IMPACT OF ARTIFICIAL INTELLIGENCE IN BREAST CANCER

Dhanvika H A
MCA Department
RNS Institute of Technology
Banglore,India
mca.dhanvikaha@gmail.com

Vishwanath V Murthy
Assistant Professor
MCA Department
RNS Institute of Technology
Banglore,India
vm.rnsit@gmail.com

***Abstract*—Cancer is a disease that is still afflicting our modern society. Breast cancer is now the most common type of cancer in women worldwide, out of all cancers. Several factors, including genetics, lifestyle, and the environment, have contributed to the rise in breast cancer prevalence among women of all socioeconomic backgrounds. As a result, proper screening for early diagnosis and treatment becomes critical in the fight against the disease. With its numerous applications, artificial intelligence (AI) continues to revolutionise various aspects of our lives. Using AI in the existing screening process simplifies and expedites the process of obtaining results. AI methods in breast cancer screening provide faster and more accurate results. Nonetheless, the process is fraught with difficulties.**

***Index Terms*—Breast cancer diagnosis, breast cancer screening, artificial intelligence, CAD (Computer-aided detection), digital pathology, Radiomics, Mammography.**

I. INTRODUCTION

Breast cancer is one of the most pressing issues women of the 21st century face. It is a significant health problem [1] and the most frequently diagnosed cancer among women worldwide [2]. Many lives are lost due to breast cancer [3]. It has a great effect on the physical and mental health of women. Breast cancer is more effective to treat if diagnosed early. The effectiveness of treatment in later stages is poor [4]. Therefore, early diagnosis and prevention can be helpful in recording more cases and reducing the number of deaths. The incorporation of artificial intelligence (AI) into screening methods is a relatively new and emerging field that is very promising in the early detection of breast cancer, thus resulting in a better prognosis of the condition. Human intelligence has always triumphed over every other form of intelligence on this planet. The defining feature of human intelligence is the ability to use previous knowledge, adapt to new conditions, and identify meaning in patterns [3]. The success of AI lies in the capacity to reproduce the same abilities [4].

II. BACKGROUND

Traditionally, radiologists manually review breast pictures (via bare breasts) for the purpose of detecting and diagnosing breast cancer. Here, indicate the financing source that applies. Remove this if none exist. eyes) and, after the conclusion of other medical professionals, make their final choice. The physical examination of breast images for the purpose of looking for breast cancer is a frequently utilised technique, but there are several unavoidable aspects about it that could result in false detection and lengthen the diagnosis process. An illustration. 1. The absence of professionals in underdeveloped nations and rural places. 2. Lack of specialists with the necessary topic expertise to accurately analyse multi-class images (images with several probable disease features). 3. Examining numerous medical photos on a daily basis can be a taxing and time-consuming process. 4.Manual analysis is more challenging due to the subtle nature of the breast tumour and the intricate structure of breast tissues. 5. Medical professionals' high levels of concentration and other fatigues make the diagnosis process difficult and time-consuming.

III. ARTIFICIAL INTELLIGENCE TECHNIQUE IN BREAST CANCER

Artificial Intelligence (AI) is a fascinating discipline that has captured our imagination since its birth in the 1950s. Its function in society's life has grown exponentially in the last decade, to a point where many of its manifestations such as face recognition or digital voice assistants are taken for granted and generate little or no astonishment in everyday users.Given the large number of women diagnosed with breast cancer every year, this field is an optimal setting for the development of a technology largely based on processing significant amounts of data(Fig.1).

Since its inception in the 1950s, artificial intelligence (AI) has fascinated us and attracted our attention. Its role in daily life has increased tremendously over the past ten years, to the point where many of its manifestations, like facial recognition or digital voice assistants, are now taken for granted and rarely surprise regular users.This industry is the ideal location for the development of a technology that is mostly reliant on processing big volumes of data due to the high number of women diagnosed with breast cancer each year (Fig. 1).

