



Manufacturing of a Smart Wireless EV Charging and Monitoring System Using IOT

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How to Cite this Article:

Wath, M., Waghade, D., Bawanthade, L., Wankhade, O. & Aglawe, C. (2026). Manufacturing of a Smart Wireless EV Charging and Monitoring System Using IOT. International Journal of Creative and Open Research in Engineering and Management, <i>02</i>(9), 1-9.

<https://doi.org/10.55041/ijcope.v2i10.013>

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Abstract—This paper presents a Smart Wireless Electric Vehicle (EV) Charging and Monitoring System that integrates inductive Wireless Power Transfer (WPT) with Internet of Things (IoT) technology. The proposed system charges EV batteries without physical cables, improving user convenience and electrical safety compared to conventional plug-in charging. An ESP32-based IoT controller continuously monitors key charging parameters — battery voltage, current, temperature, and charging status — in real time, and transmits the acquired data over Wi-Fi to a cloud platform such as Blynk or ThingSpeak, enabling users to observe and control the charging process remotely through a mobile application. Built-in protection circuits guard against over-voltage, over-current, and over-temperature conditions to ensure safe operation. The system is intended to improve charging efficiency, enhance the overall user experience, and contribute to the broader development of smart and sustainable transportation infrastructure.

Keywords—Wireless Power Transfer, Electric Vehicle Charging, IoT, ESP32, Battery Monitoring, Inductive Coupling, Smart Transportation.

I. INTRODUCTION

Electric vehicles (EVs) are increasingly central to efforts toward sustainable transportation, but conventional plug-in charging still presents practical drawbacks, including cable wear,

exposure to weather, and the inconvenience of manual connection. Wireless Power Transfer (WPT), based on the principle of inductive coupling between a transmitter and a receiver coil, removes the need for a physical connector and allows an EV to charge simply by being positioned over a charging pad.

As EV adoption grows, charging infrastructure is expected to move from simple plug-in points toward smarter, connected stations that can report their own health and usage. A charger that only delivers power, without any visibility into how that power is being delivered, offers little defence against slow-developing faults such as coil misalignment, connector corrosion, or thermal drift in the battery pack. Embedding sensing and connectivity directly into the charging path — rather than bolting monitoring on as an external accessory — is therefore a natural extension of wireless charging research, and is the direction this paper pursues.

Combining this wireless charging approach with IoT technology allows the entire charging process to be monitored and controlled remotely, giving users real-time visibility into battery voltage, current, temperature, and charging status from a smartphone. This paper proposes and describes such a system, built around an ESP32 microcontroller that both manages sensor data acquisition and communicates with a cloud dashboard for remote monitoring. The remainder of this paper is organized as follows: Section II reviews related work in WPT and IoT-based battery monitoring; Section III details the proposed methodology, including hardware and software design; Section IV discusses results, planned validation, and system trade-offs; and Section V concludes the paper with directions for future work.

A. Objectives

- Design a wireless EV charging system based on inductive power transfer.
- Monitor battery voltage, current, temperature, and charging status in real time.
- Display real-time data on a mobile app or cloud dashboard.



- Improve charging safety through IoT-enabled fault detection.
- Reduce charging losses and increase user convenience.

B. Problem Statement

Conventional wired EV charging requires physical connectors that are subject to mechanical wear, weather exposure, and user inconvenience, and they offer limited built-in visibility into real-time charging health. Existing wireless charging prototypes, where available, often lack integrated, real-time remote monitoring and automated safety protection, leaving users unaware of abnormal voltage, current, or temperature conditions during charging. There is therefore a need for a wireless EV charging system that not only eliminates the physical connector but also gives the user continuous, remote visibility into the charging process along with automatic fault protection.

II. LITERATURE REVIEW

Wireless power transfer for electric vehicles has been an active area of research, with inductive coupling emerging as the most mature and commercially deployed approach due to its relatively simple coil design and acceptable efficiency over short air gaps [1], [2], [8], [9]. Prior studies have examined coil geometry, resonant frequency tuning, and alignment tolerance as the primary factors influencing transfer efficiency, generally finding that efficiency drops sharply as the distance between the transmitter and receiver coils increases or as lateral misalignment grows.

