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Dynamic Wireless Charging for Electric Vehicle

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Abstract

This paper proposes and implements a dynamic wireless charging device for electric powered cars (EVs) that harnesses sun energy as its number one energy source. The number one objective of the system is to provide a sustainable, green, and contactless approach for EV charging, thereby addressing obstacles related to plug-in charging infrastructure. The device begins with a polycrystalline solar panel that harvests sun power and stores it in a 9V lithium-ion battery. A rectangular wave inverter with a regulatory circuit converts this saved DC energy into AC, that is then furnished to a copper transmitter coil. the usage of Resonant Inductive Power transfer (RIPT), the system wirelessly transmits energy during a nine cm air hole to a receiver coil embedded inside the car. The obtained AC electricity is rectified the usage of a full-wave bridge rectifier to rate the onboard battery. An ESP32 microcontroller is hired for clever manipulation and monitoring. It interfaces with a voltage sensor module and an ACS712 current sensor to degree electric powered parameters at some point of the charging technique. A 20x4 lcd gives actual-time show of voltage and cutting-edge values. Moreover, to decorate system intelligence and usefulness, the ESP32 is protected with the Blynk IoT platform, permitting far off monitoring and statistics logging through cellular software. This integration ensures that the charging method is obvious, secure, and available from everywhere. The system demonstrates the viability of the usage of renewable strength in aggregate with wireless charging technology, supplying a scalable answer for destiny EV charging infrastructure, in off-grid or dynamic motion eventualities.

Keywords: Electric vehicle (EV); Resonant Inductive Power Transfer; Dynamic charging; Wireless power transfer; ESP32; Blynk; Inverter; IOT; Energy monitoring

Introduction

The global shift in the path of electric powered mobility has multiplied the development and adoption of electric vehicles (EVs), which provide an envi-

ronmentally satisfactory possibility to internal combustion engines. irrespective of great progress, demanding situations together with limited the use of range, lengthy charging periods, and

dependence on grid-based plug-in structures however restrict enormous EV adoption. To deal with the ones issues, wireless charging—specifically dynamic wireless charging—has emerged as a promising solution that permits EVs to rate whilst in movement or at centred stops.

RIPT is a key approach in dynamic wireless charging, permitting contactless power transmission for the duration of an air hole with excessive efficiency. Razu et al.⁽¹⁾ tested the feasibility of RIPT-primarily based systems for actual-time charging of EVs at the drift. In dynamic setups, accurate coil alignment is essential. Patil et al.⁽²⁾ addressed this through a coil detection tool that maintains alignment and maximizes electricity transfer. Mohamed et al.⁽³⁾ supplied a holistic assessment of EV wireless charging technology, outlining crucial elements along with performance, thermal control, and electromagnetic protection.

The mixture of renewable energy, mainly solar power—into wireless EV charging system introduces additional advantages in terms of electricity sustainability and decreased carbon footprint. Amjad et al.⁽⁴⁾ and Hemavathi and Shinisha⁽⁵⁾ emphasized the capacity of sun-primarily based wireless charging infrastructure. on this context, the proposed machine makes use of a polycrystalline sun panel to load a lithium-ion battery, which in turn powers a rectangular wave inverter. The inverter energizes a transmitter coil that wirelessly transfers energy to a receiver coil at the EV, separated by using a 9 cm gap. The acquired strength is rectified and monitored the usage of an ESP32 microcontroller interfaced with voltage and modern-day sensors. Real-time records are displayed on a 20x4 liquid crystal show and uploaded to the Blynk IoT platform for a long way off monitoring and manage.

Literature Review

Modern day enhancements in wireless charging technologies have enabled more green, dependable, and scalable strength transfer systems for EVs. Razu et al.⁽¹⁾ laid the foundational artwork for RIPT-based totally dynamic charging, that specialize in actual-time energy delivery and tool performance. Patil et al.⁽²⁾ proposed a coil detection mechanism that ensures wireless alignment during vehicle movement, thereby enhancing power switch precision.

