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Breast Histopathology Image Analysis using Classical and Deep Neural Networks: A Review

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ABSTRACT: One of the main causes of death for women globally is breast cancer. Images from breast histopathology offer vital diagnostic information, but manual analysis is subjective and time-consuming. The study provides a thorough analysis of both traditional and deep learning approaches to Breast Histopathology Image Analysis (BHIA) utilizing Neural Networks (NNs). It examines public datasets, assesses several classification and segmentation tasks, and offers predictions about the direction of BHIA research in the future.

KEYWORDS: Breast Cancer, Histopathology, Deep Neural Networks, Convolutional Neural Networks (CNNs), Image Classification

I. INTRODUCTION

The most prevalent disease to be diagnosed and the primary cause of cancer-related mortality for women worldwide is breast cancer. The World Health Organization (WHO) estimates that the disease kills over 600,000 women annually and causes 2.1 million new diagnoses. By enabling medical practitioners to view tissue samples under a microscope, histopathological image analysis is essential to the identification of breast cancer. Rich phenotypic information from these images aids in the identification of cancer subtypes, including invasive carcinoma, in-situ carcinoma, and benign tumors. However, manually analyzing these images takes a lot of time, is subjective, and greatly depends on the knowledge and emotional state of the pathologist.

Medical diagnoses can now be automated thanks to the development of artificial intelligence (AI), especially in the areas of image analysis using machine learning and deep learning. Artificial Neural Networks (ANNs) are one of the most effective AI techniques for improving speed and accuracy in picture segmentation, classification, and pattern recognition. These tools provide reliable, impartial examination of histopathology images while lowering human error. They are perfect for use in breast cancer diagnostics since they have shown great promise in managing intricate and substantial image data.

There are numerous surveys on general histopathological image analysis, but there aren't many that are specifically about breast histopathology image analysis (BHIA) with artificial neural networks (ANNs), particularly deep neural networks. By providing an organized summary of more than 150 works that make use of both traditional and deep learning-based ANN techniques, this research study seeks to close that gap. The thorough evaluation examines their technique, performance, and use of datasets. It also clarifies current patterns, points out possible areas for development, and suggests future lines of inquiry for BHIA study.

MOTIVATION

Few surveys specifically address breast histopathology image analysis (BHIA) using artificial neural networks (ANNs), especially deep neural networks, despite the fact that there are many on general histopathological image analysis. This research study aims to bridge that gap by offering a systematic overview of over 150 papers that employ both conventional and deep learning-based ANN approaches. The comprehensive assessment looks at their methodology, output, and dataset utilization. Additionally, it elucidates existing trends, identifies potential areas for improvement, and proposes future research directions for BHIA.

II. LITERATURE REVIEW

1]. Spanhol et al:-The assessment of the Auto-Adaptive Parallel Neural Network Architecture, or AAPNNA, using the SBMnet dataset is presented in this paper. Two networks serve as the foundation for the artificial neural model AAPNNA, whose neurons stand in for two distinct Background models with varying rates of parameter adaptation. As evidenced by the Illumination Change category findings, one of AAPNNA's most significant features is its ability to automatically adjust to changing scenario conditions.

2]. Araujo et al:-One of the leading causes of cancer-related deaths globally is breast cancer. Hematoxylin and eosin-stained photographs of biopsy tissue are difficult to diagnose, and experts frequently disagree on the final diagnosis. Computer-aided diagnosis systems help to make this process more efficient and less expensive. Traditional classification techniques depend on feature extraction techniques created for a particular issue using domain expertise. Deep learning techniques are emerging as significant substitutes for feature-based approaches in order to address their numerous drawbacks.

3]. Cruz-Roa et al:-In this work, a deep learning method for automatically identifying and visually analyzing invasive ductal carcinoma (IDC) tissue areas in breast cancer whole slide images (WSI) is presented. Deep learning techniques are learn-from-data strategies that model the learning process computationally. This method creates a hierarchical learning representation by employing various interpretation levels or layers of the most representative and helpful features, much like the human brain does. It has been demonstrated that these techniques outperform conventional methods for the majority of difficult issues in a number of domains, including object detection and speech recognition.

4]. Rakhlin et al:-In this study, we create a deep convolution neural network-based computational method for classifying images of breast cancer histology. The ICIAR 2018 Grand Challenge on Breast Cancer Histology Images includes a dataset of hematoxylin and eosin-stained breast histology microscopy images. Our method makes use of a gradient boosted trees classifier and many deep neural network designs. Our accuracy for the 4-class classification task is 87.2%. At the high-sensitivity operating point, we find 93.8% accuracy, 97.3% AUC, and 96.5/88.0% sensitivity/specificity for the 2-class classification job to detect carcinomas. To the best of our knowledge, this strategy performs better in automated histopathology image categorization than other popular approaches.

5]. Bandi et al:-Patient prognosis evaluation may be enhanced by automated identification of cancer metastases in lymph nodes. We established the CAMELYON17 challenge in conjunction with the IEEE International Symposium on Biomedical Imaging 2017 Conference in Melbourne to allow for a fair comparison of the algorithms for this aim. 23 teams submitted a total of 37 algorithms prior to the first deadline, out of the 300 participants who registered on the competition website. 899 whole-slide images (WSIs) were given to participants so they could create their algorithms. The test set, which included 500 WSIs and 100 patients, was used to assess the generated algorithms.