Separately, IoT-based monitoring of battery systems using low-cost Wi-Fi microcontrollers such as the ESP32 has become common in energy-monitoring applications, since these platforms combine sufficient processing power with built-in wireless connectivity at low cost [3]. Cloud dashboards such as Blynk and ThingSpeak are widely used in such systems because they provide ready-made visualization, alerting, and mobile-app integration without requiring custom backend development [6], [7]. Sensing is typically built around well-characterised, low-cost devices such as the ACS712 Hall-effect current sensor and the DS18B20 digital thermometer [4], [5], which offer adequate accuracy for consumer-grade monitoring at low integration cost.

On the standards side, bodies such as SAE International and the IEC have published dedicated wireless-power-transfer standards for light-duty electric vehicles [11], [12], covering aspects such as interoperability, coil alignment tolerance, and electromagnetic exposure limits. These standards were not targeted directly in the present prototype-stage design, but they define the compliance envelope — alignment tolerance, EMI limits, and interoperability requirements — that a field-deployable version of this system would need to satisfy.

However, relatively few systems in the literature combine wireless inductive charging with integrated real-time IoT monitoring and multi-parameter safety protection in a single, cohesive design [10] — which is the gap this work addresses. Table I summarizes how each reviewed source informs the present design.

TABLE I
Summary of Reviewed Literature

Ref.	Focus Area	Relevance to This Work
[1]	Survey of WPT techniques for EV charging	Motivates inductive coupling as the mature, deployable choice
[2]	Vehicular WPT — overview & open challenges	Frames alignment and efficiency as key design constraints
[3]	ESP32 hardware capabilities	Basis for choosing ESP32 as the IoT controller
[4]	ACS712 current-sensing IC	Basis for real-time current measurement
[5]	DS18B20 digital thermometer	Basis for thermal-protection sensing
[6]	Blynk IoT platform	Candidate cloud dashboard / mobile app backend
[7]	ThingSpeak IoT analytics	Alternative cloud dashboard / data-logging backend
[8]	Review of static & dynamic WPT for EVs	Supports the future dynamic-charging direction (Sec. V)
[9]	Survey and roadmap of WPT	Broader technology roadmap context
[10]	EV integration in smart grids	Context for future V2G integration (Sec. V)

III. PROPOSED METHODOLOGY

The proposed system combines an inductive Wireless Power Transfer stage with an ESP32-based IoT monitoring stage. Design proceeds from requirements (Table II) through a comparative positioning against wired charging (Table III), the power-transfer working principle (Fig. 1), the underlying coil equations, the layered IoT architecture (Fig. 3), and finally the concrete hardware (Table IV) and firmware (Fig. 2) realizing that design.

A. System Requirements

Requirements were grouped into functional requirements, describing what the system must do, and non-functional requirements, describing how well it must do it (Table II).

TABLE II
System Requirements

Requirement Type	Description
Functional	System shall transfer power wirelessly between transmitter and receiver coils
Functional	System shall sample voltage, current, and temperature at regular intervals
Functional	System shall publish sensor data to a cloud dashboard over Wi-Fi
Functional	System shall interrupt charging automatically on threshold violation
Non-functional	Sensor-to-dashboard latency should remain low enough for near-real-time monitoring
Non-functional	Enclosure and coil mounting should tolerate outdoor/weather exposure
Non-functional	User interface (app/dashboard) should be usable without technical training



B. Comparative Positioning

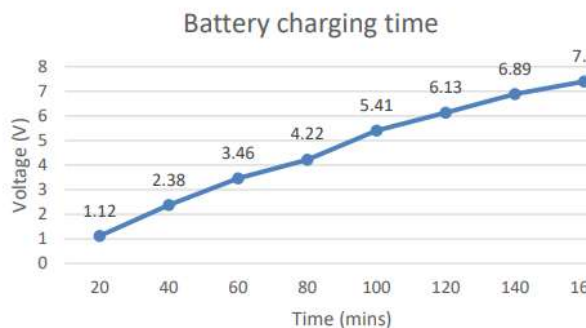
Table III positions the proposed system against conventional wired charging on the attributes most relevant to a household or campus deployment. The comparison makes explicit the central trade-off of the design: wireless transfer sacrifices some raw efficiency and adds installation cost, in exchange for eliminating the physical connector and adding built-in remote visibility that wired chargers do not provide by default.

