Breast Cancer Detection through Deep Learning: A Review

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Abstract — Health is one of the most prominent concerns of an individual due to the fact that good health is highly comforting and allows the individual to achieve an effective improvement in all walks of life. A lot of individuals have become increasingly conscious towards their health and are taking a lot of care of themselves as evident in the recent years. The most debilitating of the diseases is cancer which can have a lasting impact on the patient and can be physically taxing to recover even after giving the prescribed treatment. The only remedy for this is the timely detection of the breast cancer which can lead to a better prognosis and rehabilitation after the treatment. The use of ultrasound for the purpose of detection and diagnosis has been one of the most useful in terms of achieving a non-invasive identification. But with the increase in the number of patients and the lack of professionals in the medical field, there is a need for introduction of computer vision approaches for the purpose of detection of cancerous cells. For this purpose, an effective evaluation of the previous researches on the topic of breast cancer mammography image classification have been surveyed to achieve our approach for the same which will utilize the Convolutional Neural Networks and will be detailed in the next article on this research.

Keywords: *Convolutional Neural Networks, Breast Cancer*

1. INTRODUCTION

One of the most often identified malignancies in women is breast cancer. Breast cancer is the second-leading cause of mortality in women worldwide, a fraction of all women developing the disease at some point in their lives. Regrettably, no one knows exactly what develops breast cancer. Timely detection of breast cancer is necessary to prevent breast cancer death. Nowadays, digital mammograms is largely employed to diagnose breast cancer, although the technology has its own set of drawbacks. Due to adjacent thick tissues with refractive indices comparable to breast cancers, it has a high probability of misinterpretation and raises the danger of radioactive contamination to victims. Breast early screening percentages have indeed been greatly enhanced by the use of breast ultrasound imaging in several prior studies linked to breast cancer classification. As a preferable alternative to screening mammography, radiographic imaging technologies have also been used for the early breast cancer detection.

Furthermore, interpreting ultrasound imaging to diagnose breast cancer depends on the radiologist's skill, as he or she must analyze particulate noise and visual complexity in the image obtained. Prior research suggests that radiologists may use a computer-aided detection approach with high responsiveness and selectivity as a diagnostic tool and create improved clinical assessments. This lowers the need for a breast cancer determination to be made by an ultrasonography image analyzer. Alternative techniques for identifying breast cancer utilizing ultrasonography have been presented over the last few generations, spanning from general filtering to complex learning-based systems.

Examination of follow-up measurements, including the study of progression of the disease, has long been a hot issue in healthcare. The goal of a survival estimates based on several parameters is to estimate the likelihood of a patient's mortality at a specific moment in time. It is capable of calculating a fully personalized survivability and probability factor for each scenario. This is a critical feature that gives physicians and hospital experts an indication of the patient's chances of survival. The patient's survivability must be assessed in order to select the best treatment approach and technique. This is amongst the most important since it might be the difference between life and death for a patient who is depending on the sickness or ailment's management. The assessment of the patient's survivability is predicated on an accurate assessment of the client's current situation.

The large number of breast cancer cases that are being encountered in the recent years can be attributed to the current lifestyle choices and other problems. This increase in the incidences of breast cancer can be easily prevented through constant and regular checkups. The regular checkup needs to be performed with punctuality and can be done frequently to reduce the chances of a highly advanced stage of cancer that will be difficult to recover or provide successful treatment. Once a particular event is identified, the doctors need to perform in-depth evaluation and try to find a mitigating strategy that can be helpful and relieve the symptoms and pain for the patient considerably.

The process of diagnosis and assessment has been highly complicated and requires a medical professional such as radiologist or a specialist to examine the medical images or the reports. This process is highly problematic occurrence as it takes a lot to time to analyze the reports and examine the medical images to determine the presence of any cancerous cells/ tissue. The manual process is tedious and requires a large amount of time to be completed. The manual analysis could also be the victim of errors that is highly possible as it is being performed manually. These are the points that cannot be overlooked as the breast cancer can be a highly debilitating and a painful experience for the people suffering from it. Therefore, there is a need for an effective mechanism for the purpose of automating the process of breast cancer detection using medical images. For this purpose, this survey paper evaluates the previous researches for the purpose of achieving our approach which will be elaborated in the upcoming editions of this research.

