Three-Dimensional Wearable Sensor for Real-Time Imaging using a Back-Projection Technique

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Existing medical imaging technique such as X-rays, magnetic resonance imaging, and computed tomography suffer from lower contrast when detecting tissue abnormalities. By comparison, microwave imaging (MI) can provide advantages of non-ionized radiation, low cost, high resolution, real time performance and is studied in detecting benign tumors. MI is based on the scattered signal variability to capture the variation of dielectric constants across the imaging domain. Typically, imaging is carried out by using non-linear inverse methods. But the latter procedure is time consuming and may requires inversion of an ill-conditioned matrix, often prone to measurement errors.

In our proposed approach, the goal is to carry fast real-time imaging of the tissue cross section and to mitigate errors due to placement variations. To do so, our approach employs multiple antennas (or sensors) that excited in succession to illuminate the domain. When one of the sensors transmits, the others receive the scattered signals. The measured signals are then back-projected computationally to form the image. Notably, because the excitation elements are sequentially excited, each domain voxel is illuminated from multiple sides, leading to stronger and higher resolution images. Importantly, the proposed process is not iterative and, thus, the image can be constructed in real time.

In this paper, we present a demonstration of the proposed imaging method at 902 MHz. For higher contrast images, a wideband excitation with illumination across 0.8–1 GHz will be also presented at 50 MHz steps. A half wave dipole antenna is used for excitation with a total of 8 such antennas placed around the imaging domain. Matching layers are also used for improved penetration. At the meeting, we will present three-dimensional images generated by this real-time imaging approach.