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Research Article

Hybrid Approach for the Development of Compensation Topologies in Wireless Power Transfer Systems

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ARTICLE INFO	ABSTRACT

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The benefits of a wireless power transfer (WPT) system are simplicity, safety, and dependability. Energy transfer coils should be adjusted by electrical measures in applications to increase the system's output power and decrease its input capacity. This manuscript presents a hybrid approach for compensation topologies of WPT system. The hybrid technique is the combination of Lyrebird Optimization Algorithm (LOA) with the Dual Attention Graph Convolutional Network (DAGCN), and then it is together named as LOA-DAGCN technique.The objective of the proposed is to increase the power efficiency in WPT system. The proposed LOA method is used to optimize the optimal controller parameters and generates a set of control signals. The DAGCN is used to predict the power delivered to the load. The proposed technique's performance is put to the test using the MATLAB working environment and contrasted with other methods that are currently in use. The current techniques include Particle Swarm Optimization (PSO), Recurrent Neural Networks (RNN), and Artificial Neural Networks (ANN). According to the results, the suggested method's efficiency is 97%, the current Ann's is 87%, the RNN's is 77%, and the PSO's is 68%.

Keywords: Compensation Topologies, Series-Series, Series-Parallel, Parallel-Series, Parallel-Parallel, Wireless Power Transfer system

1. INTRODUCTION

(a) Background

Wireless technology has once again become more popular due to the growing use of mobile devices, the quick development of electric vehicles (EVs), and the installation of smart grids (SG), which need millions of energy-saving sensors. [1]. Because coupled magnetic resonance WPT systems offer convenience, flexibility, and safety benefits, there has been a surge in interest in these systems in recent years [2]. In real-world applications, the leakage inductance is always accounted for by the transmission coils. Based on various transmission coil compensation topologies, the WPT system may be categorized into four groups: series-series (SS), series-parallel (SP), parallel-series (PS), and parallel-parallel (PP) [3].The primary coil's adjustment is made to ensure that, with the lowest possible supply source power rating, the resonant frequency matches the power source's operating frequency. The secondary coil's adjustment is engineered to maximize efficiency while providing increased power to the load [4]. The concerns of output power and transmission efficiency are the most important in real-world applications. Thus, it is essential to examine the various transmission properties of various compensation topologies while taking transmission efficiency and output power into account [5]. This work can provide a reference for choosing the appropriate compensation topology while considering practical applications by conducting a comparison analysis of the two compensation approaches [6]. Worldwide, the usage of battery-powered devices has grown dramatically, including electric cars, medical implants, and cell phones. WPT offers a lot of potential uses in this space. WPT finds use in a wide range of industrial applications and robotics. Examples include the non-contact transfer of electrical energy through bending joints and robotic systems that carry out disaster relief operations in hazardous or

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inaccessible areas. Applications can also be made of it. These factors make it necessary to create WPT knowledge designs that are more effective and safe [8]. Through computations and practical research, This work aims to give an overview of current WPT topologies and to call attention to the shortcomings of the most widely used technology, inductive power transfer systems [9]. Fixing the leakage inductors in loosely coupled transformers (LCTs) is a well-known need for transmitting actual power to the load side of an IPT system. There have been several proposals for compensation networks that pay the primary and/or secondary side. Getting or enhancing the following advantageous qualities is their primary objective: The adjustable Cc has less of an impact on zero voltage switching (ZVS), which may attain excessive competence through soft switching and only needs a little inductive input impedance [10]. an output that is independent of load resistance and has a constant voltage and current.

(b) Challenges

The distinct features of Wireless Power Transfer (WPT) present a number of difficulties for compensation topologies. Providing just compensation for the usage of wireless charging infrastructure is a significant challenge since different stakeholders may profit from the technology to differing degrees. Furthermore, choosing the right pricing schemes and payment plans for WPT services can be challenging, particularly when considering variables like energy usage, travel distance, and charge duration. Managing the financial effects of implementing WPT, such as the expenses of deploying, maintaining, and upgrading infrastructure, while simultaneously making sure that service providers receive a fair return on their investment, is another to establish sustainable and effective compensation strategies.