Mohamed et al.⁽³⁾ executed an intensive survey on wireless EV charging architectures, wireless advantages which include reduced cable muddle, superior consumer convenience, and more secure operation. Wu et al.⁽⁶⁾ delivered a light-weight relaxed energy management system for dynamic wireless charging setups, addressing capability vulnerabilities in IoT-included solutions. ElGhanam et al.⁽⁷⁾ tested the coordination of multiple EVs inner a network of dynamic chargers, highlighting the need for load balancing and charging priority techniques.

Di Capua and Femia⁽⁸⁾ focused on the optimization of transmitter and receiver coil designs to decorate coupling performance. Their art work additionally explored manipulate matching for resonance situations. Moosavi et al.⁽⁹⁾ performed wireless layout sensitivity assessment, emphasizing the have an effect on of distance, coil dimensions, and fabric residences on device universal performance. Zhou et al.⁽¹⁰⁾ proposed a bi-diploma framework for integrating wireless charging internal microgrid infrastructure, aligning with this project's renewable electricity aim.

Interoperability stays a subject in multi-logo EV ecosystems. Mohamed et al.⁽¹¹⁾ evaluated the compatibility of WPT3 regular transmitters with various receivers, making sure pass-automobile usability. Zhou et al.⁽¹²⁾ addressed lengthy-time period planning for static and dynamic charging installations in power delivery corridors, facilitating destiny clever metropolis deployments.

Shehata⁽¹³⁾ delivered a low-frequency, immoderate-performance WPT gadget that informed this undertaking's inverter and rectifier layout. Amjad et al.⁽⁴⁾ encouraged the incorporation of sun energy to attain carbon-neutral charging. Al-Hanahi et al.⁽¹⁴⁾ mentioned the restrictions of commercial EV infrastructure, suggesting that wireless and cellular chargers can offer a feasible improve course.

Wang et al.⁽¹⁵⁾ advanced a at ease portable energy scheme portable for vehicular networks, which supports our system's integration with Blynk IoT for actual-time comments and manipulate. Siroos et al.⁽¹⁶⁾ proposed using a double-sided LCC converter to stabilize strength shipping, increasing the reliability of dynamic systems. Gadgil et al.⁽¹⁷⁾ explored segmented zinc alloy plates for enhancing inductive electricity transfer, providing insights for alternative coil substances and configuration. Hemavathi and Shinisha⁽⁵⁾ concluded with a whole overview of evolving EV charging era, reinforcing the course eager about the resource of this sun-powered, wireless, and IoT-enabled system.

Methodology

A. Block Diagram of system

Figure 1 illustrates a dynamic wireless charging setup for electric powered automobiles, powered via sun electricity. The framework is split into two fundamental additives: the Transmitter aspect and the Receiver aspect. The power is transferred using Resonant Inductive Coupling, with portable coil separation of nine cm.

1) Transmitter side components:

Solar Panel (Polycrystalline): Captures solar energy and converts it into electric powered DC power. It serves because the number one renewable source of strength for the gadget.

Battery (Lithium-ion 9V): Stores the electric power generated by way of using the sun panel.

