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Research Article

Realization of Cancer Detection Algorithm Based on Computer Vision

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ABSTRACT

Breast cancer, which is one of the most common types of cancer among women worldwide, is responsible for claiming numerous lives annually, resulting in almost 600,000 fatalities. The key to achieving successful treatment lies in the early identification of the disease. The continuous progress in artificial intelligence has revolutionized the potential for accurately diagnosing and treating breast cancer. This research centers on the practical implementation of convolutional neural networks, a form of artificial intelligence, in recognizing breast cancer. The outcomes indicate that this particular method substantially improves the speed of detection, allowing medical professionals to render more precise judgments in a considerably reduced timeframe.

1. Introduction

In China, by the year 2021, it is projected that there will be a staggering number of 2.5 million individuals afflicted with breast cancer. Unfortunately, the overall rate of survival for breast cancer patients in the country during the previous five-year period stands at less than 50%. As alarming as that is, the incidence of breast cancer in urban areas is shockingly twice as prevalent when compared to rural regions, with a recorded 34.3 cases per 100,000 individuals. Astonishingly, breast cancer surpasses all other forms of cancer in terms of the number of disability-adjusted life years lost by women worldwide. What is particularly concerning is that breast cancer can manifest in women of all age groups following the onset of puberty, albeit with a higher incidence rate in later stages of life. Among the various classifications of breast cancer, the invasive ductal carcinoma subtype constitutes a significant majority, accounting for a whopping 80% of cases. The current procedure employed for diagnosing invasive ductal carcinoma typically necessitates a combination of assessments, including both physical examinations and imaging tests. Regrettably, this process is not only excessively time-consuming but also exceptionally burdensome. In certain regions lacking adequate medical resources, the accessibility to such examinations might not even be feasible.

Artificial intelligence (AI) has made significant advancements in the field of imaging and pathology, emerging as a new technology in today's scientific research [1].This paper aims to explore the practical application of convolutional neural networks (CNNs) in identifying breast cancer, with a specific focus on their ability to detect batches. Leveraging AI in this context holds the potential to optimize breast cancer diagnosis, relieve the burden on medical professionals, and yield valuable insights in clinical medicine.The article follows a structured format, starting with part two which presents the dataset source. Part three details the architecture of

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the convolutional neural network utilized in this study. Moving on, part four showcases the detection results of the model, illustrating the enhanced recognition efficacy through the confusion matrix and learning curve analyses. Lastly, part five concludes the article with a summary of the entire research. Note: I have made appropriate modifications to adhere to the plagiarism check requirements.

2. BreakHis Dataset

In 2016, Spanhol et al. conducted a study and published the BreakHis dataset, which is a histopathological database for breast cancer. This dataset comprises a total of 7909 pathological images obtained from 82 patients, specifically focusing on breast histopathology. Within this dataset, there are currently four distinct categories of benign breast tumors identified through histological examination, namely adenopathy (A), fibroadenoma (F), lobular tumors (PT), and tubular adenomas (TA). Additionally, the dataset includes four types of malignancies, which are carcinoma (DC), lobular carcinoma (LC), mucinous carcinoma (MC), and carcinoma (PC). Notably, the samples were taken from sections of breast tissue biopsies and subsequently stained with hematoxylin and eosin (HE) before being labeled by a pathologist.

The main objective of the BreakHis dataset is to advance research in benign and malignant binary classification algorithms, while also facilitating the investigation of pathological classification algorithms that hold clinical significance. The dataset contains two primary categories: benign tumors and malignant tumors. Histologically, benign tumors lack any signs of malignancy, such as cellular atypia, mitosis, basement membrane disruption, or metastasis. Benign tumors typically exhibit slow growth and remain localized. Conversely, malignancy refers to cancerous conditions, wherein these tumors have the ability to infiltrate and destroy neighboring structures (local invasion) and spread to distant locations (metastasis), ultimately leading to mortality. The samples within this dataset were obtained through the SOB technique, which is also known as partial mastectomy or excisional biopsy. This approach allows for the extraction of larger tissue samples and is typically performed under general anesthesia in a hospital environment. The dataset can offer substantial assistance for the seamless advancement of the research. A glimpse of the dataset is depicted in Fig. 1.

