DETECTION OF FIBROSIS REGIONS IN THE LUNGS BASED ON CT SCANS

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Abstract: The main aim in the article was to provide an accurate, simple and fast algorithm that can increase the performance of the system and thereby the efficiency. Accurate results for lung images have not been accurate as the edges form in many diverse ways. Thereby, a universally applicable edge detection algorithm cannot comply with the purpose of detecting fibrosis. Thus by considering and furthermore introducing a deep convolutional neural network with pixel manipulation, the detection of fibrosis can be made easy, efficient and even accurate unlike the traditional learning structures. By implementing this we are free from extraction of features or even computation of multiple channels and thus suggesting a very straight forward method in terms of the detection and output accuracy.

Key words: Computer Tomographic images, convolutional neural network, pixel by pixel manipulation, pre-processing techniques, post- processing techniques, noise removal, edge detection analysis

Introduction: Various lung diseases that have evolved over the years have been detected with the rapid increase of science and technology. Due to the rapid change in the cell structure some diseases that involve the lungs cannot be detected and hence thereby reducing chances of technology and help in detecting such changes and hence unable to produce accurate results.

In order to achieve the results through these Computer Tomographic images, Researchers have used various data sets to train the system in order to identify and detect the problem. The output however accurate took a longer time to process and thus was inconvenient when applied to the field of Medical Science. Some researchers found out that this can be resolved by the removal of noise and this has proven to be successful which is based on the Hidden Markov model for the identification of lung cancer. 2D and 4D Computer Tomographic images were also sometimes insufficient to provide a confidence in the diagnosis. Thus this was solved by using a combination of both Positron Emission Tomography and Computer Tomography images. By this the output produced was far more inferior and made tumour identification in the lungs possible which was achieved by a proper joint posterior probability with that of a Fuzzy Markov Random Field Model.

All the methods involved however successful failed on one occasion which involved that of the blood tissue lining the lung. This makes it one of the biggest problem faced by the researchers today on how to identify a weak lung based on the lining of blood tissues along the walls of the lungs. The most common of all lung diseases includes the pulmonary edema where fluids leak from the blood vessels in the air sacs. Lung fibrosis can also denote various other respiratory problems but with enhanced software and technology, a confidence in the diagnosis regarding the border of the lungs can be produced.

Neural Networks have been created and developed to be trained with different data sets for various problems of the lung. Some of them include that of lung cancer, detection of pulmonary nodules and various other respiratory problems involving pneumonia. By training the neural network with appropriate data sets involving that of computer tomographic images with fibrosis, the respiratory problems such as Pleurisy can be detected at an early stage and also be able to distinguish a weak lung from that of a strong one and hence be able to use it further for surgical implants.

Thus in this research we aim at detecting the extent of fibrosis by using various computer tomographic images of various patients by improving the image processing techniques used and further more combining algorithms of various edge detection methods followed by manipulation of pixels to enhance the image used to produce accurate results. The extent of fibrosis in the particular image under research is found by comparing two computer tomographic images after application of the enhanced algorithm.

Methods and Technologies:

In this research, a description of the convolutional neural network architecture with its approach to a practical image processing application for the detection of lung fibrosis for computer tomographic images by pixel manipulation [1, 2] is presented. A convolutional neural network presented in Fig.1 can be used to detect and characterize a lung image by manipulating it pixel by pixel. Although a number of methods that have been used such as the "Combining Markov Random Fields [3] and Convolutional Neural Networks for Image Synthesis" and similar methods, edge detection is made possible by pixel manipulation thus making the detection of fibrosis in computer tomographic images possible.