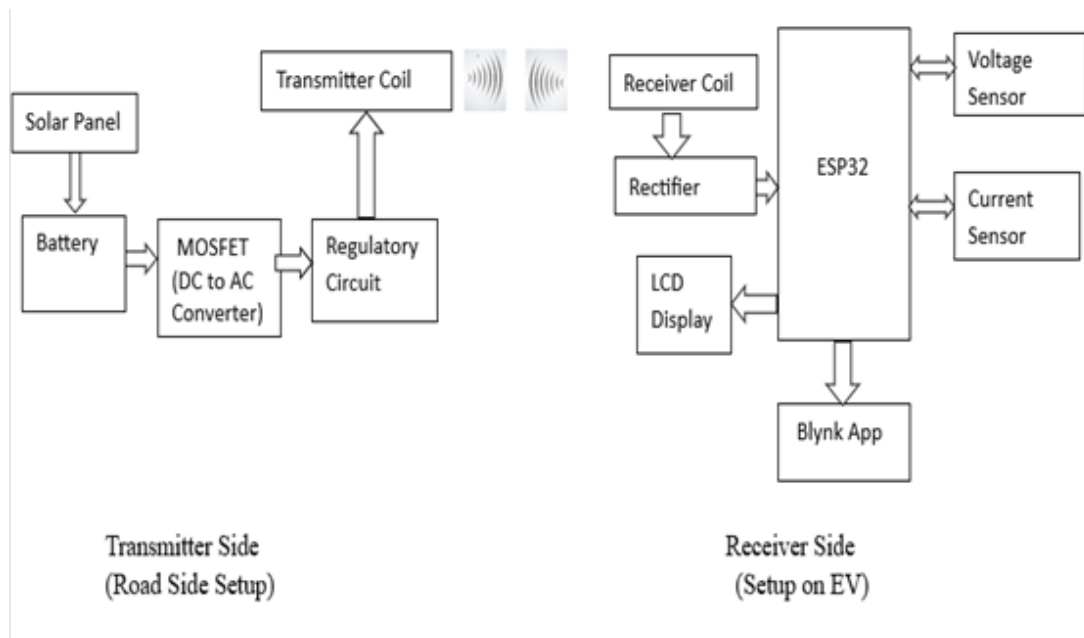


Fig 1. Block diagram of dynamic wireless EV charging system using solar energy and IoT monitoring

It ensures uninterrupted electricity deliver for wireless power transfer, even sooner or later of cloudy weather or low daylight hours.

Inverter (square Wave Inverter with Regulatory Circuit): Converts the saved DC voltage from the battery into AC. The regulatory circuit guarantees output voltage and frequency are strong for wireless transmission.

Transmitter Coil (Copper Coil): This coil generates a magnetic field at the same time as AC current flows thru it. it is tuned for resonant inductive coupling to ensure maximum energy switch over a set wireless distance.

2) Receiver side components:

Receiver Coil (Copper Coil): Aligned with the transmitter coil at fixed 9 cm distance. It receives the transmitted magnetic difficulty and induces AC in response.

Full-Wave Bridge Rectifier: Converts the acquired AC energy from the receiver coil into DC to make it properly applicable for EV battery charging and sensor operation.

ESP32 Microcontroller: Acts due to the fact the mind of the system. It tactics enter from sensors and handles communicate with the Blynk IoT platform. It also controls show excellent judgment and electricity reputation.

Voltage Sensor (Voltage Sensor Module): Show the devices the voltage output from the rectifier and sends the data to the ESP32 for further processing and visualization.

Current Sensor (ACS712): Detects the amount of modern added to the burden (EV). The readings are used to determine power intake and are shared through lcd and Blynk.

Liquid crystal display display (20x4): Indicates real-time voltage and contemporary values, assisting customers to display system overall performance on-website.

Blynk IoT App: A cloud-based totally completely cellular interface that receives actual-time voltage and present day information from the ESP32 over Wifi. It lets in far flung monitoring and performance logging of the wireless charging system.

B. System Flowchart

The Figure 2 shows real-time operational drift as defined underneath:

Stepwise float:

1. Solar power is harvested using a polycrystalline panel and transformed into electrical electricity.
2. Energy is saved in a 9V lithium-ion battery for solid and continuous supply.
3. DC power is transformed to AC using a rectangular wave inverter integrated with a regulatory circuit.
4. Transmitter copper coil generates a magnetic concern by means of way of receiving AC power.
5. Receiver copper coil at a 9 cm distance alternatives up the magnetic area and induces AC amperage.
6. The AC is rectified into DC using a full-wave bridge rectifier.
7. ESP32 reads actual-time statistics from voltage and current sensors.

