Application of Microwave Imaging for Lung Tumour Detection

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ABSTRACT

Microwave imaging has been around for some time with most researchers focusing on breast imaging [1]-[3] and a few others on brain imaging [4]. As a contribution to this field, this abstract reports the simulation and experimental setup for the detection of tumours in the lungs within a multilayer thorax model using microwave imaging methods. The simulation was set up using the HUGO human model [5] with a tumour inserted in the lung and a designed UWB antenna located around the thorax region in CST Microwave Studio. For this study, the thorax tissues considered are the lung, rib bone, muscle, fat and skin with a four term Cole-Cole mathematical formula [6] used to define the dielectric properties of the tissues. Further in the simulation, a three-dimensional multilayer model of the thorax with an embedded tumour was considered. This was used as the experiment's model; where the thorax was realized by a Plexiglas box with partitions for the thorax tissues. The tissues were formed from mixtures of water and Tween 20 (polysorbate). It was verified that the dielectric properties of the tissue simulating liquids are well comparable to the mathematical models.

The experimental set up comprises a Vector Network Analyser, an ultra-wideband antenna, thorax tissue simulating liquids, and a proposed modified delay and sum imaging (mDAS) program running on a computer. The resulting microwave images show millimetre sized tumour detection in the lungs with respiratory stages of inhalation and exhalation put into consideration. An overview of the set-up is as given in Figure 1; where (a) shows the thorax with inserted tumour, (b) is result of data processing using the delay and sum imaging algorithm, and (c) is the generated image using the modified delay and sum imaging algorithm. Location error estimation and signal to clutter ratio (SCR) were two metrics that were used to assess the detectability of embedded tumour and the performance of the proposed mDAS imaging algorithm, respectively. The location error of the embedded tumour was less than 2 cm in simulation and less than 3 cm in the experiments, while SCR was 2-4 dB higher for the modified delay and sum algorithm (mDAS) when compared to the standard delay and sum algorithm (DAS).

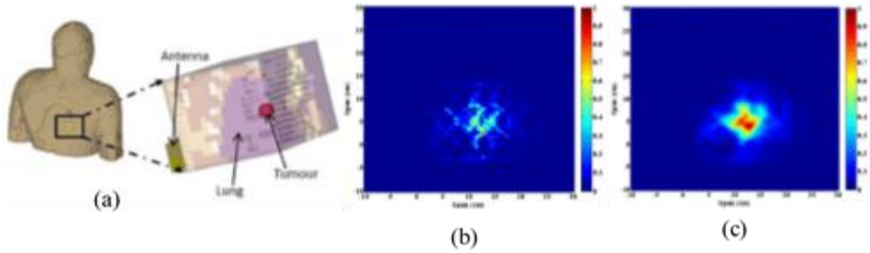

Fig. 1. An overview of the tumour detection setup: (b) is the generated image when delay and sum algorithm was used for data processing and (c) is result from using the proposed modified delay and sum imaging algorithm.

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