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Early Detection of Lung Cancer in X-Ray Images Using Cellular Neural Network and Image Interpolation

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Abstract:
The interpolation method is to increase the resolution of the lung cancer image based on the bicubic interpolation and the 2D interpolation filtering. Lung cancer is one of the leading causes of death and one of the most lethal cancers. Therefore one of the solutions to this problem is the early diagnosis. The algorithm is mainly developed for the use of general practitioners in helping them to do accurate early diagnosis of lung X-rays when there are still chances for the patient to win the illness. Early detection and treatment of lung cancer are crucially important for the improvement of patient's survival rate. Hence, a detection system using cellular neural network (CNN) is developed in order to help the doctors to recognize the doubtful lung cancer regions in x-ray films. A CNN algorithm for detecting the boundary and area of lung cancer in X-ray image has been proposed. Computer simulation result shows that the CNN algorithm is verified to detect some key lung cancer symptoms successfully. Bicubic Interpolation attempts to reconstruct the exact surface between four initial pixels. It does this by extracting sixteen pieces of information. It is resulted on a low resolution image to get a high resolution image and the image is filtered using the 2D interpolation filter. The 2D interpolation filter is used to preserve edges in an image. Finally row and column interpolation is done to get the high resolution image. This algorithm significantly increases the visual quality of the image.

Keywords: Bicubic Interpolation, 2D Filter, CNN algorithm

I. INTRODUCTION

Lung cancer is the top cause of cancer deaths in both men and women. Today Smoking causes nearly nine out of 10 lung cancer deaths while radon gas, pollution and other chemical exposures plays a smaller role. Cancer occurs when normal cells undergo a transformation that causes them to grow and multiply without control. The cells form a mass or tumor that differs from the surrounding tissues from which it arises. Tumors are dangerous because they take oxygen, nutrients, and space from healthy cells and because they invade and destroy or reduce the ability of normal tissues to function. Doctors aren't sure whether people with no signs or symptoms of lung cancer should undergo screening for the disease. Some studies show that lung cancer screening may save lives by finding cancer earlier, when it may be treated more successfully. But other studies find that lung cancer screening often reveals more benign conditions that require invasive testing and expose people to unnecessary risks. Screening for lung cancer is controversial among doctors. Studies are ongoing to determine what types of tests may be helpful and who would benefit from lung cancer screening. X-rays are a form of radiant energy that offer a wide variety of medical uses. In addition to their applications as both curative and palliative lung cancer treatments, X-rays are also used in several imaging tests that can lead to an early diagnosis of the disease. The most common X-ray imaging tests can help doctors identify potentially cancerous tumours. An X-ray image of your lungs may reveal an abnormal mass or nodule. Since the structure of CNNs is similar to the structure of the vertebrate retina and the visual system, CNNs are suitable for image processing.CNN template which can detect the cancerous area in chest radiographs are used in this algorithm to detect the lung cancer regions.

Several method has been proposed to increase the resolution of the image, the problem is quite complex as in general it results in blurring effects and zigzag errors along the edges. The edge artifacts should be removed and the edges should be preserved.

II. VARIOUS APPROACHES OF CNN AND INTERPOLATION METHODS.

The improvement in image quality has been achieved using the edge directed interpolation by modifying the interpolation scheme. Most lung cancers start in the lining of the bronchi [2]. It is thought to develop over a period of many years. First there may be areas of precancerous changes in the lung. These changes do not form a mass or tumor. They cannot be seen on an x-ray and they do not cause symptoms. But these precancerous changes can be found by analyzing cells in the lining of the airways of smoke-damaged lungs. Different parts of the body absorb the x-rays in varying degrees. One of the most important and difficult tasks the doctors has to carry out consists of the detection and diagnosis of cancerous lung nodules is from chest radiographs. Some of these lesions may not be detected due to the fact that they may be camouflaged by the underlying anatomical structure, or the low-quality of the images or the subjective and variable decision criteria used by doctors [3]. Thus, the conventional method of manual interpreting of x-ray images might yields inaccurate results due to the problem mentioned. Different people may see and interpret things differently and this could also lead to misdiagnosis. Moreover, the need for repeatability from humans involved in interpreting biomedical images is also important. Human gets exhausted by doing the same thing all over again. So, it is important to develop a computerized system to overcome human errors and misdiagnosis. CNN is a architecture which possess some of the key features of neural networks (NN) and which has important potential applications in such areas as image processing and pattern recognition [5].