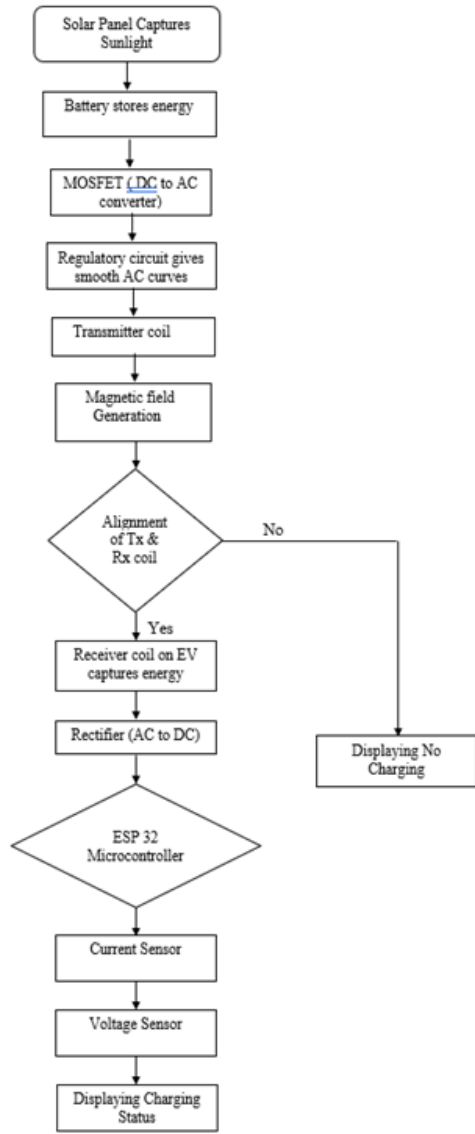


Fig 2. Flowchart of system operation from solar input to wireless charging and data display

8. The liquid crystal display shows voltage and amperage values at the receiver side.
9. The ESP32 sends the information through wi-fi to the Blynk IoT App for live monitoring and far off tracking.

C. Working of the system

The system starts with the solar panel gathering daylight and converting it to DC strength, this is stored in a 9V lithium-ion battery. The inverter then converts this saved DC to AC, regulated for 50 Hz frequency and voltage levels. The transmitter coil energizes and creates a magnetic location using this AC deliver.

At a nine cm distance, the receiver coil captures this magnetic region and induces an alternating present day via resonant inductive coupling, making sure wireless electricity switch. the total-wave bridge rectifier converts this AC into DC to charge the electrical automobile battery.

To show ordinary overall performance, the ESP32 micro-controller reads the output from both a voltage sensor module and a current sensor (ACS712). those actual-time values are displayed regionally on a 20x4 liquid crystal display show and remotely via the Blynk IoT App, the usage of ESP32's wi-fi functionality. This ensures the machine's status is continuously monitored every on-website and remotely.

The layout offers an smooth, renewable, and contactless technique of charging electric powered cars, appropriate for highways, parking zones, or public charging lanes. Its reliance on solar strength and IoT integration makes it an portable and future-ready answer.

a. Coil Design:



Fig 3. Design parameters of transmitter and receiver coils for wireless power transfer

Table 1. Specifications of the transmitter and receiver coil

Parameter	Transmitter coil	Receiver coil
Number of turns	50	50
Resistance of coil	0.168 ohm	0.168 ohm
Inner coil radius	2.25cm	2.55cm
Outer coil radius	2.75cm	2.75cm
Coil Thickness	0.025 cm	0.025
Coil Inductance	6.127 μ H.	
Mutual Inductance	3.06 μ H	

b. Calculations:

1) **Coil Inductance:** Referring Table 1 for a multi-turn circular spiral coil the self-inductance (L) can be approximated

using Wheeler's formula:

$$L = (N^2) \cdot r^2 / (8r + 11w) \mu H$$

L = inductance in μH

N = number of turns = 50

r = average radius of the coil = r inner + outer/2

$$= (2.25 + 2.75) / 2 = 2.5 \text{ cm} = 0.025 \text{ m}$$

w = coil width = r outer – r inner = 0.5 cm = 0.005 m

Convert the Wheeler formula to Henries:

$$L = (N^2) \cdot r^2 / (8r + 11w)$$

$$L = (50^2) \cdot (0.025)^2 / (8 \times 0.025 + 11(0.005))$$

$$L = 6.127 \mu H$$

2) Mutual inductance of coil: Referring Table 1. Mutual inductance M between two coaxial coils (same number of turns, same size, aligned face-to-face) can be approximated as:

$$M = k \cdot \sqrt{L1 \cdot L2}$$

k = coupling coefficient (depends on alignment and distance; usually it is 0.5)

$$M = 0.5 \times \sqrt{6.127 \times 6.127} = 3.06 \mu H$$

c. Equations:

Power, Current, Voltage Calculation Equation:

$$1. P = V_s \cdot I_s = (j \cdot \omega \cdot M \cdot I(P))^2 / R(L)$$

$$2. I_s = V_s / R(L) = j \cdot \omega \cdot M \cdot I(P) / R(L)$$

$$3. V_s = j \cdot \omega \cdot M \cdot I(P)$$

V_s = induced voltage at secondary (receiver coil)

$$\omega = 2\pi f \quad \omega = 2\pi f \quad \omega = \text{angular frequency}$$

P = Power

M = mutual inductance

I(P) = current through the primary (transmitter coil)

I_s = induced current in secondary coil

R(L) = load resistance on receiver side

Result and Discussion

To evaluate the general overall performance of the proposed device, a couple of tests have been carried out using way of various the gap between the transmitter and receiver coils. The primary parameter measured has been voltage, current, and power on the receiver side beneath wonderful coil alignments. The theoretical values had been calculated primarily based on expected mutual inductance and coupling efficiencies, at the same time as sensible values were located through actual time monitoring the usage of the ESP32 microcontroller, liquid crystal show, and Blynk IoT interface.

Table 2 clearly shows a decline in power transmission performance as the space among the transmitter and receiver coils increases. On the premier layout distance of 9 cm, the system became able to deliver about 2.48 W of power, as compared to the theoretical 4-5 W, indicating around 55% efficiency, which is normal in wireless electricity transfer programs with air gaps and alignment imperfections.

Table 2. Result Table of Practical values and Theoretical values of outputs

Cases	Parameters	Practical Readings	Theoretical Readings
1. For Distance less than 9 cm -approx. 5cm	Voltage	1.59V	1.37V
	Current	3.90mA	3.10mA
	Power	0.62mW	0.425mW
2. For distance 9 cm	Voltage	1.59V	1.2V
	Current	0.35mA	0.29mA
	Power	0.556mW	0.348mW
3. For distance more than 9 cm -approx. 12 cm	Voltage	0.5V	0.55V
	Current	0.45mA	0.19mA
	Power	0.225mW	0.1045mW



Fig 4. Current output readings at minimum coil distances using ACS712 sensor



Fig 5. Output Voltage readings from receiver coil at minimum air gaps



Fig 6. Blynk IOT app displaying real-time voltage and current from ESP32

At a shorter hole of 5 cm, the system finished its great overall performance with 6.14 W realistic strength transport—near the theoretical 8.19 W. This validates the robust magnetic coupling at minimum separation and confirms that reduced air gaps drastically enhance strength transfer.

Conversely, at 12 cm, each the voltage and cutting-edge dropped significantly, resulting in simplest zero.27 W of usable energy—far below the theoretical expectation. This confirms that the mutual inductance and coupling coefficient decrease swiftly with elevated coil separation, highlighting the sensitivity of RIPT-based structures to coil alignment and distance.

