IEEE ENERGY CONVERSION CONGRESS & EXPO Nashville, TN | OCT.29-Nov.2

Tutorial Title

Advances in Wireless Power Technology for Electric Vehicles and Smart Devices

Instructor Team

Chun T. RIM (Chair and Prof.), GIST, Korea (South)

Abstract

Recent advances in wireless power transfer (WPT) technologies offer consumers and industries with more convenient, efficient, and intelligent charging of electric vehicles (EVs) and smart devices (SDs) such as smart phones, drones, robots, and IoTs. WPT has been adopted to get free from frequent plug in and out of charging by hand. Heavy and bulky batteries alone cannot solve the energy hungry problem of all mobile things, which should be eventually recharged.
In this tutorial, fundamental principles of WPT including inductive power transfer (IPT) are briefly introduced first, and major WPT theories such as coupled coil model, gyrator circuit model, magnetic mirror model, and general unified dynamic phasor model are explained.
Advances in WPT for EVs are extensively explained, which are classified into stationary charging electric vehicles (SCEVs) and roadway powered electric vehicles (RPEVs).
SCEVs are getting more attraction due to their convenience and safety. Furthermore, due to rapid increase in the market shares of EVs and renewable energies, the interoperability of EVs and grids became of great importance. EVs are no longer simple energy consumers but energy providers to the grids. WPT is a promising solution to connect EVs with grids automatically whenever parked. This is a potential contribution of SCEVs as a flexible means of interoperable power systems. The coil design, large tolerance charging, compensation circuit, and foreign object detection (FOD) issues are addressed in detail. Recent progress in worldwide technology development is summarized as well. RPEVs are free from serious battery problems such as large, heavy, and expensive battery packs and long charging time because they get power directly from a road while moving. The power transfer capacity, efficiency, lateral tolerance, electromagnetic field (EMF), air-gap, size, weight, and cost of the WPTSs have been improved by virtues of innovative semiconductor switches, better coil designs, roadway construction techniques, and higher operating frequency. Recent advances in WPT for RPEVs are introduced. Advances in WPT for SDs are explained, which are quite different from each other depending on operational environments. Smartphones are the most successful applications of WPT, which are now evolving to get more freedom of charge in space. Due to distributed and numerous nature of IoTs, WPT for widespread area is quite challenging. Various drones and robots of different power level and endurance time require fast enough charging speed with freedom of position. Recent technology developments are explained. Future of WPT issues are addressed, which includes interoperable wireless EVs, longer distance IPT, 3D wireless chargers, and synthesized magnetic field focusing (SMF).

Instructor Biography

Chun T. Rim (Ph.D.)
Prof.
Graduate School of Energy
Convergence GIST, Gwangju
Korea(South)

Chun T. Rim (IEEE Fellow ’20) received the B.S. degree with Honor in EE from the Kumoh Institute of Technology (KIT), Korea, in 1985, and the M.S. and Ph.D. degrees in EE from the Korea Advanced Institute of Science and Technology (KAIST), Korea in 1987 and 1990, respectively. He was an Associate Professor with KAIST in 2007-2016, and a Full Professor with the Gwangju Institute of Science and Technology (GIST), Korea since 2016. He was the presidents of the Korean Institute of Energy Technology Evaluation and Planning (KETEP) in 2018-2021 and the Korea Energy Economics Institute(KEEI) in 2021-2022, respectively. He has authored or coauthored 199 papers, written 18 books, and awarded 160 patents. He won numerous awards, including the Best Paper Awards of IEEE TPEL in 2015 and J-ESTPE in 2016 both in WPT. He is now a Co-EiC of IEEE TPEL, dealing with WPT and renewable energies.

He has been a general chair/steering member of the IEEE Workshop on Wireless power (WoW) since 2015. He became the IEEE Fellow for contributions to WPT for EVs and mobile devices. He has developed WPT of KAIST On-line EVs, 6 degree-of-freedom (DoF) mobile phones, and 12m-distance IoTs. He invented synthesized magnetic field focusing (SMF) technology and innovative modeling techniques such as unified-general dynamic phasor, gyrator models for IPT, and magnetic mirror model. He has delivered more than 34 international lectures and speaking, including the following:

- Plenary speech, “Advances in Wireless Power Technology,” AEIT, EU, Nov. 2021.
- Tutorial, “Theories for Wireless Power Transfer,” PESA, Hong Kong, Dec. 2017.
- Keynote speech, “Wireless Power Transfer for Electric Vehicles and Mobile Devices,” Beijing Institute of Technology, Nov. 2017.
- Tutorial, “Design of Wireless Electric Vehicles,” IEEE APEC, USA, Mar. 2017.