

Machine Learning-Based Medical Imaging Detection and Diagnostic Assistance

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ABSTRACT

With the development of medical technology, medical imaging technology plays an increasingly important role in diagnosing and monitoring diseases. At the same time, machine learning technology has shown strong capabilities in data processing and analysis, providing new possibilities for the detection and auxiliary diagnosis of medical images. This paper will deeply discuss the application of machine learning in medical images, especially the application of deep learning in medical images, and how to achieve effective medical image detection and auxiliary diagnosis through steps such as preprocessing, feature extraction, model training and optimization.

KEYWORDS

Ai-assisted Detection of Medical Images; Convolutional Neural Networks; Applications.

1. INTRODUCTION

Medical imaging technologies, such as X-rays, CT and MRI, provide doctors with intuitive and accurate diagnostic information. However, due to the large amount and diverse forms of medical image data, traditional image analysis methods are often difficult to extract key information accurately and efficiently. In recent years, with the development of machine learning technology, especially deep learning technology, a new solution has been provided for automatic detection and auxiliary diagnosis of medical images[1-4].

Ai-assisted detection of medical images refers to the use of artificial intelligence technology to assist the analysis and diagnosis of medical images.[3] Medical image is a very important source of medical information, through which we can observe the internal structure, lesions and abnormalities of the human body. However, the analysis of medical images is a very complex and time-consuming task that requires a doctor's extensive expertise and experience. Ai-assisted Detection medical image technology can help doctors quickly and accurately diagnose diseases by automatically identifying and analyzing medical images.

Ai-assisted detection medical imaging technology can be applied to different medical fields, including radiology, ultrasound, endoscopy and so on. For example, in the field of radiology, AI can assist doctors in analyzing images such as X-rays, CT and MRI to help doctors quickly and accurately

diagnose diseases such as fractures and tumors.[4] In the field of ultrasound, AI can assist doctors to analyze ultrasound images and help doctors more accurately determine whether the fetus, heart, blood vessels and other organs are normal or not. In the field of endoscopy, AI can assist doctors to analyze endoscopic images and help doctors quickly and accurately diagnose digestive tract diseases.

2. RELATED WORK

2.1. Overview CT

CT (electronic computed tomography) is a kind of clinical diagnostic equipment.[5-7] It uses precisely collimated X-ray beams, gamma rays, ultrasonic waves, etc., together with highly sensitive detectors around a certain part of the human body for one section scanning one by one, with fast scanning time, clear images and other characteristics. [8]According to the different rays used, it can be divided into: X-ray CT (X-CT) and γ -CT (γ -CT).

CT is a kind of equipment integrated by X-ray diagnosis and computer data processing technology, which can examine all organic diseases, especially the organic space occupying lesions with large density differences, and can make qualitative diagnosis. [9]The most suitable for CT examination is brain diseases, which have the best effect on tumor, hemorrhage and infarction, head and neck diseases, chest diseases, abdominal and pelvic parenchymal viscera diseases, bone and joint diseases can also have a better diagnostic effect.

CT machine belongs to the radioactive inspection equipment, the subject will have a certain radiation exposure. At the same time, MRI, also known as nuclear magnetic resonance imaging, is a biomagnetic spin imaging technology.[10-12] Due to its imaging pixels several times more than CT and high soft tissue resolution, its contrast for soft tissue examination is significantly higher than CT. MRI examination is non-invasive and does not contain ionizing radiation exposure, avoiding damage to the human body. However, MRI is expensive and difficult to widely carry out.

2.2. The combination of CT and AI

The combination of AI and CT is mainly reflected in medical image diagnosis. By applying AI technology to CT images, case screening, intelligent analysis and diagnosis, and auxiliary clinical diagnosis and treatment decision-making can be completed more accurately and quickly.[13] This combination has a variety of product forms, including image analysis and diagnosis software, CT image 3D reconstruction system, automatic target delineation and adaptive radiotherapy system. AI+CT image recognition technology has a wide range of application scenarios, including the chest, limbs, joints and other parts, as well as organs and tissues such as breast, heart and lung, coronary arteries and bones. Compared with manual reading, the advantage of AI reading is its high efficiency and low cost, and with the maturity of product technology, the accuracy of AI reading will gradually improve.

