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The Future of Breast Cancer Detection: A Review on the Integration of Cloud-Based Deep Learning Models

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Abstract: Breast cancer is the most common cancer in women and the leading cause of cancer death worldwide. This review paper focuses on how cloud-based deep learning models have the potential to transform medical diagnostics, especially in breast cancer detection. Advanced deep learning algorithms like logistic regression, convolutional neural networks, and artificial neural network models, combined with cloud computing, have the potential to transform breast cancer detection by greatly improving accuracy rates. The detection of breast cancer can be improved in many ways by using the new technologies available today, such as quantum convolutional neural networks and secure cloud-based diagnosis systems. The paper emphasizes the need to reduce the number of specialized healthcare center screenings to make medical care more widely available, especially in underserved or remote regions. Improvements in patient outcomes and healthcare delivery are expected due to increased sensitivity in detecting breast cancer, decreased reliance on human error in the diagnostic process, and a revolutionary effect on cancer management.

Keywords: *Breast Cancer, Logistic Regression, Convolutional Neural Networks, Artificial Neural Network, Mammograms, Electronic Health Record*

1. Introduction

Millions of women are diagnosed with breast cancer every year [1], making it a major public health concern worldwide [2]. Current methods of early detection such as mammography, ultrasonography, and magnetic resonance imaging (MRI) have their drawbacks [3] [4]. Especially in women with thick breast tissue, the gold standard, mammography, has a high rate of false positives and false negatives [5]. Furthermore, it might be unpleasant, which could discourage routine screenings [6]. Improved precision and easier work for radiologists could result from developments in artificial intelligence and machine learning. There are new methods for early diagnosis, such as liquid biopsies and molecular imaging [7]. More accurate, patient-centered, and less invasive methods of detection are emerging, and this bodes well for the future of breast cancer diagnosis [8]. While progress has been made, there are still obstacles to obtaining maximum sensitivity and specificity. Tumors can be hard to spot in dense breast tissue, and patients could be less likely to follow treatment recommendations if they aren't as uncomfortable [9]. The key to better early detection rates and patient outcomes [10] lies in overcoming these obstacles. The use of cloud-based deep learning models [11], which harness the power of artificial intelligence (AI) to improve diagnostic precision and speed, is the way of the future for breast cancer detection [12]. Deep learning algorithms, in particular, convolutional neural networks (CNNs) [13], have demonstrated exceptional skills in the analysis of medical imaging data, such as mammograms, to diagnose breast cancer with a high level of accuracy [14]. When these models are integrated into a platform that is hosted in the cloud, it is possible to centralize the storage, processing, and analysis of massive amounts of medical imaging data that originate from a variety of sources [15]. The cloud-based approach allows real-time collaboration between healthcare professionals, seamless integration with electronic health record (EHR) systems [16], and iterative learning to improve AI models for early detection, personalized treatment planning, and complete patient care [17].

This review study provides a thorough evaluation of how using deep learning models trained in the cloud could improve breast cancer diagnosis. This paper presents research that highlights the potential of new technologies, especially cloud-based deep learning models, to completely revamp existing approaches to detecting breast cancer. The review study highlights the increased accuracy and efficiency gained with the incorporation of cloud-based deep learning models as one of the significant outcomes. These models make use of a plethora of medical imaging data to improve pattern recognition and categorize breast problems with pinpoint accuracy. The potential for this technical improvement to decrease the number of false positive and false negative diagnoses bodes well for the health of patients.

Several studies have explored different aspects of the Future of Breast Cancer Detection: Integration of Cloud-Based Deep Learning Models. These studies have focused on various aspects such as Breast Cancer, Breast Cancer using Deep Learning, and an overview of Breast Cancer Detection using the Cloud-Based Deep Learning model

1.1. Breast Cancer

Hong et al., (2022) [18] outlined the newest breast cancer research and prospects. Kunkler et al., (2023) [19] completed a phase 3 randomized study of irradiation omission in women 65 or older

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with hormone receptor-positive, node-negative, Breast-conserving surgery [20] with clean excision margins and adjuvant endocrine treatment is recommended for T1 or T2 primary breast cancer if tumors are ≤3 cm in size. The study by Vaka et al., (2020) [21] introduces a cutting-edge approach to finding breast cancer by using Machine Learning methods. The proposed strategy is both effective and efficient. Ak et al., (2020) [22] used numerous data mining and machine-learning strategies for spotting breast cancer have been proposed. The highest classification accuracy (98.1%) was found using a logistic regression model that accounted for all features. Wang et al., (2019) [23] investigate the use of deep features from a CNN [24] to create a breast Computer-Aided Design (CAD) technique [25]. The proposed strategy for detecting masses and classifying breast cancer is accurate and efficient in a series of extensive studies. Chaurasia et al., (2017) [26] examine the UCI machine learning Wisconsin dataset for breast cancer information to create reliable prediction models for the disease. Sequential Minimal Optimization (SMO) [27] delivers better outcomes in terms of prediction accuracy, with a value of 96.2%. Wang et al., (2017) [28] aims to present recent progress made in breast cancer screening techniques (with a focus on microwave imaging) and breast biomarkers and biosensors for early detection.

