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Deep learning based pulmonary nodule detection method research

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Abstract: In the development of modern social and economic construction, the level of scientific research and technology in various countries is getting higher and higher. The medical field began to use intelligent algorithms for detection and analysis, and achieved excellent results in practice. It is known that lung cancer is one of the most common diseases affecting human life and health, among which it ranks the first among male malignant tumor diseases and the second among female malignant tumor diseases. On the basis of understanding the research status of intelligent algorithms in the new era, this paper mainly studies the principle of tuberculosis detection methods with deep learning as the core according to the tuberculosis detection methods proposed by researchers in recent years. In the end, deep learning could help medical researchers detect more TB, improving the accuracy and sensitivity of actual tests.

Keywords: Intelligent algorithm; Deep learning; Lung cancer; Nodules of lung

1. Introducion

From a medical point of view, lung cancer refers to abnormal lung tumor cells, uncontrolled proliferation of the phenomenon becomes more serious. If patients do not receive effective treatment as soon as possible, the disease will continue to worsen and in severe cases lead to death. From the clinical point of view, the clinical manifestations of patients with lung cancer are quite different without corresponding signs and symptoms. The time, degree of manifestation and location of the disease are closely related to the complications. The patients' attention to the disease and the degree of reaction also affect the manifestations of the disease. In the early stage of lung cancer, patients themselves are likely to show no obvious symptoms, feel no discomfort, so most of the diagnosed cases of lung cancer belong to the advanced stage, lost the best opportunity for treatment. The American Cancer Society said in a statistical report that lung cancer is the most common malignancy, with a death rate of 18.4 percent and an actual incidence of 11.6 percent. Nowadays, in the prevention and treatment of lung cancer in the medical field, diagnosis and analysis are mainly carried out through the detection and diagnosis of pulmonary nodules, which refer to those lesions with a diameter lower than or equal to 30 mm in the lung imaging examination. If an X-ray of a patient's lung shows an area larger than 3cm, it is identified as a lung mass rather than a nodule, which is a likely sign of cancer. According to practical research, most people are likely to find one or more nodules in the screening process of lung cancer, among which 60% to 70% of patients over the age of 50 will be found lung nodules, but only less than 5% of patients are finally identified as malignant cancer, and more than 95% are benign. As the diagnosis results proposed by different doctors under different circumstances have a large deviation, the instability of diagnosis will be reflected in the clinical symptoms, and the cure rate of the disease will continue to decline, so the diagnosis of malignant nodules is usually arranged by professional doctors, which requires a lot of time and energy during the diagnosis.

Nowadays, scholars from various countries begin to learn from computer-aided technology to realize lung cancer diagnosis, which can not only reduce the error factors during artificial diagnosis, improve the accuracy of disease diagnosis, but also reduce the pressure of practical work and obtain more valuable data information. The early screening and effective prevention of lung cancer is an effective means to control cancer, and can improve the survival rate of patients to a certain extent. Therefore, it is the main problem in the current research of scholars around the world. Computer aided diagnosis technology can help medical workers accurately judge medical images and ensure

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that cancer diagnosis is more accurate. Nowadays, medical image related fields have achieved excellent research results at home and abroad. The common diagnostic methods are divided into two kinds: one is the traditional image detection method with manual feature extraction as the core, the other is the neural network detection method with automatic feature extraction as the core. From the perspective of practical application, traditional image detection mainly measures and analyzes radiological features, such as the size, shape and position of nodules, which can be operated with relatively simple linear classifiers. Some scholars used contour threshold method, morphology and other related operations, and on the basis of effective segmentation of the substance, used mixed space enhancement algorithm and multi-scale circular enhancement filtering algorithm to enhance the suspected areas of pulmonary nodules in the chest medical image data of patients, and used the labeled region growth algorithm to obtain the lung parenchyma. The support vector machine (SVM) algorithm based on binary feature group is selected for classification processing. From the perspective of practical application, this method can not only correctly segment the volume of the substance, but also segment and extract suspected nodular lesions from the C-T image. Some scholars have proposed to integrate image processing and pattern recognition technology to automatically detect small pulmonary nodules in patients. Gaussian mixture model and Hessian matrix will be used to segment the pulmonary structure, and then support vector machine will be used to differentiate suspicious areas into nodules or non-nodules, so as to accurately identify the lung nodules contained in them. Some scholars also put forward shapes-centered genetic algorithm model matching method in their research, which mainly detects nodules of spherical elements. This method can accurately calculate the 3D geometric shape features and combine them into the global nodule intensity distribution, and the lung nodule model image can be regarded as the reference basis for matching. Since the traditional detection method of nodules needs to collect a large number of effective diagnostic feature subsets, the actual detection error is large, and the risk of calculation analysis is high, so scholars from various countries put forward the application of neural network detection method in the exploration. Deep convolutional neural network has shown positive effects in object detection, image classification and other applications, and has also achieved excellent results in medical imaging applications. For example, deep convolutional neural network algorithm can detect the metastasis process of skin cancer, and 2D convolutional neural network and multiple convolutional neural networks can be used to simulate 3D image volume to deal with the classification of pulmonary nodules. Therefore, this paper mainly discusses the detection methods and application effects of lung nodules based on deep learning, so as to provide effective basis for technological development and innovative research in the medical field in the new era.

