PhD Thesis Title: Dose savings in digital breast tomosynthesis through image processing

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Abstract:

In breast cancer screening programs, the x-ray radiation must be kept as low as achievable, to guarantee the safety of the patients. However, low dose acquisitions yield images with low quality, which may harm the interpretation of radiologists. Therefore, there is a compromise between image quality and radiation dose. This work proposes an image processing pipeline capable of restoring low-dose acquisitions to achieve the quality of full dose acquisitions. The contribution of the new method is the capability of restoring images with quantum and electronic noise, pixel offset and variable detector gain. To validate the image processing chain, a simulation algorithm was proposed. The algorithm generates low dose clinical acquisitions, starting from full dose images. To investigate the feasibility of reducing the radiation dose in breast cancer screening programs, a simulated pre-clinical trial was conducted using the simulation method and the image processing pipeline proposed in this work. Digital breast tomosynthesis (DBT) images from 72 patients were selected. Objective measurements show that a reduction of up to 50% in radiation dose could be achieved without changes in noise intensity and signal smearing. The experiments using human observers showed that a dose reduction of 5% is enough to generate statistically significant differences in perceived image quality in DBT images. However, a reduction of up to 30% in radiation dose could not be perceived by the human reader, after the proposed image processing pipeline was applied. Thus, the image processing algorithm has the potential to decrease radiation levels in DBT exams, also decreasing the risks associated with the exam. Delivering an optimized breast cancer screening program is vital to assure the trust and wellbeing of women around the world.

References to author publications that relate specifically to the dissertation:

1. **Borges, L.R.**; Oliveira, H.C.; Nunes, P.F.; Bakic, P.R.; Maidment, A.D.A.; Vieira, M.A.C. “Method for simulating dose reduction in digital mammography using the Anscombe transformation”, *Medical Physics*, **43**(6), 2704-2714, 2016.
2. **Borges, L.R.**; Vieira, M.A.C.; Foi, A. “Unbiased injection of signal-dependent noise in variance-stabilized range”, *IEEE Signal Processing Letters*, **23**(10), 1994-1998, 2016.
3. **Borges, L.R.**; Guerrero, I.; Bakic, P.R.; Foi, A.; Maidment, A.D.A.; Vieira, M.A.C. “Method for simulating dose reduction in digital breast tomosynthesis”, *IEEE Transactions on Medical Imaging*, **36**(11), 2331-2342, 2017.
4. **Borges, L.R.**; Azzari, L.; Bakic, P.R.; Maidment, A.D.A.; Vieira, M.A.C.; Foi, A. “Restoration of low-dose digital breast tomosynthesis”, *Measurement Science and Technology*, **29**(6), 064003, 2018.