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Numerical Study Towards Combination of Microwave Hyperthermia System and Non-invasive UWB Tissue Temperature Monitoring

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Hyperthermia is a strong adjuvant procedure for cancer therapies which increases the clinical outcome of the oncological treatments. Since during hyperthermia procedure the temperature increase should be no higher than 4 – 8 °C in order to prevent damage of healthy cells, real-time and non-invasive tissue temperature monitoring is necessary. One way is to estimate the temperature based on the dielectric properties of tissues in the microwave frequency range. Therefore, ultra-wideband (UWB) sensing can be a promising approach to non-invasively monitor the tissue temperature distribution inside the human body during the treatment [1].

The combination of the microwave hyperthermia system working at the frequency 434 MHz and UWB imaging system working in the frequency band 0.5 - 7 GHz can cause interference problems. Due to the relatively close operational frequency of the hyperthermia applicator to the bandwidth of the radar and high powered hyperthermia system (100-500 Watts depending on the application), the radar sensor can be destroyed. Since the dimensions of the neck are relatively small while the heating applicators dimensions are quite large, the space for positioning of sensing antennas is limited. Before the development of the hybrid system prototype can come into focus, necessary requirements of the co-existence of both microwave systems have to be investigated via accurate and detailed numerical simulations.

In this work, we present the results of investigations applying hyperthermia waveguide applicators with strip line horn aperture [2] and passive dipole bow-tie sensing antennas in practical treatment scenarios. We have modelled and numerically tested several arrangements using Sim4Life® simulation platform, for which the distribution of the specific absorption rate and temperature in the model has been studied. The model consists of a phantom mimicking human neck with a tumor, hyperthermia applicators filled with distilled water, water bolus for better impedance matching and cooling effect and sensing antenna array in different variations. In particular, our study focuses on the optimal and safe positioning of both heating applicators and sensing antennas based on codependent influencing parameters. The results of this study provide basic findings for further development and construction of the intended hybrid system.

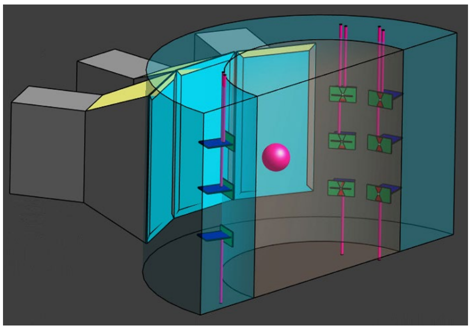

Figure 1. Measurement scenario geometry.

References

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