Smart Power Management and Traffic Control System for Electric Vehicle Using Arduino Mega

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Abstract-This paper presents a Smart Power Management and Traffic Control System for Electric Vehicles (EVs) using Arduino Mega The system enhances EV efficiency by managing dual power sources solar panels and batteries through DC voltage sensors and an LDR-based solar tracking servo mechanism. A dual-battery setup enables one battery to charge while the other powers the DC motor, with relay-based automatic switching for uninterrupted operation. For intelligent traffic control, the system uses RSSI (Received Signal Strength Indicator) to automate vehicle responses to traffic lights, improving road safety. Real-time data on power, battery levels, and traffic signals is processed by the Arduino and displayed on an LCD, with remote monitoring enabled via IoT. This integrated system promotes sustainable, safe, and smart urban mobility.

Keywords: *Electric Vehicle, BMS, Arduino Mega, Solar Tracking, RSSI, IoT, Traffic Control System, Rechargeable battery.*

I. INTRODUCTION

Electric Vehicles (EVs) are emerging as a sustainable alternative to traditional transportation, requiring efficient energy management and intelligent traffic integration. This paper introduces a Smart Power Management and Traffic Control System using Arduino Mega to enhance EV performance and safety. The system incorporates solar and battery power sources monitored via DC voltage sensors. An LDR-based solar tracking mechanism maximizes energy absorption, while a dual battery setup with relay-based switching ensures uninterrupted operation. To improve traffic responsiveness, RSSI technology enables real-time communication with traffic signals, automating vehicle speed control. The Arduino Mega processes real-time data and updates are displayed on an LCD and shared with an IoT platform. By integrating renewable energy, automation, and IoT, the system supports smarter, eco-friendly urban mobility.

II. MODELLING OF THE SYSTEM

The proposed system overcomes the limitations of conventional electric vehicles by integrating smart power management, intelligent traffic control, and IoT-based monitoring. It consists of a solar panel with an LDR-guided servo motor for tracking, dual 12V lithium-ion batteries, DC voltage sensors, a relay-based switching mechanism, RSSI module for traffic signal detection, and an LCD display for real-time data. The solar tracking system ensures maximum energy capture by dynamically adjusting the panel orientation towards sunlight. One battery charge from the solar panel while the other powers the DC motor.

Once the charging battery is full, the Arduino Mega automatically switches power using a relay, ensuring uninterrupted vehicle operation. To enhance traffic safety, an RSSI (Received Signal Strength Indicator) module detects traffic signals.

The EV's motor responds based on signal strength—automatically slowing down or stopping when a red signal is detected. This reduces the need for driver intervention, improving energy efficiency and safety.

A DC voltage sensor continuously monitors battery levels to prevent overcharging or deep discharge. The system displays real-time information like battery status, solar tracking angle, and signal response on an LCD. Simultaneously, all data is transmitted to an IoT platform, allowing users to remotely monitor system performance.

By combining renewable energy, automation, and smart traffic communication, this model ensures sustainable EV operation with improved safety, efficiency, and monitoring—suitable for smart cities and next-generation mobility solutions.

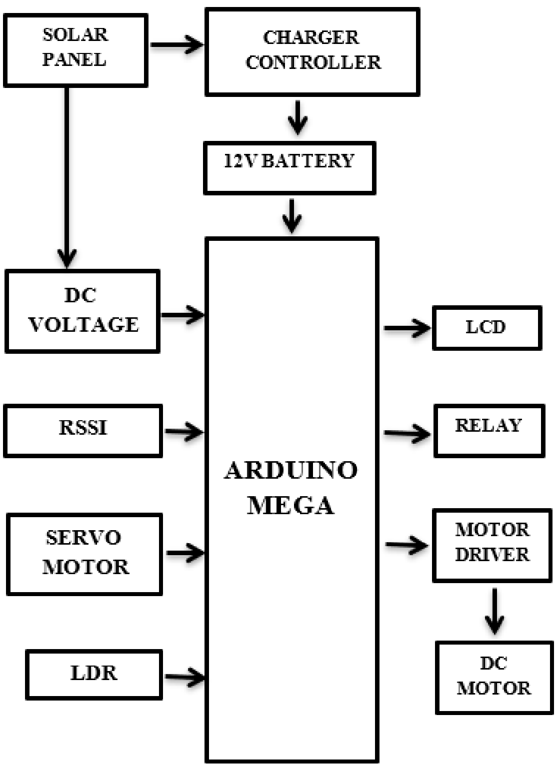

Fig 1: Block Diagram

III. LITERATURE SURVEY

In reference [1] **Smart Solar-Based Battery Charging Study**: "Design and Implementation of Solar Battery Charging System with MPPT"
Key Focus: Describes a system that uses Maximum Power Point Tracking (MPPT) for efficient solar charging of batteries.
Innovation: Introduces servo motor–based solar tracking to improve solar energy capture in real time.