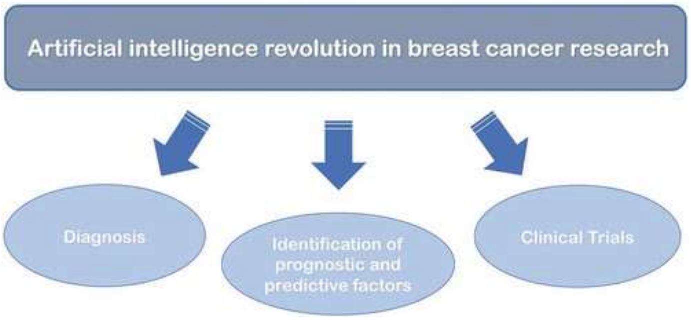

Fig. 1. Expected impact of AI in breast cancer research areas.

Medical image computing's "wind of change" for AI The term "artificial intelligence" (AI) refers to a number of methods for making robots replicate human decision-making (Fig. 2).

All methods that allow computers to learn from features taken from training examples without those attributes being explicitly coded fall under the umbrella category of AI known as machine learning (ML) [5]. Regression, support vector machines, random forest classifiers, closest neighbour algorithms, and artificial neural networks (ANNs) are a few examples of ML techniques [5]. Figure 1 illustrates the expected impact of AI on many fields of breast cancer research. Unsupervised learning and supervised learning are two general concepts [9]. Unsupervised learning seeks to find new patterns in data where the training examples don't have labels or categories.

However, depending on the quality and diversity of the data, as well as the DL model design, learning objective, and training approach, different amounts of data may be required to attain adequate accuracy. The largest data set, known as the "training set," is utilised to parameterize the model. Data that was withheld from training is used in the validation data set to further optimise the model's hyper-parameters. Finally, performance benchmarks are established using the independent testing data set. CNNs and DL are not brand-new ideas. In the past, deep CNN training was thought to be impossible because to the scarcity of essential data and high processing expenses.Today's hurdles have been lessened by the availability of larger data sets and better computational resources (such cutting-edge graphics processing units). These technological developments have made deep learning (DL) widely used in medical image computing, incorporating applications analysing mammographic imaging data for breast cancer risk assessment. These developments also contributed to the creation of crucial DL algorithms and training procedures.

A. CAD:Computer-aided detection

Since its launch in the late 1990s, computer-aided detection(CAD) has been plagued by high expectations that haven't been fully met. It was the first software announced for clinical use in the identification of breast cancer.'Old' AI was therefore envisioned as an improvement of human intelligence that could be matched with the artificial benefit of processing large amounts of data. This technology relied on algorithms programmed to analyse digital mammograms in search of the same features of malignancy that radiologists look for when reading an exam (i.e. shape, size, asymmetry, etc.). Although early results were promising, years of CAD clinical application revealed no appreciable gain in comprehensive screening performance, and overall euphoria faded until a second wave of enthusiasm was sparked by the deep learning (DL) revolution in the early 2010s.

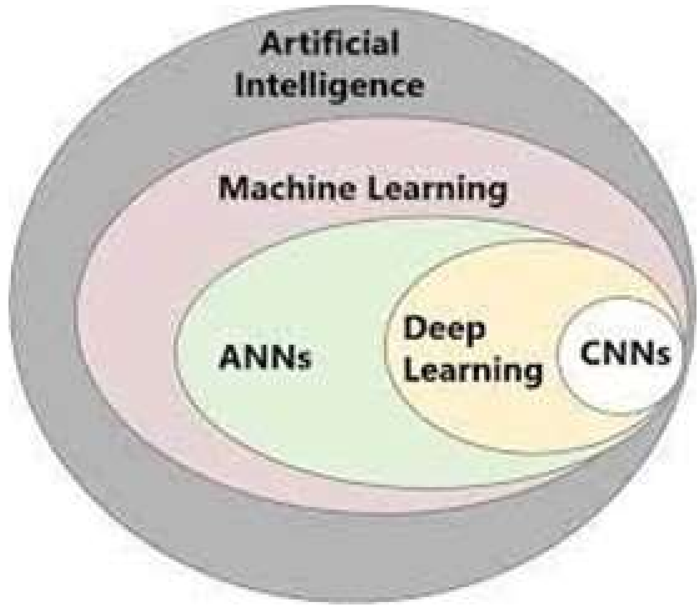

Fig. 2. The relationship between the diferent techniques in the field of artificial intelligence.

