A Novel Approach on Medical Image Processing Using Different Type of latest Techniques.

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Abstract:

MedicalImage Processing includes the analysis, enhancement and display of images captured via different imaging modalities e.g. x-ray, ultrasound, MRI, nuclear medicine etc. Rather than simply looking at an x-ray on a lightbox, image processing software assists in identifying and analyzing information that might not be apparent to the human eye.Depending on the imaging technique and what diagnosis is being considered, image processing and analysis can be used to determine several clinically meaningful characteristics of a tumor or organ.

A processing method that is applied for medical images of human body tissues or organs, such as CT scan and MRI scan, in order to perform diagnosis and clinical analysis

Medical image processing is the technique and process of creating visual representations of the interior of a body for the scientific analysis
and medical intervention. Medical imaging seeks to reveal internal structures hidden by the skin and bones, as well as to diagnose and treat disease.

Keywords: Medical Imaging, Bioimaging, Neuroimaging, Visualization, Giga-Voxel, Picture Archiving And Communication Systems (PACS), Content-Based Image Retrieval (CBIR), Virtual Reality (VR), Graphics Processing Unit (GPU) Programming

Introduction :

Medical image segmentation is the basic for organs 3D visualization and operation simulation. The precise of the segmented object is critical for doctor´s diagnosis and disease treatment. The SeeThrough application is medical image process that includes image segmentation, 3D object visualization, furthermore aiding diagnosis.

Algorithm : Segmentation methods are usually divided into two region-based and edge-based methods. In region-based methods an algorithm usually searches for connected regions of pixels with some similar feature such as brightness, texture pattern, etc. These algorithms work in the following way: The first image is in some way divided into regions. Then for each region similarity among pixels is checked. If similarity is below some threshold, region is divided into smaller regions. In the next step neighbouring regions with similar features are merged into a new bigger region.These two steps are repeated until there is no more splitting or merging. The problem in this approach is to determine exact borders of objects because regions are not necessary split on natural borders of the object.

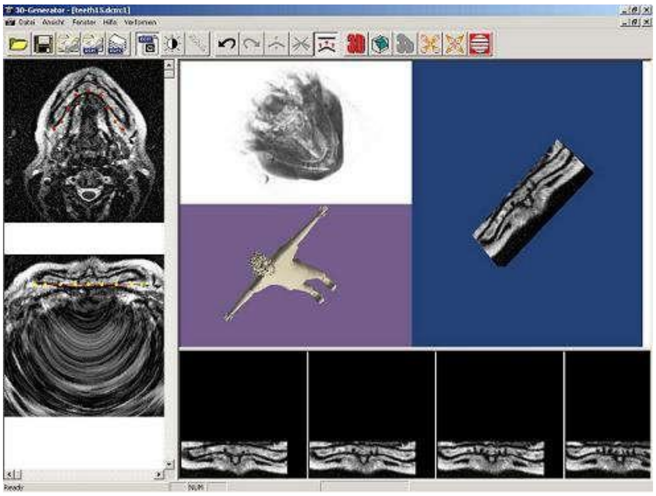
Alternative approach is edge-based.In this approach an algorithm searches for pixels with high gradient value which are usually edge pixels and then tries to connect them to form a curve which represents a boundary of the object. A difficult problem here is how to connect high gradient pixels because in real images they are usually not neighbours. Another problem is noise. Since a gradient operator is of a high pass nature, and the noise is usually also in high frequencies it can sometimes create false edge pixels.

In this application,the region-based method and edge-based method will be combined to realize the general medical image segmentation, thereafter perform 3d object visualization and volume measurement, and so on.

- **3D-Generator**

The application is used for the dentist diagnosis. During the check up procedure, the dentist gets a serial of cross-section image of patient. In every image, the teeth or gum area is arched shape. However, the dentist wants to warp the arc shape to line shape, then construct 3D image, so that he can observe the surrounding area in one plane. Our application can fulfill this requirement that perform deformation the series of images, and also visualize the result as 3D

Algorithm : The deformation is performed on 2D image. Then using these deformed images we construct 3D image. Our method is based on the work of Thaddeus ThaddeusBeier and Shawn Neely. Feature-based image metamorphosis.Computer Graphics (SIGGRAPH'92 Proceedings). Vol. 26, July, 1992. pp. 35-42. It is local morphing for that the morphing is based upon fields of influence surrounding the control elements. Using this method,it is easy to define the feature primitives. And the algorithm is intuitive and easy to realize by programming.



