

# Progress in the Application of Artificial Intelligence in Ultrasound Diagnosis of Breast Cancer

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**Abstract:** The mammary gland is an important human organ that secretes milk and feeds offspring, while breast tumors are benign or malignant tumors that occur in the breast tissue. There are many causes of breast cancer, and the incidence continues to rise, which is an important killer that threatens women's health. In recent years, a large number of researchers have been interested in the study of AI diagnosis of breast cancer. Artificial intelligence uses a specific algorithm to intelligently process ultrasound images, and develops a high-precision and high-efficiency breast cancer recognition model through training and optimization of the algorithm. At present, the application of computer-aided detection methods in breast cancer ultrasound has been gradually promoted, and the combined application of artificial intelligence has played an advantageous role in the field of breast disease ultrasound diagnosis, such as shortening the examination time, effectively improving the detection rate and diagnostic accuracy rate. The main reasons are: the accuracy of traditional AI diagnosis model of breast cancer based on machine learning is not high; The aim of this paper is to improve the accuracy of early diagnosis of breast diseases effectively and reduce the misdiagnosis rate caused by overwork of doctors on the basis of clear medical images and computer-aided diagnosis technology.

**Keywords:** Breast Cancer; Artificial Intelligence; Ultrasonic Diagnosis; CAD.

## 1. Introduction

According to the American Institute of Cancer statistics in recent years, about 250,000 women nationwide have been diagnosed with breast cancer, and the number of deaths is as high as 40,000. Due to long-term late night, irregular diet, excessive exposure to ionizing radiation and lack of exercise, there are about 50,000 to 90,000 female breast cancer patients in China, and 30,000 to 40,000 deaths. The number of new cases of breast cancer in China in 2020 is as high as 420,000. Therefore, early detection and diagnosis is the key to reducing the mortality rate of breast cancer and improving the quality of life of female patients. The use of modern medical technology for breast screening is an important way to detect early breast tumors, in which breast key target X-ray examination and breast ultrasound are the golden partners for breast cancer screening[3]. By observing changes in breast tissues and organs, target mammography can detect early breast cancer such as breast lumps that cannot be detected by the naked eye, and reduce the breast cancer mortality rate of patients by 38 to 48 percent. Breast target examination is recognized as a screening tool for the diagnosis of breast tumors because of its simplicity, painlessness, noninvasive and high screening accuracy.

Among them, conventional ultrasound is one of the most commonly used means for breast cancer screening in clinical practice. Conventional ultrasound has defects such as high examiner dependence and strong subjective judgment, and artificial intelligence can make up for these deficiencies to a certain extent[4]. By extracting the characteristics of benign and malignant lesions, artificial intelligence can help physicians analyze the images in a more detailed manner, providing more basis for physicians to distinguish benign and malignant lesions of the breast, and is expected to become an

important auxiliary worker in the diagnosis of breast diseases.

In this paper, the research progress of artificial intelligence in ultrasound diagnosis of breast cancer is discussed.

In order to provide reference for follow-up clinical diagnosis and treatment.

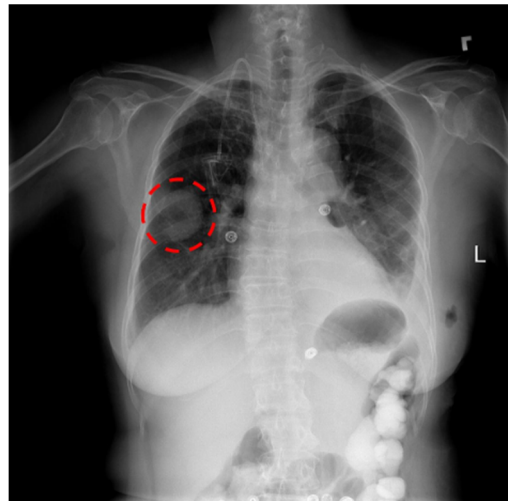


Figure 1. A chest x-ray identifies a lung mass

By using this free dataset, the hope is that academic and research institutions across the country will be able to teach a computer to read and process extremely large amounts of scans, to confirm the results radiologists have found and potentially identify other findings that may have been overlooked [5].

## 2. Related Work

Computer-aided detection (CAD) [6]based on two-

dimensional gray scale imaging is a method in which the computer learns a large number of features and multidisciplinary knowledge of benign and malignant lesions, extracts specific parameters on the image, intelligently identifies abnormal signs on the image, analyzes relevant information such as the size, shape, edge and rear echo of the tumor, and finally draws diagnostic conclusions from the machine. The application of CAD in breast ultrasound is computer.

The standard evaluation of breast lumps based on BI-RADS is performed to determine their nature, which provides a comprehensive practical reference for the examiner to diagnose breast cancer, improve the diagnostic accuracy of breast cancer by ultrasound and the examiner's ability to recognize the differentiation of malignant tumors in tissue. CAD system is generally composed of four parts[7]: preprocessing, segmentation of regions of interest, feature extraction and classification.