(c) Literature Review

Considering the full resonance condition of the compensation topology, the dynamic wireless power transfer (DWPT) system's LCC/S compensation topology parameters are designed,
Xu*et al.* [11] have introduced an original method of matching parameters that utilizes the particle swarm optimization (PSO) algorithm. Initially, a mathematical model of the compensation topology consisting of parallel capacitors, series inductors, series capacitors on the primary side, and series capacitors on the secondary side was created and constructed. This model is known as the LCC/S recompense topology. The models, experimental implementation, and mathematical calculations related to EV wireless charging have been presented by S. Vidar *et al.* [12]. In developing countriesEV's were among the most effective means of encouraging environmentally friendly transportation and lowering pollution. Because WPT technology provides a practical solution to the issues impeding the advancement of EVs, scientists have been keenly observing the quick development of this technology. EV charging uses WPT technology, which uses mutual induction to transmit power from the source to the load (battery) without the use of cables or other physical connections. Technical obstacles to EV wireless charging included recompense topologies, power pads, and alignment issues. An exhaustive examination of the voltage gain, input access, and efficacy of common recompense topologies for the first time has been provided by M. Kiyani *et al.* [13]. Researchers calculated the voltage gain sensitivity on typical compensation, comprising SS, SP, LCL-S, LCL-P, LCC-S, LCC-P, and double-sided LCC, under significant parameter changes, including load resistance, switching frequency, and coupling coefficient (Cc). A new compensation method for the series-parallel/parallel-series (PS/SP) compensatory topology has been presented by K. Wu *et al.* [14]. The suggested Depending on how the compensation components were assembled, there are four different versions of the PS/SP compensation design. Among its characteristics are almost zero phase angle (ZPA), flexible output voltage gain control, robust misalignment tolerance, and load-independent constant voltage output. To evaluate and compare the supplied theoretical analysis, prototypes utilizing the PS/SP compensation topology and the LCC/S compensation topology were constructed. The three main objectives of the dynamic wireless charging system (WCS) for electric cars are high output power, strong interoperability, and misalignment tolerance N. Xia *et al.* [15]. A hybrid wireless charging system's transmitter module utilizes coplanar double bipolar pads (BPPs). The primary side consists of two BPPs pushed out of stage to function as bipolar pads, offering a larger fundamental magnetic flux height than unipolar pads.

(d) Research Gap and Motivation

In Wireless Power Transfer (WPT), compensation topologies are hampered by a dearth of thorough research on the best compensation schemes for the many parties participating in WPT systems. Research now in existence frequently concentrates on technical elements such power transfer capacities, range, and efficiency; nevertheless, a more

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thorough examination of the financial and economic factors pertaining to compensation in WPT is required. A thorough understanding of the best pricing strategies, fee schedules, revenue-sharing plans, and cost-sharing arrangements for WPT services can aid decision-making for all parties involved and guarantee the long-term viability and expandability of WPT infrastructure. The growing use of wireless charging technologies in a variety of applications, including consumer electronics, medical equipment, and electric vehicles, is the source of compensation topologies in WPT.The increasing prevalence of WPT systems necessitates the development of efficient compensation schemes that strike a compromise between the interests of many parties, such as service providers, infrastructure operators, device makers, and end users. By investigating this topic, scientists can help create just and open compensation schemes that encourage the broad use of WPT technologies, spur industry innovation, and eventually improve the effectiveness and practicality of wireless charging solutions.

(e) Contribution

- Compensation topologies help WPT systems transfer power more efficiently by reducing energy losses.
- They enable power transfer over longer distances by minimizing losses due to factors like air gap and coil misalignment.
- These topologies adjust power transfer based on changing conditions, ensuring optimal performance in different situations.
- Advanced compensation methods help make WPT systems smaller, lighter, and more affordable by optimizing component design and materials.

(f) Organization

Theremainder of the manuscript is planned as follows: Part 2 provides an explanation of the Wireless Power Transfer System's SystemModeling and Analysis. The WPT recommended technique is presented in Part 3. The paper's explanation of the outcome and debate is provided in Part 4, and it is concluded in Part 6.

2. SYSTEM MODELING AND ANALYSIS OF WIRELESS POWER TRANSFER SYSTEM

Systems for WPThave been advanced for over ten years. As time has gone on, numerous compensation network topologies have been examined, and numerous application goals have been determined. The series-series (SS) compensated WPT system was the main emphasis because of its electrical and transfer capabilities, making it an excellent fit for high-power car battery charger applications.Similar to other configurations, the SS compensated WPT system has several criteria that need to be taken into account when developing a WPT system for aaim application with specific parameters. To obtain ideal operating characteristics, particularly efficiency and performance, it is imperative to match the impedance of the system depending on the kind of load. Fig 1 shows theStructure of WPT system with proposed approach

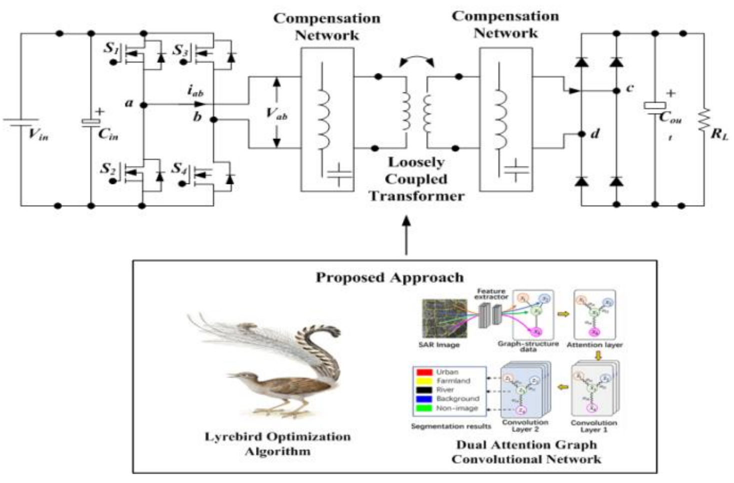

Fig 1: Structure of WPT system with proposed approach

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From fig 1, a typical WPT system, Itcontains of a load, a diode rectifier, a resonant network, filter capacitors, and a high frequency (HF) inverter at the primary side. The transformer connects the suggested LOA-DAGCN technique to the system's power efficiency. In order to lower the input source's reactive power rating and enhance power transfer to the load, a compensation network made up of inductors and capacitors is employed[16]. The dc-link capacitor C_{in} connects an HF inverter to a dc source, V_{in} .

$$m = K\sqrt{(l_P l_S} \quad (1)$$

In this case, m represented theMI among the coils, The Cc is denoted by K, while the self-inductances of the main and secondary coils are represented by l_P and l_S , respectively.