2. Methods

2.1 Medical imaging data

In the development of modern medical diagnostic technology, computed tomography, also known as CT scan, is a common medical diagnostic test technology. Compared with the traditional X-ray, it can generate multiple images of multiple parts of the human body. These images are presented to the computer display screen, printed by film or 3D printer, or transferred to the computer database, which can facilitate the application analysis of the staff of various departments of medical diagnosis. According to the analysis of the flow chart of medical image detection shown in Figure 1 below, relevant data are mainly used for the following work: first, to detect whether patients have abnormal conditions in routine chest X-ray; Second, help medical staff to diagnose the clinical manifestations and main causes of chest diseases; Third, to detect and evaluate the degree of growth of the breast tumor and the specific spread to other areas; Fourth, to assess whether human tumors respond to treatment; Fifth, to help plan radiation therapy; Sixth, assess the chest injury; Seventh, to evaluate the abnormal chest conditions detected by fetal ultrasound.

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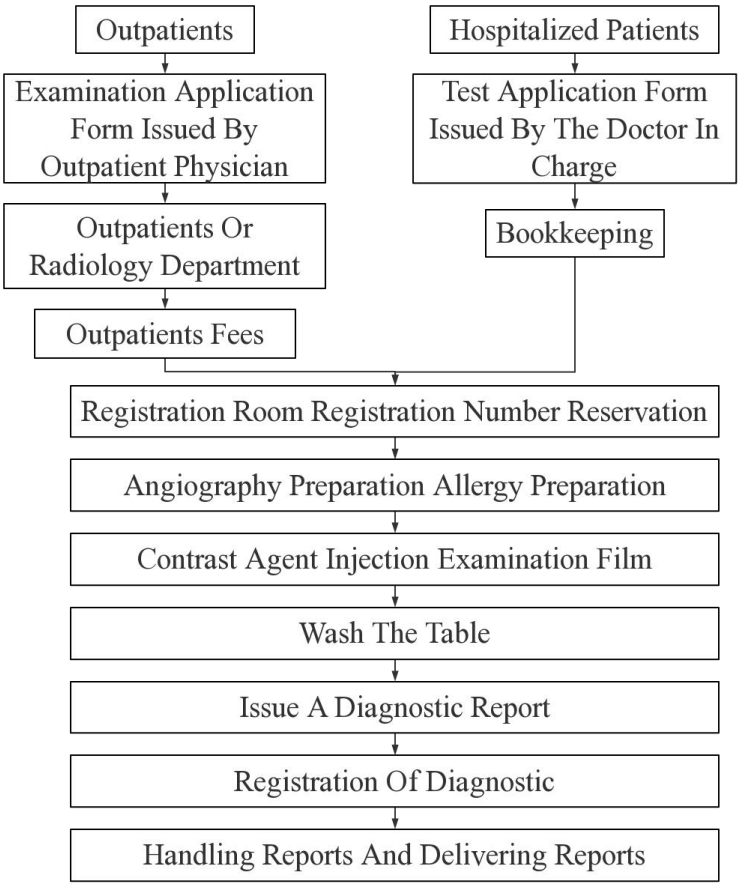

FIG. 1 Flow chart of medical image detection

2.2 Artificial neural network

As the basic component of machine learning, deep learning is proposed with neural network as the core. Biology researchers studying the human brain have found that Qi uses special processing mechanisms, also known as hierarchical processing, to process information from the outside world. When people acquire visual information, the human brain cortex, which transmits the information, will eventually be transmitted to the neurons in the next layer after transmission processing by multiple neurons. The neuron structure is shown in Figure 2 below:

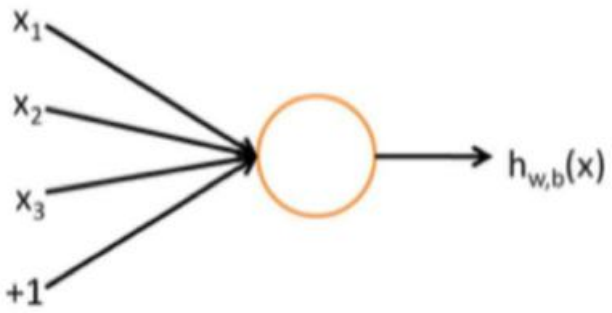

Figure 2. Structure of neurons

As the neural network model regards neurons as the smallest units, they will be arranged and connected according to the hierarchy, and each neuron will be combined with the input data to achieve the feature weighted combination, and finally input into the next layer of neurons after the activation function processing, so it meets the needs of various detection technology classification in the medical field.

