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SMART WIRELESS CHARGING FOR ELECTRIC VEHICLES AND BATTERY HEAT MANAGEMENT

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Abstract: This work proposes the design of a system to create and handle Electric Vehicles (EV) charging procedures, based on intelligent process. The Electric Vehicles charging should be performed in effective way. One of the significant challenges with widespread electric vehicle adoption is related to vehicle charging. Many potential EV drivers have range anxiety or don't want to spend much time charging an EV battery on long trips. Although dynamic wireless charging may seem like something out of a science fiction movie, it could be a viable way to overcome vehicle charging issues. These wireless power transfer systems work while the vehicle is in motion, providing numerous benefits. Dynamic wireless charging for electric vehicles allows them to charge while moving with the help of copper coil. The addition of gate system with payment web application enhances accessibility and convenience to users. Battery heat detection through voltage and temperature sensor adds safety to this system.

Keywords: Copper coil, Web application, Voltage and temperature sensor

I. INTRODUCTION

The transportation sector is a major contributor to oil consumption and CO2 emissions, making electric vehicles (EVs) a key solution for sustainability. However, EV adoption faces challenges related to efficient charging and battery management. Smart wireless charging eliminates cables, offering convenience and enabling dynamic on-the-go charging. Battery heat detection ensures safety. Together, these innovations support the widespread use of EVs and help create a carbon-neutral future. Ongoing advancements in these technologies will drive the evolution of sustainable transportation systems.

MOTIVATION

The motivation for exploring smart wireless charging and battery heat management for electric vehicles stems from the growing global demand for efficient, user-friendly, and sustainable transportation solutions. Traditional wired charging systems can be inconvenient and time-consuming, limiting the adoption of EVs, whereas wireless charging offers a hassle-free, automated alternative that enhances user experience and supports innovations like dynamic and shared charging infrastructure. Additionally, effective battery heat management is essential to address critical challenges such as energy efficiency, safety, and the longevity of batteries, as improper thermal regulation can lead to performance degradation, reduced driving range, and potential safety hazards. By integrating these technologies, the automotive industry can accelerate EV adoption, reduce environmental impact, and meet the needs of a rapidly urbanizing and technologically driven society.

OBJECTIVE

The objectives of this work are described below

- Develops dynamic wireless charging capacity.
- Monitoring the battery voltage and temperature of EVs.
- Incorporate payment system as the gate opens or closes.

By achieving these objectives it supports the widespread adoption of EVs but also aligns with global sustainability goals,

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paving the way for a cleaner, more innovative future in transportation.

II. METHODOLOGY

The implementation of our wireless charging system begins with the supply acting as the input and the starting point of the operation. When the supply is applied to the transistor, the transistor starts switching, generating wireless power with the help of a copper coil. This innovative approach eliminates the need for traditional wired charging systems. A series of transmitter copper coils are strategically fixed along the base of the road. These coils are designed to emit electromagnetic fields, enabling the transfer of energy without any physical contact. The receiver copper coil, embedded within the electric vehicle, is engineered to capture this transmitted energy efficiently. This setup ensures that vehicles passing over the road can seamlessly receive power without the hassle of plugging into a charging station. At the end of the charging road, the system incorporates a payment mechanism. As the vehicle approaches the exit point, the user is prompted to pay for the amount of energy consumed during the charging process. The exact charging amount is displayed on an LCD screen for the user's convenience. This amount can be paid using a smartphone, ensuring a quick and hassle-free transaction. Once the payment is successfully completed, the system automatically opens the gate, allowing the user to exit the charging road smoothly. This automated process not only enhances user experience but also ensures a seamless integration of wireless charging into everyday commuting.

Within the vehicle, a rectifier and a filter are employed to convert the received alternating current (AC) into pure direct current (DC). This DC power is then stored in the vehicle's battery, ensuring that the energy is utilized efficiently. To monitor the battery's status, temperature and voltage sensors are installed within the vehicle. These sensors provide real-time data, helping to ensure the battery operates within safe parameters. The status of the battery, including voltage levels and temperature readings, is displayed on an LCD screen inside the vehicle.. Overall, this system represents a significant step forward in wireless power transfer technology, offering a practical and user-friendly solution for electric vehicle charging.

