DOCTORAL DISSERTATION DEFENSE

Medical Ultrasound Compounding with the Novel Paired Angle Multiplicative Compounding (PAMC) Method

By

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Abstract:

Ultrasound is one of the leading medical imaging modalities in the world due to its low cost, portability, real time functionality, and lack of ionizing radiation. Yet, reducing its popularity is that medical ultrasound images are affected by many types of artifacts, making it difficult for an observer to interpret the image. In order to reduce artifacts, many modern (last 10 years) medical ultrasound units now implement compounding. Ultrasound spatial compounding is a method of combining multiple images from different angles in order to create a single image with improved resolution and reduced angular dependent artifactual detail. Compounding methods traditionally calculate each pixel in the compound image as a simple functional relationship between pixel elements in the component image set. In order to achieve an even better resolution and further reduce angular dependent artifacts, this paper investigates a new type of compounding we call paired angle multiplicative compounding (PAMC), in which compound images are produced by a summation of multiplied pairs of component images acquired at different angles. A PAMC image of a breast phantom demonstrates improved delineation of microcalcifications in comparison to the mean operation. Images of the forearm are used to investigate larger angles of paired multiplication, the best improving contrast ratio (28%) and signal to noise ratio (24%) when compared to the mean method. The PAMC method is found to be similar to the MEM and median compounding operations, the largest difference being that it is better preserving contributions from normal incidence, but at the expense of needing a larger angular range. Most of this larger angular range needed for improvement is still readily available from commercial beam steering units. Yet, the largest improvements in theory come at an combination angle of 90° of which can be only be practically obtained via reflection based tomography. Some 360° reflection tomographs of the peripheral musculoskeletal and breast phantom targets will be presented to demonstrate effectiveness in comparison to B-Scan images.