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Role of Artificial Intelligence for Breast Cancer Screening

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Abstract— ***Detecting breast cancer in its early stages has proven to be a life-saving development. Modern technology offers a combination of modern medical imaging, manual screenings, and patient awareness of symptoms, helping in reducing the death rates from this form of cancer worldwide. Various applications of AI are being employed to increase the precision and speed of breast cancer detection. AI algorithms use data from digital mammograms and other imaging such as ultrasound, MRI, and CT scans to detect abnormalities that may be indicative of breast cancer.***

AI-enabled systems can also assist radiologists by flagging areas of concern within an image for further investigation. As Deep learning models are being used to interpret images with greater accuracy than ever before. Therefore, early detection of the disease and effective treatment become crucial in the fight against it. With its many applications, artificial intelligence (AI) is still revolutionizing many aspects of our life. AI integration into the present screening process makes finding results easier and more convenient. However, there are numerous obstacles in the way of AI integration that must be dealt with methodically. The use of AI in breast cancer screening will be discussed in the paragraphs that follow.

Index Terms— ***Artificial Intelligence, Breast Cancer Diagnosis, Breast Cancer Screening, Machine Learning***

I. INTRODUCTION

Breast cancer is the second most frequent malignancy in women, despite the fact that early detection and treatment can greatly enhance outcomes. The World Health Organization (WHO) estimates that 460,000 people worldwide perish away from breast cancer each year, out of the 1,350,000 cases that are diagnosed.

Breast cancer can be found via screening mammography before any symptoms emerge, allowing for earlier and more effective treatment. Prospective clinical trials to enhance the precision and efficacy of breast cancer screening are made possible by the meticulous evaluation of the AI system. The significance of developing a framework or solution for early detection and diagnosis has caused many AI researchers to concentrate recently on automating this process. Another reason for the increase in research in this field is the creation of reliable AI algorithms (deep learning), the accessibility of sufficiently big datasets for training AI algorithms, and the availability of technology that can run and train these sophisticated and reliable AI algorithms.

Based on how they manage data and extract information from images, AI algorithms can be divided into two groups:

• Manually generated feature-based machine learning (ML) algorithms, which are frequently referred to as classical ML algorithms (ML is the study of AI algorithms that learn from experience without being actively programmed).

These terms describe mathematically optimized categorization algorithms that process photos or raw data and extract information from regions that stand out as dominant. Deep Learning (DL) and Deep Neural Network (DNN) methods are used in these algorithms. The study of AI systems that create increasingly abstract representations from input is known as deep learning (DL), a branch of machine learning. By using DL algorithms, the essential data representations are automatically learned, which decreases and eventually eliminates the need for manually constructed features.

DL algorithms, however, constitute the foundation of recently published frameworks because of their superior performance. Both sets of AI algorithms have shown accurate results for the analysis of breast cancer. This article examines the performance of various AI algorithms used with breast imaging modalities and offers potential avenues for further research. The most widely used tools for diagnosing cancer nowadays are supervised machine learning techniques.

II. SEARCH METHODOLOGY

This review tells a story. The authors searched through previously published works between 2017 and 2023 on Google Scholar, PubMed, Sci-Hub, Elsevier, etc. to gather information. To assess their genuine relevance, published publications were personally reviewed for their title, abstract, and even complete text. We found articles that suggested using AI/ML models to help in breast cancer diagnosis and prognostic evaluation. References from the papers that were searched as well as other articles were examined.

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Table 2.1: Proposed methodology for Search Strategy

Items	Detail
Databases and other sources searched	Google Scholar, PubMed
Search terms used	"Al and breast cancer screening"
	"AL models for breast cancer detection"
	"breast cancer"
	1 AND #2 AND #3
Time frame	2017-2023
Selection process	All retrieved articles will be screened for duplicate studies and then deleted
	The authors will individually review the literature according to its title and abstract, initially excluding any that is not pertinent to the subject.
	The included studies will be verified by a thorough reading of the entire text. Discussion will be used to settle the disagreement between the two writers in the selection process.

III. RELATED REVIEWS

A. Digital pathology and cancer management

The gold standard for diagnosing breast cancer is pathology, which also plays a significant guiding role in developing the therapeutic treatment strategy and determining the prognosis. Digital pathology is the method of taking high-resolution pictures of stained tissue slides utilizing whole-slide scanning technology. The next step is to build AI models based on various algorithms to objectively analyze the digital images, which can help pathologists with their daily work. Over the past 20 years, whole slide imaging (WSI), which permits the imaging and long-term archiving of whole slides at high resolution, has been created. Pathologists can now utilize AI to identify specific imaging signals connected to disease processes in order to improve early detection, ascertain prognosis, and select the most suitable treatments. Because of this, pathologists are able to treat more patients while still making precise diagnosis and prognoses. Despite the aging population and increasing patient load, less than 2% of medical graduates chose pathology as their area of study. AI in breast cancer pathology, as outlined in the in-depth study by Ibrahim et al. (2020), will provide information beyond what can be learned by eyeball assessment and has the potential to replace some of the pricey multigene assays.

The five supervised machine learning methods that will be examined in this study are logistic regression, random forests, K-nearest neighbors, support vector machines, and random forests.