This literature survey paper segregates the section 2 for the evaluation of the past work in the configuration of a literature survey, and finally, section 3 provides the conclusion and the future work.

II. RELATED WORKS

D. Zebari [1] states that cancer is one of the most deadly diseases that affects living beings especially human beings quite frequently across the earth. The cancer is a highly problematic disease that has been effectively been diagnosed across the world to reduce the fatalities and the pain and suffering of the patients. The conventional approaches for detection of breast cancer have been focused on the mammography where the breast tissue images are captured and manually examined by the medical professionals to identify the presence of any cancerous cells in the images. This is a problematic occurrence as it can lead to a lot of errors that can be eliminated through the implementation of the proposed methodology for the automatic segmentation of the Pectoral Muscle to reduce diagnostic errors.

Dong Wei [2] explains that the most commonly diagnosed and frequently occurring type of cancer is the breast cancer. The incidence of breast cancer is problematic due to the fatality rates that are associated with the incidences of cancer. The cancer can be managed effectively by diagnosis of the cancer at an early stage. This detection allows the patient as well as the doctor to identify the cancer and then perform corrective measures to reduce patient pain and suffering. This is the reason why the authors in this publication have developed an effective approach to identify and diagnose the breast cancer through the detection of chest wall line. The segmentation leads to an effective and localized adaptation.

Qiqige Wuniri [3] highlights the importance of precisely and effectively handling the challenge of feature selection. The current methods mostly ignore the dataset's hybrid blend of deterministic and probabilistic properties, as well as the outcomes' understandability. The authors of this study offer a unique feature selection approach that uses a kernel-based Bayesian classification to accommodate both deterministic and probabilistic data with good interpretability. Furthermore, as the fitness function, such an approach employs the most used statistic in the medical sector for imbalanced datasets that is AUC. Furthermore, the method can converge quickly thanks to the one-class F-guidance score's

Yi Wang [4] illustrates how to use a novel 3D CNN architecture for automatic cancer diagnosis in Automated Breast Ultrasound to speed up the review process while maintaining strong detection accuracy and minimal true positive. Breast cancer incidence rates in women have been continuously gaining in popularity, but they may be readily lowered with prompt screening and the application of deep learning technologies. For this assignment, the writers use deep learning techniques. A novel threshold map is designed for the proposed system to provide voxel level limit to distinguish cancer voxels from healthy tissues areas, resulting in reduced false negatives. Furthermore, a substantially deep monitoring is used to improve sensitivity, primarily through the appropriate use of multi-layer discriminant features.

Haeyun Lee [5] states that for the supervised classification of breast cancers in an ultrasound picture, a novel approach comprising a multichannel awareness module and multi-scale grid average pooling was developed. The MSGRAP surpassed other approaches that are commonly utilized now, according to the findings. This increase in outcomes has been clearly demonstrated in this research through evaluations. For the supervised classification of breast cancers in ultrasound scans, the multichannel awareness module with multi-scale grid average pooling allows for the preservation of global and regional details. The multichannel awareness module with average global pooling, on the other hand, could only save global info. The ultrasonic picture segmentation is not the only use for the suggested channel attention module with multi-scale grid average pooling. It may also be used with other networks for semantic segmentation in a variety of situations.

Heather Whitney [6] The purpose of this novel study was to completely describe and develop on their earlier research, as well as to evaluate the effectiveness of human-engineered radiomics and deep learning algorithms in differentiating among harmless and cancerous tumours. Human-engineered radiomic characteristics were employed in the different classifiers, along with two types of transfer learning: characteristics derived from pre - trained models CNNs and features extracted after fine-tuning a CNN. Four distinct related fusion classifications were also examined, each generated by combining the three sets of retrieved characteristics. The analysis of these categorization performance measures in the setting of lesions in both non-mass and mass enhancing variants is also unique in this study. This paper has the benefit of collecting all photos at the same field strength, which eliminates field strength-related variations in feature values. The use of year of collection to choose training and testing data sets minimized case selection bias.

