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A Fast Rigid Registration Algorithm for Medical Images

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Abstract

Image registration is a vital research branch in medical image processing and analysis. In this paper, we proposed a new framework for rigid medical image registration. It can also be regarded as a pre-processing of non-rigid image registration algorithms. The interest of the algorithm lies in its simplicity and high efficiency. In the registration algorithm, we firstly segmented the reference image and float image into two parts: tissue parts and background parts. Then the centers of the two images were located through performing distance transform on the two segmented tissue images. Finally, we detected the longest radius of the two tissue regions, by which we determined the rotating angle. We tested the registration algorithm on dozens of medical images, and the experimental results show us that the algorithm is competent for medical image registration.

Keywords: Image Registration; Medical Image; Image Segment; Distance Transformation

1 Introduction

Image has become an important tool for information transfer and storage, and image processing techniques such as image registration, image fusion and image defect detection [1] are widely used to enhance the visual effect of the image and improve the image quality, and process some specific information contained in the image. As the foundation and key technology of modern medical image processing and analysis, medical image registration has crucial value on clinical application. It can be applied not only for the diagnosis of disease traits, but also in guiding the treatment process through tracking lesion sites, and evaluating the therapeutic effect. As far back as 1992, the main theories of image registration and image registration applications in various fields have been summarized by Lisa Gottesfeld Brown at the University of Cambridge in literature [2]. Currently, medical image registration technology has been widely used for image

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information fusion, three-dimensional image reconstruction, and image guided surgery to locate the spatial position relationships between images [3].

Actually, medical image registration is to seek one or a series of space transformations for one medical image using computer technology, and then, to make the corresponding points in this image achieve the same spatial position with another image. When all the anatomical points are matched, or at least the points with diagnostic significance and surgery points of interest are completed, image registration can be achieved. The main image registration techniques widely used nowadays are geometrical feature-based method [4] and pixel intensity-based method [5, 6]. The former has the characteristics of less calculation and high velocity, but its registration accuracy depends on feature extraction. The features can be marks, contours, planes, etc., or the combination between them. Brian C. Chalermwat et al. [7] presented a two-phase sequential and coarse-grained parallel image registration algorithm using genetic algorithm (GA) as optimization mechanism. Wang proposed to use Artificial Bee Colony to register images [8]. The latter, pixel intensity-based method, which is attracting most attention at present, takes advantage of the image data directly without pretreatment, thus, it avoids the error caused by feature extraction. For this reason, it is robust and relatively accurate. The method based on mutual information has high accuracy, and according to recent studies it is insensitive to incomplete image and noise [9]. Josien PW Pluim analyzed two interpolation methods in [10] linear interpolation and partial volume interpolationwhich are frequently used in mutual information-based image registration. Shun'ichi Kaneko presented a selective correlation coefficient method, which is available for image registration of bad light conditions and the curve is not completely closed [11]. Many medical image registration methods have been developed over decades, different angles with different classifications. Maintz et al. classified these methods from eight different angles, which is accepted by most scholars (for details see reference [12]). According to the nature of spatial transformation, image registration can be divided into rigid and non-rigid registration [13]. The latter includes affine, projection and nonlinear transformation. Projection transformation is mainly used for 2D/3D image registration, while affine and nonlinear transformation are mainly used for soft tissue image registration, especially the parts easily deformed or displaced, such as the abdomen and lungs. The rigid registration, basis of other registration transformation, includes only translation and rotating transformation. At present, rigid registration has been more matured, especially for brain images. Wein et al. developed a new method that is applied in surgical navigation. Using rigid and affine transformation model, the method achieved automatic registration between ultrasound scan images and CT images in corresponding layers after three-dimensional reconstruction [14]. However, the automatic performance and registration speed of rigid registration for medical images still needs to be solved urgently. We note that nearly all the existing registration algorithms contain at least interaction, which makes them register images in a real time. Therefore, there has been considerable interest in finding new methods to achieve rapid medical images rigid registration.

In our study, we put forward a fast algorithm for rigid registration. The interest of the algorithm lies in its simplicity and high efficiency. In the registration algorithm, we firstly segment the reference image and float image into two parts: tissue parts and background parts. Then the centres of the two images are located though performing distance transformation on the two segmented tissue images. Finally, we detect the longest radius of the two tissue regions, by which we determine the rotating angle. We test the registration algorithm on dozens of medical images, and the experimental results show us that the algorithm is competent for medical image registration.