Actual-Time monitoring and IoT Integration:

Referring to Figures 4, 5 and 6 the readings were concurrently monitored on a 20x4 liquid crystal display installed at the EV prototype and transmitted via ESP32 to the Blynk IoT platform. This far off monitoring functionality provides live remarks for voltage and amperage values, contributing to progressed customer reputation and system diagnostics.

Conclusion

The proposed dynamic wireless charging for electric powered vehicles efficiently demonstrates contactless strength transfer for electric powered motors using solar electricity and RIPT. The gadget achieves effective strength transmission at an ideal nine cm distance, with overall performance verified via realistic voltage and current readings. real-time monitoring through ESP32 and the Blynk IoT platform guarantees inexperienced monitoring and diagnostics. The outcomes

confirm that decreased coil distance enhances electricity overall performance, making the tool possible for feasible and wise EV charging infrastructure.

Future Scope

The proposed dynamic wireless charging for electric powered automobiles demonstrates a renewable and contactless answer for electric car (EV) charging. in addition, trends and enhancements can significantly decorate its scalability, performance, and sensible usability. The following points highlight capacity destiny scope:

A. More potent Transmission performance

1. Multi-coil or Array-primarily based Transmission: Incorporating a couple of transmitter coils arranged in collection or a grid layout can increase the region of magnetic coverage, permitting uninterrupted energy switch because the vehicle movements dynamically across charging lanes.
2. Automated Resonance Tuning: Enforcing adaptive tuning circuits can preserve the finest resonant frequency no matter environmental adjustments or misalignment among coils, lowering energy loss.

B. Improved Distance and Alignment Flexibility

1. Improved Coil design: The usage of high-performance Litz twine coils or ferrite-subsidized coils can allow extended separation distance (beyond 10 cm) amongst transmitter and receiver coils without degrading power performance.
2. Magnetic area Focusing: Shielding and vicinity focus strategies can lessen stray losses and growth tolerance to misalignment among vehicles and charging floor.

C. Advanced energy garage and Conversion

1. Immoderate-ability Battery Integration: Upgrading from a 9V lithium-ion battery to an excessive-capability LiFePO_4 or graphene battery gadget can enhance charge retention and output for sustained operation.
2. Smart Inverter format: Changing the rectangular wave inverter with a natural sine wave or excessive-frequency inverter with intelligent law can similarly beautify power conversion performance.

D. Clever manipulation and monitoring

1. Mobile App Integration with Predictive Analytics: Extending Blynk IoT integration to consist of usage records, predictive maintenance signs, and energy intake forecasting the use of AI models.

2. Real-time tracking with GPS: Embedding a GPS module for real-time automobile role monitoring and associating it with dynamic charging zones in smart towns.

