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A Microwave Phased Array System for Hyperthermia Treatment of Breast Cancer

Project brief

Aims & objectives

Phased array antennas [PAA] are well known for their use in communication and radar. Recently they have been applied to medical applications, such as the heat treatment of deep-seated tumours. Focused microwave hyperthermia (FMHT), commonly used in breast, prostate, cervical, and head and neck cancers, causes the in vivo heating of the tumour region using a variety of non-invasive antenna array arrangements. This treatment activates biological processes that have been proven to help slow tumour growth and simultaneously increase the sensitivity of cancerous cells to traditional cancer therapies, reducing the intensity required from these traditional therapies. This treatment method is therefore ideal in advanced cancer stages.

Methodology

Tools & prototypes

The prototype being developed operates at a single frequency – 2.4 GHz – which is one of the most researched frequencies due to its favourable trade-off between penetration depth and focusing intensity. Using FORA antennas in a PAA system, the prototype is able to validate results obtained through specific absorption rate (SAR) optimisation implemented in CST for focusing at a targeted region overlapping the tumour. The FMWH system is controlled through a custom LabVIEW program using control data obtained from simulations.

The prototype allows for six to sixteen antennas to be used simultaneously. To keep costs and power consumption low, the manipulations of each antenna output takes place at relatively low powers until it is amplified at the very last stage, noise is kept at a minimum through proper shielding. Phase and amplitude can be adjusted in steps of 1.5° and 0.5dB respectively after the initial signal is received from a fixed power supply.

