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An Empirical Survey on Various Power Transfer Techniques in Electrical Vehicle using Wireless Mode

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Abstract— This study examines the current condition of the wireless power transfer (WPT) techniques in electric vehicle. The pros and downsides of wireless power transfer are explored, as well as its classification, application, trend, benefits and impact on society. It also offers a comparison of prior research in transfer the power wireless, pointing out upcoming different kind of method, topologies, statement, and optimization methods implemented for boost the efficiency of performance of the electric vehicle system and directing researchers in the appropriate direction for future research.

Keywords-Wireless power transfer, optimization, efficiency, benefits, topologies, communication.

I. INTRODUCTION

For a long time, classical wire systems were the primary means of transferring electricity. Age, wear, and the creation of electric sparks are all problems with traditional cable (wire) power transmission [1]. Wireless Electricity Transfer (WPT) has the potential to cause a paradigm shift by drastically altering the way power is transmitted. WPT [2] is a large method for transmitting electric power over great distances in a vacuum or environment ordinary materials.

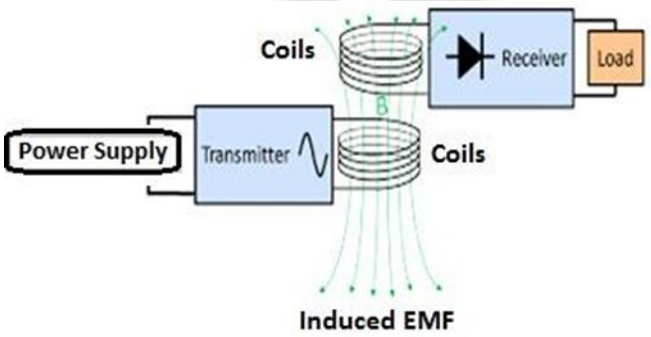

Figure 1: Basic Notion is Depicted

Idea to wireless charger a function in commercial products, most notably devices [3]. In previous years, mobile giants Huawei and Samsung released contemporary high-end smart phones. These devices have built-in wireless charging capabilities.

Qualcomm, Evatran, WiTricity, and other companies have already developed systems that can supply electricity for 15cm-30cm gap of air with acceptable efficiency. Here gives a broad review on technique for wireless transfer power. Figure 1 show the basic notion is depicted.

A. WPT Types

WPT it will classify into two types based on the energy transfer mechanism [1]: far- field and close-field WPT systems [2]. Figure 2 show the Types of Wireless Power Transfer.

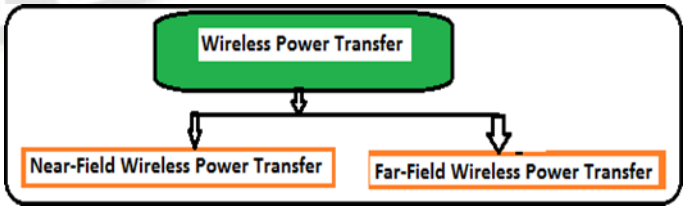

Figure 2: Types of Wireless Power Transfer

B. WPT in Fair Field

The other name of WPT in fair field is called radiation of electromagnetic. WPT [1] employs radio frequency broadcasts as a route for delivering energy as radiation [3]. The

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information's transferred through the field of electric on radiation of EMW. Microwave Power Transfer (MPT) is an electromagnetic radiation-based technology that transfers power in free space by leveraging the electromagnetic field's far-field radiation effect. [4].

Magnetron boosts power objects received from base station is used in conjunction of transmission geosynchronous and receiving from the satellite. [5]. The initial step in power transmission is happened electrical energy into some other like MW that is subsequently collected through the help of rectennas. When this procedure is utilized, the required microwave energy is not instantly transferred from Alternating Current (AC). The initial step is to convert to Direct Current (DC), then to microwave using a magnetron. Before returning to AC [5].

II. TRANSFER THE POWER THROUGH LASER

Transfer the power through laser is a method of transmitting energy at infrared frequencies for close distance. Using specialized photovoltaic cells, the laser powering receiver turns into the form of electricity the received laser light [6]. The advantage of laser is that it concentrates energy. Laser radiation, on the other hand, is potentially hazard us because it needs a straight line and precise for using on the receiver, both of them are have difficult attain practice [7]. Complex tracking techniques and a large range of gad gets are also required.

A. Solar System

One of the best applications of WPT is Solar system, and it entails sending satellite into Geosynchronous Earth Orbit with huge solar panels. These satellites are essential for generating and transmitting microwave electricity forward to the earth [10].

