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Thermoelastic Signatures of Tissue Phantom Absorption and Thermal Expansion

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Abstract—**A microwave-induced thermoelastic pressure wave method for imaging of biological tissues has been investigated. Liquid-filled test tubes inside a water tank were used as phantom models. A pulsed 2.45 GHz microwave source and a hydrophone transducer were used to generate and to detect thermoelastic pressure waves. A pattern extraction algorithm was used to analyze the wave contours. Preliminary results show that the thermoelastic waveform is proportional to the size of the test tube and depends on the type of solution within the test tube. Two test objects can be detected with a spatial resolution better than 1 cm. These results suggest that a microwave-induced thermoelastic pressure wave system may provide valuable information for imaging tissue absorption and thermal expansion properties.**

I. INTRODUCTION

Current medical imaging systems rely on a number of basic physical principles and measurement techniques. Examples include: 1) the measurement of the transmission intensity of X-ray through the body, 2) the measurement of the reflection intensity of ultrasonic wave propagation inside the body, and 3) the measurement of gamma rays emitted by selectively deposited radioactive chemicals in the body [1]. In addition, new imaging schemes such as positron emission tomography and nuclear magnetic resonance have significantly improved the diagnostic capabilities [2]. Microwaves have also been suggested as a potential imaging modality. Microwave imaging involves low levels of nonionizing radiation and could be used, cost effectively, on a long-term basis with minimal health hazard to the patient [3]. Moreover, microwave pulse-induced acoustic signals have been studied by many investigators in the last decade [4]–[7]. It is generally accepted that microwave-induced acoustic signals stem from the rapid rise in temperature and the subsequent thermal expansion of tissue which absorbed the incident microwave pulse [7]. Several reports have suggested the use of microwave-induced acoustic waves as an imaging modality for biological tissue. Olsen [8] and Lin and Chan [9] reported imaging of tissue phantoms using a hydrophone array to detect the acoustic pulse. Both of these systems measure the attenuation of the acoustic wave as it propagates through the tissue. Caspers and Conway [10] measured the distribution of absorbed microwave energy in lossy inhomogeneous materials by using radiation from open-ended, semi-rigid coaxial cables (point source) immersed in a water bath.

The purpose of this study is to further investigate the use of microwave-induced thermoelastic pressure waves as an imaging

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