CNN processors could be thought hybrid between Artificial Neural Network (ANN) and Cellular Automata (CA).

III. PROCESS METHODOLOGY

1. CELLULAR NEURAL NETWORK

CNNs can be defined as “2D or 3D arrays of mainly locally connected nonlinear dynamical systems called cells, whose dynamics are functionally determined by a small set of parameters which control the cell interconnection strength”. These parameters determine the connection pattern, and are collected into the so-called cloning templates which once determined define the processing of the whole structure.

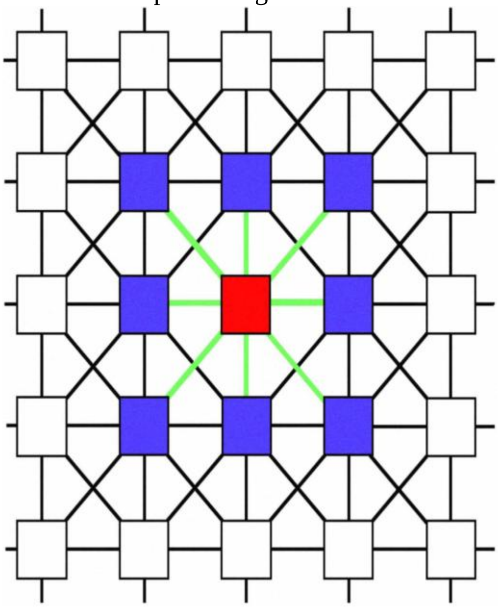

Fig.1 An Example Of CNN Cell Architecture

The role played by the cellular neural networks is that the transient behaviour which makes it possible to extract a variety of features from a single picture and to solve various image processing problems. The basic circuit unit of a cellular neural network is called a cell. The structure of cellular neural networks is similar to that found in cellular automata namely any cell in a cellular neural network is connected only to its neighbor cells.

The areas of lung cancer are hard to recognize in x-ray films. This algorithm is developed to detect the areas of lung cancer using different templates in CNN. The directed and the inverted image is processed separately step by step and the areas of lung cancer region in x-ray films are detected.

A. MEDIAN TEMPLATE

The median template is applied for both the direct and inverted image .This template is used to remove the impulse noise from the x-ray image. The corresponding CNN template is given by

$$A=\begin{bmatrix}0&0&0\\0&2&0\\0&0&0\end{bmatrix}, B=\begin{bmatrix}0&0&0\\0&1&0\\0&0&0\end{bmatrix}, z=-1 \qquad (1)$$