B. Computational radiology

Utilising computer vision, lesion detection, or pattern recognition for lesion detection for classification of lesions in accordance with BIRADS (Breast Imaging Reporting and Data System) and systematic reporting (diagnosis), computational radiology performs tasks that were previously performed by experts. Additionally, imaging biomarkers are extracted in order to simulate therapy responses based on prognostic and predictive data. Some of the essential components of AI needed for breast cancer imaging are machine learning and deep learning. Large datasets are stored using machine learning, which is then utilised to train prediction models and understand generalisations.The newest area of machine learning, known as deep learning, creates a network of artificial neural systems that can categorise and identify images. The main functions of artificial intelligence (AI) in breast cancer screening are object detection (segmentation) and tumour categorization as benign or malignant [2].

C. Radiomics

Radiomics is a method that many AI systems employ. It takes what's referred to as a feature—quantitative aspects—from an image. This typically happens as a result of pattern recognition algorithms, which identify images and

TABLE I
DIFFERENT METHODS BY WHICH ARTIFICIAL INTELLIGENCE WORKS IN BREAST CANCER SCREENING

Sr No.	Methods	Mode of functioning
1.	Machine Learning	A computational algorithm that makes use of image features.
2.	Deep Learning	Processing of image by a multi-neural layer or network.
3.	Radiomics	Extracts quantitative aspects from an image,which is called a feature.

output a list of numbers that correspond to a quantitative aspect of the area of the image that is being viewed. Radiomics is founded on the premise that features that are retrieved from data represent diverse molecular and genetic activity. To better understand disease outcomes, machine learning uses computer methods that leverage picture attributes that are retrieved from images using radiomics (Fig. 3). Radiomics uses two different kinds of machine learning: supervised machine learning and unsupervised machine learning.Data is categorised by unsupervised machine learning without the aid of any prior knowledge or information derived from the presented image. Artificial intelligence training using an existing data archive is the initial step in the supervised machine learning process. As part of deep learning, an image is processed by a multi-neural layer or network, which, like the supervised machine learning method, transforms the image into a list of numbers that reflect the attributes to be delivered.(Table 1) The use of AI for early detection in the treatment of breast cancer is carried out by utilising data from radiomics and biopsy slides. A global initiative to create learning algorithms for deciphering mammograms by lowering the incidence of false positives serves as support for this. AI has improved the likelihood of detecting metastatic breast cancer in lymph node biopsy full slide images.AI algorithms behave differently in various populations because to individual differences in risk factors and predispositions.

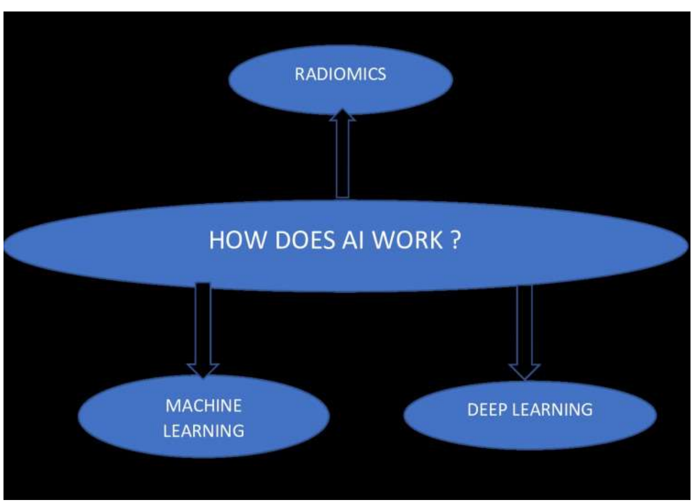

Fig. 3. Mode of functioning of artificial intelligence. .

