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Cancer diagnosis by artificial intelligence

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ABSTRACT
By2020 the rate of breast cancer exceeds lung cancer and progressed as a most common type of cancer worldwide and second highest death rate. The reason why cancer is termed as fatal is cancer progresses quicker and in most of the cases these cells are detected at an advanced stage. breast, lung ,liver cancer studies have shown that some of these systems need an precise accuracy in diagnosis .the heavy global burden of morality of breast cancer focus attention on the importance of early diagnosis and treatment . This article examines various methods of AI using image processing to diagnose breast cancer. The rise of an artificial intelligence in the medical imaging field has led to the creation of ingenious deep learning models that can predict the status of tumors results in preventing of unnecessary biopsies and dissections for patients. The relationship between tumor image and molecular characteristics allow us to perform analysis and detection on molecular level with no need invasive operations. Although AI assisted imaging breast cancer screening and detection is an emerging field, the clinical application of AI in tumor recognition, segmentation and diagnosis is still limited to research or in limited patient's cohort.

Keywords: artificial intelligence, breast cancer, deep learning, machine learning, networks, CNN, ANN

I. INTRODUCTION:

Breast cancer is one of the leading causes of death in women. Breast cancer occurs when cell tissues of the breast become unusual and uncontrollably divided breast cancer could be completely treated if detected early [1]. Mammography is one of most important early diagnosis method for breast cancer.

In the early 1980s there was an increase in the use of neural networks in the field of image and signal processing since diagnosis of breast cancer is very typical ,statistical method ,AI techniques becomes very important in this regard[2]. Breast cancer can be can be diagnosed using one of the two approaches histopathological image analysis or genomics. In this review we examine recent studies demonstrating the success of machine learning and deep learning models in diagnosis of breast cancer.

Mammographic techniques are mainly used in breast cancer screening in asymptomatic women due to good performance in detecting small tumors using a low incidence of x-ray for diagnosed breast cancer and ultrasound is most common image detection for tumor staging and biopsy guiding in clinical routine. MRI has greater sensitivity than the above two techniques in breast cancer detection through it is the most expensive one with low specificity. The artificial neural network (ANN) works in a similar way, it uses several artificial neurons ranging from 10 to 10,000 which are too much lesser than biological neurons in a brain which is in billions. ANN is statistical models which are capable of pattern recognition and machine learning [4, 5]. Computer aid diagnosis(CAD) provides efficient automated image recognition, lesion segmentation and diagnosis reduce the work of radiologist and improving diagnostic accuracy. With the advances in CAD more flexible and versatile analyses are constantly evolving, especially image based AI techniques significantly improving the clinical value of CAD in breast cancer. [6] In this review AI based imaging detections including mammography, ultrasound, MRI, and PET, in breast cancer screening and diagnosis.

Due to inherited problems associated with an image, including less contrast, noise, and lack of identification with the eye, tools have been developed to create and develop image processing. Currently, medical image processing is one of the fastest growing areas in the health sector. The purpose of the image processing is to use

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Techniques for making proper images of the human body, which are reliable for use in the diagnosis and treatment processes. [7]

Applications of artificial intelligence in pharmacy:

