Wireless Power Transfer System for Biomedical Application: A Review

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***Abstract*— Wireless power transfer system is an emerging technology that is useful to recharge the battery wirelessly for various portable and biomedical implant devices, battery free sensors, passive RF identification, near-field communications, and many others in near field region. WPT is a fundamental enabling technology which eliminates wired power connections. It is a very broad research area that has recently become applicable to implantable medical devices.Biomedical implanted devices are becoming popular in health and medical applications in a wide range of areas, such as, cardiac pacemakers, retinal prosthesis, cochlear implants, defibrillator, smart orthopedic implants, artificial hearts etc.The traditional approach of supplying power to these devices is implantable batteries, bio-fuel cell and percutaneous links. However, any battery has limited energy storage and life span similarly bio-fuel cell has low output power and percutaneous links are susceptible to infection and reliability problems. Currently, most commercial implanted devices utilize high volume, non-rechargeable batteries. These batteries inevitably need to be replaced at the end of their life span by costly surgery. In addition, bulky size of the batteries due to high energy requirement becomes an obstacle in design of compact implantable devices.**

The aim of this paper is to review WPT technology in biomedical Application and challenges in WPT system design.

The most important advantage of wireless power transfer system is longer life span as compared to non rechargeable batteries and capability to deliver power without costly invasive surgery. In addition invasive surgery involves serious health hazards which are totally eliminated by Wireless Power Transfer System.

Keywords—Compact implantable devices, Rechargeable batteries, Specific Absorption rate (SAR), Wireless power transfer systems (WPTS).

I. INTRODUCTION

Wireless power transfer is the technology that enables a power source to transmit electromagnetic energy to an electrical load across an air gap, without interconnecting cords. This technology is attracting a wide range of applications, from low-power toothbrush to high-power electric vehicles because of its convenience and better user experience. Nowadays, wireless charging is rapidly evolving from theories toward standard features on commercial products, especially mobile phones and portable smart devices. In 2014, many leading Smartphone manufacturers, such as Samsung, Apple and Huawei, began to release new-generation devices featured with built-in wireless charging capability. IMS Research envisioned that wireless charging would be a 4.5 billion market by 2016 [3]. Pike Research estimated that wireless powered products will triple by 2020 to a 15 billion market.

Similarly, Implantable medical devices have become a huge demand, with over 20 million individuals estimated to have an implanted medical devices, 250,000 new pacemakers are implanted each year; 100,000 implantable cardioverter defibrillators (ICDs) are implanted each year and in tune of 120,000 cochlear implants[3].

II. LITERATURE REVIEW

History of Wireless power Transfer began with the formation of Maxwell's equation in 1862. Maxwell described phenomenon of radio wave in his equation. Later in 1884, Henry Pointing illustrates electromagnetic wave as energy flow and used in his poynting theorem. Nikola Tesla investigated the principle of WPT at the end of the 19th century. Since; Tesla's experiment was not exploited to a commercial level because of its unsafe nature, low efficiency and financial constraints. After Tesla's initial experiments, electromagnetic wave are used for wireless communication and remote sensing application. Due to the advancement in semiconductor technologies, Tesla's proposition has now becomes a reality. The wireless nature of this transmission makes it useful in environment when implementation of physical connectors can be inconvenient, hazardous and complex for battery charging application such as biomedical implanted devices.

1. Different power Approaches and Power Ranges for Biomedical Implanted devices (IMDs)

Power approaches are categorized into two main groups:

- IMDs that work independently with or without a one-time battery.

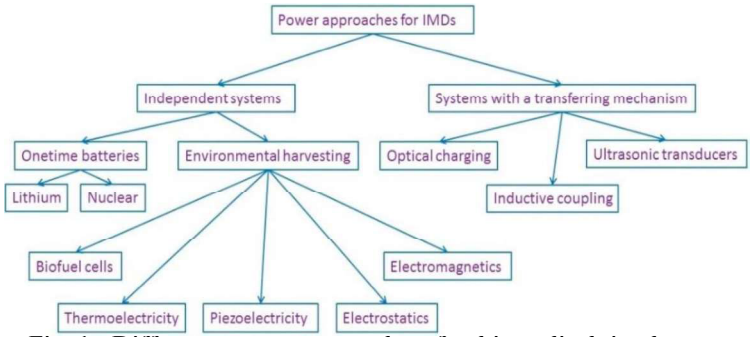

Fig 1: Different power approaches for biomedical implants [11].