2.1. Classification of Basic Compensation Topologies

The majority of semiconductor solutions are developed using one of four fundamental compensatory topologies: PS, SS, SP, and PP. Although WPT was investigated long ago, IPT systems with compensation have received increased interest during the 1990s. The markets for mobile phones and electric cars started around that time. The principal compensating capacity was first calculated using other formulae that did not account for key process variables. In certain designs, the primary capacitance is determined only by correcting the primary self-inductance. The explanations of the SS, SP, PS, and PP topologies are as follows:

2.1.1.Series–Series (SS) Topologies

In the SS topology, the transmitter coil and capacitor are linked in series with the reception coil and capacitor. By tuning the values of the capacitors and coils, the system can achieve maximum power transfer efficiency [16].The equation of SS topology is given in eqn (2).

$$\eta_{r\sec} = \frac{\omega^2 k^2}{\omega^2 k^2 + r_L r_{pri}} \quad (2)$$

Where, η is denoted as ideal transformer turns ratio, $r\sec$ stands for resonant for receiver side, ω is denoted as resonant frequency, r_{pri} is denoted as primary resistance, L is denoted as inductance

2.1.2.Series–Parallel (SP) Topologies

In SP topology, the transmitterside having a capacitor connected in series, whereas in receiver side, a capacitor is connected in parallel [17]. The equation for SP topology is given in eqn (3).

$$z_{T,sp} = r_{\mathrm{Pr}i} + j\omega l_{\mathrm{Pr}i} - j\frac{1}{\omega c_{\mathrm{Pr}i}} \quad (3)$$

Where, Z_T is denoted as total impedance of a circuit element, Sp as secondary phase, $j\omega l_{\mathrm{Pr}i}$ as inductive reactance of the primary inductor.

$$z_{R,sp} = j\omega l_{\sec} - j\frac{1}{\frac{1}{r_l} + j\omega cr} \quad (4)$$

From the above eqn, z_R is denoted as resonant inductive coupling, $j\omega l_{\sec}$ as inductive reactance of the leakage inductance, $j\omega c$ as combined inductive reactance of the magnetizing inductance (CM) and the reflected capacitance. The total resistive receiver side impedance is knownin eqn (5),

$$l_{\sec,sp} = \frac{c_{Sec} r_l^2}{1 + \omega^2 c_{\sec}^2 r_l^2} \quad (5)$$

From the above equation, $l_{\sec,sp}$ as leakage inductance of the transformer in secondary phase, By equating eqn. (3) and (4), we get $z_{R,sp}$

$$z_{R,sp} = \frac{r_l}{1+\omega^2 c_{\sec}^2 r_l^2} + j\frac{\omega l \sec}{1+\omega^2 c_{\sec}^2 r_l^2} \quad (6)$$

From the above equation, z_R is denoted as resonant inductive coupling, $C\sec$ as inductive coupling of capacitance.

Under eqn (5), we get $z_{R,sp}$,

$$z_{R,sp} = \frac{r_l}{1+\omega^2 c_{\sec}^2 r_l^2} \quad (7)$$

Here, z_R is denoted as resonant inductive coupling, Sp as secondary phase.

When the load is not constant, equation (5) is directly proportional to the load (RL). Reaching Eqn (7) indicates that, similar to EV charging, (i) the source frequency must be uninterruptedly switched in order to maintain the receiver section's resonance state. (ii) Should the getting side maintain its resonant state. The transmitter side, which sets and determines the resonance frequency, is where this cannot be accomplished. Using equation (8), one may obtain the quality factor.

$$q = \frac{1}{\omega c_{\sec}} \quad (8)$$

Where, q as quality factor of the resonant circuit, ω is denoted as resonant frequency.

2.1.3.Parallel–Series (SP) Topology

The source current in the PS topology can be defined as follows: the spreader and receiver coil are linked in parallel with a capacitor on the transmitter side $I_{T,Ps}$ and in series with a capacitor on the reception side $I_{S,Ps}$ as in eqn (9),

$$l_{t,ps} = \left[\frac{-j\left(\frac{v_S}{\omega l_{\mathrm{Pri}}}\right)\left(r_{pri} + j\omega l_{pri}\right)z_r}{\left[z_r r_{pri} + \omega^2 k^2\left(1+\omega^2 c_t^2 r^2{}_{pri}\right)\right] + j\omega l_{pri}}\right. \quad (9)$$

Where, Z_T is denoted as total current of a circuit element, v_S as source voltage, z_r as impedance of the reflected load in transmitter side, c_t capacitance with accurate time of transmitter side, r_{pri} is denoted as primary resistance.