1. In general, AI is used for analysis of machine learning to imitate the cognitive tasks of human beings. [8,9]AI technology is used to perform more accurate analysis and interpretation
2. **Maintaining of medical records:** Maintenance of the medical records of patients is a typical task to the pharmacist. The collection, storage and tracing of data are made easy by application of the AI system [11].
3. **Treatment plan designing:** The preparation of effective treatment plans is possible with the help of AI technology. The selection of a suitable treatment plan in critical situations becomes difficult the AI system can be useful to control the situation. All the previous data and reports, clinical expertise, etc., are considered in the designing of the treatment plan as suggested by this technology [12].
4. **Assisting in repetitive tasks:** AI technology can also be implemented in some repetitive tasks, such as examining the X-ray imaging, radiology, ECHO, ECG, etc., for the diagnosis of diseases or disorders[13].
5. Top pharmaceutical companies are collaborating with AI technology in their manufacturing processes for research and development and drug discovery[14]
6. Machine learning models and deep leaning models allow e-mails to be personalized at a speed and accuracy greater than that of any humans. Chatbots [15] can be used to increase the efficiency of service delivery.
7. Walgreen made a partnership with Medline, a telehealth program to create an avenue to help patients interact with physicians through video chat [16].
8. The next generation in pharmacy technology is to identify timely drug-related problems based on patient data captured from the pharmacy system and other external data systems. And to identify serious drug-related problems [17,18].
9. Considering AI applications in cancer care recently approved by the FDA[19] , the respondents indicated diagnosis ,treatment can be benefited most from the use of AI in the next ten years
10.). For about one-third of them, cancer radiology would benefit the most, followed by pathology (27.02%). Of the available options, gynecology was considered to benefit the least from using AI (1.46%).
11. AI can also help with early detection by analyzing a patient's past medication history and test results for identification of cancer [20]. For example, AI algorithms can analyze genetic data to identify mutations and risk factors associated with an increased risk of cancer incidence. By analyzing this data, doctors can determine the most desirable course of treatment for each patient [21, 22].
12. Another area where AI could majorly impact is the discovery of new drugs. by analyzing of data from clinical trials and other sources, AI algorithms can identify patterns that may indicate the potential effectiveness of a new drug[23,24]

Machine learning and deep learning models:

In this organized study, our formal search turned up 250 conference and journal papers. Eighty papers pertaining to both ML and DL remained after removing duplicates and irrelevant research that were purely medical or about breast cancer in general. While some studies focused solely on deep learning, others included combined machine learning and deep learning. In our search process, we mainly used the Scopus database to obtain the articles. This is to exclude non-refereed publications.

The imaging models we considered were ultrasound, radiography, mammography and magnetic resonance imaging (MRI), as well as various types of gene expression and gene sequencing. In this review, we focused on papers that implementing the breast cancer detection using the techniques of AI, as well as papers that predict breast cancer using both gene data and image data. For every paper, we used the following eligibility standards (1) the language is English. (2) The topic is related to breast cancer detection and treatment (3) The paper discusses hybrid models of machine learning and deep learning (4) The paper purely discusses deep learning (5) The study examines genetic expression data; (6) it examines imaging data; (7) it keeps only journal and conference publications; (8) it keeps only articles related to medicine or biomedical engineering.

AI technology is now being utilized in many important applications like remote patient monitoring, virtual assistance, hospital

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management and drug discovery etc. Particularly, in medical image analysis and diagnostics, AI is successfully contributing in identifying complex imaging patterns from the imaging data to provide a better quantitative assessment in an automated and robust manner. Various radiological imaging related tasks i.e. risk assessment; disease detection, diagnosis or prognosis, and therapy response are now being accomplished more accurately and easily by integrating AI as a tool to assist radiologists and physicians. Use of AI for medical image analysis; AI for medical applications use medical imaging (radiology) data to provide better healthcare services. Primary purpose of using AI in medical imaging is to achieve higher efficacy and efficiency in routine clinical practices and to get support in the decision making process. [25]

Conventional machine learning algorithms (CNN): ML is the term first coined by Arthur Samuel in 1959 who described it as a sub-field of AI. It is a technique that recognizes patterns from given inputs, and solves the problems based on patterns of inputs. In case of medical imaging, manually extracted handcrafted image features (defined in terms of distinguishing image characteristics like area, shapes, region of interest, texture, and histogram of image pixels from the input medical images) serve as input to ML algorithms.[26] The extracted features may further be processed through features selection algorithms to select most relevant features and finally, The goal of machine learning algorithms is to combine the chosen input information into a single value, such as a tumor signature that could indicate the probability of a certain disease condition. ML algorithms are divided into two main categories based on learning: supervised learning algorithms and unsupervised learning algorithms. These two types are further divided into classification, regression (supervised), and clustering (unsupervised) approaches based on the output generated by the algorithms [27].