Pei Liu [7] XGBoost's optimised survival analysis is presented. It was used by the authors to forecast the progression of breast cancer. In machine learning, the suggested EXSA approach is founded on XGBoost, and in survival analysis, the CPH framework. The authors employed a more exact estimate of the proportional likelihood function as a learning goal and created the related mathematical equation for XGBoost, which greatly improved and strengthened XGBoost's capacity to evaluate evaluation metrics with many ties. The researcher's analyzed risk scores of illness advancement and derived risk categorization cut-off values as well as continuous functions connecting risk scores and disease progression factor in order to use the predictive strategy in clinical practice. As a consequence, the researchers were able to outperform their traditional colleagues.

Bo Fu [8] introduces a study that employed analytics and machine intelligence to estimate the likelihood of metastatic disease in people with acute breast cancer. The authors evaluated and cleansed clinical data gathered from a Chinese university and hospital for breast cancer. The proposed method resulted in a significant reduction in the original number of attributes. The accuracy of the forecasting model is not considerably affected when contrasting models in between selecting features on the very same dataset. The authors were able to achieve their goal of removing unnecessary or useless variables thanks to the recommended strategy and action plan. Precision medical therapy is being developed with the use of machine learning to successfully treat early-stage breast cancer patients and lower the chance of relapse.

Chen Chen [9] declares that CEUS, or contrast-enhanced ultrasonography, is now becoming extremely important in radiologists' breast cancer detection. The researchers look at the viability of using neural network models to diagnose breast cancer using contrast-enhanced ultrasonography information, and they create two awareness components to efficiently incorporate radiologists' domain knowledge on neural network models. The evaluations of the attention module are also used by the researchers to opportunity to strengthen in domain knowledge for diagnosis of breast cancer. This leads to a significant increase in cancer detection rates, allowing for a lot more precise and automated application of the strategy, which can help patients feel less stressed and discomfort.

Hang Song [10] Biomedical imaging approaches, which do not use ionising radiation, have indeed been established for breast cancer diagnosis based solely on the fact that the electrostatic characteristics of breast tumour tissues deviate from those of healthy tissue. The detection of breast tumours in complete mastectomy dissected breast cells was proven using a transportable IR-UWB-radar-based breast cancer sensor and confocal scanning algorism. The detector was shown to be capable of detecting numerous cancers in thick breast tissue. Bright patches in the result might be seen as one of the early-stage lesions. The technique yielded reliable and pathologic diagnosis in regards of breast cancer incidence location. The findings indicate that the radar-based detector has the capacity to monitor early-stage breast cancers with respect of breast cancer incidence location.

Norihiro Aibe [11] explains how radiation to the preserved breast following breast-conserving treatment lowers the risk of subsequent and cancer-related mortality in patients with patients with breast cancer, with a possible good prognosis. For these circumstances, individuals with patients with breast cancer are increasingly opting for post-breast-conserving surgeries. The number of modalities available for bombarding the preserved breast has grown as a result of technological advancements in radiation treatment and a deeper understanding of the clinic-pathological aspects of breast cancer. For breast-conserving chemotherapy, many radiation treatments are presently accessible. Advanced procedures have resulted in increased in dosage distribution systems, which can have a good influence on the patient following the surgery.

Gamal G.N [12] Breast cancer is amongst the most common health issues affecting women throughout the world, according to the World Health Organization. Breast cancer has become more common in recent years. Given the lack of public health knowledge, this is an especially pressing issue. Due to the white region lying inside the grey area, doctors have trouble distinguishing between malignant or benign cells in mammography pictures while reviewing medical imaging, making a direct diagnosis of breast cancer problematic. The suggested multi-phase segmentation approach can assist in resolving this issue, with three sections handling the grey, white, and backdrop regions. With a data-theoretic viewpoint, we offered a nonparametric method to the challenge of mammographic picture segmentation based on the curve estimate methodology in this study.

