International Journal of
AI Electronics and Nexus Energy
Peer Reviewed, Referred & Indexed Journal
ISSN: 3070-0515 www.zesterapublications.com Original Research Paper

Smart Wireless Electric Vehicle Charging System Using Solar Based Inductive Energy Transfer Mechanism

Pillalamarri Nagarani[1*], Bethi Siri[2], Byra Keerthana[2], Manuka Nithin[2], Ramshetty Anvesh[2]

[1]Assistant Professor, [2]UG Student, [1,2]Department of Electronics & Communication Engineering

[1,2]Vaagdevi Engineering College, Bollikunta, Warangal, 506005, Telangana, India.

*Correspondence: Pillalamarri Nagarani (nagaraninrcm@gmail.com)

Abstract

The rapid adoption of electric vehicles (EVs) has accelerated the demand for efficient charging infrastructure, with the global EV market expected to surpass 350 million vehicles by 2030 and charging-related challenges accounting for nearly 25% of user concerns, while wireless power transfer technologies are projected to grow at over 20% annually. These applications demand intelligent systems capable of automated charging, reduced human intervention, and integration with renewable energy sources. Traditional wired charging systems rely on physical connectors, which are prone to wear and tear, require manual handling, and pose safety risks such as electric shocks and cable damage. Furthermore, they lack flexibility, aesthetic integration, and seamless automation, limiting their suitability for next-generation mobility systems. To address these challenges, the proposed Wireless Electric Vehicle Charging System utilizes inductive coupling technology combined with solar energy integration and the ESP32 microcontroller to develop an intelligent and sustainable charging solution. The system employs a primary coil embedded in the ground to generate a magnetic field, inducing current in a secondary coil mounted on the vehicle, which is then rectified to charge the battery. Solar panels serve as the primary energy source, promoting green energy utilization, while the ESP32 monitors voltage, controls charging operations, and ensures system safety. This smart system enables efficient, contactless energy transfer, enhances user convenience, reduces maintenance, and supports the development of sustainable and autonomous EV charging infrastructure.

Keywords: Electric Vehicles, Energy Efficiency, ESP32, Inductive Coupling, Internet of Things, Renewable Energy Integration, Smart Charging System, Solar Power, Wireless Power Transfer

1. Introduction

The rapid growth of electric vehicles (EVs) and the global push toward sustainable transportation have significantly increased the demand for advanced charging technologies [1]. The global EV market is expected to surpass 350 million vehicles by 2030, driven by environmental concerns and government initiatives promoting clean energy adoption. At the same time, the transition toward renewable energy sources is accelerating, with solar energy playing a key role in sustainable power generation [2]. However, conventional wired charging systems often face limitations related to convenience, infrastructure complexity, and energy efficiency. These challenges have led to growing interest in wireless power transfer technologies [3], particularly inductive charging, as a viable solution for next-generation EV charging systems.

Traditional EV charging systems rely on physical cables and connectors to transfer energy from the power source to the vehicle battery [4]. While effective, these systems have several drawbacks, including wear and tear of connectors, safety concerns in wet or harsh environments, and inconvenience in

International Journal of
AI Electronics and Nexus Energy
Peer Reviewed, Referred & Indexed Journal
ISSN: 3070-0515 www.zesterapublications.com Original Research Paper

handling cables. Additionally, wired charging infrastructure requires significant installation and maintenance efforts, especially in public or dynamic environments [5]. Conventional systems also lack seamless integration with renewable energy sources and intelligent control mechanisms, limiting their ability to optimize charging efficiency and battery health. As a result, these systems may not fully support the evolving requirements of modern smart transportation ecosystems.