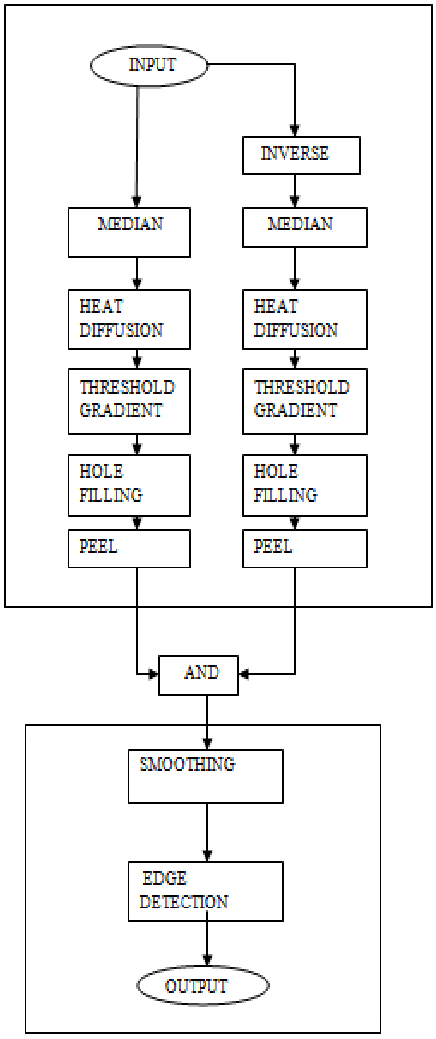

Fig.2 Flowchart of CNN Algorithm

B. HEAT DIFFUSION TEMPLATE

The heat diffusion template is used to remove the static noise in X-ray images. The corresponding CNN template is given by

$$A=\begin{bmatrix}0.1&0.15&0.1\\0.15&0&0.15\\0.1&0.15&0.1\end{bmatrix}, B=\begin{bmatrix}0&0&0\\0&0&0\\0&0&0\end{bmatrix}, z=0 \qquad (2)$$

C. THRESHOLD GRADIENT TEMPLATE

The threshold gradient template is used to detect the lung cancer region clearly in the direct and the inverted x-ray image.

$$A=\begin{bmatrix}0&0&0\\0&1&0\\0&0&0\end{bmatrix}, B=\begin{bmatrix}0&0&0\\0&0&0\\0&0&0\end{bmatrix}, z=z^{*} \qquad (3)$$

Where

$$z^{*}=(-0.3,-0.7)$$

D. HOLE FILLING TEMPLATE

The hole filling template is used to show the exact boundary for the lung cancer on original and inverted of X-ray image. The corresponding CNN template is given by

$$A=\begin{bmatrix}0&0&0\\0&2&0\\0&0&0\end{bmatrix}, B=\begin{bmatrix}0.25&0.25&0.25\\0.25&2&0.25\\0.25&0.25&0.25\end{bmatrix}, z=-4.8 \quad (4)$$

E. PEEL TEMPLATE

The peel template is used to peel the objects from the boundaries. The corresponding CNN template is given by

$$A=\begin{bmatrix}0&1&0\\1&2&1\\0&1&0\end{bmatrix}, B=\begin{bmatrix}0&0&0\\0&0&0\\0&0&0\end{bmatrix}, z=0 \quad (5)$$

F. LOG AND OPERATION TEMPLATE

This LOG AND operation template is used to find the intersection between the processed original and the inverted image. The corresponding CNN template is given by

$$A=\begin{bmatrix}0&0&0\\0&2&0\\0&0&0\end{bmatrix}, B=\begin{bmatrix}0&0&0\\0&1&0\\0&0&0\end{bmatrix}, z=-1 \quad (6)$$

G. SMOOTHING TEMPLATE

Average threshold or average is the old names for smoothing template. This template will smooth with binary output by the corresponding CNN template given by

$$A=\begin{bmatrix}0&1&0\\1&2&1\\0&1&0\end{bmatrix}, B=\begin{bmatrix}0&0&0\\0&0&0\\0&0&0\end{bmatrix}, z=0 \quad (7)$$

H. EDGE DETECTION TEMPLATE

The edge detection template is used to detect the lung cancer region boundary on the image. The corresponding CNN template is given by

$$A=\begin{bmatrix}0&0&0\\0&1&0\\0&0&0\end{bmatrix}, B=\begin{bmatrix}-1&-1&-1\\-1&8&-1\\-1&-1&-1\end{bmatrix}, z=-1 \quad (8)$$

The cellular neural network templates are used to detect the boundary of the lung cancer region.