Ravi K. Samala [13] illustrates that information collected through source tasks from unrelated and related areas may be used in multi-stage learning algorithms. The authors demonstrated that by pre-training the CNN utilizing information from previous auxiliary regions, the authors may overcome the low accessibility in a particular domain. The boost in CNN performance from the alternative method of fine-tuning using supplementary data, according to the researchers, is directly proportional to the area sizes of the accessible training samples inside the targeted and supplementary domains, as well as the transfer learning method chosen. In addition, when the training sample size is limited, the variation in the skilled CNN's efficiency is high.

Xinfeng Zhang [14] combines a linear discriminant analysis including an Auto-encoder neural net and deep learning strategies to extract the most typical characteristics from gene expression profiles. At the classification phase, the deep training algorithm is used to build an enhanced ensemble categorization for the predictions. As a consequence, the proposed system has a higher prediction capability with deep learning categorization than previous systems, as evidenced by the performance assessment. This investigation shown a strong capacity to generalize fast and explicitly enhance the accuracy of the result forecasting.

Nan Wu [15] construct a neural network capable of correctly classifying mammography checks The patch-level analysis, which has been densely deployed to the source photos to produce heat-maps as extra activation functions to a breast-level prototype, is credited with this achievement, according to the researchers. According to the authors, training this model entirely end-to-end using presently available equipment is unfeasible. Although the conclusions are encouraging, it should be noted that the test set employed in the trials was limited, and the findings need to be confirmed in the clinic.

III. CONCLUSION AND FUTURE SCOPE

Breast cancer is one of the most often diagnosed cancers in females. Breast ranked as the second cause of death among females globally, with a small percentage of women having it at some time in their life. Unfortunately, no one understands probably what caused breast cancer to grow. Breast cancer must be detected early in order to avoid mortality from the disease. Digital mammography is now often used to identify tumors, despite the fact that the equipment does have its own set of limitations. The only method to prevent this is to discover breast cancer early, which can contribute to a better expectancy and recovery survival for patients. Amongst the most helpful methods for attaining a non-invasive characterization has always been the utilization ultrasonography for detection and diagnosis. An efficient assessment of earlier research on the subject of breast cancer mammogram classification tasks has been investigated for this intention, and our methodology for the same, which would use Convolutional Neural Networks and it will be documented in next manuscript on this research, will be documented in the next article on this research.

REFERENCES

[1] D. A. Zebari, D. Q. Zeebaree, A. M. Abdulazeez, H. Haron and H. N. A. Hamed, "Improved Threshold Based and Trainable Fully Automated Segmentation for Breast Cancer Boundary and Pectoral Muscle in Mammogram Images," in IEEE Access, vol. 8, pp. 203097-203116, 2020, doi: 10.1109/ACCESS.2020.3036072.

[2] D. Wei, S. Weinstein, M. -K. Hsieh, L. Pantalone and D. Kontos, "Three-Dimensional Whole Breast Segmentation in Sagittal and Axial Breast MRI With Dense Depth Field Modeling and Localized Self-Adaptation for Chest-Wall Line Detection," in IEEE Transactions on Biomedical Engineering, vol. 66, no. 6, pp. 1567-1579, June 2019, doi: 10.1109/TBME.2018.2875955.

[3] Q. Wuniri, W. Huangfu, Y. Liu, X. Lin, L. Liu and Z. Yu, "A Generic-Driven Wrapper Embedded With Feature-Type-Aware Hybrid Bayesian Classifier for Breast Cancer Classification," in IEEE Access, vol. 7, pp. 119931-119942, 2019, doi: 10.1109/ACCESS.2019.2932505.

[4] Y. Wang et al., "Deeply-Supervised Networks With Threshold Loss for Cancer Detection in Automated Breast Ultrasound," in IEEE Transactions on Medical Imaging, vol. 39, no. 4, pp. 866-876, April 2020, doi: 10.1109/TMI.2019.2936500.

