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Design And Implementation of Ev-Battery Management System

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***Abstract*— Wireless Power Transfer (WPT) using magnetic resonance is an emerging technology that eliminates the need for physical wiring in power transmission. Based on inductive power transfer principles, WPT has rapidly advanced, achieving kilowatt-level power transfer over distances ranging from a few millimeters to several hundred millimeters with efficiencies exceeding 90%. These improvements make WPT highly suitable for Electric Vehicle (EV) charging in both stationary and dynamic applications. This paper reviews key WPT technologies for EV charging and highlights their potential to reduce charging time, extend driving range, and lower operational costs. The continued development of WPT is expected to accelerate the adoption and growth of EVs.**

***Index Terms* - Hardware Components: Arduino Uno, Arduino Nano, Node MCU ESP8266, RFID Module EM-18, Relay Module, Voltage Sensor, Current Sensor (ACS712), ADC (HX711), LCD with I2C Module, Buck Converter, IC 7805 Voltage Regulator. Software Requirements: Arduino IDE, Embedded C / Programming logic, IoT platform.**

I. INTRODUCTION

Electrification of transportation has become essential for improving energy efficiency and reducing environmental impact, with electric vehicles (EVs) emerging as a key solution. However, EVs still face challenges such as limited battery capacity, high cost, and dependency on wired charging systems, which reduce convenience and user adoption. To overcome these limitations, wireless power transfer (WPT) technology using magnetic or resonant coupling enables efficient energy transfer between transmitter and receiver coils without physical connections. In addition, RFID technology enhances system intelligence by enabling secure identification, monitoring, and communication between components. This integration of wireless power transfer and RFID-based control offers a promising approach to develop smarter, more efficient, and user-friendly EV charging and energy management systems.

II. RELATED WORK

Recent research on electric vehicle (EV) systems has focused on improving charging efficiency, user convenience, and system intelligence through advanced technologies such as wireless power transfer (WPT) and RFID integration. Several studies have demonstrated that inductive and resonant coupling techniques can achieve efficient energy transfer over short distances, reducing dependence on conventional wired charging methods. Researchers have also explored the use of IoT-based platforms with microcontrollers like Arduino and NodeMCU for real-time monitoring and control of energy parameters. In addition, RFID technology has been widely implemented for secure user authentication, vehicle identification, and automated billing in smart charging systems. Despite these advancements, challenges such as power transfer efficiency, alignment issues, cost, and scalability still remain, motivating further research in developing optimized and integrated solutions for EV charging and energy management.

2.1 Haoming Liu, Man Niu, and Weijie Wang (2020) proposed a reservation-based charging strategy for electric vehicles. The model considers road traffic conditions, charging station availability, and customer requirements. Different influencing factors are converted into weighted values in a traffic network graph. Dijkstra's Algorithm is used to find the optimal charging path and reservation plan. Simulation results showed that the method reduces charging cost and satisfies different user demands.

2.2 Boyune Song and co-authors (2020) proposed a high-power inductive pickup system for On-Line Electric Vehicle (OLEV). The system uses contactless wireless power transfer to reduce charging time, battery weight, and electric shock risk. The proposed pickup design includes series capacitors, ferrite cores, and multi-winding structures for efficient power transfer. Experimental results achieved 20 kW output power with 86.7% efficiency at 20 kHz frequency and a 250 mm air gap.

2.3 Zhang et al. (2021) highlighted the importance of Inductive Power Transfer systems in wireless EV charging. Their research focused on improving power transfer efficiency, reducing energy loss, and developing reliable communication systems. The study emphasized optimized coil and advanced circuit designs for safe and efficient wireless power transmission. Kim et al. (2020) investigated resonant inductive coupling to improve charging efficiency, transfer range, and coil alignment in dynamic parking environments

2.4 Patel et al. (2021) identified this issue as a significant obstacle to achieving global wireless charging adoption. Safety Concerns is electromagnetic interference (EMI) presents potential risks to nearby electronics and human health. found that with appropriate shielding and careful design, these risks could be mitigated; however, further research is essential to guarantee adherence to safety standards Future Directions The future of wireless charging appears promising, particularly with its integration into emerging technologies

2.5 F. Lu, H. Zhang and C. Mi,(2024) Demonstrate a capacitive power transfer (CPT) technology is an effective and important alternative to the conventional inductive power transfer (IPT). It utilizes high frequency electric field to transfer electric power. The power level and efficiency of CPT systems has been significantly improved and as reached the power level suitable for electrical vehicle charging applications.

III. PROPOSED METHOD: SIMUBOUSTRONAV FRAMEWORK

Our proposed concept is to implement an automatic electric vehicle charging station via wireless power transfer (WPT) and RFID. Our modern electric vehicle consists of power sensor to analyze the amount of the power EV has and if the battery power is low it will point out to charge in nearest WPT station. The Automatic WPT station implemented with RFID reader. Then the user needs to show their electronic License card. Reader reads all info from that card and then it will enquire for license, insurance verification. Once everything is clear the user needs to specify the amount of unit power via Lab view Based Digital Info board. Finally the power is transferred via wirelessly to the Electric vehicle using WPT technique the unit the user entered and also amount will be deducted via user bank account.