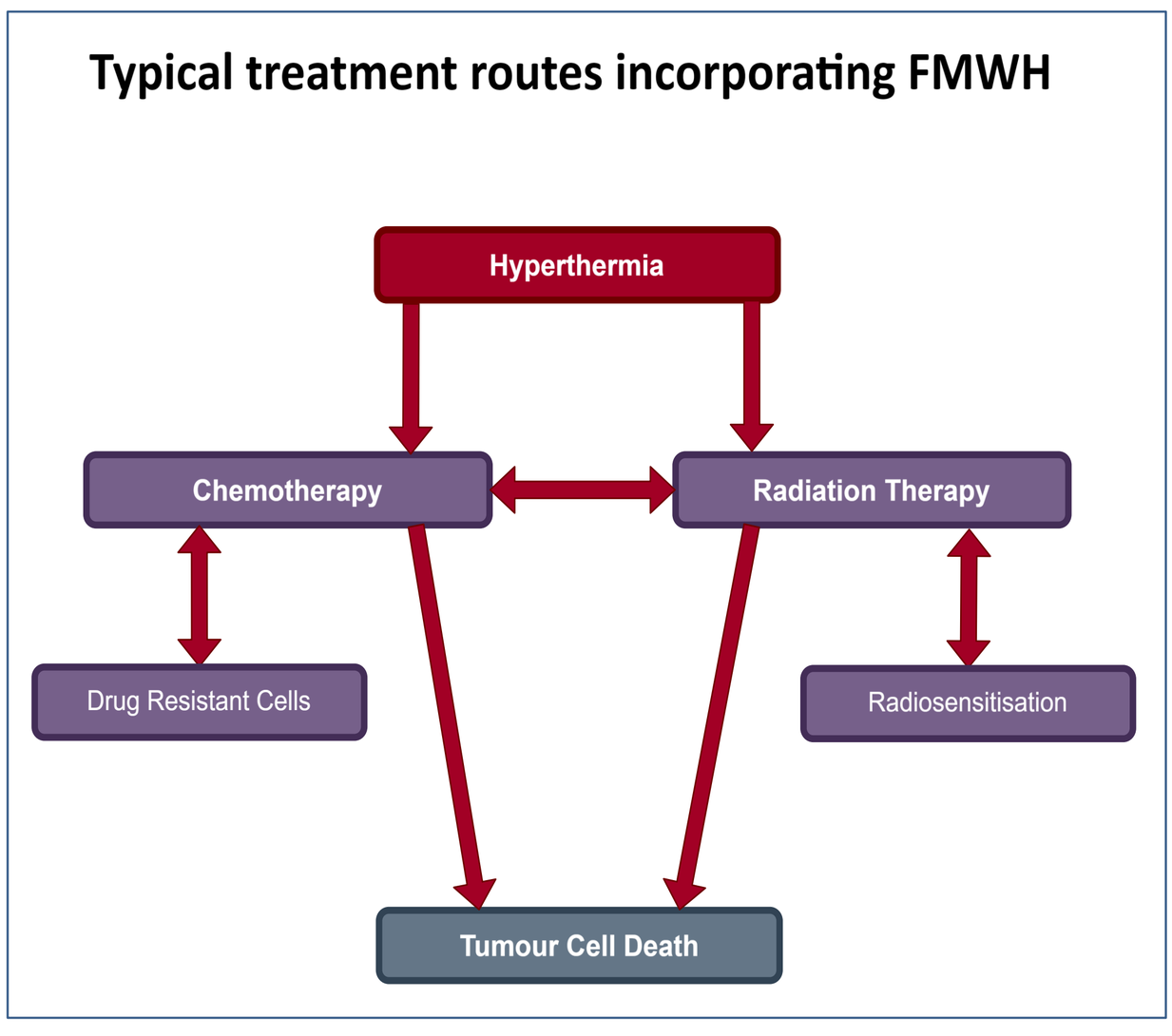

Figure 1.

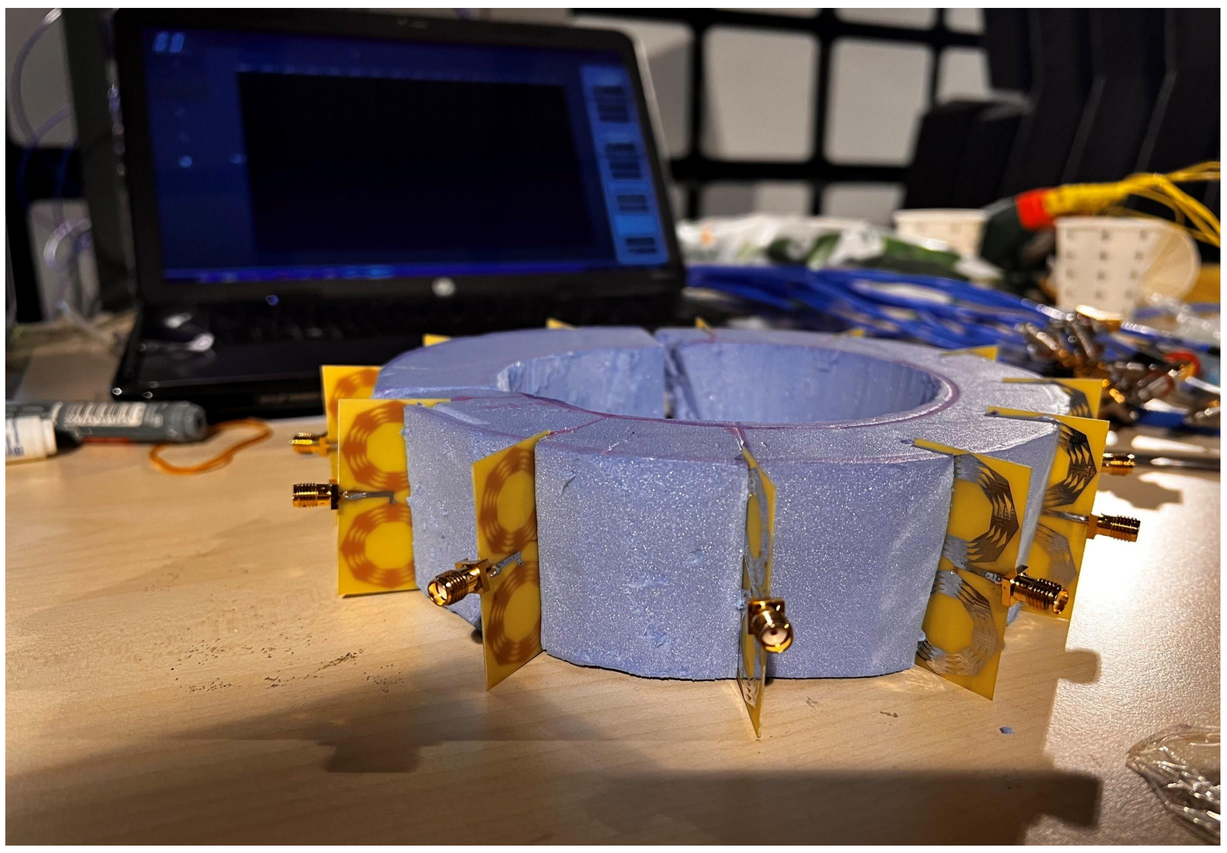

Figure 2: A testing setup of the FORA antennas in a circular configuration. Photo Credit: Iman Farhat.

Results & conclusions

Results & prototypes

The characterisation of each component of the system with regards to temperature and time were an important factor in determining the system precision, and the resulting output stability. These characteristics are monitored through the performed tests. The output is validated using a virtual network analyser (VNA) at a point during the test to ensure proper function of the prototype.

Clinical studies by have shown some benefit of FMHT in breast-preservation therapy, this research aims to add to the existing knowledge of the treatment.