Two Dimensional Paraspinal Muscle Segmentation in CT Images

Yong Wei, Ph.D.
Professor of Computer Science
Mike Cottrell College of Business
University of North Georgia
Dahlonega Campus

Paraspinal muscles support the spine and are the source of movement force. The size, shape, density and volume of the paraspinal muscles cross section area (CSA) are affected by many factors, such as age, health condition, exercise, and low back pain. It is invaluable to segment the paraspinal muscle regions in CT images in order to measure and study them. Manual segmentation of the paraspinal muscle CSA is time consuming and inaccurate. In this work, an atlas-based image segmentation algorithm is proposed to segment the paraspinal muscles in CT images automatically. To address the challenges of variations of muscle shape and its relative spatial relationship to other organs in CT images, mutual information (MI) is used as the similarity measure in the registration step to estimate the two dimensional affine transformation between the atlas and target. The affine transformation is then used to warp the boundaries of the paraspinal muscle regions from the atlas to target images. Due to the robustness of the MI-based registration in handling the variations of shape, size, relative spatial relationships among tissues and organs, and its capability in handling intersubject variations, the proposed algorithm can align the atlas with targets accurately, and the algorithm can do so without the help of the computationally expensive iterative local contour optimization to bring the mapped contours close to their truth locations in target images. These are the two salient features of the proposed algorithm. The GVF snake algorithm deforms muscle contours to refine the segmentation results after image registration.

Experimental results show the proposed algorithm can segment the paraspinal muscle regions in CT images automatically, in both intrapatient and interpatient cases. Only a single atlas is needed to process sequences of images from different patients. Furthermore, using mutual information to register atlas and target images outperforms the method using spine-spine registration. It segments the muscle regions accurately without the need of the computationally expensive iterative local contour optimization. The results provide physicians a solid foundation to estimate muscle volume in order to evaluate tissue damage due to spine surgery and monitor patient recovery progress.

Keywords: CT image segmentation; mutual information, image registration; atlas-based image segmentation; paraspinal muscle

Author Biography

Dr. Wei earned his Ph.D. in Computer Science at the University of Georgia. He also holds two MS in Artificial Intelligence and Electrical Engineering respectively, and a BS in Acoustics. Before he joined the faculty of computer science at University of North Georgia in 2007, he worked with the Sun Micro Systems Inc at Menlo Park in California as an artificial intelligence software engineer. Dr. Wei's research interests include computer vision, image and signal processing, artificial intelligence, software engineering and data science. He has published over twenty research papers in peer reviewed research journals and international conference proceedings. One of his recent publications won the Best Oral Paper award at the IEEE International Conference on Progress in Informatics and Computing 2015. He has won twice the University of North Georgia Presidential Semester Scholar award. Dr. Wei is awarded the professorship in the Mike Cottrell College of Business at UNG in 2016-17 and 2017-18 academic years.