B. WPT for Close-field

Close field WPT, the other name of close field is non-radiative charger in wireless, is based on attractive sports ground combining connecting two coils for energy transmission inside of coil's diameter [11]. Because of its safety features, in everyday household products ranging from toothbrushes to more complicated gadgets such as electric autos by wireless charger

C. WPT for Inductive system

RFID tags, medical implants [4], sensors, wirelessly charging electrical equipment, and the automobile manufacturing industry have all employed it. 14] Ease of use and implementation. Because of its low transmission frequency, affecting human by the magnetic timbre, the efficiency of transmission is maximum of 95% in the near distances [12], However, one disadvantage of traditional inductive charge will do the best of near communication distances; for long diminishes will start the performance.

D. WPT for Magnetic System

Magnetically joined timbre wireless power broadcast (MJT-WPB) works on the identical principles as inductive joined wireless power broadcast. Enables the transfer of power for primary to secondary side, source of power is called the primary side and the utilizing (user, Load) side is called secondary side [15].in stature 3 shows WPT for Magnetic System diagram. On the other hand, this magnetically joined resonant employ magnetic resonant coils with the same timbre frequency [14]. Because MJT-WPB knowledge has the possible to be working in all facet of human life, counting shopper and medical gadget, stylish home, and stimulating cars, it has caught the interest of academia and industry. The Regions are depicted in Figure 3.

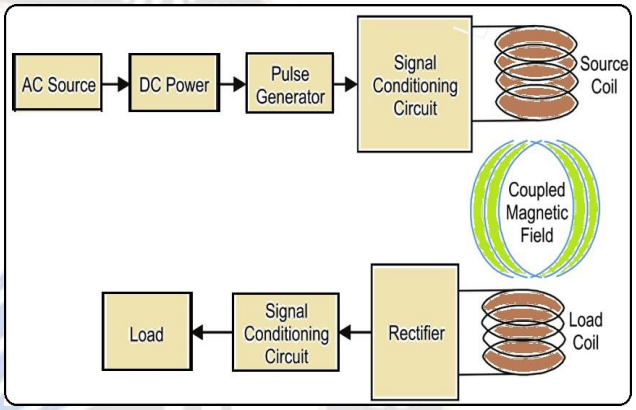

Figure.3: WPT for Magnetic System

The working frequency range from a few 100 kHz to 10 of MHz Magnetically joined Resonance Wireless Power transmits offer transfer power and efficiency than inductive joined power will transfer wireless, and is presently considered the approaches for middle-variety in WPT uses, on the other hand, loses efficiency due to axial mismatches between the receiver and transmitter coils, as well as reduced efficiency with greater distance. Figure 4 shows the regions

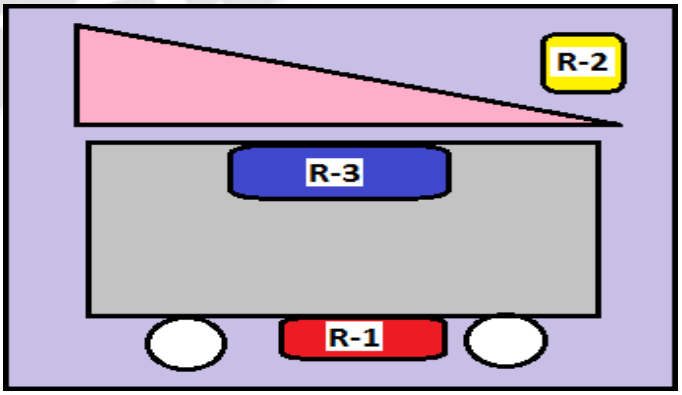

Figure 4: Regions

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E. WPT for Capacitive System

Capacitive method of power transfer function is transmission of energy among electrodes like as metal tableware (plates). An exciting retention capacitor is shaped when the handset and spreader electrodes are joint. The source produce the an additional voltage on the transmitting cover, when its used to induce an alternating potential on the recipient plate by electrostatic inspiration, resultant in irregular current flow in the weight track. [18].In Basic Schematic Circuits for Capacitive Power Transfer represent in Figure 5. Although capacitive control transmit is less expensive over inductive resonance and magnetically joined resonance; it still requires shut get in touch with flanked by the 2-metal surface.