In real-time scenarios, these limitations create several challenges affecting usability, efficiency, and safety. Physical connectors can become damaged or unsafe over time, increasing the risk of electrical hazards [6]. The need for manual intervention reduces user convenience and limits the potential for fully automated charging solutions. Furthermore, inefficient energy utilization and lack of adaptive control can impact battery lifespan and overall system performance. The absence of real-time monitoring and smart control prevents optimal energy management, particularly when integrating renewable sources like solar power [7]. These challenges highlight the need for an intelligent, wireless EV charging system that leverages inductive coupling, renewable energy integration, and IoT-based monitoring to provide a safe, efficient, and user-friendly charging solution for modern electric mobility.

2. Literature Survey

Rudomanenko et al. [8] proposed an adaptive control system for industrial robotic manipulators that adjusted control parameters based on system dynamics and operational conditions. Karatzinis et al. [9] proposed a coordination framework for heterogeneous mobile sensing platforms to monitor dispersed gas plumes using distributed sensing and data fusion techniques.

Salavasidis et al. [10] proposed an autonomous trajectory design system for mapping unknown seafloors using a team of Autonomous Underwater Vehicles (AUVs). Keroglou et al. [11] proposed a survey on technical challenges in assistive robotics for elderly people in domestic environments, focusing on perception, navigation, and human-robot interaction.

Van der Pol et al. [12] proposed coordinated deep reinforcement learning for traffic light control that enabled multiple agents to optimize signal timing collaboratively. Zhang et al. [13] proposed a survey of reinforcement learning-based control methods for signalized intersections with connected automated vehicles. The study analyzed various algorithms for improving traffic efficiency.

Hashmi et al. [14] proposed a traffic flow optimization system at toll plazas using proactive deep learning strategies to predict traffic patterns and reduce congestion. Guerrieri et al. [15] proposed a deep learning-based approach using You Only Look Once version 3 (YOLOv3) for automatic traffic data measurement through moving vehicle observation.

El-Tantawy et al. [16] proposed a multi-agent reinforcement learning-based adaptive traffic signal control system that optimized signal timings across a network of intersections. Zhao et al. [17] proposed a survey on computational intelligence techniques for urban traffic signal control, analyzing methods such as fuzzy logic, neural networks, and evolutionary algorithms.

Efthymiou et al. [18] proposed an overview of Artificial Intelligence (AI) applications for sustainable smart cities, focusing on traffic management, resource optimization, and urban planning. Choosakun et al. [19] proposed a framework for developing cooperative intelligent transport systems in Thailand, focusing on communication, coordination, and infrastructure integration. Qadri et al. [20] proposed a state-of-the-art review of traffic

International Journal of
AI Electronics and Nexus Energy
Peer Reviewed, Referred & Indexed Journal
ISSN: 3070-0515 www.zesterapublications.com Original Research Paper

signal control methods, analyzing challenges and opportunities in modern traffic management systems.

3. Proposed System

Figure 1 illustrates the architecture of a wireless EV charging system integrated with monitoring and control using the ESP32. The system utilizes AC mains power, which is processed through a regulated power supply and converted into suitable electrical forms for wireless power transfer. The primary and secondary transfer coils enable inductive coupling to wirelessly transmit energy. The received power is rectified and stored in a 12V DC battery before being used for EV charging. The ESP32 supervises the entire process, providing real-time monitoring through IoT connectivity and displaying system status via an LCD. This design ensures efficient, contactless charging along with intelligent control and remote accessibility.

Step 1: AC Power Input and Regulation The system begins with AC mains supply, which is fed into the regulated power supply (RPS) circuit. This unit stabilizes and conditions the voltage to ensure safe operation of downstream components.

Step 2: Conversion to High-Frequency AC: The regulated power is converted into high-frequency AC using an inverter circuit. This high-frequency signal is essential for efficient wireless power transfer through inductive coupling.

Step 3: Primary Coil Power Transmission: The high-frequency AC is supplied to the primary transfer coil, generating a time-varying magnetic field. This magnetic field serves as the medium for wireless energy transfer.