Segmentation

Segmentation is the process of partitioning an image into different meaningful segments. In medical imaging, these segments often correspond to different tissue classes, organs, pathologies, or other biologically relevant structures. Medical image segmentation is made difficult by low contrast, noise, and other imaging ambiguities. Although there are many computer vision techniques for image segmentation, some have been adapted specifically for medical image computing. Below is a sampling of techniques within this field; the implementation relies on the expertise that clinicians can provide.

Atlas-Based Segmentation: For many applications, a clinical expert can manually label several images; segmenting unseen images is a matter of extrapolating from these manually labeled training images. Methods of this style are typically referred to as atlas-based segmentation methods. Parametric atlas methods typically combine these training images into a single atlas image, while nonparametric atlas methods typically use all of the training images separately.Atlas-based methods usually require the use of image registration in order to align the atlas image or images to a new, unseen image.

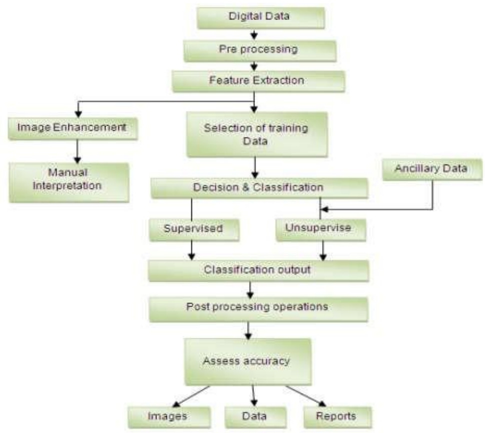
Shape-Based Segmentation: Many methods parametrize a template shape for a given structure, often relying on control points along the boundary. The entire shape is then deformed to match a new image. Two of the most common shape-based techniques are Active Shape Models and Active Appearance Models. These methods have been very influential, and have given rise to similar models.

Image-Based segmentation: Some methods initiate a template and refine its shape according to the image data while minimizing integral error measures, like the Active contour model and its variations.

Interactive Segmentation: Interactive methods are useful when clinicians can provide some information, such as a seed region or rough outline of the region to segment. An algorithm can then iteratively refine such a segmentation, with or without guidance from the clinician. Manual segmentation, using tools such as a paint brush to explicitly define the tissue class of each pixel, remains the gold standard for many imaging applications. Recently, principles from feedback control theory have been incorporated into segmentation, which give the user much greater flexibility and allow for the automatic correction of errors.

Subjective surface Segmentation: This method is based on the idea of evolution of segmentation function which is governed by an advection-diffusion model.To segment an object, a segmentation seed is needed (that is the starting point that determines the approximate position of the object in the image). Consequently, an initial segmentation function is constructed. The idea behind the subjective surface method is that the position of the seed is the main factor determining the form of this segmentation function.

However, there are some other classification of image segmentation methods which are similar to above categories. Moreover, we can classify another group as "Hybrid" which is based on combination of methods.



Fundamental steps in image processing:

1) Image acquisition: to acquire a digital image 2) Image preprocessing: to improve the image in ways that increases the chances for success of the other processes.

3) Image segmentation: to partitions an input image into its constituent parts or objects.

4) Image representation: to convert the input data to a form suitable for computer processing.

5) Image description: to extract features that result in some quantitative information of interest or features that are basic for differentiating one class of objects from another.

6) Image recognition: to assign a label to an object based on the information provided by its descriptors.

7) Image interpretation: to assign meaning to an ensemble of recognized object

Medical image computing typically operates on uniformly sampled data with regular x-y-z spatial spacing (images in 2D and volumes in 3D, generically referred to as images). At each sample point, data is commonly represented in integral form such as signed and unsigned short (16-bit), although forms from unsigned char (8-bit) to 32-bit float are not uncommon. The particular meaning of the data at the sample point depends on modality: for example a CT acquisition collects radio density values, while a MRI acquisition may collect T1 or T2-weighted images. Longitudinal, timevarying acquisitions may or may not acquire images with regular time steps. Fan-like images due to modalities such as curved-array ultrasound are also common and require different representational and algorithmic techniques to process. Other data forms include sheared images due to gantry tilt during acquisition; and unstructured meshes, such as hexahedral and tetrahedral forms, which are used in advanced biomechanical analysis (e.g., tissue deformation, vascular transport, bone implants).