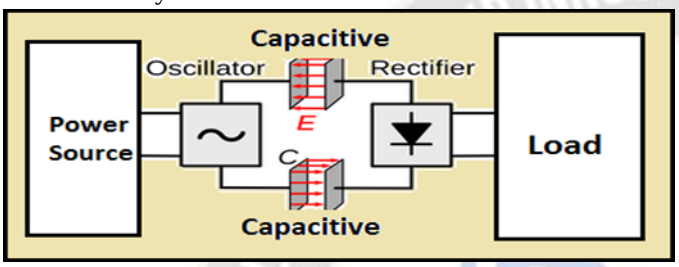

Figure 5: Basic Schematic Circuits for Capacitive Power Transfer

As a result, range limits constrain it significantly [4]. The fundamental disadvantage of capacitive WPT systems is that, due to their significantly higher relative field intensity, electric fields lack the same safety features as magnetic fields, affectation a risk to together human and electrical plans [4, 5]. Furthermore, the device's available surface limits the amount of timbre capacitance that may be achieved. However, when considering normal-sized portable electronic devices, achieving the required power density for charging is challenging, posing a design challenge [11].

TABLE 1: Comparison of ITP and CPT

Parameters	Inductive power transfer	Capacitive power transfer
Frequency	10's kHz to 10's MHz	100's kHz to 10's MHz
Gap distance	10's cm (efficiently)	<1 mm
Power	90% efficiency	90% efficiency
Gap power density	Comparable air gap power density (power stored in overlapping operational spaces)	

F. Application of WPT

Consumer electronics (phones, computers, audio players, tablets, and so on)[30] are among the industries where WPT has been used. In addition to cell phones, camera, and watch, WPT technology be capable of be second-hand to power TV [21]. Medical implant application is use to identify and pleasure person wellbeing problems [2]. WPT is as well utilized in charging systems for autonomous underwater vehicles (AUVs) [11], the IOT [31], emotional vehicle (EVs) [32,[33], and unmanned airborne vehicle (UAVs) [34].

G. WPT Advantages

It is convenient since it does not require a cable connection [26], it is affordable, and it can charge numerous devices at the same time.

Its increases manufactured goods strength deliver consistent control transmission in difficult environments including damp, unclean, or moving environments [27].

Wireless power transmission significantly simplifies manufactured goods plan. Standard components similar to influence port are completely preserved, resulting in a fully waterproof device. [28]

H. A Joint built on two spherical structure

[1] Created the three dimensional prearranged wireless transfer power it will transfer authority wirelessly in a automatic request by imitation and experiment of having the 500 kHz frequency. Twisting technique, combined made up of double sphere-shaped structure used, as shown in the figure. The combined and complete awake to revolving sphere-shaped arrangement within the massive globe with 85° automatic study. A spreader loop (SL) by way of radius is 3.85cm was used to wound a sphere- shaped construction (by means of hole). The automatic be able to spin a little spherical maximum of 450. The secondary side coils that are called by coil of receiving side its injury on top of 2.85cm/r, spherical structure, resulting in a displacement angle in degrees in figure 6.

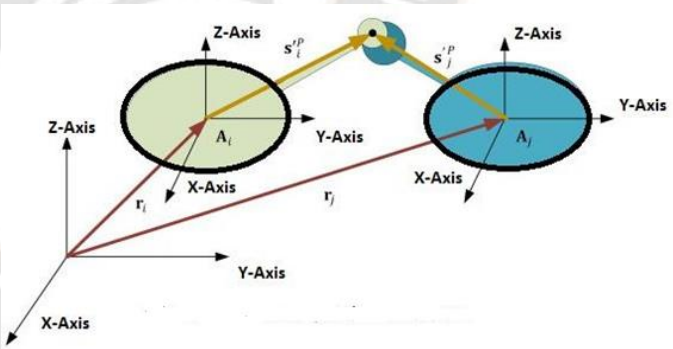

Figure 6: A joint built of dual spherical structures

By taking measurements between the vertical axes of the joint constructions, the value of was computed. According to the data, the semi-circular zigzag generates the maximum of 96% for 0° at a load (RL) of 20 of efficiency. The efficiency plummeted to less than 10% while the temperature went to 850. Under identical load conditions, the optimized WPT have 95% of efficiency & its 96% 0° & 85°.

However, if this technology is employed close the human body, when attractive ground thickness was concerted in a tiny

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region surrounding coil that could be dangerous. Furthermore, the author doesn't give details the optimized technique used in most favorable core, coil, and uncovering route element dimensions [37], the KAIST professor of Nuclear and Quantum Engineering, and his generation construct on the MIT investigate team ideas. Prof. Park's team achieved a huge increase in the coldness that emotional authority may be transmitting wirelessly.

