



Design And Implementation Of Battery Management And Wireless Charging In Electric Vehicles Using Iot

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Abstract:

As the production of electric vehicle has scaled up in the recent years in order to meet the objective of lowering the carbon footprint and eco-friendly transportation. The raise in the production of electric vehicles in accordance with hike in the price of petroleum and diesel has shifted the huge market share of the automobile industry from ICE engines to the battery powered engines. The shift in turn pushes the demand for installation of charging stations for electric vehicles at most locations. But the installation of such EV charging base stations requires high capital and sophisticated spatial infrastructure in densely populated area. Therefore, the paper proposes the AIS based mobile wireless charging system for electric vehicles which is cost effective and reliable. The system is best suited for densely populated areas, parking arenas at theatres, malls, parks etc., The Wireless Sensor Network is implemented to effectuate adaptive intelligent system, therefore leading to better accuracy and modularity.

Index Terms - Battery Management, Wireless Charging, Electric Vehicles, IOT, Battery Performance Optimization.

I. INTRODUCTION

In the evolving landscape of electric mobility, autonomous Electric Vehicles (EVs) will require intelligent and fully automated charging systems that do not rely on human intervention. Wireless Charging Systems (WCS) offer a promising solution in this regard. Unlike conventional plug-in charging methods, WCS provide greater simplicity, convenience, and reliability, especially when vehicles are stationary—such as in parking lots, garages, or even at traffic signals. These systems have been considered for both high-power applications like EVs and for stationary uses. However, WCS also face certain technical hurdles including electromagnetic compatibility (EMC) issues, limited power transmission, bulky hardware, reduced charging range, and efficiency challenges. At the heart of most EVs are lithium-ion batteries, which are favoured over traditional lead-acid batteries due to their smaller size, higher energy density, and significantly longer life cycle. Despite these advantages, safety remains a key concern. Overcharging, for instance, can degrade battery life and pose serious risks such as overheating or fire. To address these issues, a robust Battery Management System (BMS) is essential to monitor key parameters like temperature, voltage, and current in real-time, ensuring the battery operates safely and efficiently. Conventional BMS solutions typically offer only basic alerts via indicators inside the vehicle. To overcome these limitations, this paper proposes an innovative wireless EV charging and battery monitoring system that leverages Internet of Things (IoT) technologies. Through IoT integration, the system can remotely monitor battery health, optimize charging schedules, and enable real-time communication between the EV and charging infrastructure. This approach not only enhances charging efficiency and safety but also supports features like renewable energy integration and remote diagnostics, ultimately paving the way for smarter and more autonomous EV operations.

II. OBJECTIVES

To design an AI-Integrated wireless charging system for Electric Vehicle (EVs). To reduce dependency on fixed charging stations in urban areas. To Implement Wireless Sensor Networks (WSN) for smart connectivity. To develop a cost-effective and scalable charging infrastructure. To explore the feasibility of Internet of Things (IOT- based) battery management for optimization

III. ARDUINO UNO

The Arduino Uno is a microcontroller board. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. “Uno” means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduino, moving forward. The Uno is the latest in a series of USB Arduino boards, And the reference model for the Arduino platform.

IV. PROPOSED SYSTEM

Tesla coils are high-voltage transformers that are often used as transmitters for wireless power transmission. The Tesla coil is a resonant transformer, the primary and secondary LC circuits are only loosely connected. We use it as a transmitter because it's a transformer but it works differently than a normal transformer, it gives us a lot of power and a high-frequency output that produces more induction on the load side. Tesla coils use a high voltage generator to charge a capacitor (called a primary capacitor) and temporarily store the charge. When the capacitor is fully charged and connected to a special switch Tesla coils are high-voltage transformers that are often used as transmitters for wireless power transmission. The Tesla coil is a resonant transformer, the primary and secondary LC circuits are only loosely connected. We use it as a transmitter because it is a transformer but it works differently than a normal transformer, giving us more power, and more frequency output, which has a greater impact on the cargo. Tesla coils use a high-voltage generator to charge a capacitor (called a primary capacitor) and temporarily store the charge. When the capacitor is fully charged and connected to a special switch called a gap, the air between the electrodes is ionized, producing electricity. Primary capacitors can be connected in series and parallel, the difference between and is between the primary capacitor and the primary coil, and the other end of the capacitor is connected to the high-voltage generator. The RF ground is at the other end of the first coil.