2.1.4. Parallel–Parallel (PP) Topology

A capacitor is placed in parallel on the transmitter and receiver in the PP architecture I_L is given as follows in eqn(13)

$$i_l = \frac{i_r}{\left|1+\omega c_{\sec} r_l\right|} \quad (10)$$

Where, i_l as current in the primary circuit, $\omega c_{\sec}$ product of the secondary phase angle, resistance of the load linked to the receiver side, r_l load resistance.

The efficiency of the PP topology can be calculated by eqn (14)

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$$\eta_{pp} = \frac{\frac{q_t^2+1}{q_t}}{q_t + \left(\frac{1}{q_t}\right)\left(1 + \frac{k^2\left(q_r^2+1\right)^2}{q_t . q_r}\right)} \quad (11)$$

Here K is the coupling factor, q_T and q_r are the transmitter and receiver side quality factors, and η represents the optimal transformer turns ratio.

$$q_t = \frac{\omega l_{pri}}{r_{pri}} \quad (12)$$

Where, q_T is a quality factor of transmitter and receiverside r_{pri} is denoted as primary resistance.

$$q_r = \frac{\omega l_{\sec}}{r_l} \quad (13)$$

$$K = \frac{k}{\sqrt{l_{pri} . l_{Sec}}} \quad (14)$$

3. PROPOSED METHODOLOGY OF WIRELESS POWER TRANSFER SYSTEM USING LOA- AGCN APPROACH

This paper introduces a novel hybrid methodology termed LOA-DAGCN, which merges the Lyrebird Optimization Algorithm (LOA) with the DAGCN. The main aim of this study is to increase the power transfer efficacy in WPT system. Here is a brief overview of the proposed LOA-DAGCN techniques:

3.1. Lyrebird Optimization Algorithm (LOA)

The "LOA" algorithm is a novel bio-inspired metaheuristic that mimics the actions of lyrebirds in the wild [18]. The lyrebird's approach of avoiding danger is the source of the basic idea of LOA. In situations like these, lyrebirds cautiously survey their surroundings before fleeing or hiding in a peaceful area. Following a description, LOA theory is mathematically represented as two stages: exploitation, which relies on the concealment strategy simulation, and exploration, which is based on emulating the lyrebird escape approach.The lyrebird, so named because of its distinctive plumes of neutral-colored tail feathers, is one of Australia's most well-known native birdsin Figure 2, the LOA flow chart is displayed.

Step 1: Initialization

Set the input parameters to their initial values (power, voltage, and current in this case).

Step 2: Random Generation

Following the initialization step, the equation is used to express the Lyrebird population.

$$L = \begin{bmatrix} L_{1,1} & L_{1,2} & \cdots & L_{1,H} \\ L_{2,1} & L_{2,2} & \cdots & L_{2,H} \\ \cdots & \cdots & \cdots & \cdots \\ L_{n,1} & L_{n,2} & \cdots & L_{n,H} \end{bmatrix} \quad (15)$$

Here L denotes the LOA population matrix, n denotes the count of lyrebirds, H represent the count of decision variables, respectively.

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Step 3: Fitness Function
The goal function serves as the foundation for the fitness computation.