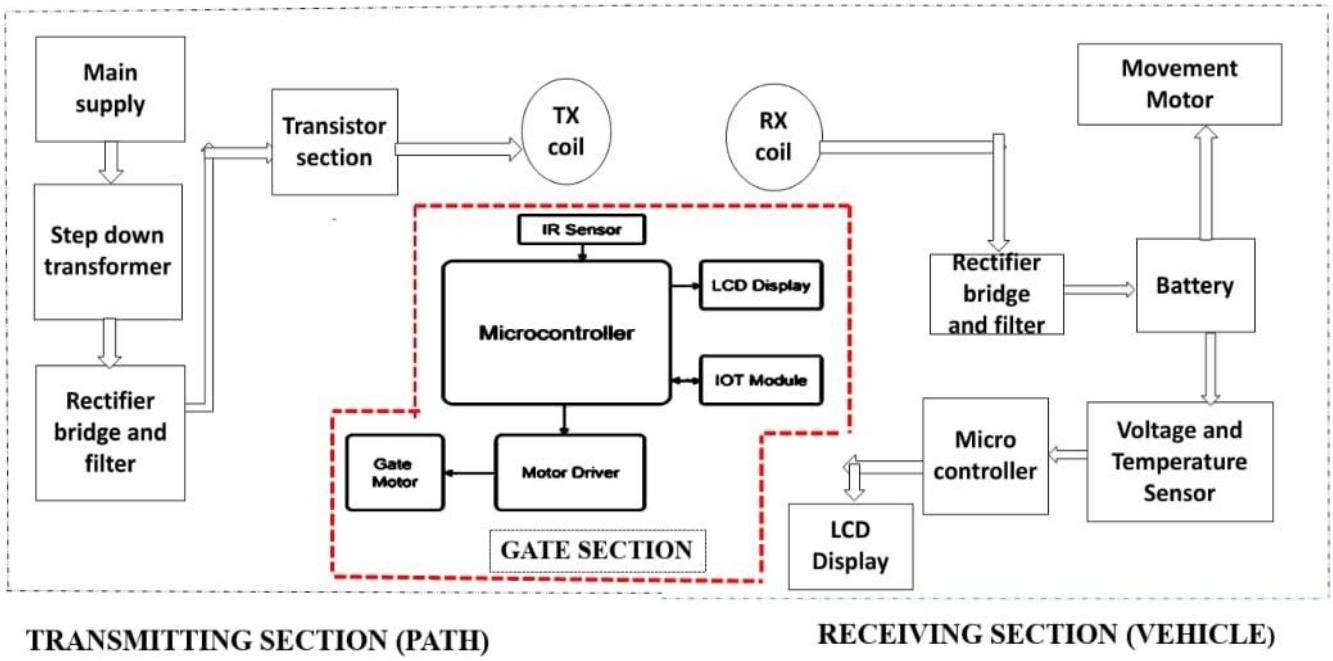

Figure1**:** Block diagram of smart wireless charging for wireless charging and battery heat detection

III. IMPLEMENTATION

Dynamic wireless charging (DWC) is a technology that allows electric vehicles (EVs) to charge while they are moving. It uses electromagnetic induction to transfer energy wirelessly to the vehicle through a high-frequency alternating magnetic field.

Here's how DWC works:

- **Charging coils**: Charging coils are embedded into the road.

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- **Inductive power transfer**: A coil is installed in the EV, and another coil is buried in the road.
- **Magnetic flux**: A high-frequency oscillating magnetic flux transfers power from the buried coil to the EV's coil.

The introduction and production of electric vehicles have created a major impact on automobile sector. Electric vehicles provide more cost efficient and sustainable solution for energy consumption and to reduce the amount of pollution. Establishing accessible and robust network of charging infrastructure is an essential pre requisite in transition from conventional to Electric vehicles. The proposed project aims at providing an alternate charging method of electric vehicles through wireless power transfer implementation.

Algorithm for vehicle

Step 1- Setup Phase:

Initialize the LCD with lcd.begin(16, 2).
Start serial communication at a baud rate of 9600 using Serial.begin(9600).
Set up the analog pin A1 for reading liquid level signals using pinMode(A1, INPUT).
Initialize the DS18B20 temperature sensor using sensor.begin().

Step 2- Main Loop:

Read Liquid Level:
Read the analog value from the sensor connected to A1 using analogRead(V_Sens).
Convert the raw value (b) into a scaled value (bb) by dividing it by 76 (arbitrary scaling factor).
Calculate the liquid level percentage (bb_p) using ((bb / 12) * 100) to normalize the value for a 12V system.
Cap the percentage at 100% if the calculated value exceeds this.
Display Liquid Level:
Clear the LCD using lcd.clear() and display the liquid level percentage (bb_p) on the first line of the LCD.

Step 3-Measure Temperature:

Request temperature measurements from the DS18B20 sensor using sensor.requestTemperatures().
Retrieve the temperature in Celsius using sensor.getTempCByIndex(0) and store it in variable t.
Display Temperature:
Display the temperature (t) on the second line of the LCD.

Delay:

Add a 500ms delay to avoid excessively rapid updates.

Algorithm for gate

Step 1- Initialization Phase:

LCD Setup:
Begin LCD operation using lcd.begin(16, 2).
Display a "Welcome..." message.
Servo Setup:
Attach the servo motor to the defined pin (D7) and set the initial angle to 0.
Wi-Fi Connection:
Attempt to connect to the Wi-Fi network using the credentials (ssid and password).
Display the device's local IP address on the LCD after a successful connection.
Server Setup:
Start a web server to handle HTTP requests.