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Some researchers have proposed in their research that deep learning and artificial neural network algorithms are the same, and various technical terms can be used interchangeably. For example, in a real network environment, artificial neural network is likely to contain thousands of nodes and hundreds of millions of links, and each node belongs to a layer, while the overall model has an input layer and an output layer, and the layer between the two is called a hidden layer. Since this kind of model requires a lot of training to run orderly, it is necessary to give full play to the learning role of deep learning. Under supervision and training, input values of test data are processed scientifically and output values are generated, and then compared and analyzed with actual values to obtain the final research results. The structure of the convolutional neural network is shown in Figure 3 below:

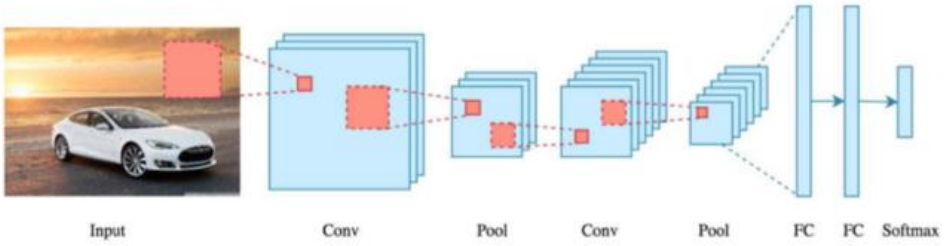

FIG. 3 Architecture diagram of convolutional neural network

2.3 Data Preprocessing

Due to the complex characteristics of pulmonary nodules, which mainly exist in the middle of the pulmonary parenchyma of chest medical images and are closely connected with the chest cavity and peripheral blood vessels, scientific treatment should be carried out according to the steps shown in Figure 4 in the practice examination:

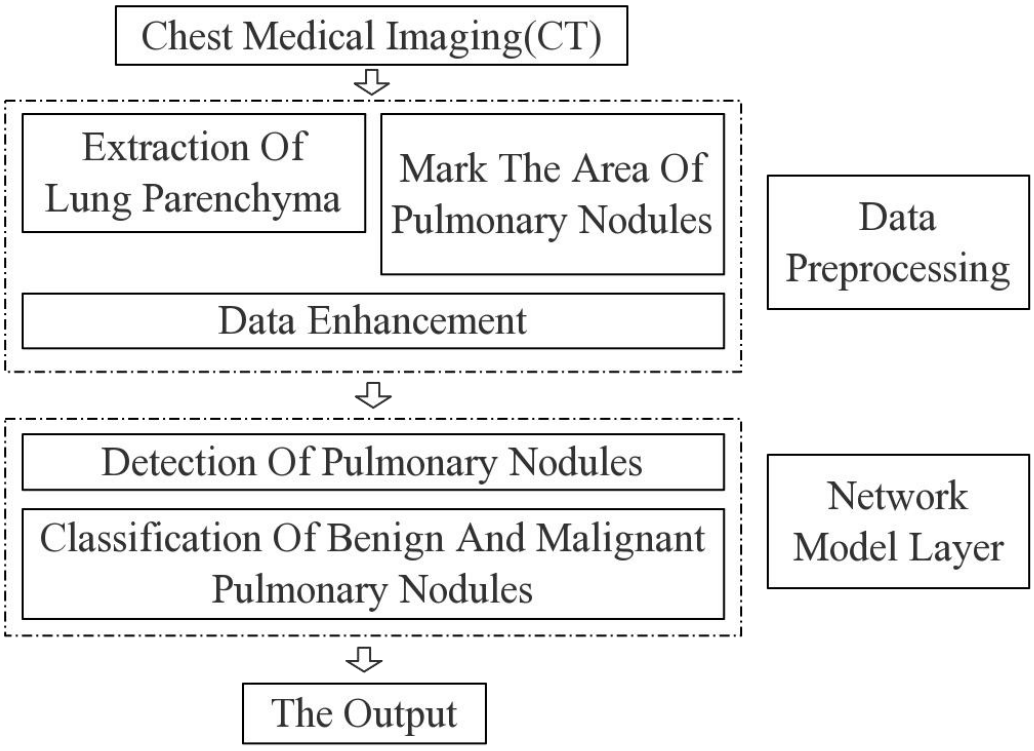

Figure 4 Flow chart of pulmonary nodules detection

According to the analysis in the figure above, the overall detection work is mainly divided into two parts: one is the pre-processing of exponential data, the other is the network model. From the perspective of practical work, data preprocessing is to study and analyze the original image, control the adverse effects of other external environment and tissues and organs in the image on the

