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Ph.D. Public Defense

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Enhanced Biomedical Ultrasound Detection of Spatially Spread Pathologies

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A method for enhancing detection of certain ultrasound-reflecting tissue pathologies is proposed, motivated by the current poor detectability of breast microcalcifications using ultrasound. It is developed by recasting the ultra- sound imaging problem as a hypothesis testing one. Statistical models are developed for an echogenic, spatially spread pathology, as well as surrounding speckle and additive noise, using spatial impulse response theory. These models are then used in the derivation of an optimum detector in the Neyman-Pearson sense. The output statistic of the formed likelihood-ratio is used to populate the image at every spatial location tested. Comparisons of detection and resolution performance are done against other current and proposed methods. Certain conditions lead to enhanced pathology detection, but the formulation obtained requires a matrix inversion and quadratic-form multiplication for every generated pixel, unless a spatially-invariant approximation is used. A mechanizable, real-time implementation is elaborated after modeling the spatially-varying ultrasound propagation in state-space to recursively and progressively calculate the likelihood-ratio as new data become available. Simplifying approximations are then made to derive an alternative, easily implemented, but suboptimal, detector.