Planar 2D X-ray mammography is generally accepted as the preferred screening technique used for Breast cancer in western breast cancer detection.

In the Western world, planar 2D X-ray mammography is widely recognized as the most effective screening method for breast cancer.

This can lead to unnecessary anxiety, additional tests, and sometimes even unnecessary biopsies.

This can cause needless worry, extra medical tests, and sometimes even biopsies that aren’t actually needed.

This can occur due to factors like dense breast tissue, tumor characteristics, or the positioning during the mammogram. Discomfort: For some individuals, mammography can be uncomfortable or even painful due to the compression of the breasts required to obtain clear images. This compression is necessary for better imaging but can cause discomfort, particularly for women with sensitive breasts. Radiation Exposure: Mammograms use low doses of radiation to capture images. While the level of radiation exposure is considered safe, repeated mammograms over time might contribute to a cumulative radiation dose, although the risk is generally minimal. Dense Breast Tissue Challenges: Dense breast tissue can make it more difficult to detect abnormalities in mammograms, as dense tissue appears white on the image, similar to tumors or masses. This can lead to reduced sensitivity in detecting cancers in women with dense breasts.

This can happen because of breast tissue density, tumor characteristics, or the position during the mammogram. Discomfort: While mammography is important for imaging the breast, some women find mammography uncomfortable or even painful because the breasts need to be compressed to get clear images. Radiation Exposure: Mammography involves the use of low doses of radiation to obtain images, and while the amount of radiation is not considered dangerous, repeated mammograms over time can add to a cumulative dose of radiation exposure, although the risk is low. Challenges with Dense Breast Tissue: Dense breast tissue poses challenges to mammography, because dense tissue is white on the mammogram, just like tumors or masses, which can decrease the sensitivity of mammography in detecting cancers in women with dense breasts.

Digital Breast Tomosynthesis (DBT) is an advanced imaging technique used in mammography for breast cancer screening and diagnosis. It's often referred to as 3D mammography. Traditional mammography captures two-dimensional (2D) images of the breast tissue, which sometimes may make it challenging to detect abnormalities due to overlapping tissue. DBT works by taking multiple low-dose X-ray images of the breast from various angles, creating a three-dimensional image of the breast tissue. This technique allows radiologists to examine the breast in thin slices or sections, making it easier to identify abnormalities, such as tumors or lesions, and reduce the impact of overlapping tissues that might obscure findings in traditional mammography.

Digital breast tomosynthesis (DBT), also known as 3D mammography, is an advanced imaging technique that uses multiple low-dose X-ray images of the breast from different angles to create a three-dimensional image of the breast tissue, allowing radiologists to examine the breast in thin slices or sections to more clearly see abnormalities, such as tumors or lesions, and minimize the influence of overlapping tissues that may obscure findings in traditional mammography.

If an accurate physics based approach is used for insertion, then the inserted structures should have the correct contrast, blur This can occur due to factors like dense breast tissue, tumor characteristics, or the positioning during the mammogram. Discomfort: For some individuals, mammography can be uncomfortable or even painful due to the compression of the breasts required to obtain clear images. This compression is necessary for better imaging but can cause discomfort, particularly for women with sensitive breasts. Radiation Exposure: Mammograms use low doses of radiation to capture images. While the level of radiation exposure is considered safe, repeated mammograms over time might contribute to a cumulative radiation dose, although the risk is generally minimal. Dense Breast Tissue Challenges: Dense breast tissue can make it more difficult to detect abnormalities in mammograms, as dense tissue appears white on the image, similar to tumors or masses. This can lead to reduced sensitivity in detecting cancers in women with dense breasts. and noise, and would ideally be indistinguishable from real lesions in clinical images. Once validated, this methodology can be used to conduct observer studies by inserting pathology that is representative of mass-like lesions (Rashidnasab et al. 2013a, Rashidnasab et al. 2013b) and micro-calcifications (Shaheen et al. 2011) into normal clinical patient images. Such an approach would then serve as an efficient alternative or pre-cursor to clinical evaluations with real subjects.

Insertion should be performed in a physics based way so the inserted structures have the correct contrast, blur, which could be a result of breast tissue, tumor characteristics, or how the mammogram is positioned. Discomfort: Mammography can be uncomfortable or even painful for some women, as compression of the breasts is needed to obtain the images, which can be uncomfortable, especially for women with sensitive breasts. Radiation Exposure: Mammograms use very low levels of radiation; however, repeated mammograms over the years may result in a cumulative radiation dose, which although small, may be of concern for some patients. Difficulties with Dense Breast Tissue: Dense breast tissue can obscure lesions in mammograms because dense tissue will appear white on the image, like tumors or masses, reducing the sensitivity for women with dense breasts. The methodology would need to be validated and then applied to observer studies where pathology mimicking mass-like lesions (Rashidnasab et al. 2013a, Rashidnasab et al. 2013b) and micro-calcifications (Shaheen et al. 2011) are inserted into normal clinical patient images, which would then be an efficient alternative or precursor to clinical evaluations with real subjects.

A model should be developed for a specific purpose (or application) and its validity determined with respect to that purpose. If the purpose of a model is to answer a variety of questions, the validity of the model needs to be determined with respect to each question. Numerous sets of experimental conditions are usually required to define the domain of a model’s intended applicability. A model may be valid for one set of experimental conditions and invalid in another. A model is considered valid for a set of experimental conditions if its accuracy is within its acceptable range, which is the amount of accuracy required for the model’s intended purpose.

If the purpose of a model is to answer a range of questions, then the validity of the model must be determined with respect to each question. The domain of applicability of a model is typically defined by many sets of experimental conditions, and a model may be valid for one set of experimental conditions and invalid for another; a model is valid for a set of experimental conditions if its accuracy is within its acceptable range, which is the amount of accuracy needed for the purpose for which the model was created.

The performance evaluation and comparison of X-ray imaging systems poses a number of practical challenges within a clinical environment. To address the above issue, two simulation chains constructed using a set of modelling tools have been developed and validated. The first methodology, total image simulation, is based around defined virtual geometric objects used alongside a virtual representation of the image acquisition process.

X-ray imaging systems in a clinical environment have several practical challenges in the performance evaluation and comparison. Two simulation chains built with a set of modelling tools are developed and validated to address the issue above. The first, total image simulation, is a methodology that uses defined virtual geometric objects and a virtual representation of the image acquisition process.

The methodologies presented can be used for rapid evaluation and comparison of 2Dmammography and tomosynthesis systems.

Tomosynthesis and 2D mammography systems can be quickly evaluated and compared using the approaches that are offered.

This work is part of the OPTIMAM project and is supported by the Cancer Research UK & Engineering and Physical Sciences Research Council Cancer Imaging Programme in Surrey, in association with the Medical Research Council and Department of Health (England). We are grateful for the help and support of staff from the Jarvis Breast Screening Unit, Guildford when performing measurements.

This work is funded by the Cancer Research UK & Engineering and Physical Sciences Research Council Cancer Imaging Programme in Surrey, in association with the Medical Research Council and Department of Health (England), as part of the OPTIMAM project. We would like to thank the staff from the Jarvis Breast Screening Unit, Guildford for their assistance with measurements.