Step 4: Secondary Coil Power Reception: The secondary transfer coil receives the magnetic field through inductive coupling, inducing an AC voltage in the coil. This enables wireless transmission of power without physical connections.

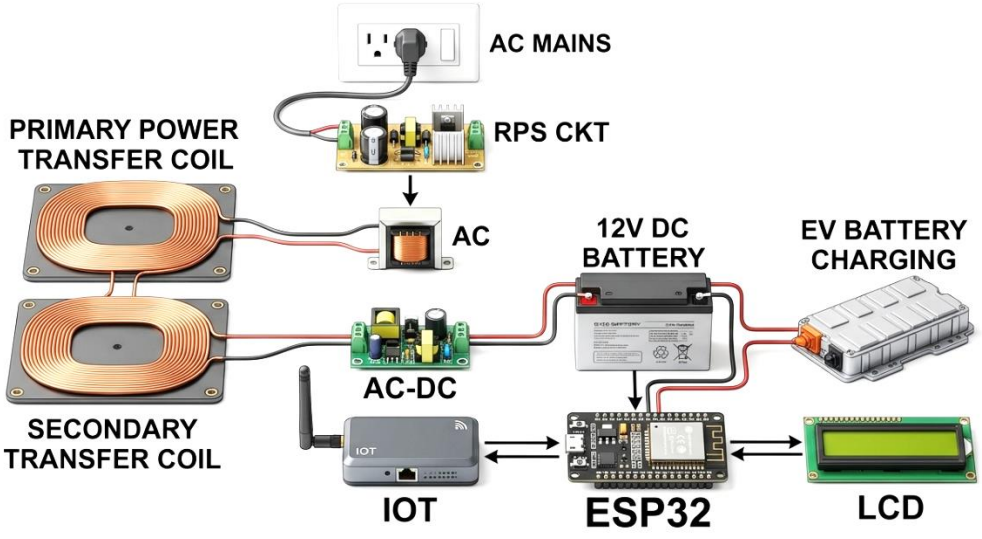


Figure 1. Proposed System

Step 5: AC to DC Conversion: The induced AC voltage is converted into DC using an AC-DC converter. This DC output is then used to charge a 12V DC battery, ensuring stable and continuous power supply.

Step 6: Battery Storage and EV Charging: The 12V DC battery acts as an intermediate energy storage unit and supplies power to the EV charging system. This stage ensures

Received: 03-03-2026 | Accepted: 06-04-2026 | Published: 13-04-2026

International Journal of
AI Electronics and Nexus Energy
Peer Reviewed, Referred & Indexed Journal
ISSN: 3070-0515 www.zesterapublications.com Original Research Paper

smooth and reliable charging of the EV battery.

Step 7: ESP32 Monitoring and Control: The ESP32 microcontroller continuously monitors system parameters such as voltage, current, and battery status. It controls the charging process and ensures safe operation by managing power flow and system conditions.

Step 8: IoT-Based Remote Monitoring: The ESP32 communicates with an IoT platform via Wi-Fi, enabling remote monitoring and control. Users can check charging status, battery levels, and system performance through a mobile or web interface.

Step 9: LCD Display and Alerts The LCD provides real-time information such as charging status and system parameters. Additionally, a buzzer alert system notifies users of important conditions like low battery or charging completion.

3.1 Working Procedure

Figure 2 shows the flowchart of proposed system. Figure 3 illustrates the circuit design of an ESP32-based wireless EV charging system integrated with IoT monitoring. The power supply section consists of a step-down transformer, bridge rectifier, filter capacitors, and a 7805-voltage regulator that provides a stable +5V output for system operation and a dedicated 5V charging port.

The ESP32 microcontroller acts as the central control unit, receiving voltage measurements from the sensing module to monitor charging conditions. An IoT module is interfaced with the ESP32 to enable real-time data transmission and remote monitoring of charging status. A 16×2 LCD display is connected to present key parameters such as voltage levels and system status to the user. This design ensures efficient wireless charging supervision, safe power regulation, and smart monitoring, making it suitable for modern EV charging infrastructure with enhanced automation and connectivity.