1.2. Breast Cancer Using Deep Learning

Humayun et al., (2023) [29] suggested a technique that uses Inception-ResNet-v2 deep learning for transfer learning. The breast cancer dataset the author tested yielded a 91% accurate model. Abdollahi et al., (2022) [30] utilized accuracy, sensitivity, specificity, and P-value on 57458 unlabeled pictures. Quantitative accuracy was 98.84%. VGG16 has 92.42% accuracy and 91.25% recall. Viswanatha Reddy et al., (2022) [31] a database-based CAD method [32] for categorizing patients as malignant, non-cancerous, or cancer-free. The author says pre-processing mammograms enhances categorization. Abunasser et al., (2022) [33] provide a deep-learning breast cancer detection and classification model. Results indicated 97.60% Precision, 97.60% Recall, and 97.58% F1-Score. Deep learning algorithms can accurately identify and categorize breast tumors.

Rabiei et al., (2022) [34] forecast breast cancer using demographic, laboratory, and mammographic data with machine learning. AUC 0.56, accuracy 80%, sensitivity 95%, specificity 80%, and Random Forest (RF) outperformed other methods. Aljuaid et al., (2021) [35] present a unique computer-aided breast cancer classification technique employing deep neural networks [36]. The average multi-class classification accuracy was 97.81%, 96.07%, and 95.79%. Siddiqui et al., (2021) [37] present a cloud-based Internet of Medical Things (IoMT) model [38] for breast cancer stage prediction. Experimental findings show 98.86% and 97.81% accuracy for training and validation. Wu and Hicks et al., (2021) [39] evaluated four breast cancer classification models (Support Vector Machine (SVM), K-Nearest Neighbors (KNN), Naïve Bayes, and Decision Tree) [40] using different threshold levels of features. ML algorithms predict triple negative and non-triple negative breast cancer.

Tiwari et al., (2020) [41] demonstrate LR, SVM [42], KNN [43], Multi-Layer Perceptron Classifier [44], ANN [45], etc. ANN and CNN maximize accuracy at 99.3% and 97.3%. Islam et al., (2020) [46] compared SVM, K-nearest neighbors, random forests [47], ANNs, and logistic regression. ANNs had the greatest accuracy, precision, and F1 score of 98.57%, 97.82%, and 0.9890, while SVM had 97.14%, 95.65%, and 0.9777. Zhang et al., (2019) [48] developed a relation extraction Bidirectional Encoder Representations from Transformers (BERT) fine-tuning method. The best system F1 scores were 93.53% for NER and 96.73% for relation extraction.

1.3. Breast Cancer Detection Using a Cloud-Based Deep Learning Model

Kumar et al., (2023) [49] suggested ResNet-50 and EffNet-50 deep learning architectures to detect damaged areas. ResNet50 and EffNet50 architectures together achieve 98.6% accuracy. Kadhim et al., (2023) [50] detect breast cancer with ML The gradient boosting model scored 96.77% on F1 scoring, besting all other methods. Pathoee et al., (2022) [51] used the Wisconsin Breast Cancer Dataset. Experimentally, the SVM model had 98.24% accuracy with an AUC of 0.993, whereas the logistic regression had 94.54% accuracy with 0.998. Lilhore et al., (2022) [52] using Fuzzy clustering is utilized for effective transition region filtration-focused picture segmentation. The revised SVM technique beat LR, DT, and SVM in feature selection, accuracy, TPR, FPR, and F1-score in experiments. Ogundokun et al., (2022) [11] suggested the Wisconsin Diagnostic Breast Cancer (WDBC) dataset. The CNN and ANN models classified 98.5% and 99.2%, respectively.

Amin et al., (2022) [53] create a secure cloud-based breast cancer diagnosis system. To increase service, reduce specialized healthcare center screenings. Gopi and Jayakumar, (2022) [54] suggested system uses positron emission tomography scan (PET/CT) images to detect and classify tumors using Lung Tumor Detector and Stage Classifier (Cloud-LTDSC). Tumor stage classification accuracy is 97%-99.1% and 98.6%, which is far higher than previous methods. Fagbuagun et al., (2022) [55] built a convolutional neural network model to identify breast cancer in women with excellent accuracy. After 80 iterations, the model has 98.25% accuracy and 99.5% sensitivity. Raheem et al., (2022) [56] construct a breast cancer prediction model. The Just JNN environment technique has 88.24% accuracy, while the suggested model provides better results. Lahoura et al., (2021) [57] suggested an ELM-based cloud-based breast cancer remote detection system. The significant experimental outcomes are 0.9868 accuracies, 0.9130 recall, 0.9054 precision, and 0.8129 F1-score.