V. ELECTRIC VEHICLE SIDE

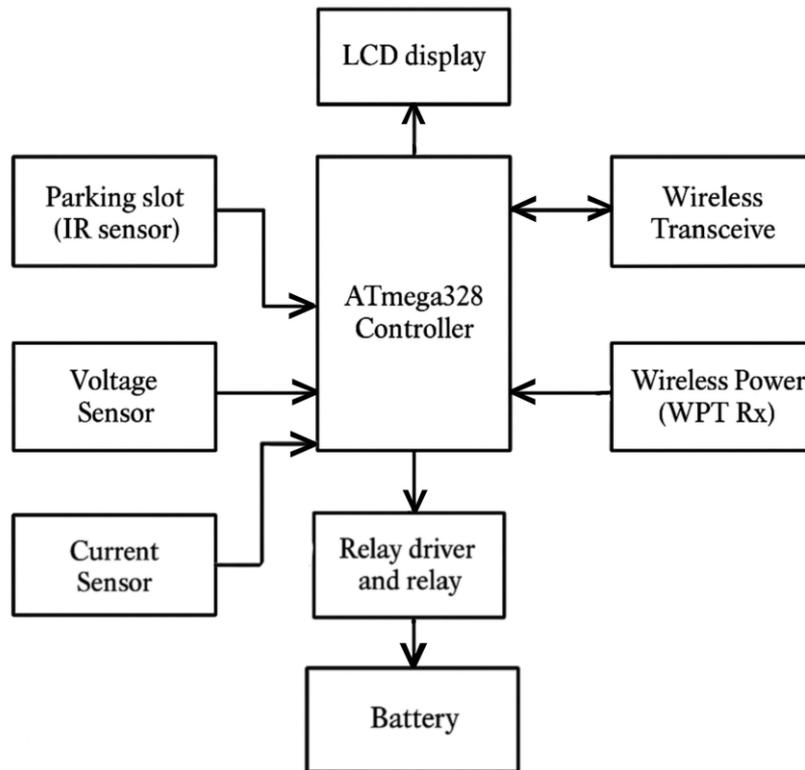


Figure 1 Block diagram of electric vehicle

VI. TRANSMITTER SIDE

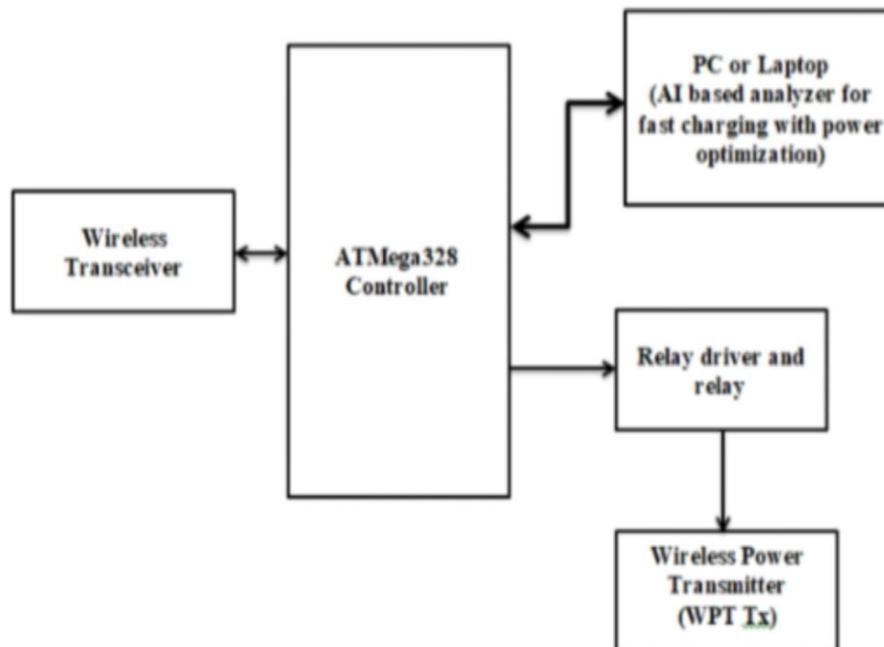


Figure 2 Block diagram of Transmitter

VII. WORKING

The proposed system comprises two units in which the parking slots circuitry, electric vehicle circuitry and charging unit circuitry combined imparts the innovation. These units has the microcontroller to initialize and distribute the control signals. The wireless may possess many sensors include IR and voltage sensors. Once the electric vehicle approaches the parking slot, the infrared sensor of the parking slot section checks the position of the electric vehicle. Once it is positioned properly, the wireless sensor network of charging unit requests for permitting the charging. The PC Ai software is analyzing and makes the system intelligent with charging time and power optimization and fast charging .If the wireless of electric vehicle unit allows, then the WPT transmitter section begins transmitting the power to the electric vehicle. The receiver WPT of vehicle unit captures the power transferred from the charging unit wirelessly. The magnetic resonance technology is used to wirelessly transfer the power as it doesn't compromise the fast-charging ability and efficiency of wired charging. The voltage sensor will be checking the battery level of the electric vehicle, once it is completely charged the request to stop the transmission of power is sent through Wireless transmitter of vehicle to the wireless receiver section of charging unit.

VIII. EXPERIMENTAL SETUP

Figure 3 and 4 shows the experimental setup of the battery management and wireless charging system. An Arduino Uno microcontroller runs the main code, managing sensors and controls. An ultrasonic sensor measures distance to detect the vehicle's position. The TX coil sends power wirelessly using a magnetic field, while the RX coil receives and converts it back to electricity. An oscillator ensures proper timing for the microcontroller. A relay driver and relay switch control high-power devices. The power supply and rechargeable battery provide energy to the whole setup.

