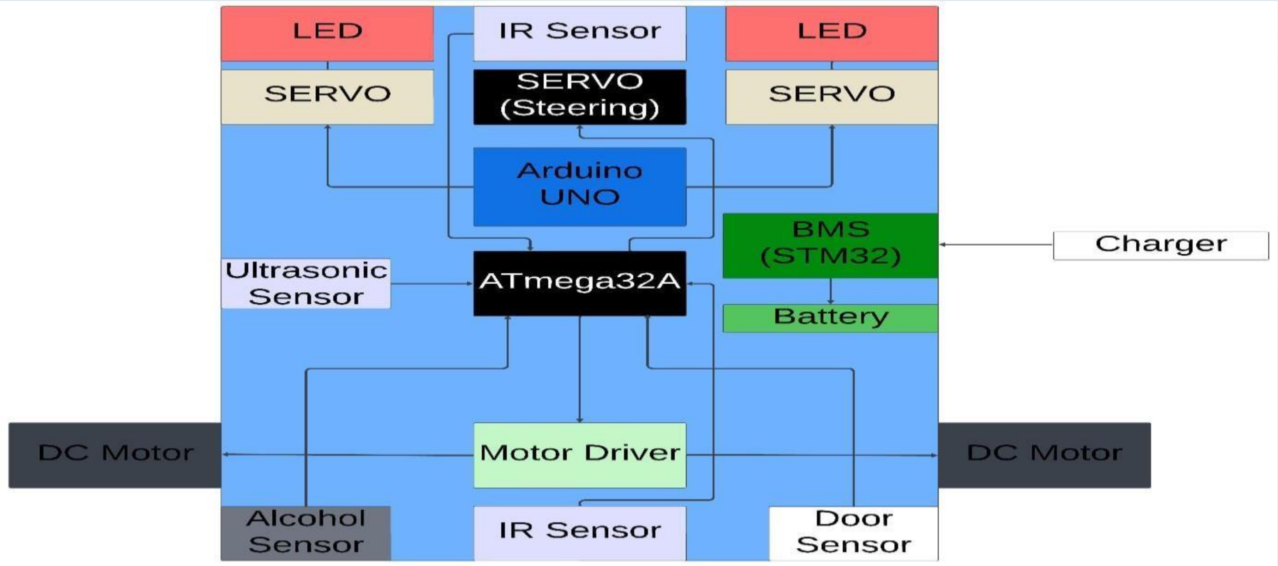
Abstract

In our research, we propose a practical methodology design and implementation of a semi-autonomous smart electric vehicle (EV) equipped with advanced features such as AI-based pothole detection, a robust battery management system (BMS), self-parking capability, and intelligent headlight intensity control. The primary objective of this research is to enhance the safety, efficiency, and user experience of electric vehicles through the integration of cutting-edge technologies.The AI-based pothole detection system utilizes sensors and machine learning algorithms to continuously monitor the road surface for hazards such as potholes, cracks, or debris. By analyzing real-time sensor data, the system can accurately identify potential road hazards and provide timely warnings to the driver or take proactive measures to mitigate their impact on vehicle performance and passenger comfort.The battery management system plays a critical role in optimizing the performance and longevity of the vehicle's battery pack. Through advanced algorithms and predictive analytics, the BMS monitors various parameters such as temperature, voltage, and current to ensure safe and efficient operation of the battery. By dynamically adjusting charging rates and load distribution, the system maximizes the battery's lifespan while ensuring sufficient energy availability for propulsion and onboard systems.Self-parking technology enables the vehicle to autonomously navigate parking spaces and execute precise maneuvers without human intervention. By integrating sensor fusion, path planning algorithms, and vehicle dynamics modeling, the system can identify suitable parking spaces, calculate optimal trajectories, and park the vehicle safely and efficiently, enhancing convenience and reducing driver workload in congested urban environments.