6]. F. Bray :-Using the International Agency for Research on Cancer's GLOBOCAN 2018 estimates of cancer incidence and mortality, this article presents a status update on the global burden of cancer, emphasizing geographic diversity across 20 global regions.

7]. Veta et al :- The Assessment of Mitosis Detection Algorithms 2013 (AMIDA13) challenge findings are presented in this document. A data collection containing over a thousand mitotic figures annotated by several observers, comprising 12 training and 11 testing participants, served as the basis for the challenge.

8]. M. Moghbel:-The performance and drawbacks of various ways gathered together according to the methodologies employed are compared in this research, which also examines new advancements and strategies offered for segmenting the breast and pectoral muscular regions. Even though it is difficult to assess these approaches using comparative analysis, this study defines a set of common performance evaluation criteria and compares different approaches according to their methodology and validation dataset.

9]. E. Kozegar:- The methods for implementing each block are categorized and analyzed in this study, which also introduces a basic architecture reflecting several CADe systems for ABUS pictures. The limits of these technologies are also examined, and a comparison of their sensitivity and false positive rate per volume is made.

10]. I. Domingues:-The use of DL architectures in computer-assisted imaging contexts is reviewed in this paper. It looks at two distinct image modalities: computed tomography, which is actively studied, and positron emission tomography, which is less studied. It also looks at the combination of both modalities, which has been a significant turning point in a number of decisions pertaining to various diseases.

11]. H. Chen:- This study proposes a novel multilayer hidden conditional random fields (MHCRFs)-based cervical histopathology image classification (CHIC) model that uses a weakly supervised learning approach to classify cervical cancer into well, moderate, and badly differentiated stages.

12]. L. Shen:-In this paper, we introduced GastricNet, a deep learning-based system for autonomous diagnosis of stomach cancer. To improve feature extraction, the suggested network uses distinct topologies for the shallow and deep layers. We test the suggested system using the BOT gastric slice dataset, which is accessible to the public.

13].M.Dabass:The most common type of colon cancer is colorectal adenocarcinoma. In essence, it starts in the glandular tissues of the intestines. Therefore, in clinical practice, pathologists use the morphology of the intestinal glands, combined with information on architectural structure and glandular development, to predict and map its course of cure.

14]. N. Coudray:-The colorectal adenocarcinoma is the most prevalent kind of colon cancer. Essentially, it begins in the intestinal glandular tissues. Thus, in clinical practice, pathologists forecast and chart the intestinal glands' course of healing based on their morphology, architectural structure, and glandular development.

15]. C. Kaushal:-Researchers can utilize this study to assess and improve the current state-of-the-art methodologies used in the CAD system, which may further reduce the gap of variability between intra and inter observer. Clinicians can use the CAD system to get a second opinion for early diagnosis.

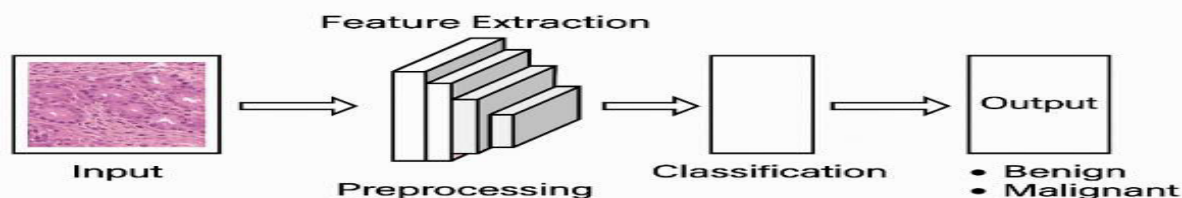
III. EXISTING SYSTEM

Current breast histopathology image analysis systems mostly rely on traditional machine learning methods or pathologists' manual inspection. These systems include hand-crafted features like color, texture, and shape, which are then followed by shallow classifiers like probabilistic neural networks, k-Nearest Neighbors (k-NN), or Support Vector Machines (SVMs). Despite their reasonable accuracy, these models were frequently constrained by their reliance on smaller datasets and manual feature engineering. Furthermore, traditional ANN techniques lacked the ability to generalize across various image magnifications and staining changes and were prone to overfitting. They were therefore less appropriate for widespread use in therapeutic settings.

IV. PROPOSED SYSTEM

The suggested method automates the interpretation of breast histopathology images by utilizing deep learning techniques, specifically Convolutional Neural Networks (CNNs). Because these models learn hierarchical patterns straight from raw pixel data, they do away with the requirement for human feature extraction. Advanced designs such as ResNet, VGGNet, Inception, DenseNet, and hybrid models that combine CNN with Generative Adversarial Networks (GANs) or Recurrent Neural Networks (RNNs) are also part of the system. BreakHis, BACH, CAMELYON, and other significant publically accessible datasets are used to train and validate these networks. Cancer diagnosis reliability is greatly increased by the deep learning models' high accuracy, resilience, and efficiency in multi-class classification and pixel-wise segmentation.

V. ARCHITECTURE



VI. CONCLUSION

The accuracy and dependability of BHIA have been increased because to deep learning techniques. CNNs and hybrid models outperform traditional techniques in terms of generalization and performance on a variety of datasets. Even though interpretability and clinical integration still present difficulties, current research shows promise for practical cancer detection applications.

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