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Aggrandize the effects of detection of lung cancer by adding local entropy in deep learning image recognition

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Abstract:

The best paradigm of image recognition is deep learning, mainly the convolutional neural network. It's a boon in the field of medical to detect the disease by image recognitions. To carry forward the applications of the deep learning approach in this article we use local entropy parameter to detect the lung cancer. The analysis results shows that this method of deep learning with local entropy gives better results than the ITTI visual attention model which generally highlights the area where the lung cancer can be significant. In this research to preprocess the input dataset of deep learning, pulmonary nodule significance based on local entropy detection method is used which decrease the size of input image, lower the convolution times, and increase the detection speed of deep learning of pulmonary nodule.

Keywords: *Deep learning, Lung cancer, Local entropy, ITTI.*

I. INTRODUCTION

Computed tomography (CT) is the most commonly used image in chest imaging, which is widely used in the detection of lung cancer[1,2].The early computer-aided diagnosis technology used commonly is completed by image preprocessing, image segmentation, feature extraction and classification[3].Compared with the traditional computer-aided detection method, the input data of deep learning is the original image, without any complicated image processing process, and without worrying about the small pulmonary nodules in the early lung cancer image being filtered out as noise[4,5].Therefore, deep learning is very suitable for detecting the small pulmonary nodules in the early lung cancer image. In addition, the traditional computer-aided detection method needs artificial design to extract which features of pulmonary nodules, but these artificial design features are not necessarily accurate. However, deep learning does not need these artificial designed features. Starting from the data itself, it can automatically extract

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the deep features of the image by overlaying the network layer, which makes the feature extraction more accurate[6-8].Although deep learning, especially convolutional neural network, is very suitable for image classification and recognition. However, when convolutional neural network is used to detect the focus of large medical images directly, it needs a lot of convolution operations, which are very time-consuming and not suitable for clinical real-time applications [9-11].

At present, the visual attention model proposed by ITTI et al is widely recognized in the academic. The ITTI model extracts the color, direction and brightness of the image, by Gauss Pyramid and central peripheral operations to generate a significant map of each feature, and then normalized, fused to get the final saliency map[12,13]. But lung cancers are different from the normal human tissues around them. That is, lung cancers are prominent in their local areas, which should be reflected in the information contained in image. The entropy of image is the image contains the amount of information. The region which has larger entropy may be the image areas of interest. The global entropy of image can't reflect the difference of different regions in image, while the local entropy can reflect the statistical characteristics of the local information of the image[14,15]. So the method for detection of lung cancer significant based on local entropy is put forward in this paper, which can be used as the preprocessing of input data in deep learning[16,17], reduce the size of input image in the process of deep learning, so as to reduce the convolution times of deep learning detection, speed up the detection speed of deep learning for pulmonary nodule.

II. IMAGE INFORMATION ENTROPY

Comparing the significance detection method based on local entropy with the ITTI model, it is proved that the significance detection method based on local entropy has better detection effect than the ITTI method.

In Section 1, the background of the method of detecting the significance of pulmonary nodules based on local entropy is introduced.

Section 2, the concepts of image entropy and local entropy of the image are described, and the calculation effect of local entropy of the lung nodule image is demonstrated by experiments

Section 3, the significance detection effect of pulmonary nodules based on local entropy was verified by experiments, and compared with the detection effect of ITTI model.

Section 4, the conclusion of the paper is summarized, and the application prospect of pulmonary nodule significance detection based on local entropy in deep learning data preprocessing is prospected.

ITTI model is the most representative. Especially in the early stage of some cancers, the lesions in medical images are not significant areas in the whole image, and sometimes they are difficult to be found. The entropy of image contains an amount of image information. The region which has larger entropy may be the image areas of interest. The global entropy of image can't reflect the difference of different regions in image, while the local entropy can reflect the statistical characteristics of the local information of an image. In image processing, the

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information entropy of the image reflects the statistical features of the image gray distribution[18].The entropy matrix not only contains the global image features, but also contains the local features of the image.

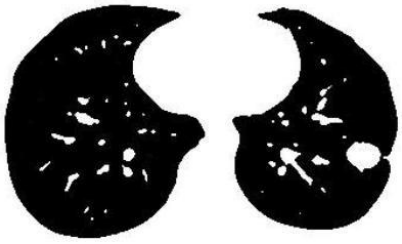

Fig 1: lung parenchyma image

Fig 2: entropy image

From the global image, the entropy matrix which is composed of the local entropy of each sub image not only describes the global characteristics of the image, but also reflects the spatial distribution characteristics of the image, which solves the problem that the entropy of the image is the same but the shape of the image is different. From a local perspective, the local entropy of each sub image reflects the statistical features of local information in image[13].The lung parenchyma image was got from chest CT image through image segmentation, as shown in Fig. 1. The entropy of the image is obtained as shown in Fig. 2.