Step 2- Main Loop:

Client Handling:
Wait for a client to connect to the server.
Read the incoming HTTP request.
Request Parsing:
Check if the request contains the command /PAY=ON:
Set the control value to HIGH.

Step 3- Gate Control:

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If the IR sensor (D0) detects an object (reads LOW):
Open the gate:
Gradually rotate the servo motor to 170 degrees.
Pause for 5 seconds (allowing the vehicle/person to pass).
Close the gate:
Gradually return the servo motor to 0 degrees.
Generate HTML Response:
Send an HTTP response containing a simple web interface with a "PAY" button (/PAY=ON) and an "EXIT" button (/PAY=OFF).

IV. HARDWARE AND SOFTWARE DESCRIPTIONS

ARDUINO UNO

The Arduino Uno SMD is a microcontroller board based on the ATmega328. It has 20 digital input/output pins (of which 6 can be used as PWM outputs and 6 can be used as analog inputs), a 16 MHz resonator, a USB connection, a power jack, an in-circuit system programming (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.

NODEMCU

Node MCU is an excellent hardware, which provides just enough versatility for us to do a majority of our developments. It is Arduino compatible, has a Wi-Fi on board and has enough kick to power our IOT devices. Whether connecting to gateway or connecting to our cloud solutions.

STEP DOWN TRANSFORMER

A stepdown transformer for smart wireless charging of electric vehicles (EVs) plays a crucial role in efficiently converting high-voltage alternating current (AC) to a lower, suitable voltage for the charging system. Typically, the primary side of the transformer receives power from the grid or an external power source, which is usually at a much higher voltage, such as 220V or 380V AC.

BRIDGE RCTIFIER AND FILTER

The bridge rectifier is made up of four diodes namely D_1, D_2, D_3, D_4 and load resistor R_L. The four diodes are connected in a closed loop (Bridge) configuration to efficiently convert the Alternating Current (AC) into Direct Current (DC). The main advantage of this bridge circuit configuration is that we do not require an expensive center tapped transformer, thereby reducing its cost and size.

LCD DISPLAY 16X2

The term LCD stands for liquid crystal display. It is one kind of electronic display module used in an extensive range of applications like various circuits & devices like any prototype, circuits, mobile phones, calculators, computers, TV sets.

INFRARED SENSOR

An infrared (IR) sensor is a device that detects infrared radiation, which is emitted by objects as heat. These sensors can detect objects and measure their temperature based on the amount of infrared radiation they emit. IR sensors are commonly used in a variety of applications, including motion detection, thermal imaging, and temperature monitoring.

TEMPERATURE SENSOR

A temperature sensor is a device used to measure the temperature of an object or environment. These sensors work by converting the physical property of temperature into an electrical signal that can be read by an instrument or a control system. Common types of temperature sensors include thermocouples, resistance temperature detectors (RTDs), thermistors, and infrared sensors.

SERVO MOTOR

A servo motor is a specialized electric motor that is designed to provide precise control of angular position, velocity, and acceleration. Unlike regular motors, which simply rotate continuously, a servo motor can rotate to a specific position within a certain range, making it ideal for applications that require accuracy and controlled movement.

TRANSISTOR

The transistor is one kind of three-terminal semiconductor device which is available in two types like BJT and MOSFET. As compared to MOSFETs, BJT characteristics are less complex. BJTs & MOSFETs include three terminals like base,

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emitter & collector whereas MOSFET includes Gate, Source & Drain.

PCB BOARD

General purpose PCBs, as their name suggests is the generalized from of PCB. By generalized we mean that we are free to make any kind of circuit as we wish using this PCB. This makes it useful for small scale production of electronic devices and for new ideas before production.

COPPER COIL

Copper coils are an essential component in dynamic wireless charging systems, which utilize electromagnetic induction to transfer power without the need for physical connectors.

LED

A Light Emitting Diode (LED) is a semiconductor device that emits light when current flows through it. Unlike traditional incandescent bulbs, which produce light by heating a filament, LEDs generate light through electroluminescence, a process where the movement of electrons through a semiconductor material releases energy in the form of photons.

SOFTWARE REQUIREMENTS

- Arduino IDE is an open source software that is mainly used for writing and compiling the code into the Arduino Module.
- It is an official Arduino software, making code compilation too easy that even a common person with no prior technical knowledge can get their feet wet with the learning process.
- It is easily available for operating systems like MAC, Windows, and Linux and runs on the Java Platform that comes with inbuilt functions and commands that play a vital role for debugging, editing and compiling the code in the environment.
- A range of Arduino modules available including Arduino Uno, Arduino Mega, Arduino Leonardo, Arduino Micro and many more.
- Each of them contains a microcontroller on the board that is actually programmed and accepts the information in the form of code.
- The main code, also known as a sketch, created on the IDE platform will ultimately generate a Hex File which is then transferred and uploaded in the controller on the board.
- The IDE environment mainly contains two basic parts: Editor and Compiler where former is used for writing the required code and later is used for compiling and uploading the code into the given Arduino Module.