Visualization

Visualization plays several key roles in Medical Image Computing. Methods from scientific visualization are used to understand and communicate about medical images, which are inherently spatial-temporal. Data visualization and data analysis are used on unstructured data forms, for example when evaluating statistical measures derived during algorithmic processing. Direct interaction with data, a key feature of the visualization process, is used to perform visual queries about data, annotate images, guide segmentation and registration processes, and control the visual representation of data (by controlling lighting rendering properties and viewing parameters). Visualization is used both for initial exploration and for conveying intermediate and final results of analyses.

The figure "Visualization of Medical Imaging" illustrates several types of visualization: 1. the display of cross-sections as gray scale images; 2. reformatted views of gray scale images (the sagittal view in this example has a different orientation than the original direction of the image acquisition; and 3. A 3D volume rendering of the same data. The nodular lesion is clearly visible in the different presentations and has been annotated with a white line.

Statistical analysis

Statistical methods combine the medical imaging field with modern Computer Vision, Machine Learning and Pattern Recognition. Over the last decade, several large datasets have been made publicly available (see for example ADNI, 1000 functional Connectomes Project), in part due to collaboration between various institutes and research centers. This increase in data size calls for new algorithms that can mine and detect subtle changes in the images to address clinical questions. Such clinical questions are very diverse and include group analysis, imaging biomarkers, disease phenotyping and longitudinal studies.

Group analysis

In the Group Analysis, the objective is to detect and quantize abnormalities induced by a disease by comparing the images of two or more cohorts. Usually one of these cohorts consist of normal (control) subjects, and the other one consists of abnormal patients. Variation caused by the disease can manifest itself as abnormal deformation of anatomy (see Voxel-based morphometry). For example, shrinkage of sub-cortical tissues such as the Hippocampus in brain may be linked to Alzheimer's disease. Additionally, changes in biochemical (functional) activity can be observed using imaging modalities such as Positron Emission Tomography.

The comparison between groups is usually conducted on the voxel level. Hence, the most popular pre-processing pipeline, particularly in neuroimaging, transforms all of the images in a dataset to a common coordinate frame via (Medical Image Registration) in order to maintain correspondence between voxels. Given this voxel-wise correspondence, the most common Frequentist method is to extract a statistic for each voxel (for example, the mean voxel intensity for each group) and perform statistical hypothesis testing to evaluate whether a null hypothesis is or is not supported. The null hypothesis typically assumes that the two cohorts are drawn from the same distribution, and hence, should have the same statistical properties (for example, the mean values of two groups are equal for a particular voxel). Since medical images contain large numbers of voxels, the issue of multiple comparison needs to be addressed, There are also Bayesian approaches to tackle group analysis problem.

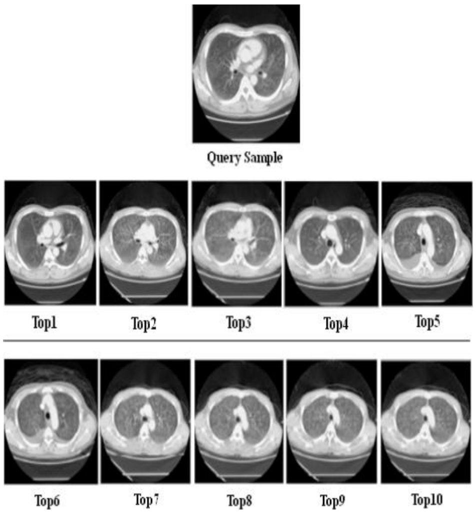


Fig: The top 10 retrieval results about liver category using our method

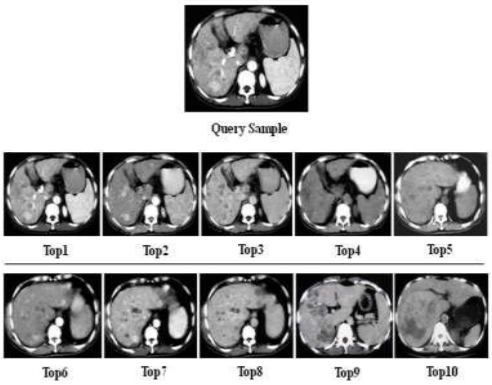


Fig: The top 10 retrieval results about chest category using our method

Algorithms used for Image Processing at Different Stages:-

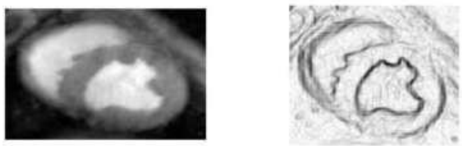
Image registration Image registration is one of the most common algorithms in medical imaging and the one with the most GPU implementations. One reason for this is the GPU's hardware support for linear interpolation, which makes it possible to transform images and volumes very efficiently. Hastreiter and Ertl (1998) were one of the first to take advantage of the GPU for image registration, mainly for its ability to perform fast interpolation in 3D. A common approach is to let the GPU calculate a similarity measure, often mutual information (Viola and Wells, 1997; Pluim et al., 2003; Mellor and Brady, 2005), over the images in parallel while the CPU runs a serial optimization algorithm to find the parameters (e.g. translations and rotations) that give the best match between the two images. The mutual information between two discrete variables a and b is defined as