III. SIGNIFICANCE DETECTION BASED ON LOCAL ENTROPY

The entropy image obtained in Figure 2 can enhance the lung nodule area, but the perception of the edge and the blood vessels is also very strong. Just according to figure 2, it is difficult to distinguish lung cancer from the surrounding tissues. In order to distinguish lung cancer from the surrounding tissue, the further significant detection is needed. Firstly, multi-scale sampling is adopted. After sampling the three layers Pyramid model is generated.

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Secondly, the central perimeter difference method in the ITTI model is adopted. Due to the sensitivity of the human eye to the central region is very high, and inhibit the sensitivity of the peripheral region to a certain extent, so it caused the non-continuous structure of the central sensitive, peripheral suppression. In order to simulate the discontinuous structure, c is defined as the central scale, $c \in \{3,4,5\}$, s is defined as the surrounding scale and $s = c + \delta$, where $\delta \in \{3,4\}$. Image of all scales are interpolated to the same scale of the image, and then the subtraction of image matrix was done between the central image and the surrounding image [13]. The formula for the central peripheral difference is expressed as equation (1):

$$E(c,s) = |E(c)\Theta E(s)| \quad (1)$$

After the central peripheral processing, the multiple entropy feature maps obtained are combined to generate the final saliency map. The calculation process of saliency map of pulmonary nodules based on local entropy is shown in Fig. 3.The obtained saliency map of pulmonary nodules based on local entropy is shown in Fig. 4 and Fig. 5.

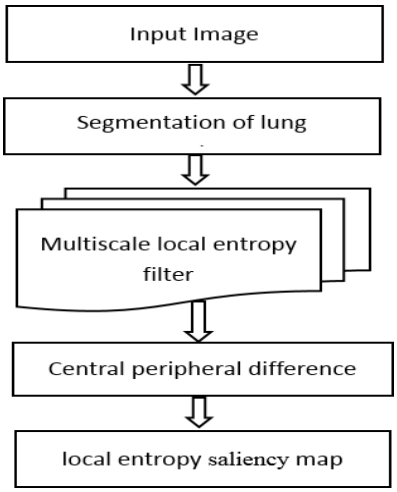

Fig 3: flow chart of pulmonary nodule saliency map calculation based on local entropy

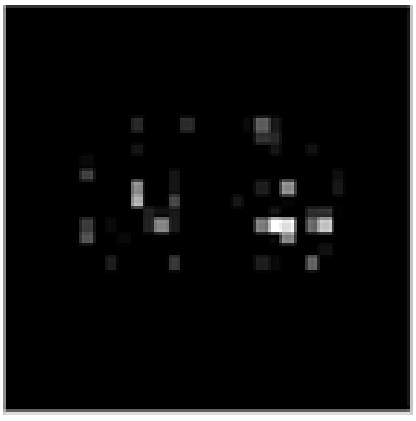

Fig 4: Entropy feature saliency map

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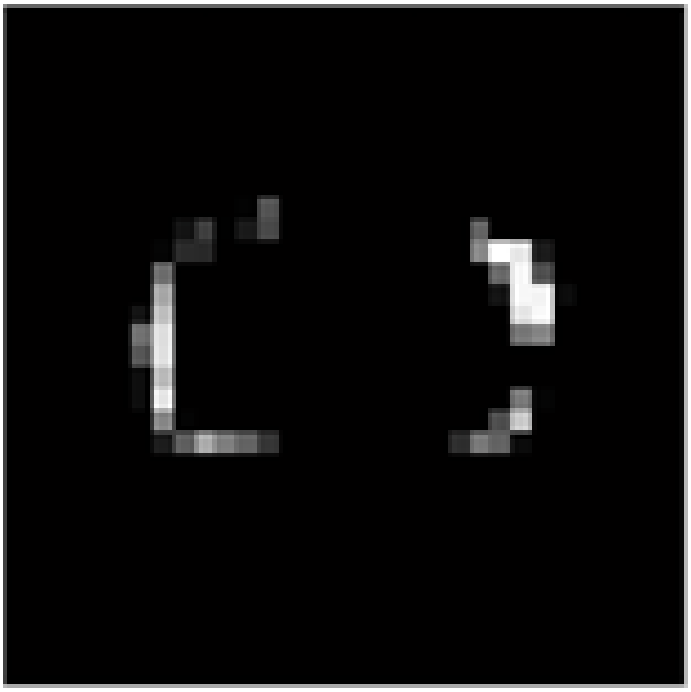

Fig 5: ITTI feature saliency map

IV. CONCLUSION

Compared with the traditional computer-aided detection method, the input of deep learning is the original image, without complex image preprocessing process, which is more suitable for the detection of small pulmonary nodules in early lung cancer images. However, deep learning needs a lot of convolution operation, which is still time-consuming for the detection of large medical images. Experimental results show that the significance detection method based on local entropy is better to locate the location of pulmonary nodules than the ITTI visual attention model. Therefore, the detection method of pulmonary nodule significance based on local entropy can be used as the preprocessing of input data in deep learning, reduce the size of input image in the process of deep learning, so as to reduce the convolution times of deep learning detection, speed up the detection speed of deep learning for pulmonary nodule, which is important for the application of deep learning technology in early detection and early diagnosis of lung cancer.

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