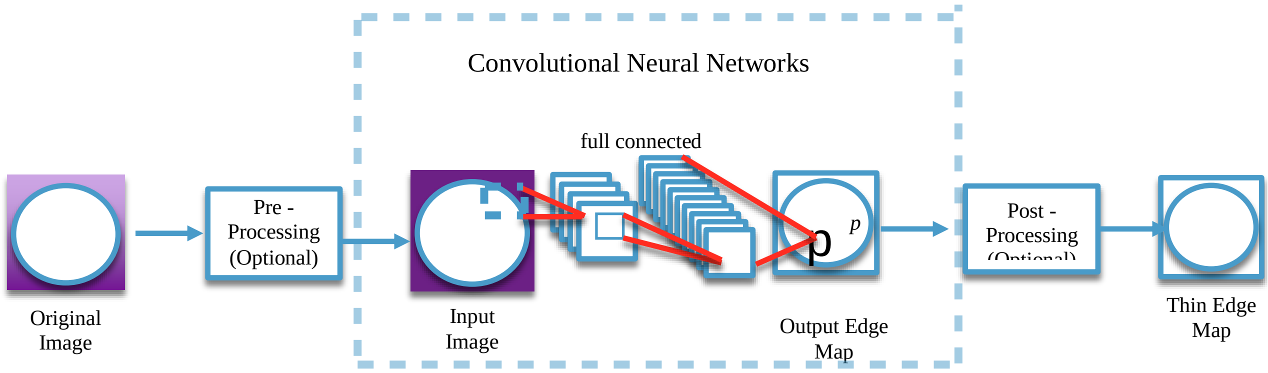

Figure 1: Process of Deep Learning Convolutional Neural Network

The Convolutional Neural Networks is trained in a way that the prediction of the edge detection is based purely on image fibrosis from a CT lung image. The training data set for the method involves that of computer tomographic images in the lung and pleural mode of the same patient. The reason being that these modes although of the same patient produces a huge difference when edge detection has been applied. Such networks are adopted so that the system is free from additional procedure involving feature extraction, thus making the method simple and further efficient without the loss of performance in edge detection. Once edge detection has been done, furthermore experiments on the network structures, combination of data, various other pre-processing and post-processing techniques [4, 5] have also been performed so as to enhance and influence the performance.

In this method the network should capture local patterns [6] from any inputed CT image in the convolutional layers and this makes it a suitable tool for solving the detection of fibrosis problem, because the edges are usually correlated locally and only specific patterns are exhibited. Thus this research is developed based on these methods by further modifying them and creating a simple design. Its furthermore simplified by the removal of pooling layers. The entire data set used in the experiment is of sample images from the the Belarus Tuberculosis Institute. Best performance can be achieved by using a simple three layered network that takes raw RGB color patch from an image as the input without any of the pre-processing. By not suppressing the image and further more applying it to the whole system the performance can be improved.

The correspondence between the boundary detected are learned from data rather than basing it on any man made assumptions. Traditional learning methods are not capable enough to learn a direct mapping from patches of certain images to prediction of an edge. In order to get an accurate representation, many have tried to compute gradient channels and multiple color or even extract the similar features of the original CT image and this has effected the performance in terms of output to a huge extent. Thus the detection of fibrosis is possible with a deep convolutional neural network with pixel manipulation.

Edge Detection Method Analysis

Once an image has been inputted into the network extra noise has to be removed by certain pre-processing techniques for accurate edge detection [7]. The convolutional neural network scans the image and then makes the edge detection pixel by pixel and this is based on the image patch that is centered on it. The Convolutional Neural Networks can be characterized as follows:

- The translation invariance which means that the neural weights are fixed with respect to it's spatial translation
- It's local connectivity as in neural connections can only exist between spatially local regions.
- The optional progressive decrease in spatial resolution such as the number of features can be
- gradually increased.

The above constraints thus make a convolutional network to operate similar to a system with interconnected filters [7], and thereby profitable comparisons can be made by other filtering systems, since the neural weights of the convolutional neural network can work as a system of finite impulsive response [8] or even wavelet filters. Thus a trained network can be custom made with a trainable filter system for a certain mapping application.

Finally, morphological operations or even non-maximal suppression [7, 8] can be applied as a post-process technique and this helps to increase the localization accuracy. The pre-process technique used is a smart algorithm that not only increases the system complexity but is straight forward and helps in noise removal. Furthermore the convolutional neural network serves more or less as a core component of the system. It takes the image patches and makes the predictions based on whether the identified central pixels are located on the edge of the CT image or not. Thus, any filter that fulfills the task of pixel comparison and identification can be employed in the system. The post-processing that takes place in the system usually covers a large amount of pixels that are considered to be inaccurate. Hence, a non-maximal suppression or morphological suppression method is employed so as to render a thin edge that is mapped in the final output of the CT image.

Method Used for the Detection and Analysis of Fibrosis Regions

Once the edge detection is done with a suitable edge detection algorithm, the extent of fibrosis is analyzed and detected by pixel manipulation. The process is illustrated in Fig. 2.

- Identification of Image Bit Depth and the Components of the Pixel Color

The depth of the image can also be referred to as the bits per pixel. This is taken as an indicator of the amount of storage space required to store the respective computer tomographic image. The smallest unit of storage in the system is the bit value in any storage medium and can simply be refereed by either 0 or 1.

