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No.2 Analysis of the Effects of Image Quality Differences on CAD Performance on AI-Based Benign-Malignant Discrimination Processing of Breast Masses

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Purpose

Mammography, an essential tool in the detection of breast cancer, comprises x-ray imaging. however, has shown that x-ray imaging incurs a higher risk of exposure and reduced lifespan to young people.

The ability to perform breast cancer benign-malignant discrimination at the screening mammography stage would make it possible to go immediately to biopsy without having to conduct a diagnostic mammography bi-directional imaging for benign-malignant discrimination.(Figure 1)

HAVING set this as our Main goal, in this study, we analyzed the differences in quality of breast cancer examination images using CAD. We then identified points for improvement, and based on them selected the type of image processing necessary for making possible AI-based breast cancer benign-malignant discrimination that utilizes breast cancer screening mammographic images.

Method

In this study, we built a breast cancer mass and used benign-malignant discrimination processing system with two types of databases, one comprising breast cancer mass screening images and the other one breast cancer mass diagnostic images, and compared final diagnosis rates.

The following 11 types of AI-based breast cancer tumor benign-malignant discrimination processing systems were used:

1. Perceptron and 3-layer NN learning method (basic machine learning methods)
2. CNN with 1 to 6 middle layers (deep learning methods)
3. VGG16, VGG19, Alexnet (three types of transfer learning that apply a model trained in one area to another area)

Next, we used image processing to compare the contrast and graininess of the screening and diagnostic images in order to find possible causes for differences in CAD performance.

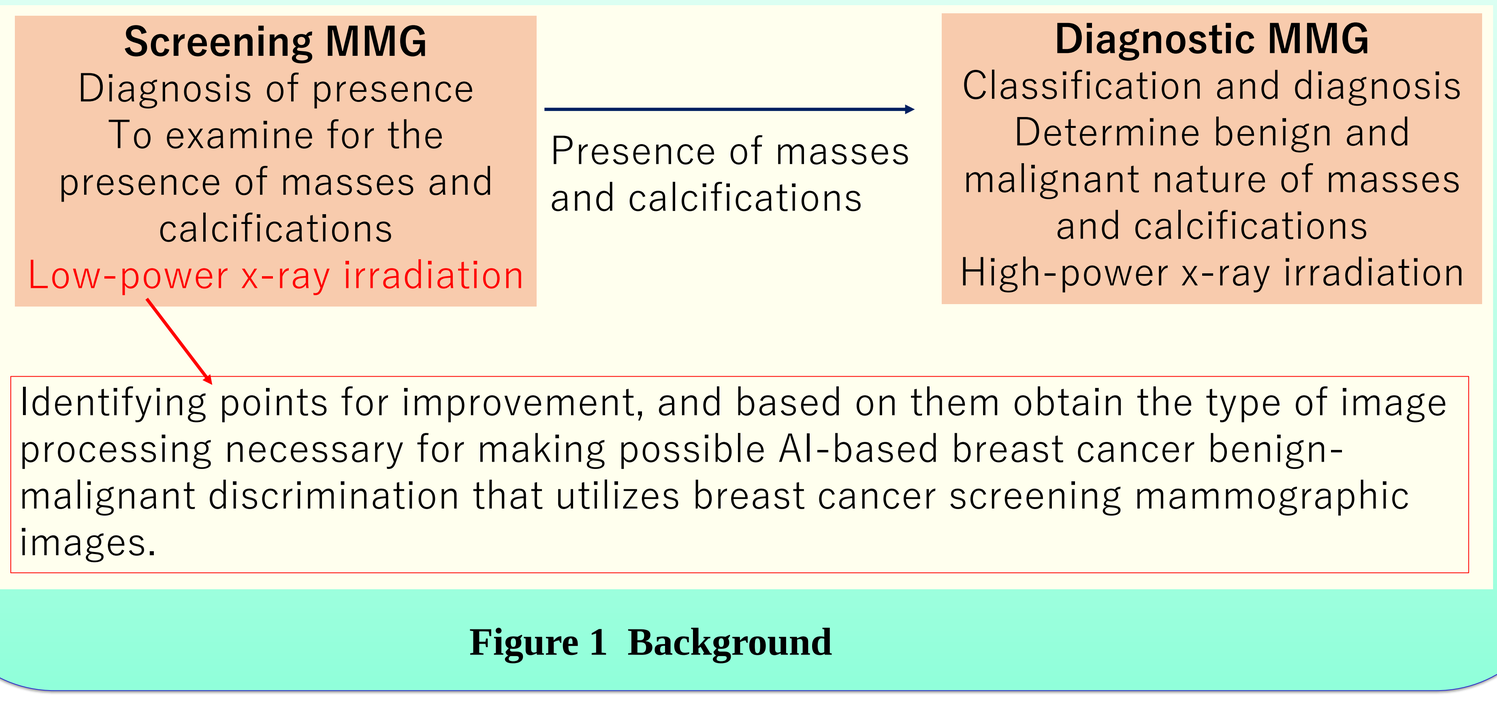


Figure 1 Background

Table 1 Results of AI-based benign-malignant discrimination processing that exhibit maximum accuracy

Maximum accuracy for screening images		Maximum accuracy for diagnostic images	
No extensions	With extensions	No extensions	With extensions
64% VGG19 Alexnet	85% Alexnet	77% CNN (middle 5)	90% VGG16

Result

As a result, we succeeded in obtaining final diagnosis rate values that are near those obtained in image interpretation by medical practitioners at 85% for screening images and 90% for diagnostic images.(Table 1) We also succeeded in analyzing the differences in the final diagnosis rates, analyzing the differences between screening and diagnostic images through measurements of radiation scattering and graininess that used image spatial frequency Fourier transform-based harmonic elimination.

Conclusion

In this study, we succeeded in analyzing the differences between screening and diagnostic images through measurements of radiation scattering and graininess that used image spatial frequency Fourier transform-based harmonic elimination.

Considerations, as graininess and contrast are negatively correlated in image processing, it is necessary to use image processing that can balance graininess and contrast.

Screening image and diagnostic image comparison results

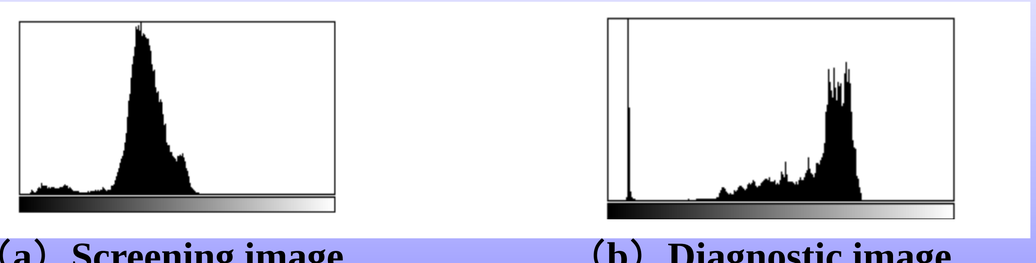
We compared the graininess and contrast of four cases for screening and diagnostic images.

・Graininess（Figure 2）
screening images：2.7225， diagnostic images：0.5855
(variation in the high frequency regions of the original image)

・Contrast（Figure 3）
screening images：17.485， diagnostic images：38.20075
(pixel variation in the original image)
（Using the method described in 4）

（a） Screening image **（b） Diagnostic image**

Figure 2 Graininess test results cases



（a） Screening image **（b） Diagnostic image**

Figure 3 Contrast test results cases