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Receiver-Position-Controlled Field Focusing for Dynamic Inductive Power Transfer Systems

Technology #13102

NCSU is seeking an industry partner to commercialize a novel technology of Wireless Power Transfer

Abstract

Wireless power transfer (WPT) based on magnetic coupling is becoming widely accepted as a means of transferring power over small to medium distances. WPT systems show promise for charging electric vehicle batteries, electronic devices, and other technologies.

Stationary wireless charging systems have relatively high efficiencies (>90%) if the source and receiver coils are well aligned. However, in dynamic charging systems (say, when powering a vehicle while driving along a roadway, powering a swarm of robots moving on a flat surface, powering factory automated guided vehicles or overhead conveyers), the issue of alignment becomes more challenging. This leads to power transfer inefficiencies and potential non-adherence to electromagnetic field emission standards.

One approach to dynamic WPT is to have an elongated source coil coupled with a small receiver. This system results in low coupling coefficient (and therefore low efficiency) due to the relatively large self-inductance of the elongated source coil. Another issue is that the field emitted in the uncoupled sections of the track needs to be contained to ensure that emissions standards are met. The issue of low coupling is solved by segmenting the source coil, so that only the sections coupled with the receiver can be selectively turned on. The challenge becomes implementing a method to control the power delivery to each section of the source coil as the function of the receiver position. State of the art solutions use receiver position sensor, communication links and complex relays or switches and compensation circuits to achieve the power flow control.

Researchers in the Department of Electrical and Computer Engineering have developed a system for transferring power between a sectionalized source and a one or more dynamically moving receivers. The proposed system uses the reflected reactance from the receiver to automatically limit the field strength in uncoupled portions of the source-receiver system, thus allowing the system to more easily meet the electromagnetic field emission standards without complex shielding circuits, switches, electronics and communication requirements. The power transfer is at its peak when the source and receiver coils are close to their maximum allowable coupling, resulting in improved system-level efficiency.

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Advantages:

- Amplifies power transfer when the source and receiver and well coupled, resulting in increased power efficiency and reduced system losses.
- Reduces power transfer when source and receiver are weakly coupled, allowing the system to meet electromagnetic field emission standards without the need for complex shielding, switches, electronics or communication channels.
- Simple method of powering multiple devices placed on a powered surface without additional communication or control steps.
- This new WPT system could be used when powering a vehicle while driving along a roadway, powering a swarm of robots moving on a flat surface, powering factory automated guided vehicles or overhead conveyers, or for powering multiple personal electronic devices placed on a surface (e.g. laptops on a table).

Related Patent Application:

- Issued PCT patent: WO 2014127036 A1 "Systems and methods for wireless power transfer "

About the inventors:

Dr. Srdjan Lukic is a professor of electrical and computer engineering at North Carolina State University. He obtained his doctoral degree at the Illinois Institute of Technology in Chicago. His primary research interests are power electronics and power systems, particularly electric vehicle systems, power management ICs and power semiconductor devices.

Zeliko Pantic is a doctoral candidate in the department of electrical and computer engineering and co-inventor of this technology. Mr. Pantic was a researcher at the University of Belgrade in Serbia before moving to North Carolina. His research interests include designing electromechanical systems, electric vehicle systems, power management integrated circuits and power electronics.

North Carolina State University graduate student Kibok Lee is a co-inventor of this technology.

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