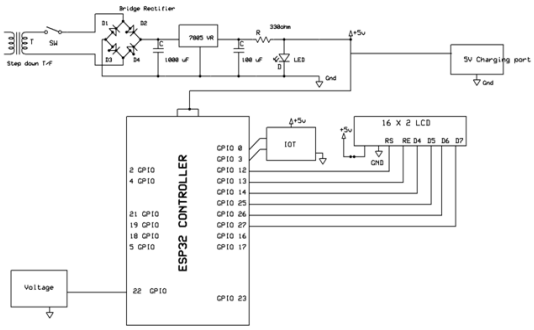


Figure 2. Circuit Diagram of ESP32-Based Wireless EV Charging Monitoring System

International Journal of
AI Electronics and Nexus Energy
Peer Reviewed, Referred & Indexed Journal
ISSN: 3070-0515 www.zesterapublications.com Original Research Paper

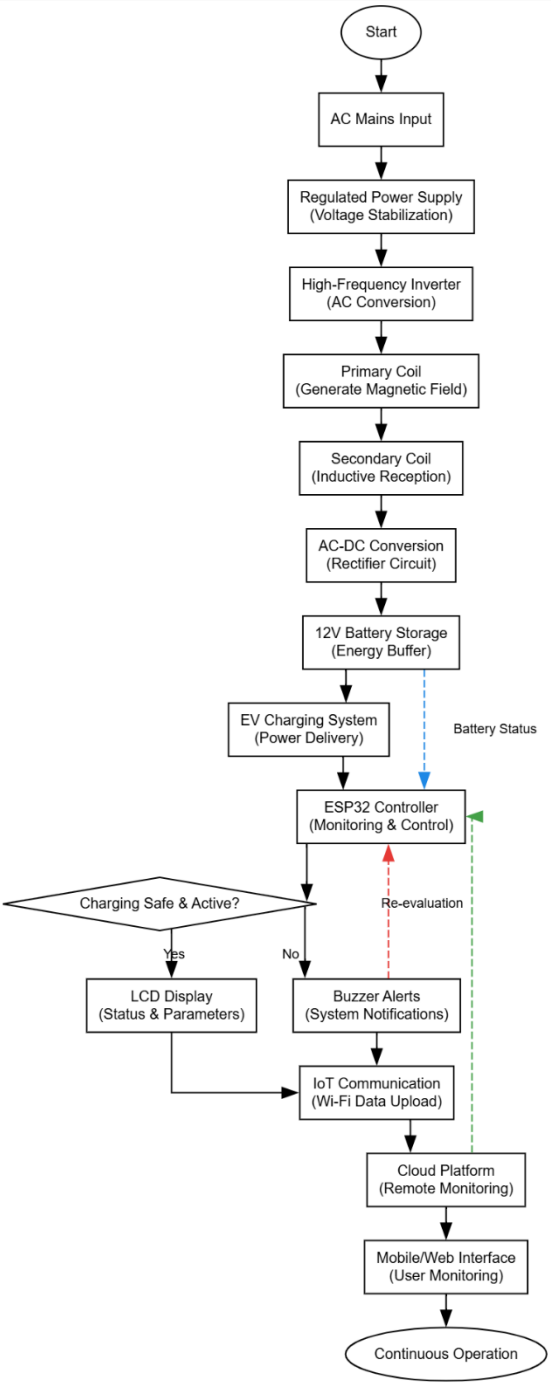


Figure 3. Working Flowchart.

4. Results and Discussion

Figure 4 shows the complete experimental setup of the wireless electric vehicle charging system. The setup includes the transmitter unit with inductive coils, power driver circuits, and the receiver unit mounted on the EV prototype controlled by an ESP32 microcontroller.