In reference [2] **Dual Battery Management in EVs Study**: "A Dual Battery Swapping System for Electric Vehicles"
Key Focus: Proposes an automated relay-based mechanism to switch between batteries during operation.
Innovation: Ensures uninterrupted power supply for EVs by alternating between charging and discharging batteries.

In reference [3] **RSSI-Based Traffic Control Study**: "Smart Traffic Signal Control Using Wireless Communication"
Key Focus: Utilizes RSSI technology to communicate traffic light status with moving vehicles.
Innovation: Enhances road safety by enabling EVs to slow down or stop automatically at red lights using signal strength detection.

In reference [4] **IoT-Enabled Monitoring for Vehicles Study**: IoT-Based Energy Monitoring and Control System for Electric Vehicles
Key Focus: Discusses real-time data logging of power usage, battery health, and environmental factors via an IoT dashboard.
Innovation: Empowers users with remote access to vehicle energy data, improving maintenance and reliability.

In reference [5] **Smart EV Energy Systems Study**: Design and Analysis of Intelligent Energy Systems in Electric Mobility.
Key Focus: Combines renewable sources, embedded control, and real-time feedback to optimize EV operation.
Innovation: Integrates energy-efficient charging, automation, and user alerts into one cohesive system.

IV. RESULT AND DISCUSSION

The Smart Power Management and Traffic Control System for the Solar Bike was successfully implemented and tested under real-time conditions. The system's primary objective automatic battery switching, intelligent traffic response, and solar power optimization was achieved using Arduino Mega, dual lithium-ion batteries, and LDR-based solar tracking.

During testing, the solar panel, when exposed to direct sunlight, was dynamically aligned using a servo motor controlled by LDR input. This adjustment significantly increased solar charging efficiency compared to a fixed panel setup. One battery charged via the solar input while the other powered the DC motor. Once the charging battery reached full capacity, the relay system, programmed through the Arduino, seamlessly switched the power supply, ensuring continuous motor operation without manual intervention.

For traffic control, the RSSI module successfully detected signal strength from traffic beacons. When the vehicle approached a red signal zone, the system reduced the motor speed or stopped it entirely, mimicking intelligent braking. This feature enhanced road safety, especially in simulated urban environments.

All system statuses—including battery voltage, current power source, and traffic signal response—were displayed on the LCD. Simultaneously, real-time data was transmitted to an IoT dashboard, allowing remote monitoring via a web interface.

The results confirmed that the proposed system is both energy-efficient and reliable. It successfully integrated renewable energy usage, intelligent automation, and real-time communication offering a scalable solution for next-generation electric mobility.

Fig 2: Solar charge controller collecting energy from solar panel

Fig 3: Battery voltage detects using voltage sensor and monitoring in LCD

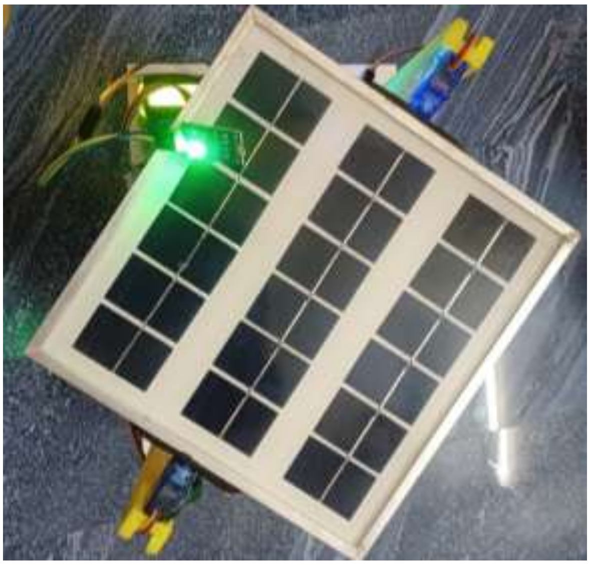

Fig 4: LDR-controlled servo aligned the solar panel in sunlight

V. FUTURE SCOPE

The proposed Solar Bike system has great potential for enhancement and scalability in future implementations. One major scope lies in upgrading the MPPT (Maximum Power Point Tracking) system using AI-based sun-position prediction algorithms to improve charging efficiency further, even under low light or cloudy conditions.

The current dual battery system can be expanded into a smart battery management network, where multiple battery packs are managed dynamically based on load, terrain, and solar input. Integration with regenerative braking can also be explored to recover energy during deceleration and feed it back into the battery.

From a traffic management perspective, advanced modules such as RFID-based traffic lane detection and GPS-based speed regulation can be incorporated for safer navigation in smart cities, the RSSI module can also be upgraded to support V2X (Vehicle-to-Everything) communication standards for interaction with other vehicles and infrastructure.

On the monitoring side, the IoT platform can be enhanced with mobile app support, predictive maintenance alerts, and integration with cloud-based analytics for long-term performance evaluation. Additionally, solar-powered charging stations for the bike can be developed for community deployment. Overall, this project can evolve into a fully autonomous, AI-powered, eco-friendly smart EV that aligns with modern urban mobility goals and supports India’s push toward sustainable transport solutions.

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