2. INTERPOLATION METHOD

The non linear interpolation techniques are better than the linear interpolation technique. In the method bicubic interpolation is used to increase the resolution of the low resolution X-ray images which is a linear interpolation technique. Bicubic interpolation is known for its interpolating pixels by collecting the information from its sixteen neighbours but it performs poorly on edges

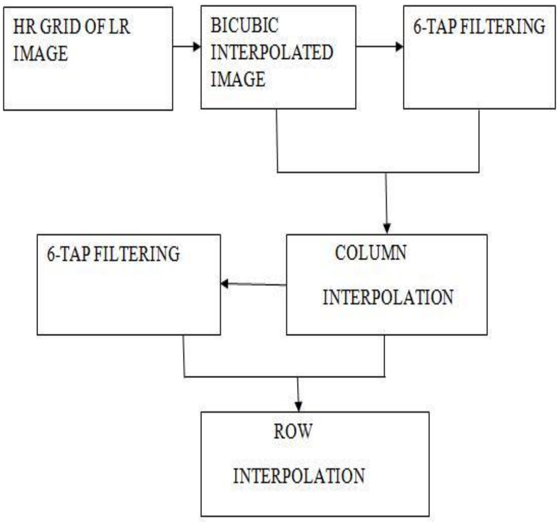

Fig.3 An Illustration of interpolation scheme.

IV. SIMULATION RESULTS

1. CNN templates results

The original and the inverted image is processed step by step using various CNN templates. The figure shows the original and the inverted input image.


Fig.4 Original Image of X-ray

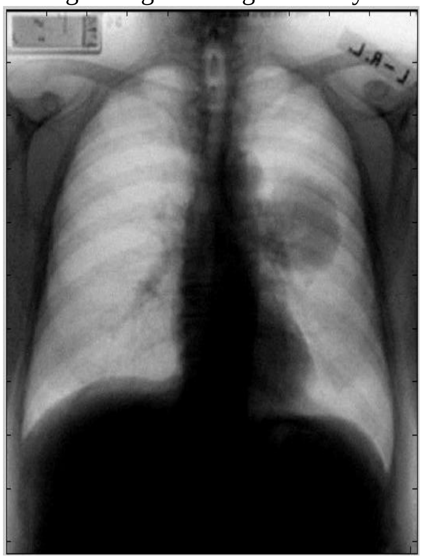
Fig.5 Inverted Image of X-ray

A. MEDIAN TEMPLATE

The figure shows the output of the median template for the original and the inverted image.

Fig.6 Output of Median Template for Original Image

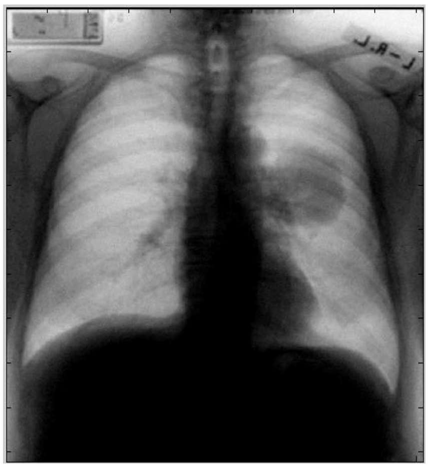

Fig.7 Output of Median Template for Inverted Image

B. HEAT DIFFUSION TEMPLATE

The figure shows the output of the heat diffusion template for the original and the inverted image.