$$I(a,b) = \sum_{a \in A} \sum_{b \in B} p(a,b) \log \left(\frac{p(a,b)}{p(a)\,p(b)} \right)$$

Edge Detection Technique

Edge detection is an image processing technique for finding the boundaries of objects within images. It works by detecting discontinuities in brightness. Edge detection is used for image segmentation and data extraction in areas such as image processing, computer vision, and machine vision. Common edge detection algorithms include Sobel, Canny, Prewitt, Roberts, and fuzzy logic methods. Consider the ideal case of a bright object O on a dark background

$$I(x) = \varphi\left(\frac{S(x)}{\varepsilon}\right)$$



(a) Original image. (b) Sobel edge detector.

Feature Extraction

Contrast limited adaptive histogram equalization (CLAHE) is a popular technique in biomedical image processing, since it is very effective in making the usually interesting salient parts more visible. The image is split into disjoint regions, and in each region local histogram equalization is applied. Then, the boundaries between the regions are eliminated with a bilinear interpolation. The main objective of this method is to define a point transformation within a local fairly large window with the assumption that the intensity value within it is a stoical representation of local distribution of intensity value of the whole image

$$p_n = 255 \cdot \left(\frac{[\phi_w(p) - \phi_w(\text{Min})]}{[\phi_w(\text{Max}) - \phi_w(\text{Min})]} \right) \quad (1)$$

$$\phi_w(p) = \left[1 + \exp\left(\frac{\mu_w - p}{\sigma_w} \right) \right]^{-1} \quad (2)$$

Super-Pixel Classification using Slic Algorithm

This paper uses the simple linear iterative clustering algorithm (SLIC) to aggregate nearby pixels into super pixels in retinal fundus images. Compared with other super pixel methods, SLIC is fast, memory efficient and has excellent boundary adherence. The number of desired super pixels is the main parameter why we used SLIC and it is simple also only because of this parameter. We adopted a new super pixel algorithm, simple linear iterative clustering (SLIC), which uses a k-means clustering approach for proper generation of super pixels. This algorithm is best when compared to other conventional methods

Circular Hough-Transformation

We established an approach based on the In order to detect small circular spots in the image, will implement an approach called Circular Hough Transformation. Images are obtained by detecting circles on the images using circular Hough transformation. With this technique, from the image a set of circular objects can be extracted. Circle shape of the optic disk is computed using circle equation given below

$$r^2 = (x - a)^2 + (y - b)^2$$

Classification

Although group analysis can quantify the general effects of a pathology on an anatomy and function, it does not provide subject level measures, and hence cannot be used as biomarkers for diagnosis (see Imaging Biomarkers). Clinicians, on the other hand, are often interested in early diagnosis of the pathology and in learning the progression of a disease From methodological point of view, current techniques varies from applying standard machine learning algorithms to medical imaging datasets, to developing new approaches adapted for the needs of the field. The main difficulties are as follows:

Small sample size (Curse of Dimensionality): a large medical imaging dataset contains hundreds to thousands of images, whereas the number of voxels in a typical volumetric image can easily go beyond millions. A remedy to this problem is to reduce the number of features in an informative sense (see dimensionality reduction). Several unsupervised and semi-/supervised, approaches have been proposed to address this issue.

Interpretability: A good generalization accuracy is not always the primary objective, as clinicians would like to understand which parts of anatomy are affected by the disease. Therefore, interpretability of the results is very important; methods that ignore the image structure are not favored. Alternative methods based on feature selection have been proposed,.

Conclusion: The investigation is enhancing the quality of the ultrasound images using modified aura based transformation. This transformation technique is relatively less expensive, simple, and less time consuming. The duration for processing the image is very less. The investigations showed that the processed ultrasound images were enhanced in quality. The enhanced image is helpful in predicting the diseases inside the human body more effectively and accurately

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