$F = Min\,[m]$ (16) m is denoted as mutual
Inductance between the coils

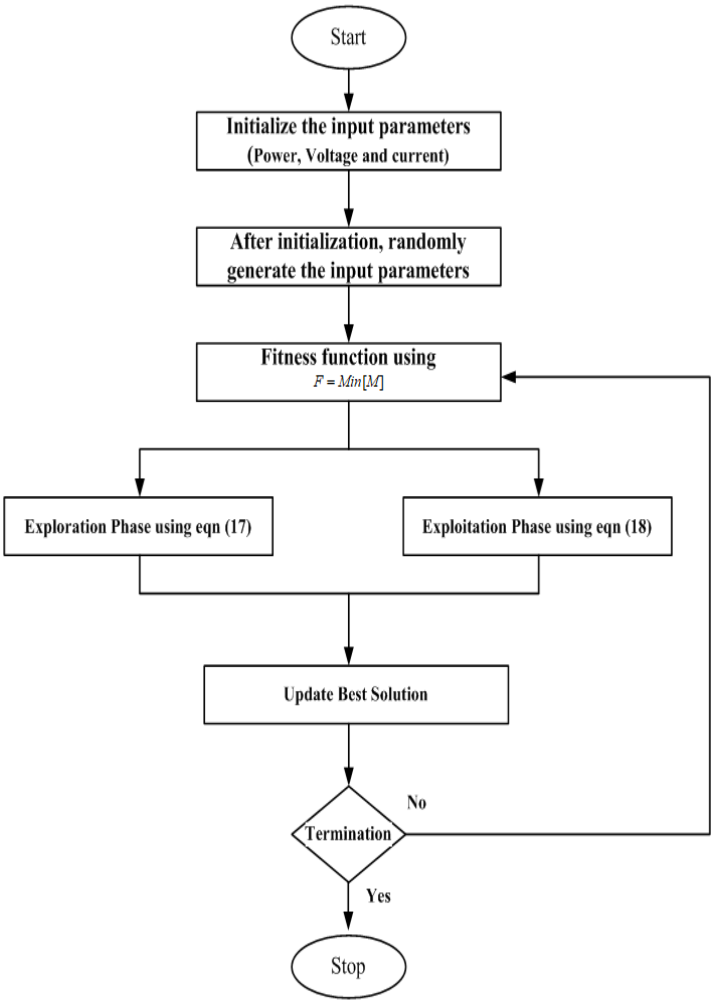

Fig 2: Flowchart of LOA

Step 4: Escaping Strategy (Exploration Phase)
Each population member's location in the search space is updated throughout this phase of LOA based on the modeling of the lyrebird's transition from the hazardous zone to the harmless zone. The lyrebird's position changes significantly as it is moved to a secure area, allowing it to scan different regions of the problem-solving environment and showcasing LOA's exploring capabilities in global search. Throughout this phase of LOA, the populace member's position in the search space is updated depend on the modeling of the lyrebird's departure from the hazard zone to the harmless zone.

$$DB_j = \{Z_P, \quad E_P < E_j \ \ and \ \ P \in \{1,2,....,M\}\}, \qquad \text{Where } j = 1,2,.........,M, \tag{17}$$

The collection of safe areas for the j[th] lyrebird and the P^{th} row of the Z matrix, represented by Z_P, has a higher objective function value than the jth LOA member, and DB_j

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Step 5: Hiding Strategy (Exploitation Phase)

During this stage of LOA, the location of the populace associate in the search space is efficient in line with the lyrebird's modeling strategy for hiding in its immediate harmless zone. The lyrebird exhibits the potential of LOA to be utilized in local searches as it takes in little phases to find a good beating location and exactly examines its environments, which causes a slight shift in place.

Based on the modeling of the lyrebird's migration towards a nearby suitable hiding spot, the LOA design employs the following equation to choose a new location for each LOA associate. If this new position improves the value of the goal function, it replaces the previous position of the associated component this is decided by

$$z_{j,i}^{k2} = z_{j,i} + \left(1 - 2l_{j,i}\right).\frac{vc_i - qc_i}{T} \quad (18)$$

$$Z_j = \begin{cases} Z_j^{k2}, E_j^{k2} \leq E_j \\ Z_j \ , Else \end{cases} \quad (19)$$

Where $z_{j,i}^{k2}$ is its ith dimension, z_j^{k2} is the suggested LOA's concealment strategy, and E_j^{k2} denotes its objective function value. These values are utilized to determine the jth lyrebird's new position, $l_{j,i}$ are arbitrary count from the interval [0, 1], and T represent the loop counter.

Step 6: Update Best Solution

The optimal answer found during algorithm iterations is added to the results as a solution to the specified problematic once all algorithm iterations have been completed.

Step 7: Termination Criteria

Verify that the termination conditions are met; if not, move on to step 3; if so, the optimum course of action has been identified.

3.2. Dual Attention Graph Convolution Network (DAGCN)

The DAGCN method is used to anticipate the power supplied to the load. The three components of the DAGCN are the fully connected classifier, the self-attention pooling layer, and the attention graph convolution module [19]. This section discusses the drawbacks of traditional GCNs before introducing our attention graph convolution module and self-attention pooling layer. This is one method of calculating conversations inside the system:

$$W^{j+1} = \phi(\widetilde{V}\widetilde{D}^{-1}W^j U) \quad (20)$$

The adjusted graph structure is shown by $\widetilde{D}$ and $\widetilde{V}\widetilde{D}^{-1}$ in this instance, while the diagonal node degree matrix is denoted by $\widetilde{V}$. For every node U, the adjacency matrix with self-connections is represented by $\widetilde{V} = V + I_m$. Additionally, it reveals the model parameter that need training.

WW W^j becomes a node attributes vector with H-hop local structure information after completing this operation j times.

The following convolution results are the only ones that can be obtained by using the results of each phase in the replication of the W^j concession. The AGC layer's primary goal is to increase the model's reliance on the k-hop convolution output while still extracting valued data from each hop. The convolution output will be a logical arrangement of the maximum relevant data obtained from the multiple hop convolution methods. Show the attention behavior and apply it to a hierarchical γ_{s_m} node representation in the manner described below:

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$$\gamma_{s_m} = \sum_{k=1}^{j} \alpha_{ki} W_{s_m}^{j} \quad (21)$$

When determining the significance of each hop's aggregation result, for simplicity, utilize vanilla consideration, where α denotes the attention weight and $W_{s_m}^{j}$ the node s_m specifies the local structure in j -hops. Details on the hierarchical structure are included in the final node representation.

$$\gamma_{s_m}^{n+1} = \sum_{k=1}^{j} \alpha_k W_{s_m}^{j} \quad (22)$$

$$W_{s_m}^{0} = \gamma_{s_m}^{n} + Y \quad (23)$$

Construct an attention graph convolution module using the residual learning approach. Then, stack attention convolution layers to maximize the advantages of DL and generate deeper hidden options, which will ultimately result in an enhanced final node representation (γ_{s_m}).Each AGC layer takes as input the entirety of the output from its predecessor and the original Y .