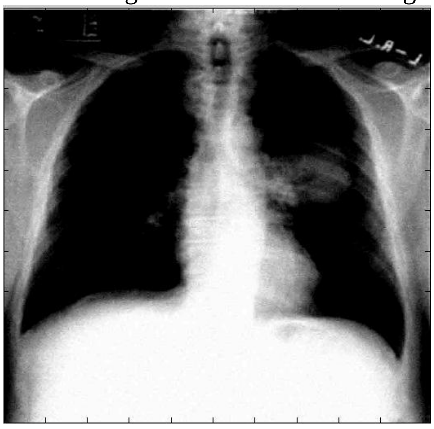

Fig.8 Output of Heat Diffusion Template for Original Image

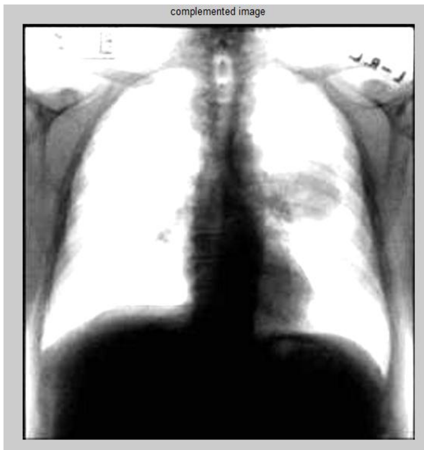

Fig.9 Output of Heat Diffusion Template for Inverted Image

C. HOLE FILLING TEMPLATE

The figure shows the output of the hole filling template for the original and the inverted image.

Fig.10 Output of Hole Filling Template for Original Image

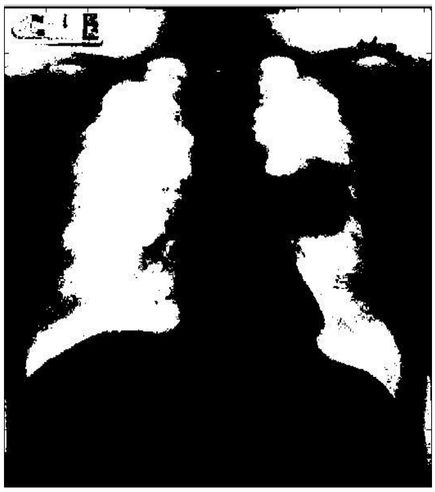

Fig.11 Output of Hole Filling Template for Inver

D. PEEL TEMPLATE

The figure shows the output of the peel template for the original and the inverted image.

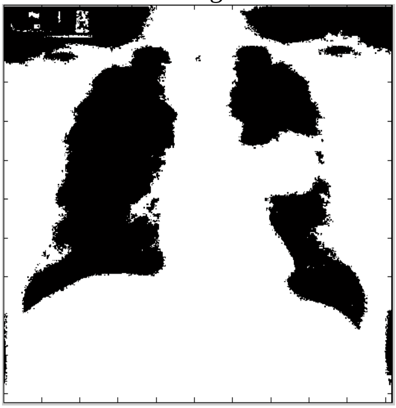

Fig.12 Output of Peel Template for Original Image

Fig.13 Output of Peel Template for Inverted Image

E. LOG AND OPERATION TEMPLATE

The figure shows the output of the LOD AND operation template.