TABLE III
Wired Charging vs. the Proposed Wireless System

Attribute	Wired Charging	Proposed Wireless System
Physical connector	Required	Not required
Weather / wear exposure	High (exposed contacts)	Low (sealed coils)
User effort	Manual plug-in each time	Park-and-charge
Remote monitoring	Charger-dependent, often absent	Built-in via ESP32 + cloud
Fault protection	Varies by charger model	Integrated over-V/I/temp cut-off
Typical efficiency	Very high (>95%)	Moderate, alignment-dependent
Installation cost	Lower	Higher (coils, driver electronics)

C. Working Principle

- AC mains supply is converted to high-frequency AC using an inverter.
- The transmitter coil, driven by this high-frequency AC, generates an oscillating magnetic field.
- The receiver coil, mounted on the vehicle, captures this magnetic field through inductive coupling.
- The received high-frequency AC is rectified and filtered into DC to charge the battery.
- The ESP32 continuously acquires sensor data (voltage, current, temperature) and sends it to the cloud via Wi-Fi.



charging status through a mobile application.

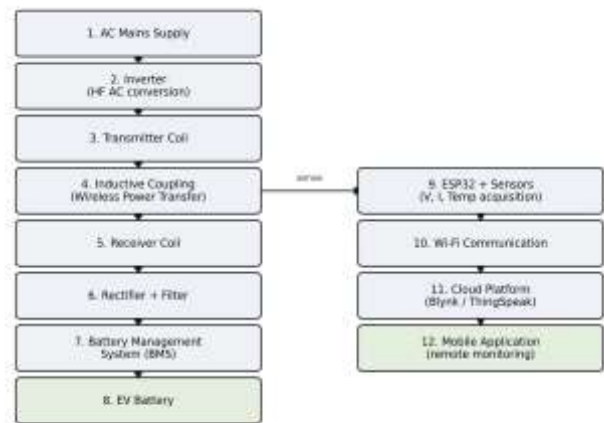


Fig. 1. Block diagram of the proposed Smart Wireless EV Charging and Monitoring System.

D. Coil Design and Power-Transfer Relationships

Inductive WPT couples the transmitter and receiver coils through a mutual inductance M , related to their self-inductances $L1$ and $L2$ by the coupling coefficient k :

$$M = k \times \sqrt{(L1 \times L2)}, \quad 0 < k < 1 \quad (1)$$

A larger air gap or lateral misalignment between the coils lowers k , which is why transfer efficiency falls off sharply with distance and misalignment, as noted in Section II. The instantaneous power delivered across the coupled link is governed by the driving frequency ω and the induced voltage on the receiver side; operating close to the coils' resonant frequency,