To output the weights vector α , use the attention mechanism with the convolution module's graph node representation as the input.

$$\beta = soft\max(h_2 \tan w(h_1 Q^T)) \quad (24)$$

Where h_1 and h_2 are the c-by-c and c-by-r weight matrices, correspondingly, and r denotes a hyper parameter for the count of subspaces that reflect and are utilized to build the graph representation regarding the node representation. An array of weights is generated instead of a vector when $r \geq 1$ and α are connected.

A matrix that generates a complete representation of the graph is called a graph illustration. Each column in the matrix represents an illustration in a single subspace. A completely connected layer and a $soft\max$ layer that receives G as input are the final steps in completing the graph categorization.

$$X = soft\max(ZG + C) \quad (25)$$

4. RESULT AND DISCUSSION

In this section the simulation outcome and the discussion of the performance of the suggested method is described. The primary objective is to increase the power transfer efficiency in WPT system. The proposed LOA method is used to optimize the optimal controller parameters and generates a set of control signals. The DAGCN is used to predict the power delivered to the load. By then, the proposed model is performed in MATLAB/Simulink working platform. Fig 3 display the Series parallel topologies of mutual inductance (M) vs transfer power, transfer efficiency. Here the transfer of power from 0 to 35 and the transfer of efficiency from 0 to 45. From the results plotted in the graph as display in fig 3, as the "M" rises the transfer power and transfer efficiency increases, the maximum transfer efficiency is around 44.29%.Fig 4 shows the Series parallel topologies of mutual inductance vs output power, efficiency. Here the output power from 0 to 110 Watts and it reduced up to 0.1. Then the efficiency flows from 0 to 99%. It also reveals that when the mutual inductance grows, the output efficiency also increases. For a value of M is 0.001Micro hennery, the efficiency is 91.98, while the output power reduces to 12.19 Watts. Fig 5 shows the series- series topologies of mutual inductance vs transfer power, efficiency. Here the output power flows from 0 to 160watts and the efficiency flows from 0 to 10%. The "M" increases the output power and output effectiveness, the maximum output efficacy is around 19.08%.

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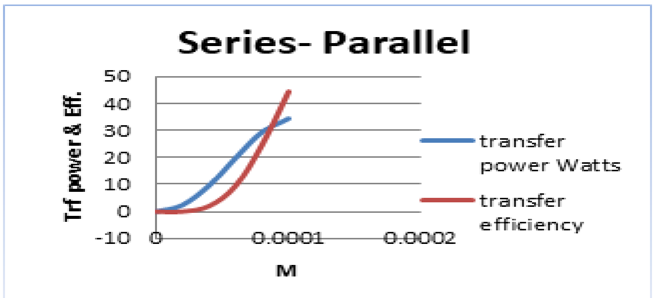