- Representation of Data in Pixel Byte Format

The 32 Bits per pixel that was equated to the 4 bytes per pixel is now used in turn as in each byte is used to represent a color component. Hence the image format will be referred to as 32 Bits per pixel 'argb' which means that the color components that are contained in the pixels are red, green, blue and the component of alpha. The possible range of values can start from 0 and end till 255 and this is in terms of bytes. When the Component of Alpha is thus set to 255 it is thereby an expression of no transparency and when it equates to 0 is a representation of the associated pixel to complete transparency, and thereby negating the color values by the other remaining color components.

- Manipulation of Individual Pixel Color Components

When the expressed value of a color component is updated there will be a change on the whole by the respective pixel that was expressed by the color value. This changes the intensity of the color components. For example let us consider that if the value of a blue color component was doubled, the result would be the color having twice the intensity as before.

- Retrieving a Byte Array from Color

When an image's underlying data is expressed in the form of a byte array while accessing it, in order to signal the Garbage Collector of an addition memory existing, the method requires a new mechanism. This may not be updated when the values are shifted in the memory to a whole new address.

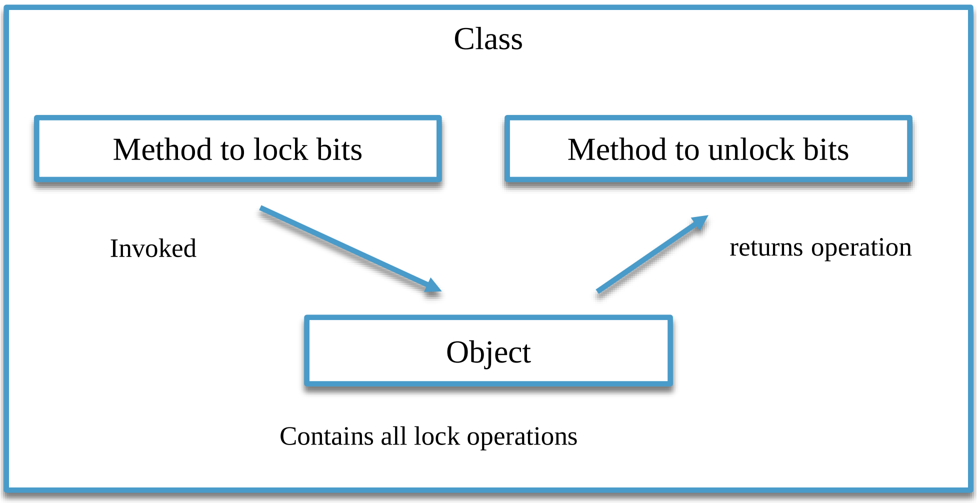

Figure 2: Process of Retrieving the Byte Array

- Components Filtration of Bitmap Color Components Algorithm

The implementation involves that of two Bitmap images, as in a pleural mode image and lung mode image of the same patient, to be blended by considering one as a source image and the second as an overlay image. Thus an algorithm is created for this method and this should be defined as class containing public properties that affects how the synchronization of the image is achieved.

- Blending Bitmap Images

In this process a method is defined as an extension method to target the class specified while retrieving a byte array. This method helps in creating a net memory for the bitmap of which the color values for the source and overlay bitmap image are calculated and thus defined by an object parameter that was defined in the bitmap color component process.

- Conversion of the 32 Bit Per Pixel ARGB Format

The method that is created to blend the enum type values is used to perform a number of calculations for each color component and this is based on the Blend type that is specified only by the specified object. It is very important to check if the method returns a value and thus ensuring that the new color component values is within the range from 0 to 255. Any value that exceeds the highest limit that is more than 255, the value should be assigned to 255 and if the value is less than 0, that is a negative value, it should be assigned to a 0.