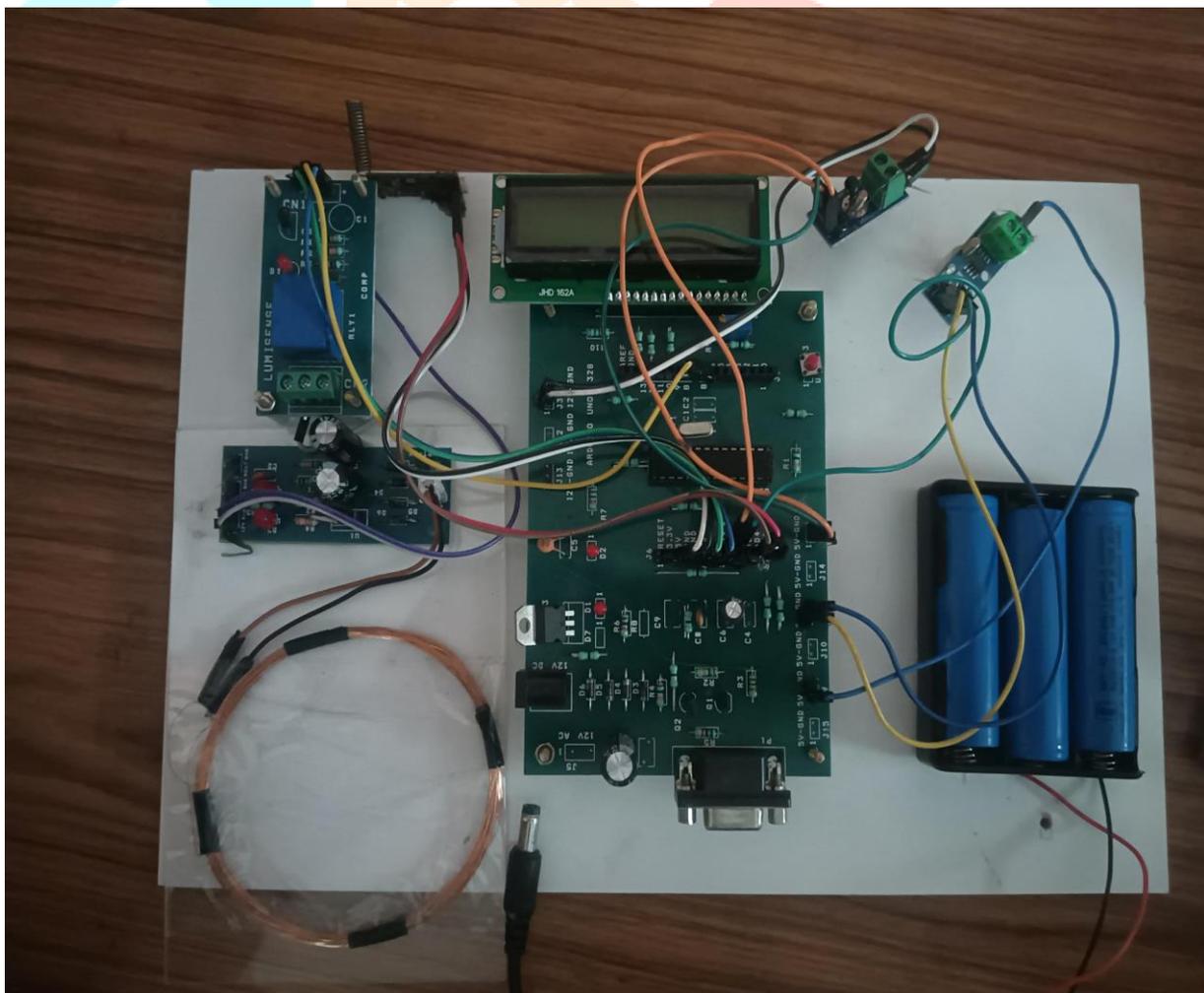


Figure 3 Electric vehicle side

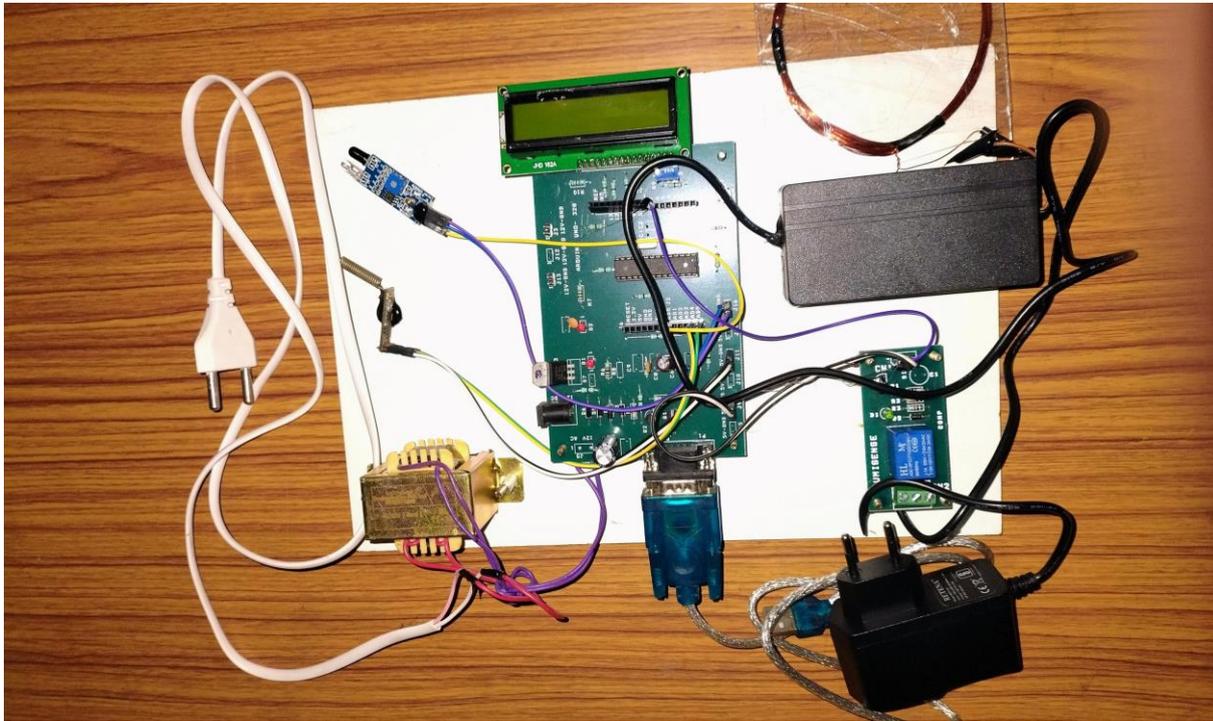


Figure 4 Transmitter side

IX. POWER SUPPLY

Power supply is a reference to a source of electrical power. A device or system that supplies electrical or other types of energy to an output load or group of loads is called a power supply unit or PSU. The term is most commonly applied to electrical energy supplies, less often to mechanical ones, and rarely to others.

X. SOFTWARE REQUIREMENT

Arduino is a prototype platform (open source) based on an easy-to-use hardware and software. It consists of a circuit board, which can be programmed (referred to as a microcontroller) and a ready-made Many applications can be solved more easily and efficiently with C than with other more specialized languages. The Cx51 optimizing C Compiler is a complete implementation of the American national Standards Institute (ANSI) standard for the C Language. Cx51 is not a universal C compiler adapted for the 8051 target. It is a ground-up implementation dedicated to generating extremely fast and compact code for the 8051 microprocessor. Cx51 provides you the flexibility of programming in C and the code efficiency and speed of assembly language. Since Cx51 is across compiler, some aspects of the C programming language and standard libraries are altered or enhanced to address the peculiarities of an embedded target processor.

XI. TECHNICAL SPECIFICATIONS ARDUINO UNO

Operating Voltage 5V

Input Voltage (recommended) 7-12V

VIN: The input voltage to the Arduino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.