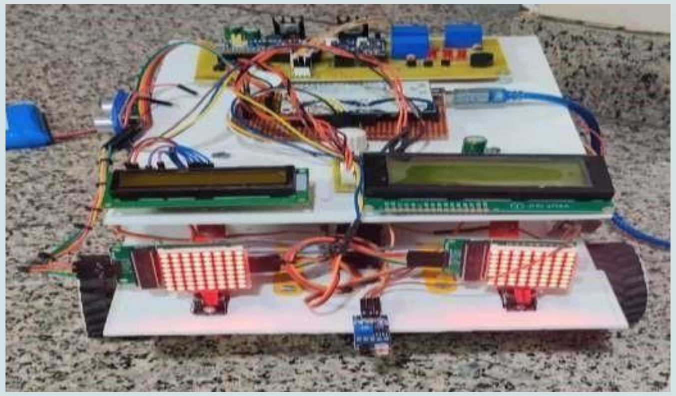
Introduction

A semi-autonomous smart electric vehicle that utilizes AI for pothole detection, incorporates a battery management system, enables self-parking, and includes headlight intensity control involves several interconnected systems working together to enhance the vehicle's functionality and safety.Pothole detection using AI involves equipping the vehicle with sensors, such as cameras to scan the road surface continuously. These sensors capture data about the road condition, including potholes, cracks, or uneven surfaces. The AI algorithm processes this data in real-time, identifying potential hazards like potholes based on predefined criteria such as depth, width, and location.The battery management system is crucial for optimizing the performance and longevity of the vehicle's battery. It monitors various parameters such as temperature, voltage, and current of each battery cell. By continuously analyzing this data, the system can ensure that the battery operates within safe limits, preventing overcharging, overheating, or over-discharging, which can damage the battery and reduce its lifespan.Self-parking technology enables the vehicle to park itself without the need for direct human intervention. Utilizing sensors, cameras, and AI algorithms, the vehicle can detect suitable parking spaces, calculate the optimal trajectory, and maneuver into the parking spot safely and accurately. This feature enhances convenience for the driver, especially in crowded urban environments where parking spaces are limited .Headlight intensity control adjusts the brightness of the vehicle's headlights based on external conditions such as ambient light levels, oncoming traffic, and weather conditions. By automatically adapting the headlight intensity, the system improves visibility for the driver while minimizing glare for other road users, enhancing overall safety during nighttime driving or adverse weather conditions.Integrating AI with pothole detection allows the vehicle to react proactively to road hazards, such as adjusting suspension settings or providing warnings to the driver.

Research and design Block Diagram



Semi-Autonomous smart electric vehicle using AIbased Driving assistance Hardware



Results and Analysis

The SSEV implements all its functions without any error or delay. The self parking system can be implemented in any car with low cost. The dimensions have to be adjusted for implementation in a live size model. The system detects open and closed doors as well as if there is presence of alcohol in the air in the vicinity of the vehicle. The parking process is also completed smoothly with bumping into the obstacles. The BMS system gives accurate reading of the voltage, current and temperature parameters and the fast charging and slow charging features function as expected.

Conclusion

The integration of AI-driven pothole detection, advanced battery management systems, self-parking capability, and intelligent headlight intensity control represents a significant advancement in the development of smart electric vehicles. These technologies collectively enhance safety, efficiency, and convenience for drivers and passengers.By detecting potholes and other road hazards in real-time, the AI-based system helps drivers avoid potential accidents and damage to their vehicles, contributing to overall road safety. Additionally, the robust battery management system ensures the optimal performance and longevity of the vehicle's battery, addressing concerns about range anxiety and battery degradation commonly associated with electric vehicles.Furthermore, self-parking capability and intelligent headlight intensity control streamline the driving experience, reducing driver workload and enhancing convenience, especially in urban environments. These features make electric vehicles more accessible and user-friendly, ultimately accelerating the transition towards sustainable transportation solutions. Overall, the integration of these technologies marks a significant step towards safer, more efficient, and environmentally friendly mobility.

Future Scope

Semi-autonomous smart electric vehicles with AI pothole detection, advanced battery management systems, self-parking capability, and intelligent headlight intensity control is promising. One area of potential growth lies in further advancements in AI algorithms and sensor technologies. As AI continues to evolve, future vehicles could become even smarter and more capable of accurately detecting and reacting to road hazards in real-time, thereby enhancing safety and reducing accidents further.Additionally, there is scope for the integration of renewable energy sources and energy harvesting technologies to enhance the sustainability of electric vehicles. By incorporating solar panels or kinetic energy recovery systems, future vehicles could generate additional power to supplement their onboard batteries, extending their range and reducing dependence on external charging infrastructure. This could significantly increase the appeal of electric vehicles and accelerate their adoption worldwide.Moreover, as autonomous driving technology continues to mature, future smart electric vehicles could become fully autonomous, offering passengers the ability to relax or work while the vehicle handles all aspects of driving, including navigation, parking, and avoiding road hazards. This would not only improve convenience and productivity but also further enhance safety by reducing human error and driver fatigue. Overall, the future scope for semi-autonomous smart electric vehicles is vast, with endless possibilities for innovation and improvement in safety, efficiency, and sustainability.

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