ISSN: 0974-5823 Vol. 6 (Special Issue, Nov.-Dec. 2021)

International Journal of Mechanical Engineering

POWER TRANSFER AND FORCED GENERATION USING DYNAMIC WIRELESS POWER TRANSFER

Mrs. Shweta
Lecturer, Department of Mechanical Engineering, Mangalayatan University, Beswan, Uttar Pradesh.

Mr. Ashutosh Kumar
Faculty Associate, Department of Mechanical Engineering, Usha Martin University, Ranchi, Jharkhand.

ABSTRACT
For both environmental and motion control reasons, electric vehicles (EVs) are becoming more popular. Compared to internal combustion engines, their electric motors provide a faster and more accurate torque response than conventional engines. In spite of their limited range, electric cars need frequent recharging because of their poor range per charge. As a consequence, achieving wireless power transfer—the transmission of electromagnetic energy without the need of physical connections such as cables or waveguides—requires compromising on numerous critical requirements (such as efficiency) (such as stability). Several different devices and items are necessary for a smart home to function (IoT). Using electrical hookups or Lithium batteries to power all of them just confuses things further. Wireless power transmission (WPT) uses magnetic fields to transfer energy across short distances."

KEYWORDS Electric vehicles (EVs), Dynamic charging, system, wireless charging, wireless power transfer.

INTRODUCTION

Aside from the obvious environmental benefits, electric vehicles (EVs) are also capable of sophisticated motion control. Compared to internal combustion engines, their electric motors can respond more quickly and precisely to torque. Electric vehicles, on the other hand, must be charged often because of their restricted range. Users should be charged and the load should be reduced as a result of a charging network being established. Wireless power transfer systems for charging automotive accumulators are getting enough attention right now. Batteries may now be recharged on the go, which is in line with the norms of the world's most advanced nations. Wireless power transmission for moving transportation vehicles is still in the prototype stage, however, according to the latest research and development. The electromagnetic induction technology is used to charge accumulated batteries through wireless electro power transfer. Wireless power transmission systems that use electromagnetic inductance and a long distance between their transmitting and receiving transformer windings might benefit from the resonance inductive power transfer technology.

LITERATURE REVIEW

MINGZHAO SONG ET.AL (2021) The usage of wireless power transfer is limited due to the fact that it depends on electromagnetic field management techniques that were initially introduced decades ago and that it sacrifices certain essential aspects in the process (such as efficiency). — the transmission of electromagnetic energy without physical connectors like wires or waveguides — is becoming increasingly common (such as stability). Wireless power transmission has evolved in recent years thanks to new methods of manipulating electromagnetic fields. For wireless power transmission, new physical effects and materials are being developed. These are discussed below. Some of the solutions that we are investigating include coherent perfect absorption, exceptional points, and parity–time symmetry, as well as on-site power generation. The utilisation of acoustic power transmission, as well as the usage of metamaterials and metasurfaces, is also examined in this study Aspects of wireless power transmission technologies that might be explored in the future are also discussed here.

ALI HAJIMIRI ET.AL (2021) Our circuits and algorithms demonstrate arbitrary and nonuniform array-based dynamic 3-D lensing and focusing of electromagnetic power in radiative near- and far-field regions. Long-range wireless power transfer, volumetric sensing and imaging, high-speed communications, and optical phased arrays are just a few possible applications. A system's theoretical performance limits may be calculated. Adaptive algorithms do not need prior information of the receiver's location in order to focus power on the receiver(s) (s). As a result, it uses orthogonal bases to simultaneously adjust the phases of many components. 2-D orthogonal and pseudo-orthogonal matrices are generated using Hadamard and pseudo-Hadamard matrixes. There's no need for factory calibration since the GU and RU work together to quickly and reliably focus energy. For low-rate and high-latency communications, orthogonality allows batch processing. For immediate refocusing at various places, secondary vector-based computations may be used. The use of an emulator allows for more thorough testing of a system. The RF lensing methods described in this article can be used successfully, according to extensive testing. At distances larger than one metre, a wireless transmission may recover more than 2 W of dc power. Dynamic power projection is possible at different angles and distances larger than 10 m from the system. In the future, wireless power, sensing, and communication will all be integrated into a single system.