Fig 3: Mutual Inductance vs Transfer Power, Transfer Efficiency

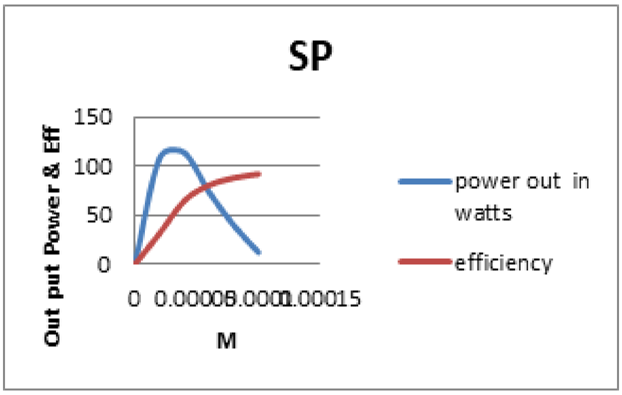

Fig 4: Mutual Inductance vs Output Power, Efficiency

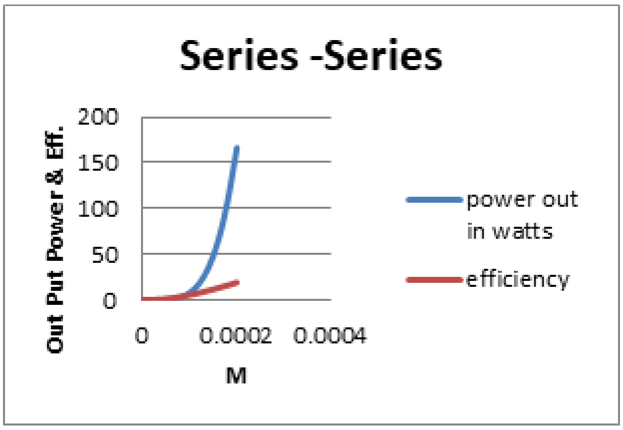

Fig 5: Mutual Inductance vs Transfer power, Efficiency

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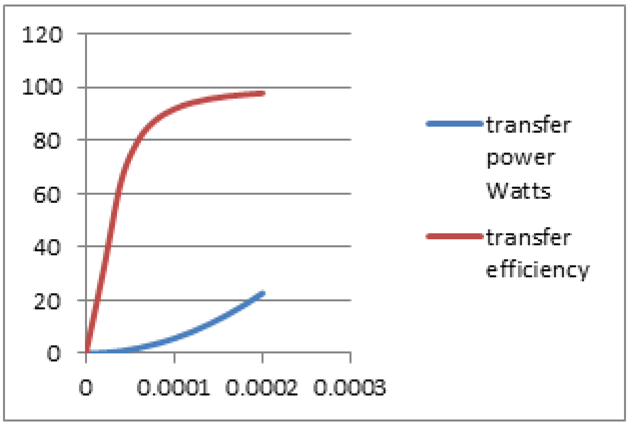

Fig 6: Mutual Inductance vs Output Power, Efficiency

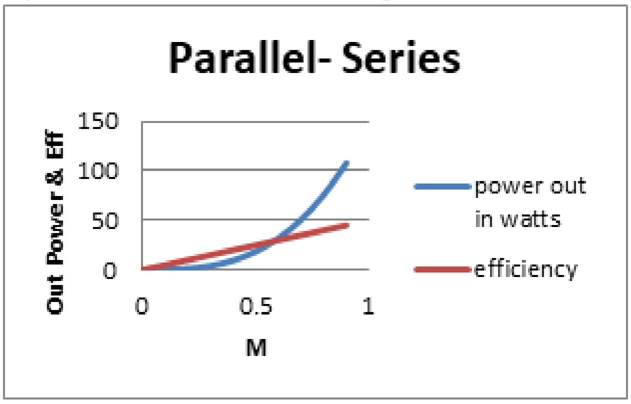

Fig 7: Mutual Inductance vs. out power, Efficiency

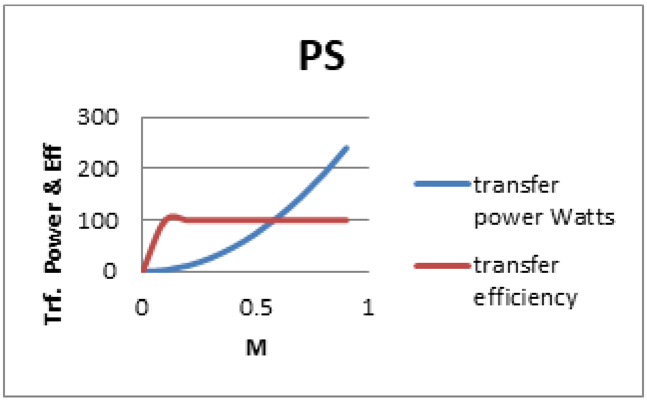

Fig 8: Mutual Inductance vs. Output Power, Efficiency

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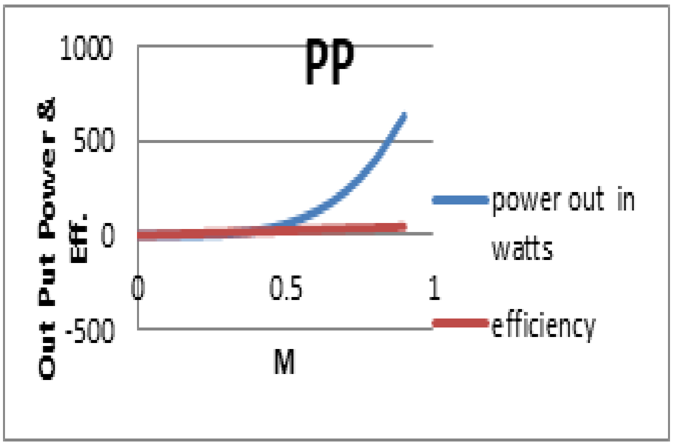

