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A Systematic Study of Segmentation Methods For Detection of Kidney Tumor Using Computed Tomography Images.

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Abstract

This paper provides a Systematic study of segmentation methods for detection of kidney tumor using Computed Tomography images. There are large numbers of CT image segmentation algorithms are available, CT image segmentation can be divided into edge based, texture based, Thresholding .We studied the performance of algorithms in each category using a kidney CT image. We found that the algorithms that already implemented are more suitable for relatively homogeneous kidney tumors. In addition computed tomography (CT) provides wide range of physiological and anatomical information. In the process of detection of tumor in CT, segmentation plays vital role for partitioning an image into different sub region with homogeneous properties. In this paper various methods that have been used for segmentation in MRI are reviewed and a new approach by incorporating the advantages of Region growing is proposed.

Keywords: Kidney Tumor Images, Segmentation algorithm.

Introduction

Human body is made up of many types of cells. Each type of cell has special functions. Most cells in the body grow and then divide in an orderly way to form new cells as they are needed to keep the body healthy and working properly. When cells lose the ability to control their growth, they divide too often and without any order. The extra cells form a mass of tissue called a tumor. Identification of tumor involves test like CT and MRI. CT plays vital role in identifying location, size and type of kidney tumor.The goal of image segmentation is to cluster pixels into salient image regions, i.e., regions corresponding to individual surfaces, objects, or natural parts of objects. Segmentation could be used for object recognition, occlusion boundary estimation within motion or stereo systems, image compression, image editing, or image database[1].cancer is the most deadly disease in both men and women there are several types of cancer like kidney cancer, lung cancer, Prostrate cancer, Breast Cancer, Uterus Cancer etc these diseases can cause of death Hence diagnosis of the cancer in the early stages is crucial.CT imaging is a widely used technology for diagnosing and treatment of cancer.

Computerized Kidney tumor Detector is a software system that reports detected abnormalities in kidneys and gives a diagnosis of potential diseases. The system takes CT-scan images, stool analysis, from different machines already available in most hospitals and laboratories. After the data is inputted, the system analyzes it and gives a diagnosis with a high accuracy[2]. Unlike some other software with static databases, which could become obsolete as new medical discoveries are made, this system is equipped with an intricate learning algorithm that allows it to be updated easily. This system is developed to assist the medical staff in their diagnosis by allowing them to save time in detecting small defects in the kidney. The intent of this paper is to study, design and develop a computer supported medical system that will help a physician or team of physicians diagnose a disease based on image and test results and using knowledge based data. It is important to note, however, that this software does not claim to replace the physician, as human expert evaluation is often necessary, especially in new cases. In Europe, kidney cancer accounts for nearly 3% of all cancer cases [. Laparoscopic partial nephrectomy or minimally invasive surgery is the standard treatment for kidney surgeon for small tumors (40mm or less)[3][4]. A successful partial nephrectomy means the tumor is completely remove, but some amount of healthy tissue is left in the organ. In order to do this, identification of the location and shape of the tumor inside the kidney is important. Ultrasound (US), computed tomography (CT) and magnetic

resonance imaging (MRI) are currently utilized by doctor to predetermine the location, size and shape of the tumor before surgeon. Compare to ultrasound and MRI, CT has the advantage of short acquisition time, less radiation. But ultrasound images usually contain strong speckle noises and artifacts, which make it difficult to properly segment the interested objects with correct position[4].

Materials And Method

If an image has been pre-processed appropriately to remove noise and artifacts, segmentation is often the key step in interpreting the image. CT is very important in order to improve the diagnosis and treatment of brain tumor, by detecting tumor at its early stage. Segmentation of medical images is first important step in their analysis, the segmentation gives organ detection and variation of growth of tissues as a output in medical images. In this paper several segmentation techniques are discussed as below. The CT image segmentation can be divided into the following categories [5]:

- Edge or boundary based methods
- Texture based methods
- Thresholding Method
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A) Edge OR Boundary Based Method

Edge based segmentation is the location of pixels in the image that correspond to the boundaries of the objects seen in the image. Edge detection approach is most frequently used for segmenting images based on local changes in intensity. In this method boundary or edge on an image is defined by the local pixel intensity gradient.

The three fundamental steps used for edge detection are as follows:

1. In the first step image smoothing for reduction of noise is done.
2. Detection of edge points are the second step in which there is extraction of all the points in an image that have intensities to become edge points.
3. The last step of this method is Edge localization in this step there is a selection among the edge elected in the previous step that are true members of the set of points that forms an edge.

Closed region boundaries are required to segment an object from an image. The desired edges are the boundaries between such objects. Xie Mei et al [10] in 2009 developed a method for edge detection of weak edges of brain by Canny algorithm, by labeling all the 8-connected edge with the different number and then they classify with that edge, for the size of all 8-connected edge circumference being different and then based on this information they plot the histogram according to the size of edge and lastly weak edge of the brain is detected by histogram segmentation.

For instance, these methods have problems with images that are[5]:

- Edge-less
- Very noisy
- Boundary that are very smooth
- Texture boundary

Other problems of these techniques emanate from the failure to adjust/calibrate gradient function accordingly thus produces undesirable results as[6]:

- The segmented region might be smaller or larger than the actual.
- The edges of the segmented region Might not be connected.

B) Texture Based Methods

Each texture can be thought as containing a narrow range of frequency and orientation components[7]. Thus texture scan be used to perform tasks such as the segment the CT image into distinct objects and then analysis surface geometries. By using texture filter like multiple band-pass filters filter, the image tuned to the frequency dominant and orientation component, it is possible to localize similarities in texture image. The output of the filters can be used to determine the regions occupied by the textures. Gabor filters is used here as our test algorithm. The Gabor filters, are band-pass filters with tunable centre frequency, orientation and bandwidth. The filter outputs reflect the spatial and orientation composition of a texture[7].

