Inductive and Radiating Energy Harvesting for an Implanted Biotelemetry Antenna

Quang-Trung Luu\(^2\), Stavros Koulouridis\(^1\), Antoine Diet\(^2\), Yann Le Bihan\(^2\), Lionel Pichon\(^2\)

\(^1\) School of Electrical and Computer Engineering, University of Patras, Patras, Greece, koulouridis@upatras.gr
\(^2\) Group of Electrical Engineering - Paris, UMR 8507 CNRS, CentraleSupelec, Université Paris Sud, Gif-Sur-Yvette, France, Lionel.Pichon@geeps.centralesupelec.fr

INTRODUCTION

Electromagnetic (EM) energy has been proposed as alternative source for permanent implants or for utilizing battery-less implanted devices. For years the focus has been put on inductive power transfer through the use of coils but lately the so called Radio Frequency (RF) or Radiating approach has been considered. The latter has been initiated by the need to design autonomous implants of very small sizes that support wireless signal transmission.

Indeed, miniaturized antennas operating in the 400MHz – 2500MHz have been proposed in several configurations for supporting wireless biotelemetry. For example in (H. Li, Y.-X. Guo, C. Liu, S. Xiao, and L. Li, IEEE Antennas Wirel. Propag. Lett., 14, 1176–1179, 2015) a planar antenna operating in the 400MHz MedRadio Band has been proposed while in (S. Bakogianni and S. Koulouridis, IEEE Antennas Wirel. Propag. Lett., 15, 234–237, 2016) a miniaturized planar dipole has been introduced for in-body communication at the same frequency and a wire dipole antenna has been developed in 950MHz region (H.-Y. Lin, M. Takahashi, K. Saito, and K. Ito, IEEE Trans. Antennas Propag., 61, 3, 1363–1370, 2013). Other works focus on ISM 2.45GHz frequency band.

Inductive wireless transfer for implanted devices has been based on several coil configurations systems in very close distances in-between (in terms of wavelength). By proposing designs at kHz region or at frequencies of few MHz efficient designs have been obtained. Still the coil sizes have been kept relatively large. Lately, in order to minimize coil sizes, the sub-GHz area has been proposed. The use of 1-2 mm diameter loops could lead to combined designs of inductive circuits with antennas that support wireless charging and medical telemetry. The idea is that very small loops would not affect the relative larger antennas while the larger loops (lower frequencies) could interact with antenna and affect its performance. Still, the use of inductive loops requires distances between external applicator and implanted receiver of 1-2 cm (D. Ahn and M. Ghovanloo, IEEE Trans. Biomed. Circuits Syst., 1–13, 2015), (A. S. Y. Poon, S. O’driscoll, and T. H. Meng, IEEE Trans. Antennas Propag., 58, 5, 1739–1750, 2010) and therefore placement of the external applicator directly on the body. Moreover, displacement of the external applicator or unwanted misalignment between external and internal system can greatly affect wireless transmission performance. In any case such problems have been addressed but not necessarily solved.

Radiating (or RF) charging propose an alternative path. Use of antennas for wireless energy transmission could possibly achieve greater distances and robust designs combined with greater efficiencies. Work in this field is not extended. In (S. Bakogianni and S. Koulouridis, 2016 EUCAP, pp. 1–5, 2016) a novel miniaturized rectenna for wireless telemetry and power transfer at MedRadio (402-405MHz) and ISM (902.8-928MHz) bands, correspondingly, has been proposed.

In this work we are exploring the idea of integrating inductive wireless charging in the 15x15x1.25 mm\(^3\) antenna of . We also draw some comparisons with the work in (S. Bakogianni and S. Koulouridis, 2016 EUCAP, pp. 1–5, 2016). A first approach was discussed in (S. Koulouridis, S. Bakogianni, A. Diet, Y. Le Bihan, and L. Pichon, in IEEE Anten and Prop Society, AP-S International Symposium (Digest), 2016, pp. 1–4). The main restriction applied is the embedding of the proposed device in depths larger than 10mm and the use of frequencies below 1GHz.