Fig 9: Mutual Inductance vs. Output Power, Efficiency

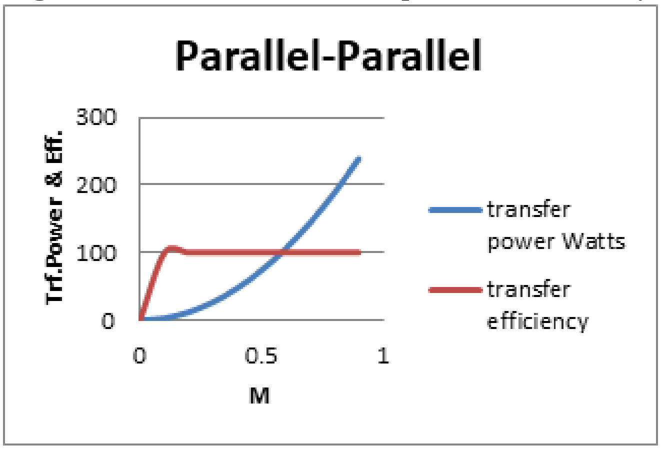

Fig 10: Mutual Inductance vs. Transfer Power, Efficiency

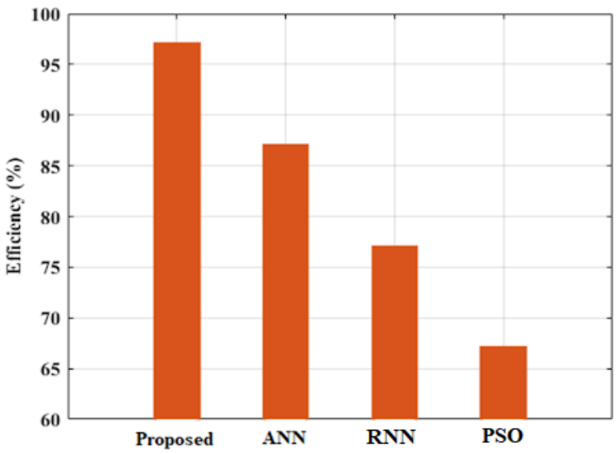

Fig 11: Comparison of efficiency of proposed and existing methods

Fig 6 shows the series- series topologies of mutual inductance vs output power, efficiency. Here the transfer power flows from 0 to 20watts and the efficiency flows from 0 to 100%. It reveals that as the mutual inductance grows, the transfer efficiency also increases. For a value of M is 0.002 micro hennery, the efficiency is 97.84, while the transfer power reduces to a value of 22.708Watts.Fig 7 shows the parallel- series topologies of mutual inductance vs output

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power, efficiency. Here the output power flows from 0 to 100watts and the efficiency flows from 0 to 50%. As the mutual inductance increases the transfer power and transfer efficiency, the maximum transfer efficiency is around 19.08%. Fig 8 shows the parallel- series topologies of mutual inductance vs output power, efficiency. Here the transfer power flows from 0 to 210watts and the efficiency flows from 0 to 100%. For a value of M is 0.900001 Micro hennery, the efficiency is 100, while the transfer power reduces to 240.04 Watts. Fig 9 shows the parallel- parallel topologies of mutual inductance vs output power, efficiency. Here the output power flows from 0 to 510watts and the efficiency remains constant at 0 %. The maximum transfer efficiency is approximately 45% for a value of M of 0.900001 Micro Henery, and the output power is approximately 633.8 watts. Fig 10 shows the parallel- parallel topologies of mutual inductance vs output power, efficiency. Here the transfer power flows from 0 to 210watts and the efficiency flows at 0 to 100%. At a value of M of 0.900001 Micro Henery, the efficiency is 100, while the transfer power falls to a value of 238.79 Watts. Comparison of efficiency of proposed and existing methods is display in Fig 11. The suggested approach gives higher efficiency of 97% when likened with other existing methods. Table 1 display the contrast of different topologies with SS, SP, PS and PP.

Table 1: Contrast of Different Topologies

Topologies	**Input Voltage**	**Rectified Voltage**	**Battery Charging Voltage**
SS	230	217.4	235.1
SP	230	217.4	235
PS	230	217.3	235
PP	230	217	242.8

4.1. Discussion

Different topologies, including PS, PP, SP, and series-parallel combination, are all used in the simulation. The PP model transfers far more power from the simulation than the other models and it does so with the highest efficiency of the four models. Since the PP model has the best performance in expressions of efficacy and power transfer, it is evident that it is the best option for building a resonant WPT system. The efficiency of the delivered power reduces more quickly as the distance between the coils grows. The Series-Series and Series-Parallel topologies have been shown to be the most optimum for most parameters among all topologies for the majority of claims and power levels. The SS topology is advised for the unit turns ratio between the main and secondary coils. The load and magnetic coupling coefficients have no effect on the resonance frequency. In the case that the output voltage is low, the SP remedy is suggested concurrently. You may reduce the size of the secondary side coil as much as you like, but if the distance changes, you will need to fine-tune the primary side coil.

5. CONCLUSION

In this manuscript, the LOA-DAGCN hybrid approach is proposed for the WPT system. The main goal is to increase the powertransfer efficiency in WPT system. The suggested LOA technique is used to optimize the optimal controller parameters and generates a set of control signals. The DAGCN is used to predictthe power transported to the load. The suggested approach exhibits a high rate of power transmission. The suggested technique's performance is put to the test using the MATLAB working environment and compared with other methods that are currently in use. Additionally, several compensating topologies are simulated for the WPT system's output power.depend on the outcomes, it can be terminated that the suggested technique's efficiency is 97%, which is greater than the effectiveness of current approaches.

5.1. Limitations

- Power transfer efficiency decreases with distance.
- Some energy is lost during transmission, reducing overall efficiency.

- Other electronic devices can interfere with power transfer.
- Current technology has limits on the amount of power that can be transmitted efficiently.

5.2. Future Scope

- Research is ongoing to improve efficiency and extend the range of wireless power transfer, potentially enabling applications such as powering devices in remote locations or even wirelessly charging electric vehicles while in motion.
- Wireless power transfer can be utilized in environmental monitoring systems, allowing for the remote powering of sensors and data collection devices in challenging or inaccessible environments.

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