C) Thresholding Method

Thresholding is the simplest way to perform segmentation, and it is used extensively in many image processing applications.Thresholding is based on the notion that regions corresponding to different regions can be classified by using a range function applied to the intensity values of image pixels. The assumption is that different regions in an image will have a distinct frequency distribution and can be discriminated on the basis of the mean and standard deviation of each distribution[7] .

Thresholding based image segmentation aims to partition an input image into pixels of two or more values through comparison of pixel values with the predefined threshold value T individually. Failure to find the most suitable algorithm to determine the threshold value T the result might be one or all of the following:

- The segmented region might be smaller or larger than the actual.
- The edges of the segmented region might not be connected.

An Efficient Diagnosis of Kidney Images Using Association Rules'[8] Jacksy Susan Jose, R.Sivakami, N. Uma Maheswari, .Venkatesh Proposed a method based on association rule-mining to enhance the diagnosis of ultrasound kidney images. This is to implement a computer-aided decision support system for an automated diagnosis and classification of kidney images. The diagnosing of diseases as well as to enhance the health care of patients, the increasing use of image exams in the last 25 years has greatly improved. As the volume of images has grown at a fast pace, the radiologists have more and more images to manually analyze. Thus the process of diagnosing becomes tiresome and consequently more susceptible to errors. In order to avoid such bottleneck we go for computer aided diagnosing. they presented a method which is based on association rules and it can be integrated into a CAD. This approach is divided into four major steps: pre-processing, feature extraction and selection, association rule generation, and generation of diagnosis suggestions from classifier. The results are applied to real databases and the proposed system achieves high sensitivity and accuracy for diagnosing. This brings more confidence to the diagnosing process.

Limitations of Thresholding [7]:

- The major drawback to threshold-based approaches is that they often lack the sensitivity and specificity needed for accurate classification.
- The problem gets severe in case of multi-modal histograms with no sharp or well-defined boundaries.
- It is often difficult to define functional and statistical measures only on the basis of gray level value (histogram).

D) Region Growing Method:

Region-based techniques rely on common patterns in intensity values within a cluster of neighboring pixels. The cluster is referred to as the region, and the goal of the segmentation algorithm is to group regions according to their anatomical or functional roles.

Region-based segmentation methods attempt to partition or group regions according to common image properties. These image properties consist of :[8]

- Intensity values from original images, or computed values based on an image operator
- Textures or patterns those are unique to each type of region.
- Spectral profiles that provide multidimensional image data.

The algorithm of region growing technique can be stated as follows [1].

1. In the first step pixel or group of pixels which belongs to the region of interest called seeds are formed.
2. In the next step pixels in the region of interest are examined and added to the growing region in accordance with the homogeneity criteria. Until no more pixels can be adjoined to the growing regions, this step continues.
3. And in last step the object illustration is done by all added pixels to the growing regions.

In the medical image segmentation field region growing technique can be applied in kidney segmentation, cardiac images, extraction of brain surface etc. The key advantage of region growing technique is, these methods can correctly separate the regions that have the same properties that are define. One of the drawbacks of this method is, noise or variation of intensity may result in over segmentation.

We briefly conclude the advantages of region growing.

1. Region growing methods can correctly separate the regions that have the same properties we define.
2. Region growing methods can provide the original images which have clear edges the good segmentation results.
3. The concept is simple. We only need a small numbers of seed point to represent the property we want, then grow the region.
4. We can determine the seed point and the criteria we want to make.
5. We can choose the multiple criteria at the same time.
6. It performs well with respect to noise.

Limitations of Region Growing Segmentation:

1.The assumption does not hold true in all cases.
2.To overcome this, group pixels using given principles and use domain-dependent knowledge.
3.Match regions to object models.

Applications:

1. 3D – Imaging : A basic task in 3-D image processing is the segmentation of an image which classifies voxels/pixels into objects or groups. 3-D image segmentation makes it possible to create 3-D rendering for multiple objects and perform quantitative analysis for

the size, density and other parameters of detected objects.

2. Several applications in the field of Medicine like magnetic resonance imaging (MRI).

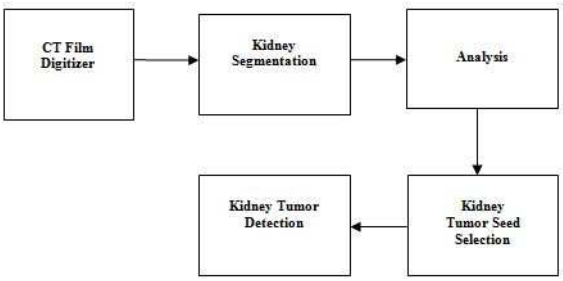

Fig 1: Methodology of Region growing Method

As shown in proposed system the digitized image with geo-metric resolution and gray-scale will be converted into Portable Gray Map (PGM) file format using CT film digitizer. The output of film digitizer will be segmented by using a Graph Cut oriented active appearance model and Region growing Method for kidney tumor detection. In order to locate the kidney tumor seed, the inside of the kidney and boundary region of the kidney will be investigated.

Conclusion

Compared to all the approaches of segmenting an CT image, our technique the modified Automatic approach with Region growing method offers many advantages including better accuracy, greater noise reduction, and faster speed. Various segmentation methods for CT image have been discussed in this paper. However due to the complex structure of kidney these method cannot produce effective results in constraints with the computational time and diseased area calculation. By using the advantages of Region growing method significant reduction in computational time and calculation of exact area of the tumor can be achieved.

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