Deep learning algorithms: It uses artificial neural networks to perform sophisticated computations on large amounts of data. This particular kind of machine learning is predicated on the composition and operations of the human brain. neuronal network is structured like the human brain and consists of artificial neurons, also known as nodes. These nodes are stacked next to each other in three layers [28, 29]

1. The input layer
2. The hidden layer(s)
3. The output layer

Various imaging techniques used in artificial intelligence:

Breast cancer is the largest cause of cancer among women, accounting for one-third of all the cancer types. Obtaining the best outcomes in breast cancer depends on early diagnosis. Therefore, imaging techniques have been developed to increase the likelihood of early diagnosis of breast cancer and reduce unnecessary biopsy. Table shows a summary of advantages and disadvantages of each method. Currently, digital image processing techniques are often used in solving machine visual problems and have provided good result.

Advantages and disadvantages of a various imaging techniques in breast cancer

s.no.	Imaging method	Application	Advantage	Disadvantages
1	Mammography	Golden standard imaging and diagnosis of breast cancer early stages	• It uses low levels of X-rays for imaging • This method is good for detecting DCIS and calcifications • Mammography is the gold standard method to detect early-stage breast cancer before the	• Radiation risk and other risks • Risk of false alarm • It is difficult for the radiologist to interpret the results from mammograms as mammograms generally have low contrast • Double reading of mammogram leads to increase in the cost of detection • Mammography alone misses

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			lesions become clinically applicable.	many Cancers in dense breasted women.
2	Ultrasound	Suitable for dense and soft tissues Suitable for dense and soft tissues	• Widely available and accessible • Noninvasive • Quick • Highly sensitive • Suitable for women with dense breasts	• Quality and interpretation of the image depends highly on the skill of the person doing the scan
3	Thermography	Suitable for muscle tissue	• Noninvasive	• Physicians can have difficulty interpreting the images because of the low quality and low resolution of the images taken by the first generation of the medical infrared imaging cameras

Effective deep learning models:

We found that the highest accuracy is obtained when binary classification is used, and that binary classification is generally more accurate than multiclass classification. Among the papers, the CNN model appears to be the most frequently used model for both binary and multiclass classification. For these kinds of models, a hybrid of deep learning and machine learning also appears to be effective. A hybrid between ML and DL is evident algorithm has been heavily utilized in these papers additionally, these papers utilize the SVM algorithm from machine learning.

When it comes to breast cancer detection using imaging, ANN and CNN were the most widely used algorithms in both gene sequence and images data. Many other algorithms were used, such as DNN and SVM, but most of the papers used CNN and ANN with various parameters and properties [30, 31].

Different datasets for MRI and gene sequencing: [32, 33, 34, 35]

Many other breast cancers imaging datasets could be found most of them public and free the dataset can be used independently if it is very large, as the DDSM dataset is. The dataset can be combined with another dataset to increase the size of the data pool if it is not big enough to yield high performance results. Researchers mostly used the MRI and Wisconsin breast cancer datasets because, as we can see, they are both publicly available and have large sample sizes.

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Public and private datasets for gene sequencing				
s.no.	Dataset	Publicity	Cost	Link
1	The cancer Genome Atlas	Public	Free	Http://cancergenome.nih.gov
2	METABRIC datasets	Public	Free	Https://ega-archive.org/datasets/EGAD00010000268
3	Array express database	Private	-	-
4	GEO database	Public		Https://www.ncbi.nlm.nih.gov/geo/info/download.html
5	STRING and BIOGRID	Private	Free	-
6	NCI Genomic Data Commons (GDC)	Public	paid	Https://gdc.cancer.gov/
7	Spark dataset	Public	Free	Https://drive.google.com/file/d/1yd1gwk2owgoooq9wi1k7puoakd7cbs8t/view

	public and private datasets for MRI imaging			
1	Wisconsin breast cancer dataset	Public	Free	Https://archive.ics.uci.edu/ml/datasets/Breast+Cancer+Wisconsin+(Diagnostic)
2	Helsinki University & Netherlands Cancer Institute & Vancouver General Hospital	Private	-	-
3	MRI dataset	Public	Free	Https://wiki.cancerimagingarchive.net/display/Public/RIDER+Breast+MRI#2251275749b786f1af5747c39abd8eda0d12e2b7
4	University of Vermont Medical Center	Private	-	-
5	Digital Database for Screening Mammography (DDSM)	Public	Free	Https://wiki.cancerimagingarchive.net/display/Public/CBIS-DDSM#225166295e40bd1f79d64f04b40cac57ceca9272
6	Stanford Tissue Microarray Database (TMA)	Private	-	-
7	Mammographic Image Analysis Society (MIAS)	Public	Free	Http://peipa.essex.ac.uk/benchmark/databases/index.html

