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Diagnosis and analysis of liver cancer using image processing

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Abstract
The detection and diagnose of liver tumors from CT images by using digital image processing, is a modern technique depends on using computer in addition to textural analysis to obtain an accurate liver diagnosis, despite the method's difficulty that came from liver's position in the abdomen among the other organs. This method will make the surgeon able to detect the tumor and then easing treatment also it helps physicians and radiologists to identify the affected parts of the liver in order to protect the normal parts as much as possible from exposure to radiation. This study describes a new 2D liver segmentation method for purpose of transplantation surgery as a treatment for liver tumors. Liver segmentation is not only the key process for volume computation but also fundamental for further processing to get more anatomy information for individual patient. Due to the low contrast, blurred edges, large variability in shape and complex context with clutter features surrounding the liver that characterize the CT liver images. In this paper, the CT images are taken, and then the segmentation processes are applied to the liver image which will find, extract the CT liver boundary and further classify liver diseases.

Keywords: medical image methods; liver cancer diagnosis and treatment.

Introduction

Medical imaging equipment has developed rapidly in the last decade, with widespread usage in clinical diagnosis and treatment. Two main imaging modes are employed that utilize di_erent principles and equipment. The first is the anatomical imaging mode that mainly provides anatomical information with high resolution. The X-ray-based method, computed tomography (CT), which falls into the category of anatomical imaging, is the first technique developed for the noninvasive acquisition of images within the human body. CT is particularly e_ective for imaging tissues with large di_erences in density. At present, whole-body scans can be performed with the latest generation of CT systems, including multi-slice etectors that allow precise visualization, even for very small vessels. Magnetic resonance imaging (MRI) uses radio waves and magnets to generate body tissue images. Compared to CT, MRI uses nonionizing electromagnetic radiation, and appears devoid of exposure-related hazards. The technique employs radiofrequency (RF) radiation in the presence of carefully controlled magnetic fields to produce high-quality, cross-sectional images of the body in any plane. Using MRI, high spatial resolution can be e_ectively used to identify soft tissue within the human body . The functional imaging mode mainly provides functional metabolic information. One such method is single photon emission computed tomography (SPECT). SPECT imaging instruments provide three-dimensional (tomographic) images of the distribution of radioactive tracer molecules introduced into the body which is generated from multiple 2D images of the body at di_erent angles [3]. Another widely used method in this mode is positron emission tomography (PET). PET is a nuclear medicine functional imaging technique used to observe metabolic processes in tissue of organs, as an aid to disease diagnosis . The main di_erence between SPECT and PET is the decay mechanism of the radiotracers used:

while SPECT measures photons of Gamma decay from a tracer nuclide, the PET scan uses 0.511-kev annihilation photons that are created when positrons, which are emitted from radiotracers, come to rest and meet with free electrons in organs. At a relatively low resolution, both SPECT and PET can be applied to reflect functional and metabolic information. Ultrasonography (US), which also falls into this category, is a technique for detecting the scattering and reflection of sound at an ultra-frequency level that allows the e_ective imaging of muscle, soft tissue, blood vessel and bone surfaces. US equipment is easy to use, and produces real-time images. However, the depth penetration of US is limited by several factors, such as the medium through which the ultrasound travels.

All these available image techniques have di_erent strengths and weaknesses. Therefore, an optimal combination of these methods can allow a simultaneous expression of information from various aspects of the human body within a single image. Such an image can accurately reflect internal structure and function, in turn providing physiological and pathological information. These image-gathering and analysis procedures compose the medical image fusion process. The current review presents a chronicle of available studies on the application of image fusion in malignant tumor diagnosis, with particular focus on liver cancer. Various methods exist for a comprehensive liver cancer treatment, including surgical resection, radiofrequency ablation, tumor embolization, etc. In clinical practice, an

individualized treatment plan is established, relying on patient information such as the localization of lesions, and is highly dependent upon imaging technology. On the basis of Ultrasonography, CT, MRI, PET and other imaging technologies, the key for optimizing multidisciplinary treatment for liver cancer is to improve and combine existing medical imaging technologies, which would allow the clear visualization of tumor lesions along with their characteristic indicators, such as tumor size, margin, the absence of vascular invasion, adjacent structure involvement, lymph node metastasis and distant spread.

The remainder of this article is divided into five sections. Section 2 discusses the imaging methods commonly used in liver tumor diagnosis and treatment; Section 3 provides a brief introduction of the general procedure used for medical image fusion; Section 4 presents several image fusion algorithms; Section 5 describes the application of image fusion in liver tumor imaging; and Section 6 covers our Conclusion and suggestions for further research.

Medical Imaging Methods

CT

An X-ray beam is used to scan internal organs up to a certain thickness. In this technique, a detector receives X-ray attenuation values of the organs in di_erent directions on this plane, followed by obtaining the digital matrix of the tissue attenuation coe_cient of a scanning layer after data transformation. The values in the matrix are converted and displayed on the fluorescent screen with di_erent grayscale in black and white to generate CT images [1]. CT plays a critical role in clinical diagnosis and the treatment of liver cancer.