LIONEL PICHON (2020) This technology is now commercially feasible in a wide range of applications, from consumer electronics to medical implants. The benefits of WPT over regular cable charging for electric cars are many. However, even though some commercial vehicles currently have a wireless charging system, it is vital to explore a variety of domains in order to enhance design methodologies. Magneto-coupling systems are one of the most crucial components of wireless power transmission, and their efficiency and stray field levels have a considerable impact on both. According to the findings of this study, electric automobiles may benefit from three types of inductive power transfer. Concerns about human exposure and the impact of system parameter uncertainties are addressed after consideration of the coupling system's architecture and efficiency.

LUKE HUTCHINSON ET.AL (2019) If you're concerned about vehicle range, on-board energy storage capacity, and network dispersion of static charging systems, WPT may be a solution. WPT (Wireless Power Transfer) has the potential to speed up the adoption of electric cars (EVs) by making them more user-friendly and more affordable, as well as extending their range indefinitely. Current traction battery technology, conductive and inductive charging methods, important dynamic charging parameters, and notable WPT charging system development are all discussed in this article.. Read more.. To recognise the work that has to be done in the area of driver, vehicle and infrastructure interaction, the DWPT system requirements are summarised and international standards are underlined. The gap is not a technical one; rather, it is a matter of implementing the new technology properly. Interoperability difficulties across nations and systems can't be avoided if system designs aren't planned and deployed in accordance with established standards. These situations and places are described in order to bring about effective deployments, in which the technologies' influence is maximised with the minimal amount of infrastructure and technology consumption.

TOSHIYUKI FUJITA ET.AL (2017) With the introduction of electric vehicles (EVs), a solution must be found in order to overcome issues such as limited range and long recharging periods. A dynamic wireless power transfer (WPT) system is one of the most effective choices for supplying electric power to moving electric automobiles. As discussed in the next sections, this paper's WPT system has multiple fixed main and secondary coils as well as a moving secondary coil. This system's unique characteristic is the use of a single vehicle-side coil for both dynamic and stationary WPT. The dynamic WPT system formed from a stationary WPT system is equal to the stationary system in terms of its equivalent circuit, according to theoretical analysis. Circular coils might cause misalignment and flux distribution problems in the dynamic WPT system, hence solenoid coils are recommended. As part of a 3 kW dynamic WPT system, it is designed, produced, and tested to verify the principles of operation and the capability of continuous power transfer.

WIRELESS POWER

The notion of a "smart house" depends on a wide range of gadgets and items (IoT). As a result, supplying all of them with electricity through wall connectors or Lithium batteries becomes more difficult. It is possible to transmit electricity across small distances using magnetic fields through wireless power transmission (WPT). Nonradiative and radiative methods are used in WPT. In consumer items such as electric toothbrushes, smart cards, RFID, and pacemakers, the near-field nonradiative form is already in use. For smart homes, this version is more suited since it focuses on a smaller number of devices in smaller spaces. In contrast, long-distance P2P power transmission utilises a radiative approach. Either laser or microwave beams are used. These, on the other hand, are not suitable for usage at home.

REVIEW THE CLASSIFICATION OF WPT

For onboard battery chargers, electricity is delivered via one of three WPT energy transfer methods: an electromagnetic field, an electric field, or a mechanical force. The physical mechanisms that WPT 300tilizes are often used to classify it.

Table 1. WPT Classification of Different Energy-carrying medium

Energy-carrying medium	Technology		Power	Range	Efficiency	Comments
Mechanical force	Mechanical force		High	Medium	High	Capable of EV charging
Electric field	Capacitive power transfer		Low	Low	High	Both power and range are too small for EV charging.
Electromagnetic field	Near field	Traditional Inductive power transfer	High	Low	High	The range is too small for EV charging
		Coupled Magnetic Resonance	High	Medium	High	Capable of EV charging
	Far field	Laser, Microwave	High	High	High	Need a direct line-of-sight transmission path, large antennas, and complex tracking mechanisms.
		Radio wave	High	High	Low	Efficiency is too low for EV charging.