References

- 1) Razu RR, Mahmud S, Uddin MJ, Islam SS, Misran N, Bais B. Wireless Charging of Electric Vehicle While Driving. *IEEE Access*. 2021;9:157973–157983. Available from: <https://doi.org/10.1109/ACCESS.2021.3130099>.
- 2) Patil D, Miller JM, Fahimi B, Balsara PT, Galigekere V. A Coil Detection System for Dynamic Wireless Charging of Electric Vehicle. *IEEE Transactions on Transportation Electrification*. 2019;5(4):988–1003. Available from: <https://dx.doi.org/10.1109/tte.2019.2905981>.
- 3) Mohamed N, Aymen F, Alharbi TEA, El-Bayeh CZ, Lassaad S, Ghoneim SSM. A Comprehensive Analysis of Wireless Charging Systems for Electric Vehicles. *IEEE Access*. 2022;10:43865–43881. Available from: <https://doi.org/10.1109/ACCESS.2022.3168727>.
- 4) Amjad M, i Azam MF, Ni Q, Dong M, Ansari EA. Wireless charging systems for electric vehicles. *Renewable and Sustainable energy reviews*. 2022;167:112730. Available from: <https://doi.org/10.1016/j.rser.2022.112730>.
- 5) Hemavathi S, Shinisha A. A study on trends and developments in electric vehicle charging technologies. *Journal of Energy Storage*. 2022;52(Part C):105013. Available from: <https://doi.org/10.1016/j.est.2022.105013>.
- 6) Wu X, Li G, Zhou J. A Lightweight Secure Management Scheme for Energy Harvesting Dynamic Wireless Charging System. *IEEE Access*. 2020;8:224729–224740. Available from: <http://dx.doi.org/10.1109/ACCESS.2020.3044293>.
- 7) Elghanam E. On The Coordination of Charging Demand of Electric Vehicles in A Network of Dynamic Wireless Charging Systems. *IEEE Access*. 2022;10:62879–62892. Available from: <https://doi.org/10.1109/ACCESS.2022.3182700>.
- 8) Capua GD, Femia N. Optimal Coils and Control Matching in Wireless Power Transfer Dynamic Battery Chargers for Electric Vehicles. *IEEE Access*. 2021;9:166542–166551. Available from: <https://dx.doi.org/10.1109/access.2021.3129910>.
- 9) Moosavi SA, Mortazavi SS, Namadmalan A, Iqbal A, Al-Hitmi M. Design and Sensitivity Analysis of Dynamic Wireless Chargers for Efficient Energy Transfer. *IEEE Access*. 2020;9:16286–16295. Available from: <https://doi.org/10.1109/ACCESS.2020.3048029>.
- 10) Zhou Z, Liu Z, Su H, Zhang L. Bi-level framework for microgrid capacity planning under dynamic wireless charging of electric vehicles. *International Journal of Electrical Power & Energy Systems*. 2022;141:108204. Available from: <https://doi.org/10.1016/j.ijepes.2022.108204>.
- 11) Mohamed AAS, Shaier AA, Metwally H, Selem S. Interoperability of the universal WPT3 transmitter with different receivers for electric vehicle inductive charger. *eTransportation*. 2020;6:100084. Available from: <https://doi.org/10.1016/j.etrans.2020.100084>.
- 12) Zhou Z, Liu Z, Su H, Zhang L. Planning of static and dynamic charging facilities for electric vehicles in electrified transportation networks. *Energy*. 2023;263(Part E):126073. Available from: <https://doi.org/10.1016/j.energy.2022.126073>.
- 13) Shehata EG. Design of high efficiency low frequency wireless power transfer system for electric vehicle charging. *Electrical Engineering*. 2022;104:1797–1809. Available from: <https://doi.org/10.1007/s00202-021-01436-w>.
- 14) Al-Hanahi B, Ahmad I, Habibi D, Masoum MAS. Charging Infrastructure for Commercial Electric Vehicles: Challenges and Future Works. *IEEE Access*. 2021;9:121476–121492. Available from: <https://dx.doi.org/10.1109/access.2021.3108817>.
- 15) Wang Y, Luan HT, Su Z, Zhang N, Benslimane A. A Secure and Efficient Wireless Charging Scheme for Electric Vehicles in Vehicular Energy Networks. *IEEE Transactions on Vehicular Technology*. 2022;71(2):1491–1508. Available from: <https://dx.doi.org/10.1109/tvt.2021.3131776>.
- 16) Siroos A, Sedighzadeh M, Afjei E, Fini AS, Yarkarami S. System Identification and Control Design of a Wireless Charging Transfer System with Double-Sided LCC Converter. *Arabian Journal for Science and Engineering*. 2021;46:9735–9751. Available from: <https://dx.doi.org/10.1007/s13369-021-05548-0>.
- 17) Gadgil AA, Bairolia A, Daya JLF, Balamurugan P. Dynamic Wireless Charging System for Electric Vehicles Based on Segmented Zinc Alloy Plates. In: *Inventive Systems and Control*; vol. 672 of Lecture Notes in Networks and Systems. Springer, Singapore. 2023;p. 339–348. Available from: https://doi.org/10.1007/978-981-99-1624-5_25.