MRI

By applying a certain radiofrequency pulse to an organ in a static magnetic field, H protons in the organ tissue are excited, leading to the phenomenon of magnetic resonance. Upon termination of the radiofrequency pulse, H protons induce magnetic resonance signals during the relaxation process. After receiving magnetic resonance signals, spatial coding and image reconstruction, magnetic resonance images are generated . MRI images achieve an excellent soft tissue resolution of liver and other organs, with a clear display of anatomical structures, such as vascular and biliary systems and lesion morphology, and provide valuable multi-orientation and multiparameter information, such as di_usion-weighted imaging (DWI), perfusion-weighted imaging (PWI) and MR spectra. These data aid in determining the spatial location of the anatomical structure, and are beneficial for the metabolic analysis of liver tumors, leading to improved diagnostic value. However, the image can be a_ected by gastrointestinal gas and respiratory movement, and the location, puncture and ablation of lesions under the guidance of MRI all require special instruments and devices. Based on the same mechanics as MRI in terms of atomic physics, function MRI (fMRI) generates images of the metabolic activities within the anatomic structures generated by MRI scans [2].

PET

A positron that is emitted from a radionuclide-labeled compound (commonly 18FDG) annihilates with an electron resulting in two 0.511-kev photons. These two photons are emitted in nearly opposite directions (180-degree angle apart, at one particular location in liver), and are registered simultaneously by the ring detector around the patient, so that the PET can accurately locate, analyze and quantify the distribution of radioactively-labeled drugs in the body. After computer reconstruction, three-dimensional human body images are obtained . Changes in the physiological and biochemical levels of liver cancer and normal liver tissue cells can be determined noninvasively, quantitatively and dynamically in vitro through C, N, O, F and other nuclide markers of glucose required for tissue metabolism, with the aim of evaluating the distribution and activity of liver cancer cells in patients. Therefore, PET is a unctional molecular imaging technique with high sensitivity, and can e_ectively aid in characterizing the metabolism of liver cancer, detecting recurrence and evaluating the outcome of radiofrequency or microwave ablation therapy.

General Procedure of Medical Image Fusion

Image fusion technology is mainly applied to solve the limitations of single-modal image guidance, including optical, medical and electromagnetic tracking imaging [3]. The medical fusion method contains two stages: image registration and the fusion of relevant features from the registered image. Registration of di_erent imaging modals is performed using external sensor coils, internal references, or anatomical markers [3]. The registration of the images requires a method to correct the spatial misalignment between the multimodal images that often results from scale changes, rotations and translations. This step matches the input images using their characteristics in order to acilitate the image fusions. The next stage is to find some rules to integrate multiple input images into one comprehensive image. The medical image can be fused by each pixel, feature extraction, region segmentation and marker point determination of anatomical structure or lesion condition. After fusion is complete, the operator interface often displays with original and overlapping cross-sectional images side-by-side. The fused image can help doctors to make accurate decisions for various diagnoses. For the e_cient treatment of liver tumors, information on tumor size, location and number can be obtained by the fusion method accurately. Compared with ultrasound technology used previously, the development of new image fusion technology has greatly improved diagnostic accuracy [4]. For instance, image fusion guidance technology has been widely used in thermal ablation therapy in which two-dimensional Ultrasonography does not clearly show liver cancer lesions. This method uses high-contrast CT/MRI along with real-time guidance and the evaluation of ablation borders via Ultrasonography to demonstrate clear liver cancer lesions. More examples of medical image fusion applied in liver tumor diagnosis and treatment will be further discussed in Section.

LITERATURE REVIEW

Chung-Ming Wu, et al. [1] proposed a texture feature calle d Multiresolution Fractal (MF) feature to distinguish normal, hepatoma and cirrhosis liver us ing ultrasonic liver images with an accuracy of 90%.

Yasser M. Kadah, et al. [5] extracted first order gray level parameters like mean and first percentile and second order gray level parameters like Contrast, Angular Second Moment, Entropy and Correlation, and trained the Functio nal Link Neural Network for automatic diagnosis of diffused liver dise ases like fatty and cirrhosis using ultrasonic images and showed that very good diagnostic rates can be obtained using unconventional classifiers trained on actual patient data .

Aleksandra Mojsilovic, et al. [5] investigated the application n and advantages of the non-separable wavelet transform features for diffused liver tissue characterization using B-Scan liver images and compared the approach with other texture measures like SGLDM (Spatial Gray Level Dependence Matrices), Fractal texture measures and Fourier measures. The classification accuracy was 87% for the SGLDM, 82% for Fourier measures and 69% for Fractal texture measures and 90% for wave let approach.

CONCLUSION

The proposed system is used to segment the tumor with consi derable satisfaction. Results are evaluated with radiologists. The proposed system can be extended for other types of images or for other classes of liver diseases, provided that the feature vectors are reevaluated and the neural networks are retrained. This can be helpful for teaching and for fresher to improve their diagnostic accuracy. In the is paper liver segmentation and enhancement is done using CT images. The proposed method segments the liver using global threshold and then by identifying the largest area. The proposed method is invariant in terms of size and shape of liver region. Experimental results show that our method performs well in enhancing, segmenting and extracting liver region from CT images.

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