The author urbanized "Dipole Coil Resonant System (DCRS)" having the ferrite center wound on the center to extend the variety of inductive authority transmit to three, four or five distance in meters, sandwiched between spreader and reception coil having the 29 % of efficiency, 16% of efficiency and 8% efficiency. To transfer energy, this team used a 20 kHz oscillating frequency on secondary side coil.

This system was employed in various trials, with results showing that in commission at 20 kHz shaped a upper limit authority output of 1403W at 3 metres, 471W at 4 metres, and 209W for five/meters. The watts of hundred watts transfer power its gives the results of 36.9%, 18.7%, and 9.2 percent overall system powers at distance of 3, 4, and 5 meters. For nonadjacent and adjacent instances, however, the timbre was not taken into account [38].

Second, because of their composite arrangement and huge dimension, handset coil are hard in the direction of integrate into portable consumer products. The authors of [39] investigated the relay effect for wireless power transfer using magnetic resonant timbre to increase the energy transfer distance. Microwave Studio simulation software from Computer Simulation Technology (CST) was utilized for modeling and numerical analysis. According to the authors, a typical wireless power transfer system has a power efficiency of only 4.6 percent when sending energy across a 1- meter distance.

Table 2 depicts a variety of efficiency-based methods. in the direction of conquer the limitation, a 24cm communicate wind having the frequency is 40.58 MHz was placed connecting with transmission side and the receiving side of the coils, to enhancement of system authority transmission detachment. In comparison without a impart loop, the relay coil resulted in a 50% gain in power efficiency after installation [40].

Optimization/simulation method used	Topology method used	Frequency	Coil diameter	Vout/Output power	Distance	Efficiency %
ANSYS electronics	Series-series	500(kHz)	Tx coil =7.7cm Rx coil =5.7cm	5v		96
Numerically modeled		20(kHz)		1,403W, 471W, 209W	3m 4m 5m	29 16 8
Computer Simulation Technology (CST) Microwave Studio simulation software	relay resonator coil	41.587(MHz) 29.982(MHz)	24cm 28cm		1m	71 89
Mathematical analysis		13.56(MHz)			30cm	60

TABLE 2 Some Different method based on Efficiency

The logical and convenient aspects of omnidirectional WPT using a cubic transmitter [41], and they proposed that a cubic transmitter coil be used in this study to achieve omnidirectional power transfer. Were employed to assess the efficiency of the proposed omnidirectional WPT using analysis and implementation

At a 13.56 MHz operating frequency and a 30 cm ideal spacing, the cubic transmitter was able to achieve a 60 percent efficiency omnidirectional power transmission capability. However, the transmitter and receiver coils' 20 cm loop dimensions, and the coil could not be described as portable because it would take up space in the work area. In addition, no optimization report for calculating the suitable extent of the pick and choose coils and detecting path fundamentals was given.

Since the shut connection stuck linking the digit of turns on the excitation and pick and choose, as well as excitation and discovery circuit, a mismatch between the transmitter and receiver characteristics may occur.

III. SIMULATION AND RESULT

The measurements of ESRs were taken from the coils with the resonant capacitors at the resonant frequency close to 20 kHz. Table 3 shows the measured impedances and the calculated PTE of the three different coils in open space and under automotive body. All of the measured inductances are smaller than the simulated values, because the winding widths of the fabricated coils are approximately 10 % larger than those of the simulation models. In addition, due to the difference between the simulation model and the real automotive body structure, the amounts of the impedance variations are reduced. Nonetheless, R2 of the Coil 1 is increased over 1000 %, and the calculated PTE of Coil 1 is decreased from 97.91 % to 88.17 % by the influences of the automotive body. On the other hand, it can be seen that the optimized design is almost not affected by the automotive body and the most efficient coil design under automotive body.

TABLE 3: Estimated Quality factor for Inductive coupling method and Magnetic Coupling Method.