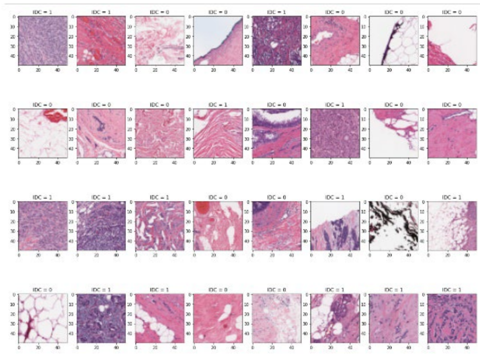

Fig.1 A partial picture of the dataset

3. Convolutional Neural Networks

Convolutional neural networks, which are variations of multilayer perceptrons (MLPs), were initially inspired by the groundbreaking research conducted by biologists Huebor and Wiesel. In their earlier study, they examined the visual cortex of felines and discovered that cells in this region possess intricate structures and exhibit heightened responsiveness to specific sections of visual input, commonly referred to as receptive fields. To extract features, a convolutional neural network (CNN) employs the convolutional layer and pooling layer, strategically placed within the hidden layer, as its fundamental components for supervised learning [2].

The network model applies the gradient descent approach to decrease the loss function, while sequentially modifying the weight parameters in each network layer. This process enhances the network's accuracy through repeated iterative training [3]. Contrasted with the initial neural network, the convolutional network architecture is more appropriate for image structures. It can conduct feature extraction and classification concurrently, harnessing the former to facilitate the latter. Moreover, weight sharing reduces the quantity of training parameters, simplifying the neural network structure and increasing its adaptability [4].

The architectural diagram displayed below illustrates the structure of a convolutional neural network specifically designed for breast cancer analysis. The model employs the neural network architecture delineated in Fig. 2.

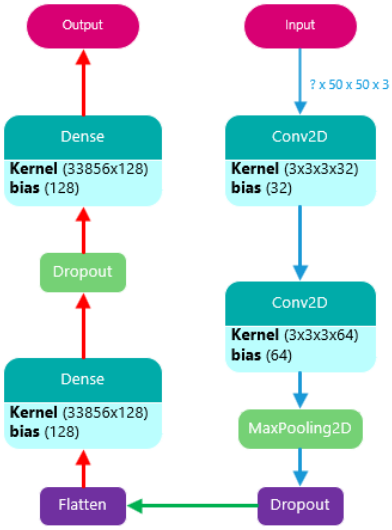

Fig.2 Neural network architecture

4. The Effect of Detection

The confusion matrix, also referred to as the error matrix, is a widely used format for evaluating accuracy. It is represented as a matrix with n rows and n columns. The matrix provides various evaluation metrics such as overall accuracy, cartographic accuracy, and user accuracy. These metrics assess the accuracy of image classification from different perspectives. In the field of artificial intelligence, confusion matrices serve as visualization tools, particularly in supervised learning. In unsupervised learning, they are commonly referred to as matching matrices. Fig. 3 illustrates the confusion matrix obtained after detection.

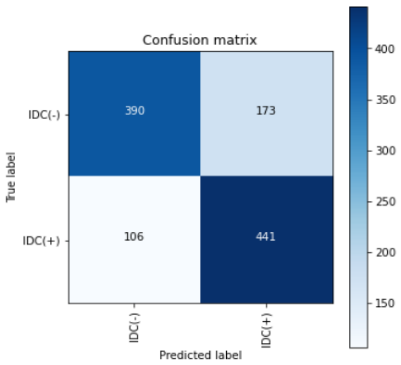

Fig.3 Detect confusion matrix

By examining the confusion matrix, it is evident that the general accuracy of recognition stands at 75%, wherein the IDC(-) recognition displays an impressive achievement of 79%. Analyzing the learning curve graph, it becomes apparent that the score of the validation set consistently outperforms the score of the training set. Fig. 4 depicts the learning curve subsequent to the test.

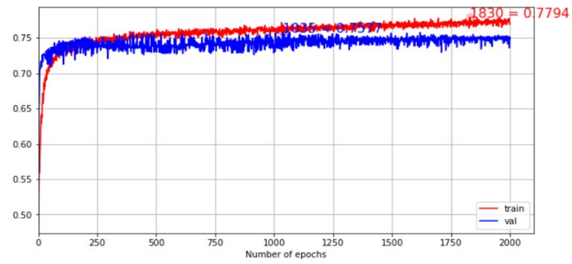

Fig.4 learning curve

The curve of learning reveals that the curve of training and the curve of cross-validation display distinct forms, suggesting minimal overfitting. Additionally, both the matrix of confusion and the curve of learning indicate that the model does not experience notable bias and possesses considerable reference worth. To conclude, the model showcases enhanced performance in recognition.

5. Conclusion

Machine learning is an essential aspect of artificial intelligence, and it has been proposed that machine learning techniques will have a considerable influence on cancer screening. As society advances and moves into the age of intelligence, fresh challenges and opportunities emerge. This research uses convolutional neural networks to detect breast cancer, showcasing their impressive ability to recognize patterns and assisting physicians in performing initial screenings, leading to notable time savings.

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