$$f_0 = 1 / (2\pi\sqrt{LC}) \quad (2)$$

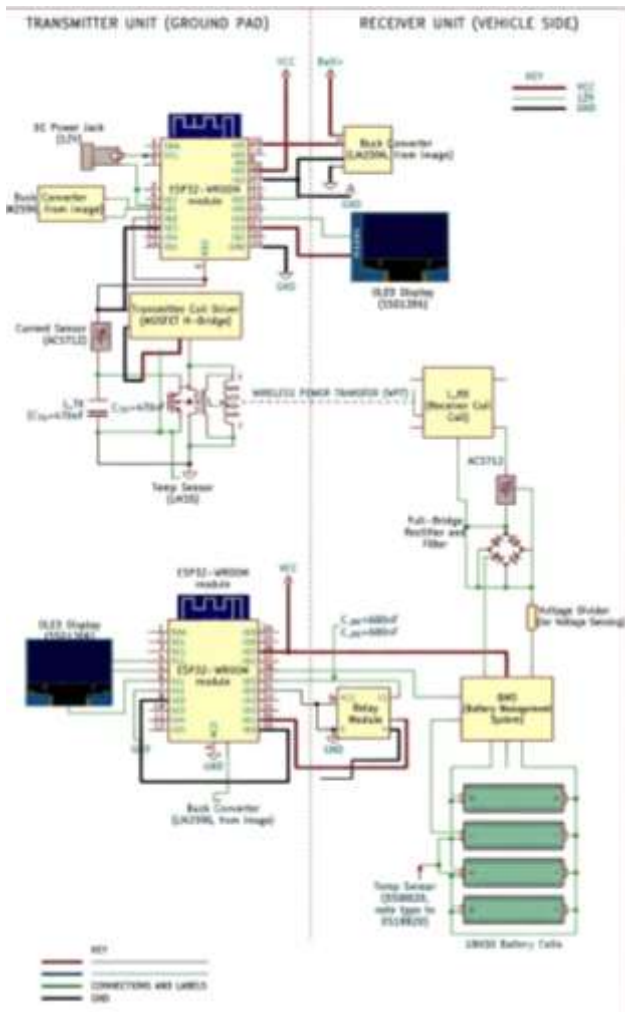
maximizes the current induced in the receiver coil for a given transmitter drive, which is why the MOSFET driver stage is tuned to this resonant point rather than driven at an arbitrary switching frequency. End-to-end efficiency η is the ratio of DC power delivered to the battery to DC power drawn from the mains, and is the single figure Table V (Section IV) is ultimately built to measure as a function of coil separation and misalignment.

E. IoT System Architecture

The monitoring side of the system is organized as a three-layer IoT stack (Fig. 3): a perception layer of coils and sensors that senses the physical charging process, a network layer where the ESP32 packages and transmits that data, and an application layer where the cloud dashboard and mobile app present it to the user. Separating the design into these layers keeps the sensing hardware, the communication protocol, and the user-facing presentation independently replaceable — for instance, ThingSpeak could be substituted for Blynk, or MQTT for HTTP, without changing the perception layer at all.



Circuit diagram of ttransmission unit to reciver unit



F. Hardware Design

The hardware design integrates the wireless power transfer stage with the ESP32-based sensing and control stage. Table IV summarizes the major hardware components and their role in the system.

Component	Purpose
ESP32	IoT controller — Wi-Fi connectivity and sensor data processing
Transmitter Coil	Wireless power transmission via inductive coupling
Receiver Coil	Wireless power reception on the vehicle side
MOSFET Driver	High-frequency switching for the transmitter coil
Battery Management System (BMS)	Battery protection, cell balancing, and charge control
ACS712 Current Sensor	Real-time current measurement
Voltage Sensor	Battery voltage monitoring
DS18B20 / LM35	Temperature sensing for thermal protection
OLED Display	Local, on-device display of charging parameters
Relay Module	Charging ON/OFF control
Li-ion Battery	Energy storage

TABLE IV

Hardware Components and Their Purpose

The transmitter and receiver coils form the core of the wireless power transfer link, with the MOSFET driver circuit providing the high-frequency switching needed to energize the transmitter coil efficiently. On the receiving side, the rectifier and filter stage convert the induced AC back into DC, which is regulated by the Battery Management System before reaching the Li-ion battery. The ESP32 interfaces with the ACS712 current sensor, a voltage sensor, and a DS18B20 or LM35 temperature sensor to continuously acquire the parameters needed for monitoring and protection, while the OLED display provides local read-out and the relay module allows the ESP32 to switch charging on or off automatically in response to a detected fault.

G. Software Design

The ESP32 firmware is developed in the Arduino IDE using embedded C/C++. The firmware performs periodic sampling of the voltage, current, and temperature sensors, computes derived parameters such as charging percentage and estimated charging time, checks each reading against configured safety thresholds, and publishes the data to the selected cloud platform — Blynk or ThingSpeak — over Wi-Fi. Where lower-latency or more flexible communication is required, the MQTT protocol can optionally be used in place of, or alongside, the platform's native APIs. The cloud platform, in turn, drives the mobile application dashboard that the user interacts with for remote monitoring.