Efficiency ηmax	Estimated Quality Factor(Q)	
	Inductive Coupling Method	Magnetic Resonant Coupling Method
88%	292	312
90%	358	378
92%	458	478
94%	625	645
96%	960	980
98%	1970	1990

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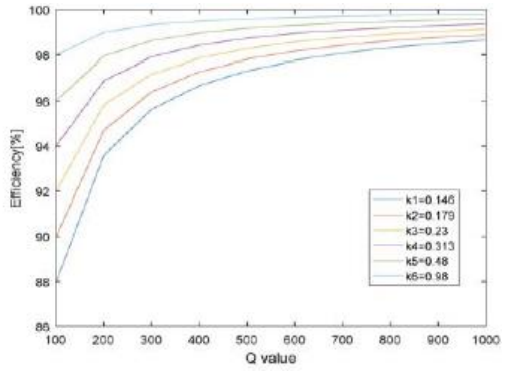

Figure 7: Coupling Coefficient estimation curve for Inductive coupling method

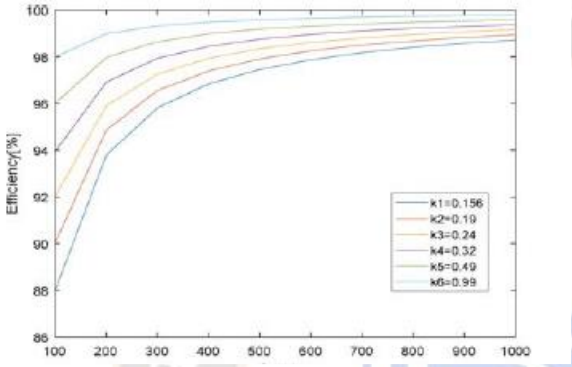

Figure 8: Coupling Coefficient estimation curve for Magnetic coupling method

Figure 7 and Figure 8 shows the Comparison of inductive and magnetic coupling method. The inductive coupling method is better than magnetic coupling method.

The experimental verification of the proposed concept is being described. To test operational characteristics of e-scooter WChS, the focus was given on identification of efficiency characteristic of proposed concept together with gain characteristic of coupling elements. The variables for which individual dependencies have been realized are output power, operational frequency and distance between coupling elements. The primary side consists of an EMI filter, a rectifier, a DC/DC (Buck) converter for voltage reduction and a voltage inverter. The secondary side consists of a rectifier, a DC/DC (Buck) converter and an electronic load. Equivalent resistance values were determined analytically according to [14].

TABLE 4: Comparison of Impedance measurement results

In open space	
Parameter	Optimized design
R1	63 mΩ
R2	61 mΩ
L1	304 µH
L2	299 µH
M	36 µH
η0 (calculated)	########
Under automotive body	
Parameter	Optimized design
R1	69 mΩ
R2	70 mΩ
L1	305 mΩ
L2	300 µH
M	37 µH
η0 (calculated)	########

The first measurement was performed for a mutual distance of the coupling coils of 7 cm. The resonant frequency of the system at this distance was 83,1 kHz. The highest efficiency achieved for given distance was 80 % for output power of app. 100 W. Second measurement was performed for 6 cm of distance between the coupling coils. The resonant frequency was 80,4 kHz, while the highest efficiency achieved was 81,03 % at an output power of app. 125 W. Measurements of efficiency performance were realized for 5 cm distance between the coupling coils. The resonant frequency for this case was 96,2 kHz the highest efficiency achieved was 92,5 % at output power of 160 W. The graphical interpretation of previously described results is shown in Figure 9.

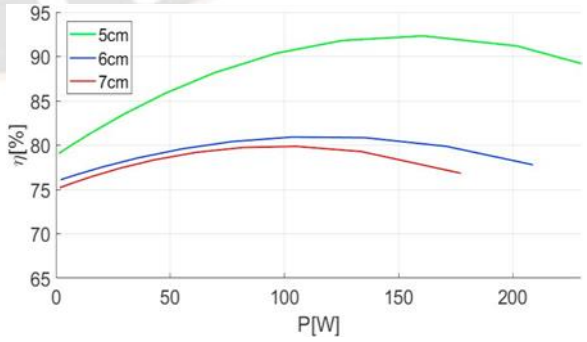

Figure 9: Efficiency performance vs. output power and transmitting distance

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IV. CONCLUSION

In this review paper, studied about the chosen researchers urbanized the tested a variety of compensation methodologies for various applications, inside arrange to get better the performance on authority convey in wireless medium by different strategies. Comparing with some other methods maximum of 94 % efficiency we achieved. This review paper will use full for improve the wireless power transfer and want to implement in all the electrical industry and electronics system. The comparison of prior research in transfer the power wireless, point out the upcoming different kind of method, statement, and different methods implemented for raises efficiency of performance and its directing researchers in the appropriate direction for future research.

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