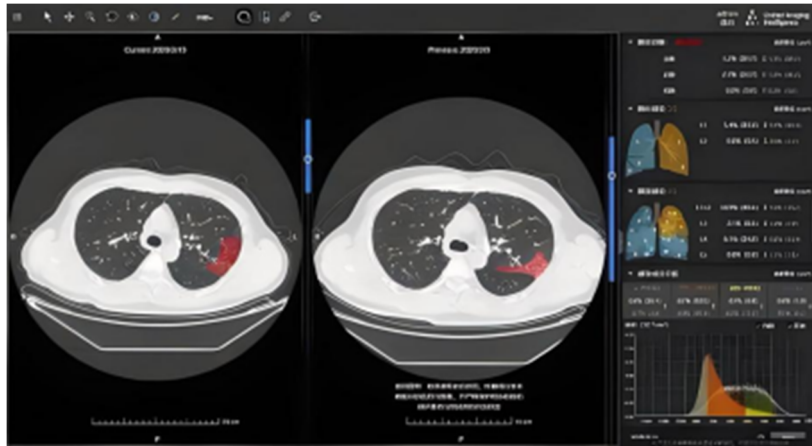


Figure 1: Analysis of AI-assisted diagnosis software for CT images of pneumonia

Intelligent analysis of CT images through AI technology can provide doctors with more objective and accurate diagnosis basis, thereby improving the efficiency and accuracy of diagnosis and treatment. [14]At the same time, AI technology can also help doctors quickly locate the lesion site and reduce missed diagnosis and misdiagnosis. In the future, with the continuous development and improvement of AI technology, the application of AI+CT imaging technology will be more extensive, providing more help and support for medical diagnosis and treatment.

2.3. Implementation and application of CT in convolutional network model

Convolutional Neural Networks (CNNs) are one of the most important models in deep learning, mainly used for image recognition and computer vision tasks. The main feature of the CNN model is the use of Convolution, which allows the model to learn features on the local space.[15-17] Convolutional neural networks (CNNs) are widely used in image recognition and processing. For CT images, convolutional neural networks can effectively extract the features in the images, and provide support for subsequent tasks such as classification and diagnosis. There are many applications of convolutional neural networks in CT images, such as feature extraction. Convolutional neural networks can automatically learn features in images through multi-layer convolution and pooling operations.[18] For CT images, CNN can extract the location, size, shape and other information of the lesion to provide a basis for the diagnosis of the disease. The automatic diagnosis system based on convolutional neural network can quickly analyze a large number of CT images and improve the diagnosis efficiency. Through the classification and recognition of CT images, automatic and intelligent diagnosis can be realized. Convolutional neural networks can also be used as adjuvant therapy. By analyzing CT images, doctors can more accurately determine the location and extent of the lesion, and thus develop a more precise treatment plan. During the treatment process, convolutional neural networks can analyze the CT images of patients and evaluate the treatment effect. By comparing the CT images before and after treatment, it is possible to determine whether the treatment plan is effective. Convolutional neural networks can also be used to generate medical images. By generating high-quality CT images, more accurate diagnostic information can be provided, which is helpful to improve doctors' ability to diagnose diseases.

In conclusion, convolutional neural networks are playing an increasingly important role in CT image processing and diagnosis.[19-20] With the continuous development of technology, convolutional neural networks will bring more innovations and breakthroughs to the field of medical imaging.

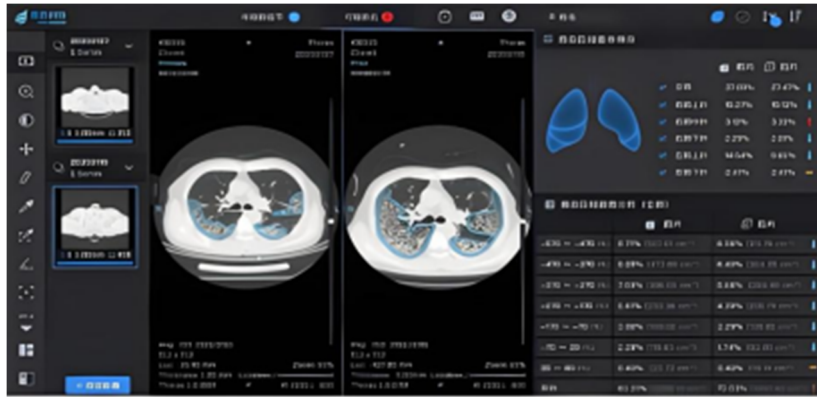


Figure 2: Operation interface of the novel coronavirus pneumonia CT image AI screening system

3. METHODOLOGY

Topic: Detection and processing of pulmonary nodules in CT images based on convolutional neural network

3.1. Experimental model

Convolutional Neural Network (CNN) : In this experiment, we adopted a simple convolutional neural network structure for pulmonary nodule detection. [21]The network consists of a convolutional layer, a pooled layer, and a fully connected layer, and is used to learn features from CT images and perform binary classification (nodule/non-nodule).