### 3. METHOTOLGY

CAD automatic breast ultrasound scan system (ABUS) based on three-dimensional ultrasound imaging is a three-dimensional imaging mode of breast ultrasound, which helps physicians to better identify lesion structure by multi-plane reconstruction imaging. During this era of swift advancements in artificial intelligence across multiple domains, numerous fields are witnessing a significant increase in the adoption of AI technologies[8]. showcasing the significant impact and potential of A-driven solutions. Our study delves into the utilization of deep learning models, particularly the Xception model with data augmentation, represents a transformative advancement in the field of casting product quality inspection. Casting defects, a long-standing challenge in the industry, can be effectively addressed through automated defect detect.

However, machine scanning and post-processing images still require manual identification of benign and malignant, which consumes a lot of time and cost. In the mode of ABUS-CAD (ABUS-CAD), the final discriminant classification of the image obtained from ABUS can be done directly by the computer[9].

#### 3.1. Architecture Model

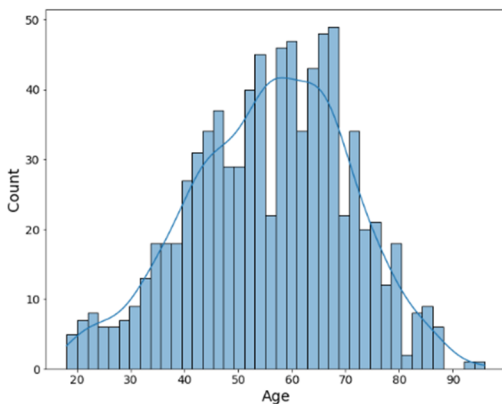


Figure 2. Mammogram quality model

#### 3.2. Data Set Introduction

ABUS-CAD can realize the integration of scanning classification, and at the same time improve the diagnostic differences caused by different experience, operation skills and equipment of the examiner, reduce the scanning time on

the basis of conventional ABUS, and can automatically detect and classify lesions, avoiding missed diagnosis and misdiagnosis caused by the lack of experience of the examiner. The drawback is that ABUS can establish multiple lesion views in the detection of lesions, while in current clinical practice ABUS-CAD[11] only interprets and assesses lesions from one slice Angle, if comprehensive evaluation of lesions from two or more slices Angle can be performed, the expected effect of breast cancer diagnosis will be improved. In future studies, if the blood flow information around the lesion and the detection of axillary lymph nodes are added to ABUS, and then the lesions are analyzed by CAD, it will be of great help for ultrasound diagnosis of breast cancer accompanied by lymph node metastasis.

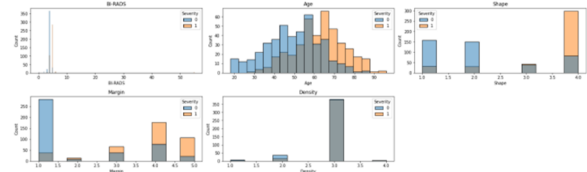


Figure 3. Data Set Exploration

At present, the features extracted from ultrasonic images mainly include morphology, statistics, texture and distribution. In this paper, the morphological features and texture features of the image are mainly used, which are important for the surface of the image object [12].

There is a high consistency between the CAD detection and diagnosis of different image signs and the differentiation of benign and malignant breast mass lesions. There are significant statistical differences in the detection and diagnosis of CAD and the diagnosis of benign and malignant lesions with different mass densities, burr signs, edges and gland types, and the intensity of action is also surprisingly similar. The results of multivariate analysis of all factors were 45.681, 2.160, 1246, 1.987 and 3.1008.040, 1.665, 2.844, respectively. Further research revealed a high degree of similarity not only in the overall, but also within the features. There were no statistical differences in the CAD measurement and classification of benign and malignant mammary glands between lobed and irregular shapes, clear and partially clear edges, fuzzy and ambiguous edges. It also shows that the current CAD in these signs of detection technology and diagnostic strategy is still insufficient, need to be improved

	precision	recall	f1-score	support
0	0.83	0.87	0.85	127
1	0.86	0.81	0.84	122
accuracy			0.84	249
macro avg	0.84	0.84	0.84	249
weighted avg	0.84	0.84	0.84	249

Figure 4. Accuracy statement

Features, including the spatial distribution relationship between pixels in the image. HOG is used to calculate and count the gradient direction histogram of the local area of the image to form features; LBP is used to describe the local texture features of the image; GLCM is used to extract texture features including energy, entropy, contrast, correlation, etc., and the effect of benign and malignant detection of breast tumors is improved by combining the features of HOG, LBP and GLCM.