B. Bayesian Belief Network

An automated breast cancer screening method based on association rules and neural networks is proposed by Karabatak M., et al. In this case, AR is utilized to measure intelligent classification. Performance of the predicted AR+NN (combining 2 methods) scheme is compared to NN model. By employing AR, the input feature space is reduced from nine to four dimensions. On the WBC database, a 3-fold cross validation approach is used throughout the testing phase to evaluate the projected system's 95.6% accuracy. This study demonstrated that AR may be used to shorten feature lengths and suggested using the AR+NN model to get quick, automatic diagnoses for additional diseases.

C. Bayes Classifiers for Breast Cancer detection

For three prediction models for breast cancer survivorship, Chaurasia et al. (2018) used three well-known data mining techniques: Naive Bayes, RBF Network, and J48, and they demonstrated the effectiveness of the NB algorithm.

Cross-validation was performed on the final focused Bayesian classifier utilizing a train-and-test cross-validation methodology to get classification accuracy estimates and strongly predictive regions. The NB algorithm was used by Stojadinovic et al. (2010) to determine breast cancer risk.

In 2017, Mandal et al. evaluated the effectiveness of the NB classifier with that of Logistic Regression, Decision Tree, and other methods for the identification of breast cancer.

IV. ARTIFICIAL INTELLIGENCE'S POTENTIAL IN TREATING BREAST CANCER: CHALLENGE

A. Interpretability

Deep learning's "black box" issue raises a crucial question of "explainability or interpretability." According to Loder, J., Nicholas, L., and others (2018), physicians are hesitant to base their decisions on output produced by AI. Technology must be easy to use, simple to understand, and understandable in order to realize its full therapeutic potential (Giger ML 2021). Depending on elements such as illness propensity, pixel-level activation, data collection method, workflow efficiency, or cost, the system's output will be of interest to a range of clients, including doctors, researchers, government officials, and insurance companies. J.D. Fuhrman and others in 2022. Through the use of apps (like Grad-CAM) that place emphasis on the image pixels that the algorithm uses in its decision-making, researchers have discovered a number of practical methods for explainability in medical imaging. It may also be simpler to grasp if human descriptions are correlated with AI output.These tools can help people comprehend why an AI system might not work in particular situations or populations. The question of how to trust algorithms when they forecast things that don't match how a user—in this case, a radiologist—would read an image—like emphasizing parts outside the body—remains.

B. Robustness

The second major problem is the durability and repeatability of AI algorithms due to the complexity of medical picture recognition and diagnosis. AI systems that are exceedingly sensitive to even the smallest variations in visual data may be required for these tasks. As a result, a variety of factors (such as picture capture parameters, segmentation decisions, or skewed training data) may cause the output of such algorithms to concentrate in an undesirable location. Deep learning AI systems are vulnerable to robustness issues since the training data might have an impact on the trained model's and classifier's performance. Additionally, a computer's trust in its own work may change if it is having trouble identifying the scenario.

C. Bias and transferability in AI based system

According to El NaqaI M et al. (2021), attempts should not be biased and that AI algorithms must also be generalizable to new populations and imaging systems. To be successfully incorporated into clinical practice, AI algorithms must be equally effective over a wide spectrum of persons with regard to age, race, ethnicity, socioeconomic status, risk factors, the range of cancer appearances on imaging, and imaging modalities. Applying performance predictions from AI algorithms that depend on training with existing data to various demographics or imaging systems may be difficult. A few publicly accessible image repositories, including the Medical Imaging and Data Resource Center (MIDRC) and The Cancer Imaging Archive (TCIA), aim to address this problem by providing equitable access to a diverse population of imaging studies for a range of illnesses and clinical tasks (Medical Imaging and Data Resource Center (MIDRC).2022).

D. Ethical Issues

Given that the majority of AI systems are either not yet FDA-approved or are only FDA-approved for a certain purpose, ethical usage of AI is a major topic of focus. Regulatory bodies have made an effort to address AI regulation and implementation, including the FDA and the European Medicines Agency. The transition from manually reading cases to reading cases with AI assistance may require changes to clinical processes. Future studies should assess how AI affects radiologists, patients, and healthcare systems as a whole from a clinical and monetary perspective. For this effort, hospitals and clinicians might need to create new billing codes. (2019) R. Masud et al.

V. CONCLUSION

AI, in particular DL, is being used more and more in medical imaging and performs exceptionally well in applications requiring medical picture processing. With its benefits of quick computation, strong repeatability, and lack of weariness, AI can give clinicians objective and useful information and lessen their workload as well as the rates of missed and incorrect diagnoses. Artificial intelligence (AI) has the potential to improve the efficacy and efficiency of breast cancer screening through the use of quantitative, repeatable, and objective algorithms. Since artificial intelligence systems are capable of identifying complex patterns that may be difficult for the human eye to notice, they should be created to be noise-resistant and generalizable to a variety of disease representations.2019 and 2020 Bi WL, Hosny A, Giger ML, Sheth D, and Schabath MB.

AI's potential for breast cancer screening:

Twenty years ago, CAD was introduced into mammography screening. AI-based techniques simplify neoantigen discovery, but additional money is required for the study. AI can be used to predict the efficacy of immunotherapies. The pathologist can make an early diagnosis and give patients with high-quality care thanks to these innovative techniques. The usage of AI does have some restrictions, though. To control the use of AI, numerous authorities are already in place. It should be able to overcome these obstacles and popularity of general screening approaches based on AI, enhancing the general quality of life for cancer patients [Dileep G, Gianchandani Gyani SG(2022)].

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