3.1 HARDWARE REQUIREMENT

•Power Supply unit

•Battery

•Coil Winding

•Arudinouno controller

•Arduinonano controller

•Current sensot

•LCD Display

•2 Axis RobotsThis separation ensures modularity and embedded scalability.

3.2 SOFTWARE REQUIREMENT

•Arudino IDE Complier

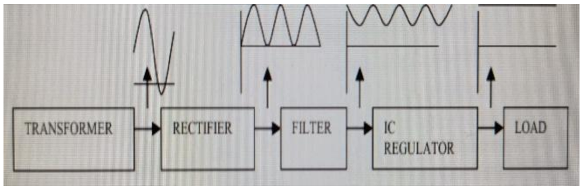
•Proteus Testing Tool

•Embedded C : Language

IV. EXPERIMENTAL SETUP AND PERFORMANCE EVALUATION

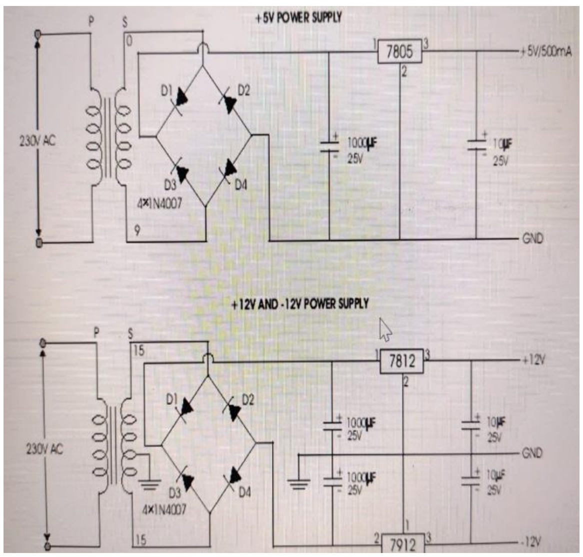
4.1 Power supply

The ac voltage, typically 220V rms, is connected to a transformer, which steps that ac voltage down to the level of the desired dc output. A diode rectifier then provides a full-wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage variation.



4.2 IC voltage regulators

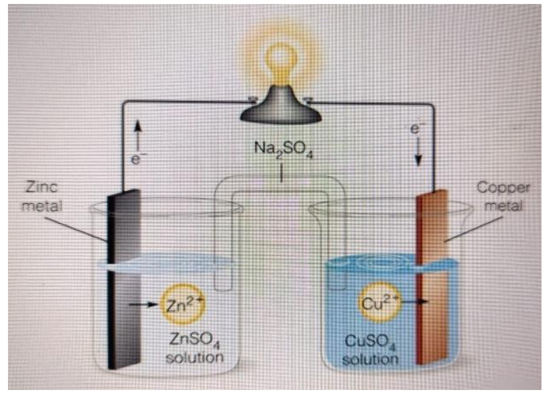
Voltage regulators comprise a class of widely used ICs. Regulator IC units contain the circuitry for reference source, comparator amplifier, control device, and overload protection all in a single IC.



This article gives detailed information about an Arduino Nano board, and it is one kind of microcontroller board which is designed by the Arduino team. This microcontroller is based on Atmega168 or Atmega328p. It is fairly similar to Arduino Uno board but when it comes to pin-configuration and features, this nano board has replaced Arduino Uno due to small in size. As we know that while designing an embedded system small size components are preferred. Arduino boards are mainly used to build electronic projects.

4.3 Battery

An electric battery is a device consisting of two or more electrochemical cells that convert stored chemical energy into electrical energy. Each cell has a positive terminal, or cathode, and a negative terminal, or anode. The terminal marked positive is at a higher electrical potential energy than is the terminal marked negative. The terminal marked negative is the source of electrons that when connected to an external circuit will flow and deliver energy to an external device.



V. DISCUSSION AND PRACTICAL IMPLICATIONS

Wokwi is an embedded systems and IoT simulator supporting ESP32, Arduino, and the Raspberry Pi Pico. Your code never leaves your computer - Wokwi runs the simulation inside VS Code, using the firmware binaries from your project. Features • Supported architectures: RISC-V, ARM, Xtensa, and AVR.

• Huge library of electronic components: sensors, LEDs, LCDs, motors, relays, etc.
• Integration with ESP-IDF, PlatformIO, and Arduino.
• Virtual Logic Analyzer - Capture digital signals in your simulation (e.g. UART, I2C, SPI) and analyze them on your computer.
• Built-in WiFi Gateway that allows the simulated ESP32 to connect to the your local network and the internet, and use cloud services.
• Virtual Logic Analyzer - Capture digital signals in your simulation (e.g. UART, I2C, SPI).
• GDB integration - Debug your code using the VS Code debugger.

VI. CONCLUSION

In this system, we are presenting the Wireless Power Transmission. As the electric vehicle in the market is increasing. We can use the wireless charging system to charge our vehicles. This system shows the efficiency and implementation of the charging station in future technology. This paper also covers future technology like payment through RFID tags and self serviced entry and exit gate to maintain congestion at the station. This will be helpful for those who are doing research in the field of wireless power transmission. And many had came up with the greatest invention like charging mobile wirelessly, and other electronic gadgets too.

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