D. Mammography

The most common technique for detecting breast cancer is mammography [4]. A high-resolution image is obtained, which is then saved and used indefinitely[10] without regard to the user's age or body type. Systems for full-field digital mammography can generate raw images as well as processed images. AI examines photos to identify breast masses, mass segmentation, breast density, and a determination of cancer risk. One of the most crucial phases in computer-aided diagnosis (CAD) is the detection of breast masses because they are a frequent finding in breast cancer patients. Microcalcification and macrocalcification are the two types of calcifications that show up as tiny spots on mammography. CAD systems are currently able to find microcalcifications. The diagnosis is directly impacted by breast mass segmentation, which is recognised as real segmentation. The mammography is automatically segmented into breast masses using fuzzy contours. Due to individual differences in abnormalities, breast segmentation might be difficult to detect. The prognosis of the patient is significantly improved by proper AI segmentation [1]. Two-dimensional mammograms are used to determine breast density. Risk factors for breast cancer include age, family history, reproductive characteristics,oestrogen, and personal lifestyle factors.

CAD was incorporated into mammography screening twenty years ago. Numerous studies were conducted to compare the effectiveness of radiologists performing a single reading against CAD performing a double reading. It did not necessarily demonstrate any benefit over the other, but it is said that the use of both has increased success rates. The potential for AI-based CAD to achieve high sensitivity has also been demonstrated by studies [6]. It can be used as a prescreening tool to exclude low-risk mammography and to shorten reading time in digital breast tomosynthesis (DBT). The majority of the time, CAD has been utilised in patient care as a second opinion or decision support, but it must undergo appropriate review and show effectiveness before being fully implemented.It is important to check the stability of results obtained over time.

AI advancements in mammographic image analysis for assessing the risk of breast cancer Kallenberg et al. were among the first to investigate the potential of deep learning in predicting breast cancer risk. They implemented a convolutional sparse autoencoder that learned a hierarchy of increasingly abstract features from unlabeled data and a straightforward classifier that connected the learned features with breast cancer. Their technique showed promising case-control classification performance when trained and tested on contralateral mammographic pictures of patients with unilateral breast cancer and matched healthy controls from two separate databases[3]. A different approach was presented by Li et al., who used a set of FFDM images from two high-risk populations, namely BRCA1/2 gene-mutation carriers and unilateral cancer patients, as well as healthy controls, to apply a pre-trained AlexNet model and feature extractor. DL models using large cross-sectional screening cohorts that represent the general screening population, with normal mammographic images acquired at least one year prior to the diagnosis of breast cancer, were used. These study designs more accurately conceptualise the task of assessing the risk of breast cancer, as one of their therapeutic goals is to detect high-risk women before a cancer diagnosis.

Additionally, it is crucial to employ breast cancer cases and controls who are the same age or to provide age-adjusted evaluation measures in such study designs to avoid inflated performance estimates of risk prediction. The given models have shown encouraging results, frequently exceeding cutting-edge breast cancer risk models with AUCs ranging from 0.60 to 0.84. Collectively, all of the research offer preliminary evidence that FFDM-based DL models have potential as more precise predictors of breast cancer risk than previous epidemiology-based models and density-based models. Researchers have looked into the possibility of AI in identifying women who are most likely to be diagnosed with a cancer that was undetected, hidden, or growing quickly in tandem with studies on long-term risk assessment.A risk model was created by Eriksson et al. that takes into account factors including age, automated breast density, mammographic characteristics (such as worrisome microcalcifications and masses), and differences in the bilateral parenchymal pattern discovered by commercial software that is DL-based.In order to create a breast cancer detection model that can be used with both 2D maximum suspicion projection (MSP) pictures created from DBT reconstructed slices and FFDM images, Lotter et al. [8] adopted an annotation-efficient DL technique. In order to create a cancer risk score, McKinney et al. created an ensemble of three DL models that each operate on a separate level of analysis (individual lesions, individual breasts, and patient level). All three AI systems showed encouraging predictive performance in short-term breast cancer risk assessment after being trained on huge datasets of mammographic pictures collected around the time of breast cancer diagnosis or in between subsequent screening tests.It is necessary to conduct more study on the decoupling of intrinsic risk from early cancer symptoms and cancer masking [5] and risk assessment at different time periods, while also taking into account the variations in screening intervals across different nations. Furthermore, because a woman's breast tissue changes over time and in response to different interventions (such as menopause, hormone replacement therapy, and risk reduction surgery), developing methods that take into account this sequential imaging data may improve assessment of a woman's personal risk throughout her lifetime of screening. Additionally, no DL models have been expanded to include volumetric risk evaluation with DBT, which could result in significant performance gains (Fig. 4).