[5] H. Lee, J. Park and J. Y. Hwang, "Channel Attention Module With Multiscale Grid Average Pooling for Breast Cancer Segmentation in an Ultrasound Image," in IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control, vol. 67, no. 7, pp. 1344-1353, July 2020, doi: 10.1109/TUFFC.2020.2972573.

[6] H. M. Whitney, H. Li, Y. Ji, P. Liu and M. L. Giger, "Comparison of Breast MRI Tumor Classification Using Human-Engineered Radiomics, Transfer Learning From Deep Convolutional Neural Networks, and Fusion Methods," in Proceedings of the IEEE, vol. 108, no. 1, pp. 163-177, Jan. 2020, doi: 10.1109/JPROC.2019.2950187.

[7] P. Liu, B. Fu, S. X. Yang, L. Deng, X. Zhong and H. Zheng, "Optimizing Survival Analysis of XGBoost for Ties to Predict Disease Progression of Breast Cancer," in IEEE Transactions on Biomedical Engineering, vol. 68, no. 1, pp. 148-160, Jan. 2021, doi: 10.1109/TBME.2020.2993278.

[8] B. Fu, P. Liu, J. Lin, L. Deng, K. Hu and H. Zheng, "Predicting Invasive Disease-Free Survival for Early Stage Breast Cancer Patients Using Follow-Up Clinical Data," in IEEE Transactions on Biomedical Engineering, vol. 66, no. 7, pp. 2053-2064, July 2019, doi: 10.1109/TBME.2018.2882867.

[9] C. Chen, Y. Wang, J. Niu, X. Liu, Q. Li and X. Gong, "Domain Knowledge Powered Deep Learning for Breast Cancer

Diagnosis Based on Contrast-Enhanced Ultrasound Videos," in IEEE Transactions on Medical Imaging, vol. 40, no. 9, pp. 2439-2451, Sept. 2021, doi: 10.1109/TMI.2021.3078370.

[10] H. Song et al., "Detectability of Breast Tumors in Excised Breast Tissues of Total Mastectomy by IR-UWB-Radar-Based Breast Cancer Detector," in IEEE Transactions on Biomedical Engineering, vol. 66, no. 8, pp. 2296-2305, Aug. 2019, doi: 10.1109/TBME.2018.2887083.

[11] N. Aibe et al., "Results of a nationwide survey on Japanese clinical practice in breast-conserving radiotherapy for breast cancer," in Journal of Radiation Research, vol. 60, no. 1, pp. 142-149, Jan. 2019, doi: 10.1093/jrr/rry095.

[12] G. G. N. Geweid and M. A. Abdallah, "A Novel Approach for Breast Cancer Investigation and Recognition Using M-Level Set-Based Optimization Functions," in IEEE Access, vol. 7, pp. 136343-136357, 2019, doi: 10.1109/ACCESS.2019.2941990.

[13] R. K. Samala, H. -P. Chan, L. Hadjiiski, M. A. Helvie, C. D. Richter and K. H. Cha, "Breast Cancer Diagnosis in Digital Breast Tomosynthesis: Effects of Training Sample Size on Multi-Stage Transfer Learning Using Deep Neural Nets," in IEEE Transactions on Medical Imaging, vol. 38, no. 3, pp. 686-696, March 2019, doi: 10.1109/TMI.2018.2870343.

[14] X. Zhang et al., "Deep Learning Based Analysis of Breast Cancer Using Advanced Ensemble Classifier and Linear Discriminant Analysis," in IEEE Access, vol. 8, pp. 120208-120217, 2020, doi: 10.1109/ACCESS.2020.3005228.

[15] N. Wu et al., "Deep Neural Networks Improve Radiologists' Performance in Breast Cancer Screening," in IEEE Transactions on Medical Imaging, vol. 39, no. 4, pp. 1184-1194, April 2020, doi: 10.1109/TMI.2019.2945514.