Sewn-in fractal antenna for radio wave emission type non-contact power transmission

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ABSTRACT

The ventricular assist device (VAD) is powered by an external power source and has problems such as the risk of infection at skin penetration sites. To address these concerns, non-contact power transmission via external charging is considered effective. This study proposes non-contact power transmission for implantable devices like VADs, employing radio wave emission type transmission for stable long-distance power transfer, crucial for charging artificial hearts. The hypothesis explores the use of sewn-in coils as antennas, given their potential as high-frequency antennas.

Electromagnetic field simulations serve as key metrics for antenna fabrication, optimizing for efficient operation at 144MHz. Evaluation in simulations focuses on antenna size and Return loss, aiming for a small size suitable for sewing onto clothing with low Return loss at 144MHz. High-performing antennas in simulations are fabricated and measured using Vector Network Analyzers and Spectrum Analyzers to assess antenna characteristics such as Return loss and transmission efficiency. Experimental measurements are conducted in two environments a scattering environment and a radio wave anechoic chamber. Return loss and transmission efficiency are measured for different fractal degrees and Litz Wire thicknesses.

In simulations, the Vicsek fractal antenna exhibits the best Return loss at approximately -18dB compared to other antennas. Consequently, the Vicsek fractal antenna is fabricated and tested. In a scattering environment, the second-degree fractal shows lower Return loss, reaching -25dB, but near the human body, third-degree fractals demonstrate lower Return loss. In terms of transmission efficiency, when antennas are spread out, the efficiency is better for larger first-degree fractals. However, near the human body, there is no significant difference in efficiency among different fractal degrees, with all antennas achieving only a few percent efficiency. These trends hold true in both scattering environments and radio wave anechoic chambers. Furthermore, all fractal antennas exhibit a figure-eight pattern in the azimuthal direction. These results reveal the characteristics of Vicsek fractal antennas and the impact of Litz Wire thickness on their performance.