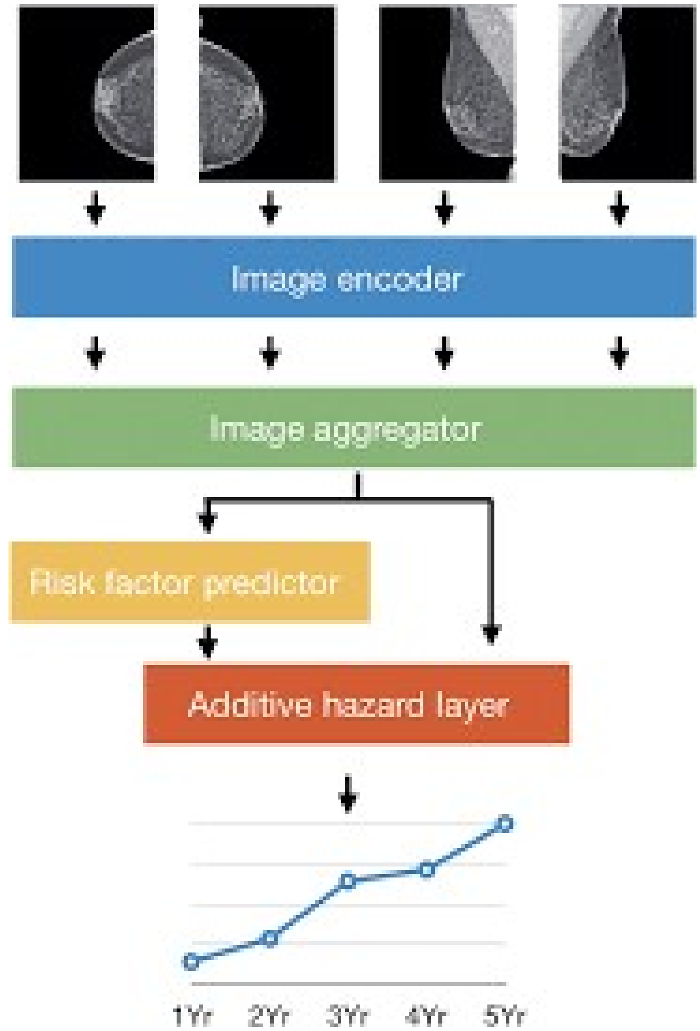

Fig. 4. Use of the four standard mammographic views in long-term risk assessment via artificial intelligence.

E. Challenges

- The field of cancer treatment has greatly benefited from AI. It has produced amazing results and offers the potential to transform all present treatment modalities. Where we draw the boundary between artificial intelligence and human intelligence is the only issue. Data gathered from populations is the foundation of AI. As a result, there will undoubtedly be a growing discrepancy in the collection of data on individuals from various socioeconomic backgrounds[7].
- Another illness whose prevalence varies among different racial groups is cancer. Studies on the effectiveness of AI contain predetermined results that can be used to gauge the standards and reliability of those studies.
- People must be able to autonomously reproduce and build AI robots for them to be really recognised, just like any other scientific finding. This implies that a common code must be accessible to all, which is only achievable if data are shared equally among all users.
- Image data is the focal point of the AI models used to treat cancer. The issue with this specific feature is that patient histories maintained as electronic health records in various hospitals are frequently underutilised. The

software systems of hospitals globally must contain easily accessible databases and user-friendly software, which is a challenging task at the moment and requires the collaboration of the engineering and medical communities.
- Building doctor trust in using AI to guide their decisions is a hurdle in its implementation. Doctors must receive sufficient training on how to use AI technology.