Figure 5 illustrates the transmitter side inductive coils and power driver circuits used for wireless energy transfer. The primary coils generate a magnetic field which transfers energy wirelessly to the receiver coil placed on the vehicle.

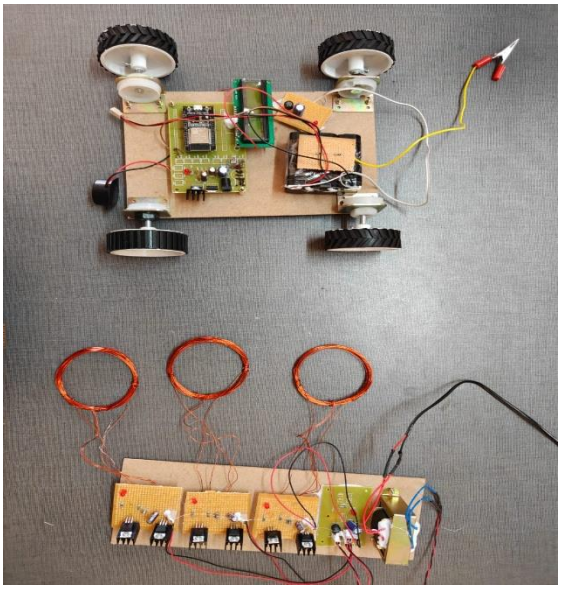


Figure 4. Hardware Setup of Wireless Electric Vehicle Charging System

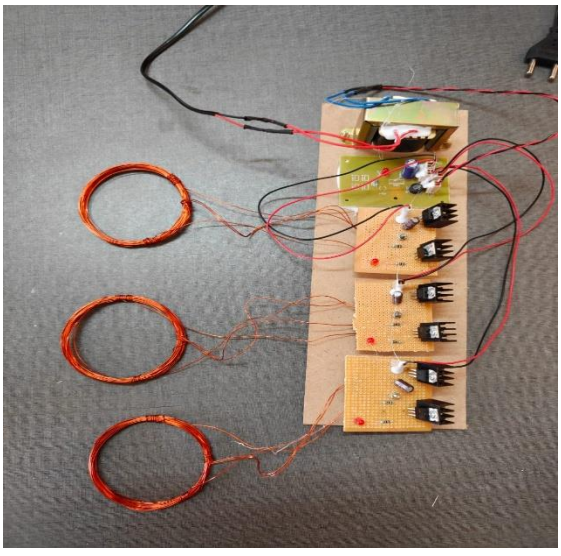


Figure 5. Inductive Power Transmission Coil Arrangement

Figure 6 shows the EV prototype equipped with a receiver coil and charging circuit. The ESP32 microcontroller monitors the charging parameters and controls the wireless charging process to safely charge the vehicle battery.

Received: 03-03-2026 | Accepted: 06-04-2026 | Published: 13-04-2026

International Journal of
AI Electronics and Nexus Energy
Peer Reviewed, Referred & Indexed Journal
ISSN: 3070-0515 www.zesterapublications.com Original Research Paper

Figure 7 presents the IoT monitoring dashboard that records charging voltage levels and system status. The interface displays real-time charging data with timestamps, enabling remote monitoring of the EV wireless charging process.

