A THREE DIMENSIONAL MODEL FOR GENERATING THE TEXTURE IN B-SCAN ULTRASOUND IMAGES

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The texture that an organ exhibits in an ultrasound B-scan image can often be an important component in the evaluation of the disease state of the organ. This texture is dependent upon properties of the organ as well as properties of the ultrasound imaging system. To gain insight into the relationships between these properties and the texture in the images, mathematical models for generating ultrasound B-scan texture have been proposed. For reasons of simplicity and computational efficiency, these models have been limited to characterizing the 3-D imaging situation by 2-D simulations.

In this thesis, a realistic and computationally efficient 3-D model for generating the texture in B-scan images is proposed and tested. Aside from its 3-D nature, this model also differs from the other models in that it utilizes a highly realistic ultrasound beam theory, and it incorporates instrumental factors such as the frequency content of the pressure pulse emitted by the transducer, the physical characteristics of the transducer, and the frequency response of the tranducer--receiver system. The inclusion of such factors permits a direct comparison between theory and experiment. Such a comparison is carried out, and several new texture measures are employed in the process. The model is found to perform most adequately in predicting the texture in images of a phantom containing a large concentration of Rayleigh scatterers. The influences of pulser--receiver characteristics and the depth of the imaged region on the imaged texture pattern are observed both experimentally and theoretically. Furthermore, a study is performed in which the model is applied to the situation of imaging a low scatter spherical inhomogeneity that is embedded in a relatively high scatter medium. The model is found to accurately predict the appearance of the inhomogeneity in images which are created when the scanning plane of the transducer passes through the center of the object, and when the scanning plane is displaced from the center of the object. The work described in this thesis represents a foundation upon which future investigations and models can be built.