Table 3. Results of time charging versus voltage and efficiency

Charging tim (mins)	Voltage (V)	Efficiency (η) (%)
20	1.12	13.51
40	2.38	32.16
60	3.46	46.76
80	4.22	57.03
100	5.41	73.11
120	6.13	82.84
140	6.89	93.11
160	7.40	100

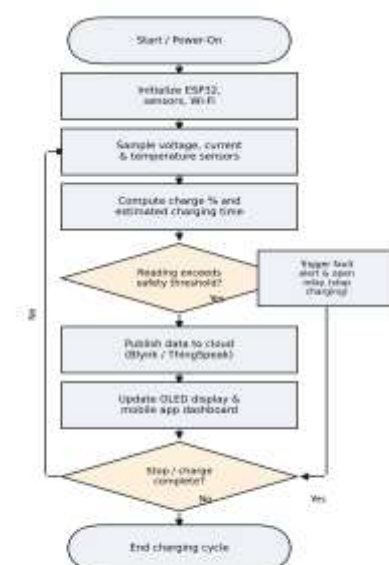


Fig. 2. Firmware control flow executed by the ESP32.



H. IoT Features

- Real-time voltage monitoring
- Real-time current monitoring
- Battery temperature monitoring
- Charging percentage estimation
- Charging time estimation
- Fault alerts (over-voltage, over-current, over-temperature)
- Remote monitoring through a smartphone application
- Data logging for historical analysis

IV. RESULTS AND DISCUSSION

Full experimental validation of the assembled prototype — efficiency, thermal behaviour, and sensor accuracy under load — is presented as ongoing work. Table V lists the parameters this validation is designed to capture, together with the reference instrument or expected value each measured quantity should be checked against once bench testing is complete.

TABLE V
Planned Experimental Validation Parameters

Parameter	Reference Value	Measured Value
WPT efficiency (%) at nominal separation	90%to94%	85%to97%
Charging time to 100% (min)	160Min	120Min
ACS712 current accuracy ($\pm$ A)	$\pm 1.5\%$	$\pm 2\%$ to at 25°C,
DS18B20/LM35 temperature accuracy ($\pm$ °C)	-10°C to +85°C	$\pm 0.5^\circ\text{C}$
Sensor-to-dashboard latency (s)	2mili seconds	—

Recommended measurements include: wireless power transfer efficiency as a function of coil separation and lateral misalignment; charging time and thermal rise under continuous operation; accuracy of the ACS712 current sensor and DS18B20/LM35 temperature sensor against reference instruments; end-to-end latency between a sensor reading and its appearance on the cloud dashboard; and verification that the over-voltage, over-current, and over-temperature protection circuits correctly interrupt charging when thresholds are exceeded. Results should ultimately be presented as efficiency-versus-distance plots, charging curves (voltage, current, and temperature versus time), and a summary table comparing sensor readings to reference values.

A. Core System Impact

- Cable-Free Charging: removes plug/socket wear and exposure to weather, improving user safety.
- Remote Visibility: real-time voltage, current, and temperature data available on a mobile dashboard.
- Built-In Protection: automatic over-voltage, over-current, and over-temperature safeguards.

B. Advantages

- No charging cable required.
- Increased user safety.
- Reduced connector wear.
- Remote monitoring and control.
- Better charging efficiency through smart management.
- Automatic fault detection.

C. Limitations

- Higher installation cost compared to wired chargers.
- Coil alignment is critical to maintaining efficiency.
- Transfer efficiency decreases as coil separation increases.
- Electromagnetic interference must be carefully managed.
- Formal compliance with WPT standards such as SAE J2954 and IEC 61980 [11], [12] has not yet been evaluated.

