Targeted Electromagnetic Ablation for Liver Cancer: Design and Simulation of a High-Precision Catheter System

Ablation using an electromagnetic field is a promising minimally invasive cancer therapy method that accurately targets cancerous tissues while causing the least amount of harm to nearby healthy structures. By precisely delivering electromagnetic radiation to malignant tissues, this method aims to create controlled thermal ablation zones. To improve the accuracy of electromagnetic energy delivery for liver cancer ablation therapy, this study focuses on simulating and optimizing catheter designs.

The crux of this work is to develop a catheter system that integrates precise electromagnetic energy delivery with real-time monitoring of the ablation zone. This enables oncologists to target tumors effectively while protecting vital healthy liver tissues. The design must be optimized in terms of energy propagation, dynamic physiological factors, and reliable performance.

An Ultra-Wideband (UWB) antenna was designed for the catheter system during the project's first phase. The wide frequency coverage and excellent spatial resolution provided by the UWB antenna are essential for distinguishing between healthy and cancerous tissues. We will use this antenna design as the basis for our future catheter technology research.

The modelling and assessment of a catheter design in a real-time virtual environment is the primary objective of the project's subsequent phase. These simulations will take into consideration dynamic factors like tissue heterogeneity and organ mobility, guaranteeing that the catheter system is strong enough to function reliably in clinical settings. By leveraging these simulations, we intend to improve the catheter's design to distribute energy precisely while reducing heat damage to healthy tissue. To predict the necessary energy levels for efficient ablation, the project will also investigate dose prediction algorithms that make use of tissue-specific electromagnetic characteristics. This will increase the treatment's accuracy by enabling the device to modify energy delivery in response to real-time feedback from the tissue environment.

Essentially, this effort aims to build a catheter system that is medically adaptive and offers electromagnetic ablation therapy that is safe, effective, and precise for patients suffering from liver cancer.