Table 1 shows how an electromagnetic field may be used to charge an electric vehicle. For WPT technology, the following is a list of the general Electromagnetic fields: WPT that may be utilised for long-distance power transfers, such as those between solar power satellites and the earth, such as electromagnetic radiation (microwave, laser, or radio wave). Major frequency operation is from 300 MHz to 3000 Ghz. It's not possible to use lasers or microwaves to charge electric vehicles, according to Table 1. Radio waves are inefficient for charging electric vehicles. For transmissions in the near field, this technique is also known as capacitive coupling WPT. Electric cars cannot be charged using this technology since it lacks the requisite power and range. Magnetic coupling WPT (inductive or resonant) is much safer than electric induction/coupling for near-field transmission. Technology that uses resonant coupling transfer in the form of electromagnetic resonance transfer (ERCM) is based on the coupled-mode theory. This coupled-mode theory decreases power loss due to the large air gap and the absence of significant placement limitations. The gadget created in is 90 percent efficient inside 1 m due to its excellent characteristics. It is possible to classify WPT as either a fixed charge or a dynamic charge. Whether or not the car is moving is dependent on the amount of time it takes to charge. The ERCM WPT technology for EVs, whether it is static or dynamic, is capable.

THIRD GENERATION WIRELESS IN-WHEEL MOTOR

The third-generation wireless in-wheel motor is described in detail in this section (W-IWM3). WPT and the in-wheel motor are combined in this arrangement. A drive system with an in-wheel motor is one in which the motor is built into the wheel itself. First-generation in-wheel motors with WPT8 were created by the authors' research group, as were second-generation wireless in-wheel motors (W-IWM2) with dynamic WPT. The DC-DC efficiency of the 9 W-IWM2 is 92% and its power supply capability is 12 kW. Specifically, the 18 kW and 95% efficiency objectives for the following model W-IWM310 represent an improvement above W-IWM2. Figure 1 shows the W-IWM3 and its attachment; Figure 2 shows the system setup.

(A) Overview of W-IWM3

(B) W-IWM3 with vehicle

Figure 1Third generation wireless in-wheel motor

UNSOLVED PROBLEMS OR DIFFICULTIES

The WPT system is already attracting the interest of an increasing number of researchers. According to Bi and colleagues, energy and environmental evaluations have been examined together with economic and regulatory considerations as well as health and safety considerations. He argues that driving performance and energy economy should be continually enhanced and raised. The initial expense of implementing dynamic WPT may be prohibitive. Mobile EVs with dynamic WPT-based WPT systems coverage. Driving in the desert, bush, or other secluded locales is a particularly challenging experience for an electric vehicle. Is there a way to recharge the EV in this area? Does the EV have to be used solely in urban areas, or may it go on public roadways and highways? There may be a difficulty with the financial aspect of the project. It would not be possible to handle the financial burden in third-world nations or emerging countries. Among the requirements for a WPT system are high efficiency, a large air gap, and a high output level. Numerous research focused at enhancing productivity, on the other hand, have produced a slew of findings. An air gap of 150 mm was sufficient for 95 percent efficiency in two-coil systems with adjustable coils. The WPT system's efficiency is still poor as a consequence of its transmission and conversion losses. More work is needed before the WPT system can be used effectively in the real world. The WPT system's efficiency could be improved with a new mathematical model for expressing compensation topology, proper resonant circuit design containing LCC or LCL, or improved topologies for obtaining better optimal inverter topology, appropriate circuit parameter design, and duty cycle selection. Increasing the AC input supply voltage may reduce transmission losses and improve mobility in the long term. The WPT construction costs might be significantly lowered if the power rail width is decreased. " It's time to look into and draught universally agreed-upon criteria and standards.

