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A simulation-based study on transmitter coil geometries to enhance the efficiency of Wireless Power Transfer (WPT)

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Wireless Power Transfer (WPT) technology uses a time-varying electromagnetic (EM) field to transfer power from a transmitting source to a receiving device according to Faraday's Law of electromagnetic induction. The WPT systems usually consist of transmitter and receiver coils located in the near field that are designed to resonate at the same frequency. This enables resonator coils to exchange energy efficiently via coupled mode resonance. However, in the existing WPT systems, the generated EM fields propagate as nondirectional EM waves. Consequently, a significant amount of energy would be off-targeted, wasting a considerable amount of useable energy. According to the EM wave propagating properties, the shape of the transmitter coil can be optimized to directionalize the transmitted EM field. By directionalizing the generated EM fields, the WPT efficiency can be enhanced. This study is primarily focused on presenting a novel method to enhance the wireless power transmission efficiency and the transmitting range of an overall WPT system by modulating the geometry of the transmitter coil. In this study, a novel wireless power transmitting coil design is proposed, and the proposed coil design consists of a curved shaped array of resonant coils, which can directionalize the generated EM fields in a WPT system. The proposed transmitting coil structure is developed by placing an array of coils on a concaved shape surface and the 3D model is designed by using a 3D CAD design software and simulations are performed in "EMS" simulation software. Based on simulation results, it can be concluded that the EM field intensity, efficiency, and the transmission range of a WPT system can be enhanced by directionalizing the transmitter generated EM fields to reduce the wastage of the useable energy in the generated EM fields. Furthermore, this proposed transmitting coil design can be used to generate and transmit EM energy, targeting a receiver fixed at a specific point.

Keywords: Wireless Power Transfer (WPT), transmitter coil geometries, antenna design, power transfer efficiency

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