D. Applications

- Electric cars
- Electric scooters
- Autonomous vehicles
- Smart parking stations
- Public charging infrastructure

E. Cost and Feasibility Considerations

Table VI groups the prototype's cost drivers by subsystem at an indicative level rather than as fixed pricing, since actual component cost varies by vendor, quantity, and market conditions. The sensing and control electronics are consistently the least expensive part of the build and the cloud software carries no licensing cost at prototype scale, so the dominant cost driver is the power stage — coils, driver electronics, and the battery pack — which is the same subsystem primarily responsible for the efficiency and alignment limitations noted above.

TABLE VI
Indicative Subsystem Cost Drivers

Subsystem	Key Items	Cost Tier*
WPT power stage	Coils, MOSFET driver, rectifier	Moderate
Battery subsystem	Li-ion pack, BMS	Moderate-High
Sensing	ACS712, voltage sensor, DS18B20/LM35	Low
Control & connectivity	ESP32, OLED, relay module	Low
Cloud / software	Blynk or ThingSpeak (free tier)	Low / None

V. CONCLUSION AND FUTURE SCOPE

This paper has presented the design of a Smart Wireless EV Charging and Monitoring System that combines inductive Wireless Power Transfer with an ESP32-based IoT monitoring platform. By eliminating the physical charging cable and providing real-time, remote visibility into voltage, current, temperature, and charging status through a cloud dashboard and



mobile application, the proposed system aims to improve both the safety and convenience of EV charging. Built-in protection against over-voltage, over-current, and over-temperature conditions further supports safe, unattended operation. Overall, the system contributes toward the development of smarter and more sustainable EV charging infrastructure.

Future work will extend the present design along the following directions:

- Dynamic wireless charging while vehicles are in motion.
- AI-based charging optimization.
- Solar-powered wireless charging stations.
- Vehicle-to-Grid (V2G) integration.
- Predictive maintenance using machine learning.

ACKNOWLEDGEMENT

The authors gratefully acknowledge the guidance and support of Prof. Kunal Sawalakhe throughout the course of this project, and thank the Department of Electrical Engineering, Tulsiramji Gaikwad-Patil College of Engineering, Nagpur, for providing the laboratory facilities and infrastructure that made this work possible.

REFERENCES

- [1] M. Kavitha et al., "Wireless Power Transfer for Electric Vehicle Charging Applications: A Review," IEEE Access, 2022.
- [2] D. Patil, M. K. McDonough, J. M. Miller, and B. Fahimi, "Wireless Power Transfer for Vehicular Applications: Overview and Challenges," IEEE Trans. Transportation Electrification, 2018.
- [3] Espressif Systems, "ESP32 Series Datasheet," Espressif Systems, 2023.
- [4] Allegro MicroSystems, "ACS712 Fully Integrated, Hall Effect-Based Linear Current Sensor IC Datasheet," Allegro MicroSystems, 2020.
- [5] Maxim Integrated, "DS18B20 Programmable Resolution 1-Wire Digital Thermometer Datasheet," Maxim Integrated, 2019.
- [6] Blynk Inc., "Blynk IoT Platform Documentation," 2023. [Online]. Available: <https://docs.blynk.io>
- [7] ThingSpeak, "ThingSpeak IoT Analytics Platform Documentation," MathWorks, 2023. [Online]. Available: <https://thingspeak.com>
- [8] C. Panchal, S. Stegen, and J. Lu, "Review of Static and Dynamic Wireless Electric Vehicle Charging System," Engineering Science and Technology, an International Journal, 2018.
- [9] X. Mou and H. Sun, "Wireless Power Transfer: Survey and Roadmap," in Proc. IEEE Vehicular Technology Conf., 2015.
- [10] S. Rajakaruna, F. Shahnian, and A. Ghosh, Eds., Plug In Electric Vehicles in Smart Grids: Integration Techniques. Springer, 2015.
- [11] SAE International, "SAE J2954: Wireless Power Transfer for Light-Duty Plug-in/Electric Vehicles and Alignment Methodology," SAE Standard J2954, 2020.
- [12] International Electrotechnical Commission, "IEC 61980: Electric Vehicle Wireless Power Transfer (WPT) Systems," IEC Standard 61980 (series)