CONCLUSION

There is now a count showing that traditional transportation uses internal combustion engines to produce over a 25% ratio of environmental pollutants. There has been an increase in the need for EV technology development. In spite of these difficulties, consumers have not yet adopted the Plug-in charging strategy for electric vehicles. Starting with the WPT system's construction, the essay covers the fundamentals of electromagnetic resonant coupling in a concise manner. With an increase in transmission and reception distance, the resonance frequency of the transformer (which is aiming for the transmission inductance coils resonance frequency) will be reduced. Reducing the transmitting circuit's resonance frequency improves wireless power transmission efficiency and expands the resonance transformer's ideal distance between coils;

REFERENCE

1. Luke Hutchinson et.al “Potential of Wireless Power Transfer for Dynamic Charging of Electric Vehicles” DOI:10.1049/iet-its.2018.5221
2. Toshiyuki Fujita et.al “A Dynamic Wireless Power Transfer System Applicable to a Stationary System” DOI:10.1109/TIA.2017.2680400
3. Song, M., Jayathurathnage, P., Zanganeh, E. et al. Wireless power transfer based on novel physical concepts. Nat Electron 4, 707–716 (2021). https://doi.org/10.1038/s41928-021-00658-x
4. Lionel Pichon “Electromagnetic analysis and simulation aspects of wireless power transfer in the domain of inductive power transmission technology” Volume 34, 2020 - Issue 13
5. M. Yilmaz, V. T. Buyukdegirmenci, and P. T. Krein, “General design requirements and analysis of roadbed inductive power transfer system for dynamic electric vehicle charging,” in Proc.2012 IEEE Transportation Electrification Conference and Expo, 2012, pp. 1-6.
6. S. Raabe and G. A. Covic, “Practical design considerations for contactless power transfer quadrature pick-ups,” IEEE Transactions on Industrial Electronics, vol. 60, no.1, pp.400-409, Jan. 2013.
7. Y. Moriwaki, T. Imura, and Y. Hori, “Basic study on reduction of reflected power using DC/DC converters in wireless power transfer system via magnetic resonant coupling,” in Proc. IEEE 33rd International Telecommunications Energy Conference, 2011, pp. 1-5.
8. K. Iimura, N. Hoshi, and J. Haruna, “Experimental discussion on inductive type contactless power transfer system with boost or buck converter connected to rectifier,” in Proc. IEEE 7th International Power Electronics and Motion Control Conference, 2012, vol. 4, pp. 2652-2657.
9. T. Imura and Y. Hori, “Maximizing air gap and efficiency of magnetic resonant coupling for wireless power transfer using equivalent circuit and Neumann formula,” IEEE Transactions on Industrial Electronics, vol. 58, no. 10, pp. 4746- 4752, Oct. 2011.
10. Mohamed, A.A.S.; Meintz, A.; Zhu, L. System Design and Optimization of In-route Wireless Charging Infrastructure for Shared Automated Electric Vehicles. IEEE Access 2019, 7, 79968–79979.
11. Foote, A.; Onar, O.C.; Debnath, S.; Chinthavali, M.; Ozpineci, B.; Smith, D.E. Optimal Sizing of a Dynamic Wireless Power Transfer System for Highway Applications. In Proceedings of the 2018 IEEE Transportation Electrification Conference and Expo (ITEC), Long Beach, CA, USA, 13–15 June 2018.
12. Ali Hajimiri et.al “Dynamic Focusing of Large Arrays for Wireless Power Transfer and Beyond” VOL. 56, NO. 7, JULY 2021
13. Suul, J.A.; Guidi, G. Overview and Electro-Technical Evaluation of the State-of-the-Art for Conductive and Inductive Power Transfer Technologies, SINTEF Energy Research Report 2018. Available online: https://www.sintef.no/globalassets/project/elingo/18-0733---rapport-3---technology-fordynamic-on-road----6-til-nett.pdf (accessed on 30 September 2019).

14. Cirimele, V.; Freschi, F.; Mitolo, M. Inductive power transfer for automotive, applications: State-of-the-art and future trends. In Proceedings of the 2016 IEEE Industry Applications Society Annual Meeting, Portland, OR, USA, 2–6 October 2016
15. Cichon, D.J.; Wiesbeck, W. The Heinrich Hertz wireless experiments at Karlsruhe in the view of modern communication. In Proceedings of the 1995 International Conference on 100 Years of Radio, London, UK, 5–7 September 1995; pp. 1–6.