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Commonly used features for breast cancer classification:

When looking at the imaging data, many general features are considered such as symmetry, compactness and concave points. One more kind of component is connected with the bosom picture explicitly. For instance, negligible attachment measures how much cells outwardly of the epithelial wall will generally remain together. Another example is uniformity of cell size, which is represented by 0 if it is not uniform and 1 if it is uniform. Clump thickness describes if cells are mono- or multi-layered. Uniformity of cell size evaluates consistency in cell size in the sample. [36]

Comparison of gene sequence data with image data [37]:

	Image	Gene
Features	More features, most obtained using CNN	Fewer features but more effective
Performance	Best accuracy is 0.993	Best accuracy is 0.998
Advantage	Easy to use CNN, more available datasets	More accurate, more confidence
Disadvantage	Many related and nonrelated features.	Hard to obtain enough datasets, possibly expensive, complex.
Medical confidence	Most common	A focus of recent research

Image acquisition:

The first step in the process is to capturing of an image. Digital photos are used to collect data in this step. The image format is generally a portable gray map, which is fixed format, and does not erase the image data when compressing images.

Image preprocessing:

The next stage involves preprocessing the input images to reduce noise and enhance their quality. Preprocessing of images is done by the middle filter. Preprocessing, in addition to deleting or reducing noise, improves image contrast and quality. [38]

Feature extraction:

The modification of input data into a set of extracted features is called feature extraction. There are many ways to extract features. Some of the most commonly used methods are as follows: 1) spatial features, 2) transform feature, 3) edge and boundary features, 4) color features, 5) shape features, and6) texture features. The use of feature extraction techniques is crucial for diagnosing illnesses. Tissue characteristics play a critical role in distinguishing the mass from the breast's native tissue. Tissue features are very useful in differentiating the mass from the natural tissue of the breast. These categories of features are capable of separating natural and abnormal lesions of the masses or micro calcifications [39].

To sum up, a variety of algorithms were employed in the research; some publications used multiple models in succession, while others only used one model. The most popular algorithms for both gene sequence and image data were ANN and CNN. The majority of the papers used CNN and ANN with different parameters and properties, though many other algorithms, like DNN and SVM, were also used [40, 41].

Multiple feature selection techniques were employed, beginning with XGboost. The mRNA and protein expression profiles of patients with breast cancer were analyzed by the authors using XGboost and a random forest multilayer network. In a data science workflow, random forests are frequently utilized for feature selection because their trssee-based methods naturally rank features according to how well they.

II. CONCLUSION:

While machine learning techniques are used in the majority of papers published in the field of breast cancer detection and subtype classification, deep learning models have not received much attention in this field. Researchers now have the chance to predict patient status using a variety of deep learning mechanisms, including LSTM, GAN, and RNN.

A significant discovery has been made: the CNN algorithm is widely used for both gene expression and MRI image data. These models frequently produce good results when compared to

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alternative algorithms. It might be of interest to researchers to carry out additional research and use CNN to create more hybrid algorithms.

While breast cancer diagnosis can be extremely precise, the results obtained from other image sets may not always match consequently, by running tests on a bigger collection of images, future research can be done to enhance the system's functionality and validate it. AI offers a bright future for a highly effective and precise breast cancer diagnostic model. Before it is used in clinical practice, though, more optimization and validation through randomized clinical trials are necessary.

Because gene sequence data covers a large area and offers endless opportunities for research and results, researchers have recently directed their attention toward it. The majority of the research on breast cancer subtype classification and detection that we could find. This gives room for more research on a number of related issues, including determining risk levels and forecasting the likelihood of recurrence.

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