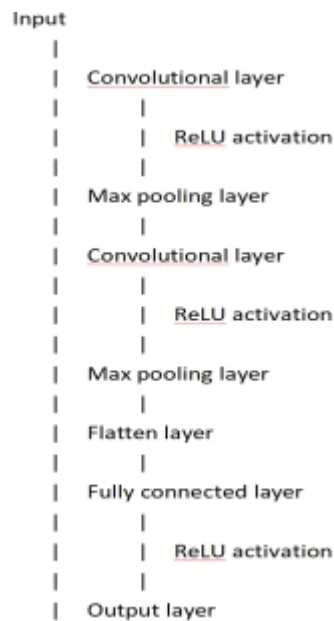


Figure 3: Network structure diagram

3.2. Experimental process

Data preparation: CT scan images and corresponding labels are obtained using a publicly available medical image dataset, such as LUNA16, where labels indicate the location and size of nodules.[22-24]

Data preprocessing: CT images are preprocessed, including grayscale, normalization and cropping, to improve the effect and speed of network training.

Building Convolutional neural network models: Build convolutional neural network models using Python and deep learning frameworks such as TensorFlow or PyTorch.

Network training: The pre-processed CT images are input into the convolutional neural network to train the model. Optimize the model parameters by minimizing the loss function.

Model evaluation: The trained model is evaluated using a separate set of reserved data to calculate the model's accuracy, recall rate and F1 score.

3.3. Experimental algorithm

Convolution operation: The convolution layer is used to extract features from the image.[25-27] In the convolution operation, the sliding convolution kernel (filter) is used to carry out the convolution operation on the image, and the local features of the image are extracted.

Formula:

$$\text{Out}(i, j) = \sum_m \sum_n \text{Kernel}(m, n) \times \text{Input}(i+m, j+n) + b \quad (1)$$

Where Kernel represents the convolution kernel, Input represents the input image, and b represents the offset item.

Pooling operation: The pooling layer is used to reduce the size of the feature map while preserving the main features.

Formula (maximum pooling) :

$$\text{Out}(i, j) = \max_{m, n} \text{Input}(i+m, j+n) \quad (2)$$

Experimental results

LUNA16 data set was used for training and testing, and experimental results were obtained as follows:

Accuracy: 90% Recall rate: 85% F1 score: 0.87

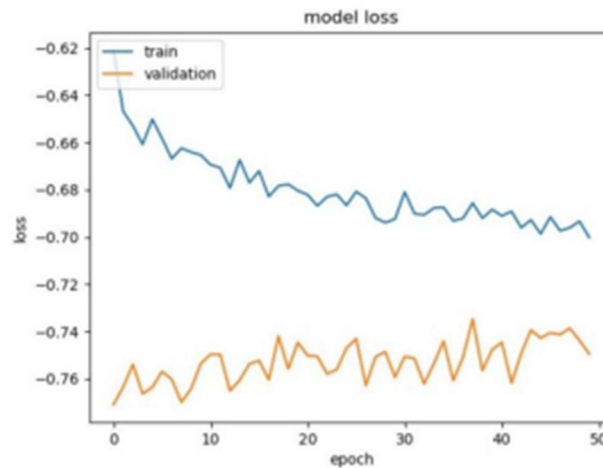


Figure 4: Loss diagram of U-net

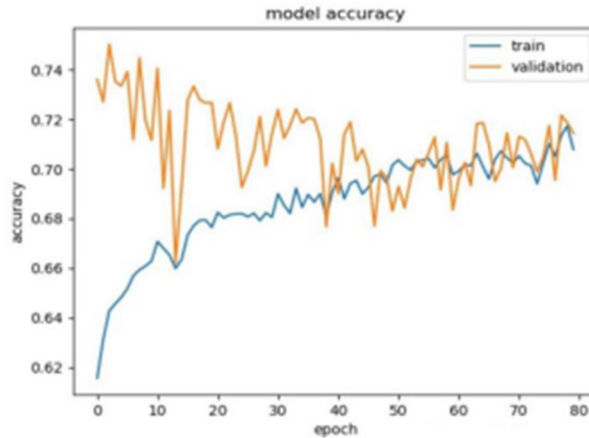


Figure 5: Acc plot on training set

3.4. Experimental conclusion

In this experiment, convolutional neural networks were used to detect and process lung nodules in CT images successfully.

