Fusion ultrasons et micro-ondes en imagerie du sein via transformation de Radon morphologique

Fused ultrasonic and microwave breast imaging via morphological Radon Transform

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Mots clés : imagerie du sein, ultrasons, microondes, fusion de données, transformée de Radon topologique, breast imaging, ultrasound, microwave, data fusion, morphological Radon transform

Abstract. Despite many investigations, early-stage detection of breast cancer remains challenging. To fuse ultrasonic (US) and microwave (MW) data for breast imaging appears a good option, as to benefit from the complementary information provided, namely, high resolution from US data and high contrast from MW data, e.g., [1-5]. With US datasets, one mostly wishes to appraise the support of each breast inner structure, with the MW datasets the aim is to get the electromagnetic parameters in identified homogeneous zones. US datasets used are small, which means that any volume of data can be transferred quickly. Yet, US imaging is subject to measurement errors, and much depends upon the physician in charge.

This study is a continuation of works [1-2, 5] under the 2nd and 3rd authors of the present contribution, and investigates the optimisation of US images that can be captured using a so-called Morphological Radon Transform (MRT) approach. MRT indeed makes it possible to determine the connected components of a compact, e.g., [6], among other theoretical references by the same author. Utilizing the MRT, US images can be retrieved in a fast, efficient manner based on properly simulated measurements, in a hypothesized 2D (cross-section) context at the present stage of our investigation. Initial results suggest that, when the connected components are convex, US images can be directly derived using a backprojection technique. To probe further, star-shaped intersections have been added to the retrieved US images for non-convex components. Then, additional work enables to remove the added star intersections using an iterative scheme method. Such a removal of star intersections helps to avoid false alarms that might occur when detecting an anomalous zone.

In short, the MRT appears as a promising approach, even if the theory sustaining it is not straightforward [6], which should improve the US imaging, consequently, the early detection of a tumor. That is, this makes it easier and faster to extract essential structural characteristics and delimit regions wherein disease detection should be concentrated upon with the MW modality afterwards, since the latter shows the difference between healthy tissues and tumoral tissues (with high conductivities and permittivities in comparison).

To complement, one intends to discuss whether 3D situations (say, a hemispherical breast with close to the skin ellipsoidal tumors, in line with [7]) could be approached the same way, now by superimposition of 2D cross-sections, as this is foreseen to be simpler than variational Bayesian tools [1] and faster than learning tools [2, 5] whenever those extended to 3D — [1-2, 5] involved US and MW data from realistic 2D models, how the MRT performs in this case is to be studied as a first step.

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