V. RESULT

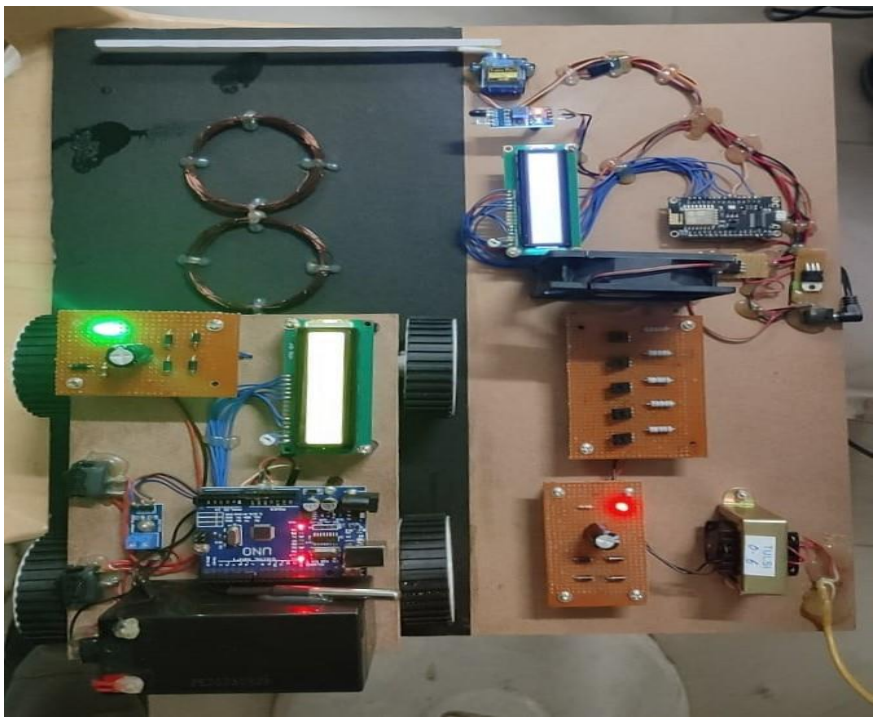

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Figure 2: Complete model

Figure 3: Lcd showing the Voltage level and temperature

Figure 4: Lcd showing the IP address for payment page

Figure 5: Payment page

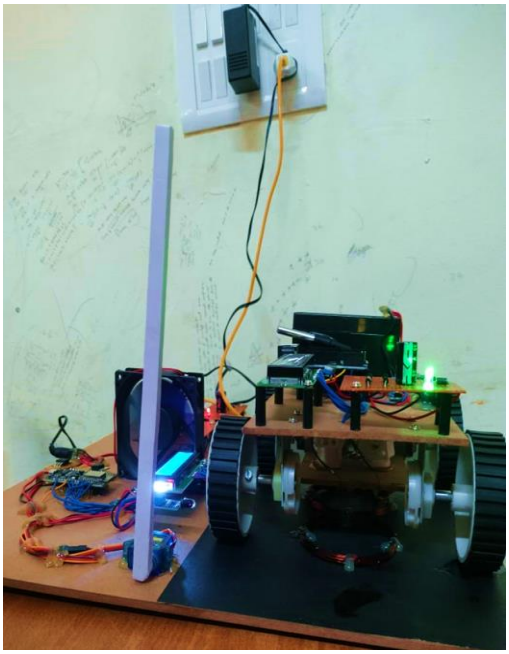

Figure 6: Gate opened after payment

VI. CONCLUSION

Dynamic wireless charging for electric vehicles (EVs), integrated with automated payment systems and advanced battery management, represents a transformative innovation in the transportation industry. This technology addresses critical challenges such as range anxiety, charging convenience, and infrastructure congestion by enabling EVs to charge while in motion. By providing continuous power transfer through embedded charging lanes, it enhances the practicality of EVs, making them more appealing for both individual and commercial use.

The seamless and contactless payment process further simplifies user experience, making EV adoption more accessible and efficient. Dynamic wireless charging, when combined with automated payment and battery management, offers a revolutionary solution that supports sustainable, convenient, and efficient transportation. It reduces dependence on traditional charging stations, enhances the performance and longevity of EV batteries, and provides a user-friendly charging experience. As the world moves toward greener transportation, this technology could play a pivotal role in accelerating the global transition to electric mobility, paving the way for smarter cities and a cleaner environment.

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