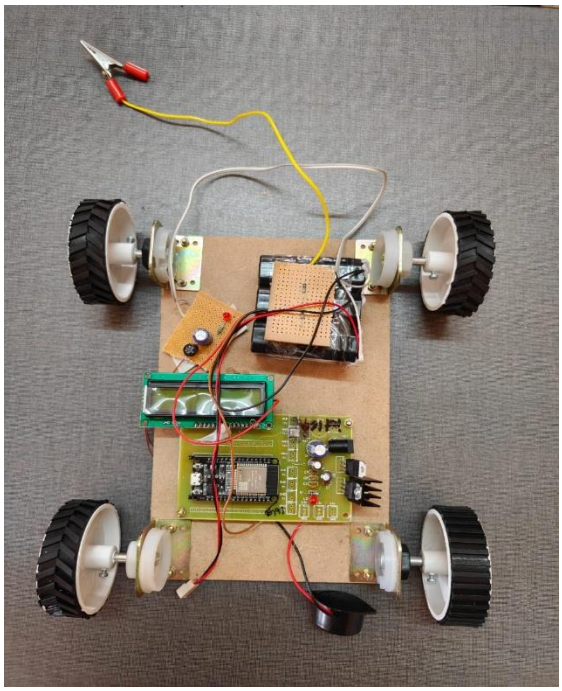


Figure 6. Electric Vehicle Prototype with Receiver Charging Circuit

S.No	Voltage	Date
1	Low_Voltage_0.00	2026-02-09 14:32:52
2	Low_Voltage_0.00	2026-02-09 14:32:18
3	12.31	2026-02-09 14:24:37
4	Low_Voltage_0.00	2026-02-09 14:23:37
5	Low_Voltage_0.00	2026-02-09 13:43:44
6	12.32	2026-02-09 13:43:39
7	12.31	2026-02-09 13:42:15
8	Low_Voltage_0.00	2026-02-09 13:41:18
9	12.33	2026-02-09 13:40:46
10	Low_Voltage_0.00	2026-02-09 13:36:29
11	Low_Voltage_0.00	2026-02-09 13:29:08
12	12.30	2026-02-09 13:28:11
13	Low_Voltage_0.00	2026-02-09 13:27:12
14	Low_Voltage_0.00	2026-02-05 17:50:10

Figure 7. IoT Cloud Dashboard Showing Charging Voltage Data

5. Conclusion

The proposed Wireless Electric Vehicle Charging System presents an innovative and sustainable solution to the growing challenges of EV charging infrastructure by integrating inductive coupling technology, solar energy, and intelligent control through the ESP32 microcontroller. By enabling contactless power transfer, the system eliminates the limitations of traditional wired charging such as cable wear, safety risks, and manual intervention, thereby enhancing user convenience and operational reliability. The use of solar energy promotes eco-friendly charging and reduces dependence on conventional grid power, supporting sustainable energy goals. Additionally, real-time monitoring and control by the ESP32 ensure efficient energy transfer, system safety, and optimized charging performance under varying conditions. This advanced approach not only improves efficiency and reduces maintenance costs but also aligns with the future of smart cities and autonomous mobility. Finally, the system contributes to the development of clean, efficient, and intelligent EV charging infrastructure, addressing modern transportation needs while promoting environmental sustainability.

References

[1] Pergantis, E.N.; Sangamnerkar, A.S. Sensors, Storage, and Algorithms for Practical Optimal Controls in Residential Buildings. ASHRAE Trans. 2023, 129, 437–444.

[2] Explainable AI Framework for Policy-Compliant Anomaly Detection in Data Pipelines. (2025). Inaternational Journal of Communication Networks and Information Security, 16(4). https://doi.org/10.48047/ijcnis.16.4.2111

[3] Gaddam, S. Integrating Analytics into the Development Process: Bridging the Gap between Data Insights and Design Execution.

[4] Prodduturi, S. M. K. To Secure Your Paper as Per UGC Guidelines We Are Providing A ElectronicBar code.

International Journal of
AI Electronics and Nexus Energy
Peer Reviewed, Referred & Indexed Journal
ISSN: 3070-0515 www.zesterapublications.com Original Research Paper

[5] Reddy, S. K. R. (2025). Tailoring Loyalty Rewards Systems across Industries: Cloud vs On-Prem Solutions. International Journal of All Research Education and Scientific Methods (IJARESM).

[6] Takayanagi, M.; Yoshino, M.; Kikuchi, G.; Kanke, T.; Suzuki, N. Autonomous adaptive control of manufacturing parameters based on local regression modeling. Behaviormetrika 2024, 51, 499–513.