## 4. Results

Methods Based on the region of interest extraction, segmentation, feature extraction and classification results achieved in the single-view breast cancer CAD system, the system matched suspicious regions in axial (CC) view and oblique (MLO) view, extracted relevant features, and obtained an optimal feature set by stepwise discrimination. The classifier is applied to the optimized feature set to identify and make decision on lumps. The specific description is as follows: The matching of the lump area in cc view and MLO view: The coordinate system is established with the upper corner of the breast wall side. The chest wall line refers to the junction between the breast area and the chest wall. The chest wall line in CC view is on one side of the breast and parallel to the edge of the image, and the chest wall line is fitted by gradient scanning in MLO view. The nipple, which is not visible in most views, is determined by detecting the breast contour and selecting the farthest point on the breast contour from the chest wall line. Make a vertical line from the nipple perpendicular to the line of the chest wall, defined as the center line. The principle of mass matching is based on the radiologist's opinion that after different angles of compression, the distance between the lump and the nipple is basically unchanged in the direction of the projection of the center line. First calculate the projected length of the distance from the suspected lesion area to the nipple on the center line in one view: then label such a matching center line in the other view, which is perpendicular to the center line of the view, and the distance from the nipple to it is the projected length just calculated. With the matching center line as the central axis, such a ribbon area can be determined. 2. Feature extraction and feature optimization of suspected lesions: This system combined the features of the two views and referred to previous research results, and selected 24 features including mutual information, gamma coefficient correlation, association, etc. A stepwise discriminant method is used to delete the redundant features from the 24 initial feature sets, and finally an optimal feature set consisting of 8 features is obtained, including the following: discrete cosine measurement, correlation degree using the median, sequential measurement, local bivariate histogram measurement, local bivariate histogram Chi-square measurement, comprehensive density, matching distance, and single view detection fractional value. 3. Classification and discrimination of matching pairs: The concept of decision score based on distance is proposed in this paper. The specific method is as follows: The sample to be decided is mapped to a one-dimensional space, and the ratio of the distance between the mapping point and the false-positive sample center and the sum of the distance between the two sample centers is calculated. The ratio reflects the degree of similar mass in the suspected lesion area. The closer the ratio is to 0, the closer the sample is to the false-positive sample center, and vice versa, the closer the sample center is to the true positive sample center.

ROC curves were used to compare the mammogram findings of two doctors after CAD

Research methods for benign and malignant tumor detection in breast ultrasound images are mainly divided into two categories: (1) Methods based on manual feature extraction: The gray scale symbiosis matrix was calculated by extracting the minimum boundary rectangular region around the lesion, and 22 symbiosis statistics were calculated from 6

quantization levels, 4 directions and 10 distances, respectively. Fisher linear discriminant analysis was used to evaluate the discriminant ability of texture features.

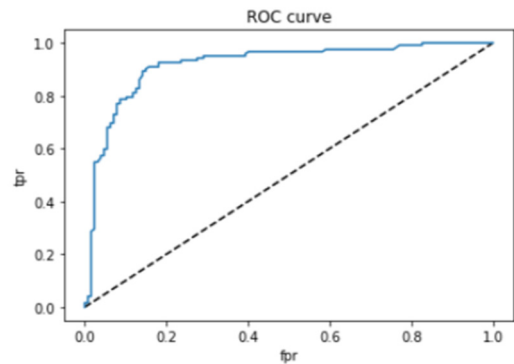


Figure 5. Result curve

Secondly, it is a method to distinguish benign and malignant breast tumors in ultrasound images based on morphological characteristics. Firstly, the edge of breast tumors in ultrasound images is extracted, and then three corresponding morphological parameters are calculated on the obtained edge. Finally, Fisher linear criterion, error backpropagation neural network and radial basis function neural network are used to classify the morphological parameters.

## 5. Conclusion

Artificial intelligence has shown certain advantages in the ultrasound diagnosis of breast cancer, for example, reducing the workload of physicians, improving the repeatability of examinations, shortening the examination time and improving the detection rate and diagnostic efficiency. However, at present, there are still some problems in the application of artificial intelligence in breast cancer ultrasound diagnosis. As the application of artificial intelligence in the medical field is still in its infancy, there is still a lack of large-scale and standardized medical databases in China, which cannot meet the requirements of artificial intelligence for data testing and model establishment. However, whether the differences of disease spectrum and ultrasound equipment imaging in hospitals in different countries and regions will cause the lack of universality of artificial intelligence modeling needs to be further verified. In addition, the acceptance and recognition of artificial intelligence in patients is generally low, and it cannot reflect humanistic care, which hinders its development to a certain extent.

Future applications of AI in breast cancer ultrasound diagnosis may include: (1) the development of AI systems that can learn and evaluate dynamic ultrasound images; (2) Develop a multi-modal artificial intelligence system that can combine all kinds of focal sonogram information (color Doppler, spectral Doppler, etc.) to improve the diagnostic accuracy; Artificial intelligence is not only limited to the classification of breast cancer, but also can classify benign lesions such as breast fibroadenoma, mammary inflammatory diseases and breast cysts; (4) The role of artificial intelligence ultrasound in the evaluation of treatment effect, recurrence monitoring and survival prediction of breast cancer patients; (5) Formulate relevant use of artificial intelligence Laws, regulations and ethical systems to clarify the attribution of responsibility if mistakes are made during the inspection

process.

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