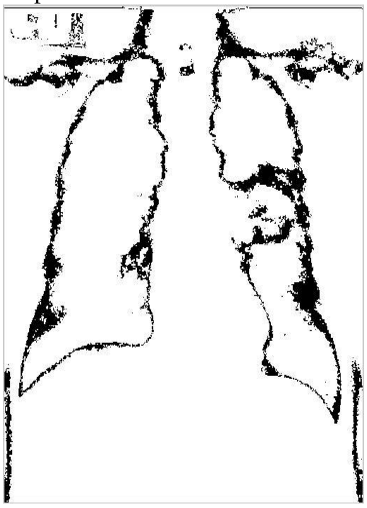

Fig.14 Output of LOG AND Operation Template

F. SMOOTHING TEMPLATE

The figure shows the output of the smoothing operation template

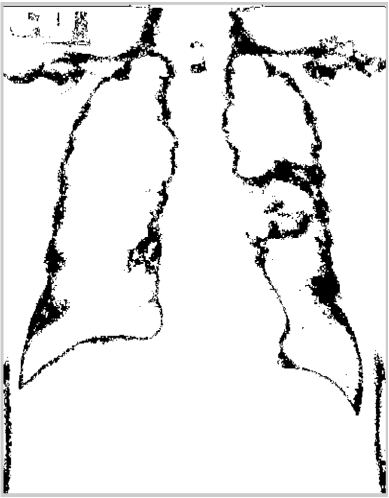

Fig.15 Output of Smoothing Template

G. EDGE DETECTION TEMPLATE

The figure shows the output of the edge detection template

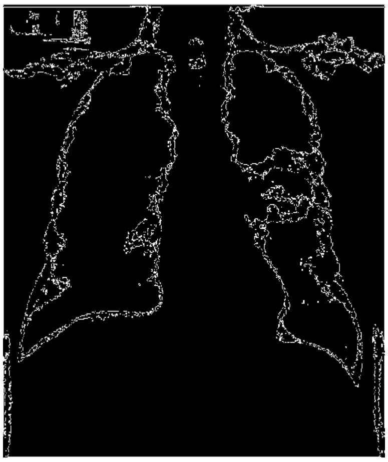

Fig.16 Output of Edge Detection Template

2. Interpolation method results

In the method bicubic interpolation algorithm is applied and 2D interpolation filter is used to preserve the edges. The filter preserves edge smoothness and refines the interpolated pixels to produce visually high quality images. The results demonstrate that our new interpolation algorithm significantly enhances the quality and Peak Signal to Noise Ratio (PSNR) of the interpolated images.

Fig.17 original image

Fig.18 Output Image

V. CONCLUSION

The detection of lung cancer is hard to regonize in X-rayimages.So an algorithm has been devolped using Cellular neuarl network using various templates.The edges of the lung cancer region has been detected using the CNN algorithm and it will be used for the radiologist to interpret the lung cancer region in the X-ray images.The CNN algorithm detected the lung cancer region same as the radiologist interpretation. The algorithm is mainly use of general practitioners in helping them to do accurate early diagnosis of lung X radiographs when there are still chances for the patient to win the illness. The bicubic interpolation and the 2D interpolation filter is used in the proposed method to enhance the visual quality of the image.

REFERENCES

[1]Abdullah.A.A, Mohamaddiah.H “Development of Cellular Neural Network Algorithm for Detecting Lung Cancer Symptoms” *IEEE transactions on bio medical sciences and engineering, page(s):138-143.2010*

[2]Leon O. Chua and Lin Yang, “ Cellular Neural Networks: Theory” :*IEEE Transaction on Circuits and Systems, Vol. 35, pp. 1257-1272.1988*

[3]Leon O. Chua and Lin Yang, (1988). “Cellular Neural Networks: Theory”.*IEEE Transaction on Circuits and Systems, Vol. 35, pp. 1273-1290.1988*

[4] Zhenghao Shi, Lifeng He, Tsuyoshi Nakamura, Kenji Suzuki and Hidenori Itoh, .” Survey on Neural Networks Used for Medical Image Processing”. *International Journal of Computational Science, Vol. 3, pp. 86-100.2009*

[5]Satoshi Hirakawa, Csaba RekeczJ, Yoshifumi Nishio, Akio Ushida,Tamas Roska, Junji Ueno, Ishtiaq Kasem and Hiromu Nishitani.”Detecting Lung Cancer Symptoms with Analogic CNN Algorithms Based on a Constrained Diffusion Template”. *IEICE Trans. Fundamentals, E-80A, pp. 1340-1344.1997*

[6] A.J. Patti and Y. Altunbasak, “Artifact reduction for set theoretic super resolution image reconstruction with edge adaptive constraints and higher-order interpolants,” IEEE Trans. Image Processing, vol. 10, no. 1, pp. 179-186, Jan. 2001.

[7] Nicola Asuni, Andrea Giachetti (2008) „Accuracy Improvements And Artifact Removal In Edge Based Image Interpolation‟. s.l. : Proc. 3rd Int. Conf. Computer Vision Theory and Applications, pp. 8.

[8] Akhtar, P. Azhar, F.(2010) „ A Single Image Interpolation Scheme for Enhanced Super Resolution in Bio-Medical Imaging‟ s.l. : IEEETrans. on Bio informatics and biomedical engineering, vol. 10, pp. 1521-1527.