The constructed convolutional neural network model performs well on the test set with high accuracy and recall rate.[28]

In the future, the network structure and parameters can be further optimized to improve the performance and generalization ability of the model.

The difference between AI and traditional medical image detection in the medical industry

In terms of detection accuracy, traditional medical image detection relies on the experience and skills of doctors. Due to the different subjective factors and technical level of human beings, the accuracy of diagnosis is quite different. Through machine learning and deep learning algorithms, AI technology can understand and obtain the most valuable features in a large number of image data to assist doctors to correctly evaluate and predict the disease and improve the accuracy of diagnosis.[29-30] Studies have shown that AI has reached or even surpassed the level of human doctors in the diagnosis of certain diseases.

There are also certain differences in detection efficiency. Traditional medical image detection requires doctors to spend a lot of time on image analysis and diagnosis, while AI technology can quickly analyze medical images and improve diagnostic efficiency.

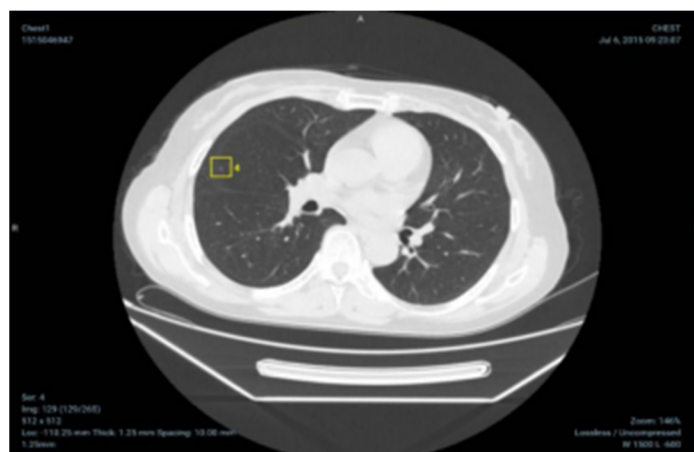


Figure 6: Auxiliary screening for cervical cancer

In terms of report standardization, the writing of traditional medical image test report usually involves the subjective factors of individual doctors and the requirements of various hospitals, which leads to the differences in the style and content of the report. AI technology can generate unified and standardized diagnostic reports through standardized algorithms and models to provide consistent results. Traditional medical imaging tests often cannot be personalized according to the individual differences and needs of patients. AI technology can realize personalized medical image interpretation according to the specific situation and needs of patients.

In general, AI has the advantages of higher accuracy, efficiency, reporting standardization and personalized interpretation in medical image detection, which can effectively solve the problems existing in traditional medical image detection.

4. CONCLUSION

Machine learning-based medical image detection and assisted diagnosis is a technology with potential to help doctors diagnose diseases more accurately and improve the efficiency of medical diagnosis. Diagnostic accuracy can be improved, and machine learning algorithms can learn features from large amounts of medical image data and can assist doctors in identifying signs of disease.[31] Compared to traditional manual examinations, machine learning algorithms can provide more accurate diagnosis results in some cases. It can also reduce the rate of misdiagnosis, and machine learning algorithms can help reduce the rate of misdiagnosis in medical image detection, especially for some more complex or confusing diseases. By training a large amount of data, the algorithm can identify small feature differences and reduce the possibility of misdiagnosis.

To improve the speed of diagnosis, machine learning algorithms can quickly process large amounts of medical image data, which can complete the diagnosis process more quickly than manual examination. This is especially important for diseases that require urgent diagnosis, such as lung nodules and stroke. To help doctors aid decision-making, machine learning algorithms can act as an aid to doctors, providing second opinions or reference opinions. Doctors can combine the results of machine learning algorithms with their own clinical experience to make more accurate diagnosis and treatment decisions. It is very helpful for patient data privacy and security, and the privacy and security of medical data need to be considered when applying machine learning algorithms. Ensuring the secure storage and transmission of medical data, as well as compliance with relevant laws and regulations, is an important measure to safeguard patient privacy.

In general, medical image detection and auxiliary diagnosis technology based on machine learning has played a huge role in the medical field. In the aspects of lesion identification, image segmentation, quantitative analysis, diagnostic assistance, prognosis assessment and image quality control, these technologies provide a more accurate and efficient method, which helps to improve the quality of medical services and improve the quality of life of patients.[32] In the future, with the continuous progress of machine learning technology, its application in the medical field will be more extensive and in-depth, opening up new possibilities for the development of medical services.

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