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detection results, and form the input data that meets the requirements of the network model layer. By obtaining the lung parenchyma and marking the pulmonary nodules, the data enhancement technology is used to expand the data, which can effectively complete the image preprocessing. At the same time, the 3D image should be cut and analyzed, and the data set required for network model training should be obtained on the basis of forming several small cubes.

2.4 Network model framework

Since the application of deep neural network model needs to store a large amount of data information to enhance the application effect of learning tasks, this paper proposes a 3D DenseUnet convolutional network model for automatic detection of pulmonary nodules. The specific structure is shown in Figure 5 below:

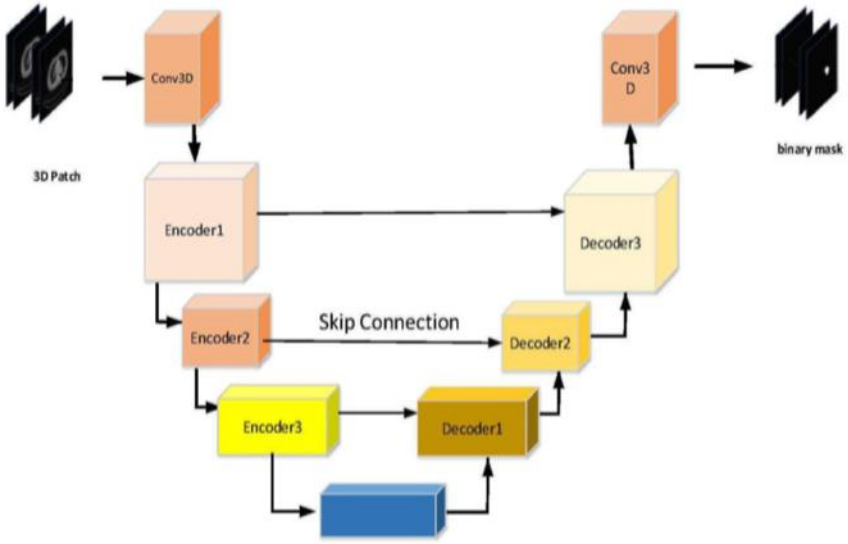

Figure 5 Overall architecture of 3D DenseUnet neural network

3. Result analysis

This paper chooses CentOS operating system for research and experiment, in which the experimental code is Python. The neural network is implemented by tensroflow and PyTorch framework. The image data is in standard format and Pydicom library will be used for parsing and processing. In the data set, which included a total of 1,010 patients, the actual number of nodules detected reached 7,371, with 2,669 nodules larger than 3 mm and 4,702 nodules smaller than 3 mm. Finally, the evaluation results of the model framework as shown in Table 1 below were obtained:

Table 1 Evaluation results of the model framework

Network Architecture	Dice Coefficiet	Sensitivity
2D Unet	0.6732	0.8237
3D Unet	0.7424	0.8567
3D-Dense Unet	0.7842	0.8678

Combined with the data change analysis in the above table, it can be seen that the performance ability of the 3D data image editing model is higher than that of the 2D convolution model, and the corresponding coefficient is higher than 0.07, and the coefficient of the 3D DenseUnet model is higher than that of the 3D Unet model by 0.04. Therefore, the pulmonary nodule detection method with deep learning as the core in this study has research value and will be a major issue for future research scholars to continue to explore.

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4. Conclusion

In summary, since medical image diagnosis plays an important role in the innovation and development of the current medical industry, it is the main content discussed by current researchers to integrate deep learning algorithm to optimize and analyze chest medical image data and accurately detect lung nodules, benign and malignant of patients. In the process of social economy and technological innovation and development, future scholars should gradually optimize the existing lung nodule detection method theory according to the clinical diagnosis and application situation, pay attention to the development of effective treatment measures for different situations, pay attention to the study and training of professional and technical personnel, so as to optimize the detection and prevention level of malignant diseases in China.

Acknowledgements

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