PERFORMANCE IMPROVED CAPACITIVE WIRELESS POWER TRANSFER SYSTEMS

タレック マハムウト アティア モスタファ

氏　　名　：Tarek Mahmoud Atia Mostafa

Name

論 文 名 ： PERFORMANCE IMPROVED CAPACITIVE WIRELESS POWER TRANSFER SYSTEMS
(容量結合無線電力伝送システムの性能向上研究)

Title

区　　分　：甲

Category

論 文 内 容 の 要 旨

Thesis Summary

Electric power is one of the main contributors of the life quality of any nations. Generally, the power is transmitted through wires which suffer from a lot of problems such as excessive cost and movement freedom limitation. Wireless power transfer (WPT) technology and its different topologies introduce an efficient solution for a future without wires. These WPT technologies can be categorized via different ways, for instance, based on the distance of transmission, WPT technologies can be divided into the following three groups; (i) far field or in other words long-range that includes laser-beaming or microwave power transmission, (ii) for mid-range, which possesses the resonant inductive coupling power transmission technology, (iii) for short-range power transmission, inductive coupling power transmission (IPT) technology, the most widely used technique in this range, or capacitive coupling power transmission (CPT) technology is used.

CPT technology, as one of the near-field WPT technologies, which uses an alternating electromagnetic field to transfer power wirelessly, is currently gaining significant research attention and is the core of this dissertation. CPT is distinguished by several advantages such as low standing losses and electromagnetic interference (EMI), ability to transfer power through electrically isolated metal barriers, and small size and light weight. Accordingly, CPT technology is applied to wide range of applications including integrated circuits, biomedical devices, consumer electronics, and electric vehicles.

The thesis will start by a brief historical summery of WPT technology and its most known methods. Then, the CPT technology will be covered from the operating principle, system structure, circuit analysis, state of art and main advantages and challenges perspectives.

Two main challenges have been addressed and new topologies are introduced for performance improved CPT system. Firstly, due to the small coupling capacitances, the system is often too sensitive with a high-quality factor (Q), and the maximum voltage across the coupling plates are too high. This thesis proposes a novel CPT system with DC-DC buck converter on the secondary side and CPT system with a step-down transformer on the secondary side with inherent lower Q and thereby less sensitivity to parameters variations, and reduced voltage stress that results in a safer system.

Secondly, up-to-date studies have neglected the load value effects on the CPT system performance. In this thesis, a detailed analysis is carried out on how the load value can affect the CPT systems' performance and a controlled buck-boost converter is introduced to track the optimum load so maximum power transfer and high efficiency can be maintained over a wide range of load operation.

By the end of this dissertation a feasibility study for an e-waste dismantling facility in Cairo, Egypt is introduced. This feasibility study aims to provide a guide to set up an economically viable e-waste recycling business by calculating the main costs and revenues of the recycling system considering the environmental standards.