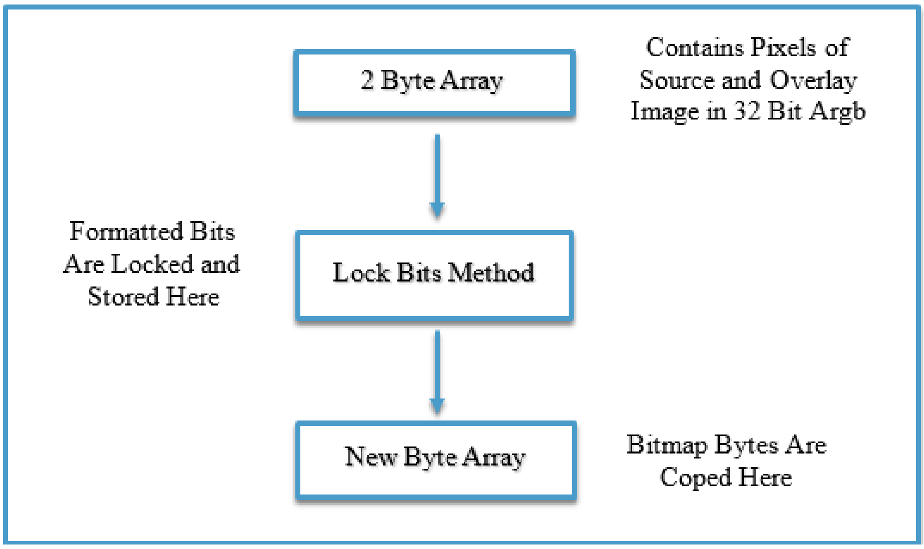

Figure 2: Process of Creating a Memory for the Bitmap

Conclusion:

Thus to solve this task, first previously used methods for the process of image detection and image learning were analysed and the advantages and disadvantages of using various technologies were discussed. In conclusion to the detection of fibrosis which can be made possible by the use of a well trained convolutional neural network by ensuring a pixel by pixel manipulation. Once the pixels are detected by the pre-processing techniques, an edge detection algorithm which furthermore provides an accurate result by a bit array allocation after which the removal of noise takes place by a certain post-processing non-maximal suppression or morphological suppression method.

Finally, edge detection is done by passing two computer tomographic images in two modes such as the pleural and lung mode through the convolutional neural networks to get an accurate edge detection after which a comparison between the two images is done to detect the fibrosis of the lung. From the relative output, lung diseases related to fibrosis of the lungs can be detected and identified and thus making it possible to provide more accurate results.

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LUNG REGION SEGMENTATION BASED ON COMPUTER TOMOGRAPHIC IMAGES

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Abstract. The article is written for the benefit of hospitals in order to identify segments of the lungs and thereby help in the process of bisecting lungs according to their respective segments during surgery. Further research in this area can also help in identification of various abnormalities related to each segment and also identify abnormal walls of unhealthy lungs. Segmentation of the lungs has not been implemented in reality, as the lung, being an organ with dynamic chest volumes during respiratory cycles, makes it impossible to address changes during respiration unlike fixed structures like the brain. Further, abnormalities situated on the walls of lung segments, make it more difficult to address volume changes concerned with the lungs. The author of this paper has provided a more effective method to identify various lung segments by using various well known segmentation techniques combined together to identify moving lung image segments more effectively.

Key words: lung segmentation, ct images on organs, segmentation methods, study of lung imaging, abnormalities in lung segments, combined segmentation.

Introduction. In computer tomography related to cardio-vascular system, high resolution computer tomography (HRCT) is used, which in turn helps to diagnose diseases that cannot be or is difficult to detect through physical examination, such us tumours, cancer, pneumonia, etc [1]. When the lung has a high density of pathologies, it becomes even more difficult to segment it as it becomes more difficult to detect its different segments and also more difficult to detect the borders of various segments.

Detection and segmentation must be performed with even more accuracy, because elimination of any intricate detail in any of the images can lead to fatal results. It can even lead to the death of the patient, if some pathology that had to be detected was carelessly eliminated while attempting to segment the lungs.

In the past, segmentation of the lungs was carried out manually from the inputs provided by the radiologists who have expertise in diagnosing anatomic boundaries and lung pathologies [1, 2]. Due to the progress of software and computational efficiency in recent times, lung segmentation could be carried out automatically instead of manual intervention. Currently, single lung segmentation methods cannot be used as it is not improvised enough to accurately segment the lungs. Clinically these methods have not been used as their efficiency is not enough to take the risk of using them in hospitals. Most of the methods that exist use a particular subset to identify abnormalities in images. However, they usually fail to identify lesions in the lung or near the lung. They also fail in accuracy and computational efficiency.

Medical Image Segmentation usually occurs by incorporating object recognition where we understand everything related to images and also the details connected with the image which could be easily performed computationally with proper user interaction, and object delineation where the boundaries of the object are identified [3]. Delineation is almost impossible as it is difficult to identify the total spatial extent of the lung. Most of the segmentation processes that have been identified