F. Future of artificial intelligence in breast cancer treatment

It is now simpler to retrieve data from people in our contemporary era of mobile applications[9]. Through these smartphone apps, it is possible to monitor and easily retrieve several metrics including blood pressure and heart rate. The standard of medical care and patient satisfaction have both increased as a result. However, there are other ethical risks to take into account when utilising AI techniques, including data confidentiality, privacy breach, patient autonomy, permission, etc. Numerous precautions are taken to guard against any breach of privacy, and laws are in place to prohibit malpractice [8]. The fact that radiomics are not widely used in current clinical practise is another drawback of employing AI in breast cancer screening. The majority of studies are tiny, retrospective studies, which detracts from their credibility in comparison to large, prospective investigations. But eventually, AI may replace many of the tasks performed by radiologists, and even if they aren't replaced, it will undoubtedly help them make decisions. It is a viable choice because it is non-intrusive, and with more research, it will be able to use more AI power.

CONCLUSION

Breast cancer has proven to be a significant burden for both individuals and the medical community. Early cancer diagnosis has become simpler as a result of the AI being incorporated into the various screening techniques. Radiomics, deep learning, and machine learning are some of the methods AI is used in breast cancer screening[2]. These cutting-edge methods help the pathologist make an early diagnosis and provide high-quality patient care. The usage of AI does have some restrictions, though. There are numerous pieces of regulation in place to control AI use. AI is able to identify calcification, which helps with patient diagnosis and management, as well as breast mass, segmentation, and density of tissue. It should be able to overcome these obstacles and make progress with more research and improved technologies[10].

REFERENCES

[1] Artificial Intelligence in Breast Cancer Screening and Diagnosis Monitoring Editor: Alexander Muacevic and John R Adler: https://www.tandfonline.com/doi/full/10.1080/147371 40.2021.1951240

[2] Artificial intelligence in mammographic phenotyping of breast cancer risk: a narrative Review Aimilia Gastounioti1,2, Shyam Desai1, Vinayak S. Ahluwalia1,3, Emily F. Conant4 and Despina Kontos1

[3] How will artificial intelligence impact breast cancer research efficiency? Gianluca FranceschiniORCID Icon, Elena Jane MasonORCID Icon,Armando OrlandiORCID Icon,Sabatino D'ArchiORCID Icon-SanchezORCID Icon Riccardo MasettiORCI,Alejandro Martin D Icon https://www.tandfonline.com/doi/full/10.1080/147371 40.2021.1951240

[4] Lamb LR, Lehman CD, Gastounioti A, Conant EF, Bahl M. Artifcial Intelligence (AI) for screening mammography, from the AI special series on AI applications. Am J Roentgenol. 2022. https://doi.org/10.2214/AJR.21. 27071.

[5] Mohamed AA, Luo Y, Peng H, Jankowitz RC, Wu S. Understanding clinical mammographic breast density assessment: a deep learning perspective. J Digit Imaging. 2018;31(4):387–92.

[6] Breast-cancer tumor size, overdiagnosis, and mammography screening effectiveness. Welch HG, Prorok PC, O'Malley AJ, Kramer BS. N Engl J Med. 2016;375:1438–1447. [PubMed] [Google Scholar]

[7] Early detection and screening for breast cancer. Coleman C. Semin Oncol Nurs. 2017;33:141–155. [PubMed] [Google Scholar]

[8] Breast-cancer tumor size, overdiagnosis, and mammography screening effectiveness. Welch HG, Prorok PC, O'Malley AJ, Kramer BS. N Engl J Med. 2016;375:1438–1447. [PubMed] [Google Scholar]

[9] Awareness of breast cancer among surgical patients in a tertiary hospital in Malaysia. Kirubakaran R, Chee Jia T, Mahamad Aris N. https://pubmed.ncbi.nlm.nih.gov/28240018/. Asian Pac J Cancer Prev. 2017;18:115–120. [PMC free article] [PubMed] [Google Scholar]

[10] Breast cancer screening, mammography, and other modalities. Fiorica JV. Clin Obstet Gynecol. 2016;59:688–709. [PubMed] [Google Scholar]