Yu et al., (2021) [58] suggested a 5G-5GB remote e-health deep-learning-empowered breast cancer auxiliary diagnosis method. Rural breast cancer diagnosis accuracy is 98.19 percent. Alanazi et al., (2021) [59] suggested approach achieves 87% accuracy, reducing human diagnostic errors. Siddiqui et al., (2021) [60] using decision-based fusion, both breast cancer prediction models achieved 97.97% accuracy in identifying its phases. Khan et al., (2020) [61] proposed BCP-T1F expert system is used to diagnose breast cancer early. BCP-T1F has 96.56 percent accuracy, while BCP-SVM has 97.06 percent. Bisarya et al., (2020) [62] showed that quantum convolutional neural networks beat classical ones in accuracy and temporal complexity. Saba et al., (2019) [63] suggest utilizing breast cytology pictures and a cloud-based decision support system to detect and classify breast cancer aggressive cells. Results demonstrate 98% accuracy.

2. Discussion

Breast cancer diagnosis using cloud computing and sophisticated deep learning models is an exciting new area that this review paper seeks to investigate. The study highlights how this combination has the potential to improve breast cancer detection and diagnosis worldwide by analyzing several different studies. Particularly impressive are the high levels of accuracy demonstrated by investigations like that conducted by Pathoee et al. (2022) using logistic regression. Ogundokun et al. (2022) and Fagbuagun et al. (2022) provide other examples of the adaptability of deep learning algorithms in breast cancer detection and highlight the effectiveness of cloud-based integration in optimizing these algorithms. The use of quantum convolutional neural networks and secure cloud-based diagnosis systems highlight this integration's multifaceted approach to breast cancer detection. Lung tumor detection using integrated technologies such as PET/CT imaging and Cloud-LTDSC hints at the potential for this integration to be applied to other types of cancer as well. Healthcare in rural or underserved areas can be made more accessible and affordable by reducing the number of people who need to be screened in specialty clinics, as this review explains. This study makes significant progress in breast cancer diagnosis and treatment. Exploring cloud-based deep learning models satisfies the need for more accurate and time-saving breast cancer screening. Cloud-based resources can evaluate massive amounts of medical imaging data in real-time, boosting breast cancer diagnosis speed and accuracy. Since it is scalable and economical for healthcare organizations, this integration allows more people to use cutting-edge diagnostic tools. It shows that deep learning algorithms can analyze high-dimensional medical pictures like mammograms and MRIs. Deep learning algorithms allow models to learn and recognize complicated breast cancer symptoms, enabling earlier and more accurate identification. The way breast cancer is diagnosed has changed, which could improve patient outcomes and survival. By showcasing significant advancements that have the potential to improve diagnostic accuracy, reduce human errors, and revolutionize cancer diagnosis and management, this review concludes that a bright future lies ahead for breast cancer detection through the integration of cloud-based deep learning models. Consistent innovation in this space has the potential to transform healthcare delivery, ultimately improving outcomes for patients.

3. Conclusion

Cloud-based deep learning models are a promising medical diagnostics frontier, and this review paper concludes with a comprehensive breast cancer detection roadmap. Cloud computing and cutting-edge deep learning algorithms could revolutionize breast cancer detection. Logistic regression, CNNs, and ANN models are promising examples from this review due to their high accuracy rates. Multiple approaches can improve breast cancer detection, such as quantum convolutional neural networks and secure cloud-based diagnosis systems. The study's scope extends to a thorough investigation of the possible benefits and uses of cloud-based deep-learning models for spotting breast cancer. The study intends to assess and anticipate how combining state-of-the-art deep learning technology with cloud-based platforms might improve the precision, efficiency, and improvability of breast cancer detection. Traditional imaging methods, machine learning strategies, and new deep learning models intend to all be explored in this study of breast cancer screening methods. The author's objective is to weigh the pros and cons of these methods so that readers can form their own opinions about whether or not they have a place in contemporary medicine. The paper emphasizes the importance of reducing screenings at specialized healthcare facilities to increase healthcare availability, especially in underserved or remote areas. Cloud-based deep learning models are expected to improve breast cancer detection, reduce human errors, transform cancer diagnosis and management, improving patient outcomes and healthcare delivery.

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3.3. Conflicts of Interest

The authors declare no conflicts of interest.

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