[7] Poojari, R. (2025). A Comparative Analysis of Fine-Tuning Versus Retrieval-Augmented Approaches for Enhancing Healthcare-Centric Large Language Models.

[8] Rudomanenko, A.; Chernyadev, N.; Vorotnikov, S. Adaptive control system for industrial robotic manipulator. In Proceedings of the Modern Problems of Robotics: Second International Conference, MPoR 2020, Moscow, Russia, 25–26 March 2020; Revised Selected Papers 2. pp. 153–164.

[9] Karatzinis, G.D.; Michailidis, P.; Michailidis, I.T.; Kapoutsis, A.C.; Kosmatopoulos, E.B.; Boutalis, Y.S. Coordinating heterogeneous mobile sensing platforms for effectively monitoring a dispersed gas plume. Integr. Comput.-Aided Eng. 2022, 29, 411–429.

[10] Salavasidis, G.; Kapoutsis, A.C.; Chatzichristofis, S.A.; Michailidis, P.; Kosmatopoulos, E.B. Autonomous trajectory design system for mapping of unknown seafloors using a team of AUVs. In Proceedings of the 2018 European Control Conference (ECC), Limassol, Cyprus, 12–15 June 2018; pp. 1080–1087.

[11] Keroglou, C.; Kansizoglou, I.; Michailidis, P.; Oikonomou, K.M.; Papapetros, I.T.; Dragkola, P.; Michailidis, I.T.; Gasteratos, A.; Kosmatopoulos, E.B.; Sirakoulis, G.C. A survey on technical challenges of assistive robotics for elder people in domestic environments: The aspida concept. IEEE Trans. Med. Robot. Bionics 2023, 5, 196–205.

[12] Kalae, U. K. (2025). Optimizing cost-effective cloud data pipeline orchestration across multiple cloud providers. Journal of Information Systems Engineering and Management, 10(63s), e726–e741.

[13] Zhang, K.; Cui, Z.; Ma, W. A survey on reinforcement learning-based control for signalized intersections with connected automated vehicles. Transp. Rev. 2024, 44, 1187–1208.

[14] Hashmi, H.T.; Ud-Din, S.; Khan, M.A.; Khan, J.A.; Arshad, M.; Hassan, M.U. Traffic Flow Optimization at Toll Plaza Using Proactive Deep Learning Strategies. Infrastructures 2024, 9, 87.

[15] Guerrieri, M.; Parla, G. Deep learning and yolov3 systems for automatic traffic data measurement by moving car observer technique. Infrastructures 2021, 6, 134.

[16] Vasagam, M., Kumar, A., & Garg, A. (2026). Learning Execution Plan Embeddings for Multi-Dimensional Query Resource Prediction. IEEE Access.

[17] Patyrykin, K. (2025). CANCEL CULTURE PROBLEM. Lex Localis: Journal of Local Self-Government, 23.

[18] Purmani, S. S. R. (2025). Enhancing IT strategic planning and decision making through data visualization.

International Journal of
AI Electronics and Nexus Energy
Peer Reviewed, Referred & Indexed Journal
ISSN: 3070-0515 www.zesterapublications.com Original Research Paper

International Journal of Enhanced Research in Management & Computer Applications, 14(4), 75–81

[19] Kumara, S. (2026, February). A Lightweight Deep Learning Based Classification Models for Non-Human Identity Threat Detection. In 2026 IEEE 5th International Conference on AI in Cybersecurity (ICAIC) (pp. 1-6). IEEE.

[20] Qadri, S.S.S.M.; Gökçe, M.A.; Öner, E. State-of-art review of traffic signal control methods: Challenges and opportunities. Eur. Transp. Res. Rev. 2020, 12, 1–23.

Received: 03-03-2026 | Accepted: 06-04-2026 | Published: 13-04-2026