5V. The regulated power supply used to power the microcontroller and other components on the board. This can come either from VIN via an on-board regulator, or be supplied by USB or another regulated 5V supply. 3V3. A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.

GND - Ground pins.

XII. PHYSICAL CHARACTERISTICS

The maximum length and width of the Uno PCB are 2.7 and 2.1 inches respectively, with the USB connector and power jack extending beyond the former dimension. Three screw holes allow the board to be attached to a surface or case. Note that the distance between digital pins 7 and 8 is 160 mil (0.16"), not an even multiple of the 100 mil spacing of the other pins and high-quality "ingredients" (components) as per following receipt:

Input Voltage (limits) 6-20V

Digital I/O Pins 14 (of which 6 provide PWM output)

Analog Input Pins 6

DC Current per I/O Pin 40 mA DC Current for 3.3V Pin 50 mA

Flash Memory 32 KB of which 0.5 KB used by bootloader

SRAM 2 KB

EEPROM 1 KB

Clock Speed 16 MHz Power

The Arduino Uno can be powered via the USB connection or with an external power supply. The power source is selected automatically. External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the Gnd and Vin pin headers of the POWER connector. The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts.

Conclusion

Wireless charging is a ground-breaking advancement in EV infrastructure. It offers a contactless, efficient, and user-friendly charging experience. By eliminating physical cables, it simplifies the charging process. This enhances convenience, especially in urban and fleet settings. Operational costs are reduced through predictive maintenance systems. Smart energy management lowers downtime and extends equipment life. These improvements make EV ownership more cost-effective over time

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