Comments on 'Ventilation from four-dimensional computed tomography: density versus Jacobian methods'

This article has been downloaded from IOPscience. Please scroll down to see the full text article.
(http://iopscience.iop.org/0031-9155/56/11/N03)

View the table of contents for this issue, or go to the journal homepage for more

Download details:
IP Address: 140.128.67.244
The article was downloaded on 10/06/2011 at 03:32

Please note that terms and conditions apply.
Comments on ‘Ventilation from four-dimensional computed tomography: density versus Jacobian methods’

Geoffrey Zhang\(^1\), Tzung-Chi Huang\(^2\), Thomas Dilling\(^1\), Craig Stevens\(^1\) and Kenneth Forster\(^1\)

\(^1\) Radiation Oncology, Moffitt Cancer Center, Tampa, FL, USA
\(^2\) Department of Medical Radiological Technology, China Medical University, Taiwan

E-mail: geoffrey.zhang@moffitt.org

Received 10 December 2010, in final form 24 January 2011
Published 16 May 2011
Online at stacks.iop.org/PMB/56/3445

We read with interest the article by Castillo et al (2010) on comparison of ventilation calculations from 4D-CT images between density and Jacobian methods. In this work, the authors performed ventilation calculations from 4D-CT images using three published methods and compared the results with \(^{99}\text{Tc}\)-labeled aerosol single photon emission computed tomography (SPECT) for seven patients who had 4D-CT and SPECT images taken on the same day. The SPECT images were considered the gold standard for comparison. The three methods included in their comparison are (1) density-based specific ventilation (Guerrero et al 2006), (2) Jacobian-based specific ventilation (Reinhardt et al 2008), referred to as analytic implementation of the Jacobian method in Castillo et al and (3) geometry-based specific ventilation (Zhang et al 2009), referred to as Jacobian-based specific ventilation: geometric implementation in Castillo et al. The authors concluded that all the methods correlated well with global measurements of the resting tidal volume. The Dice similarity test performed in their study showed similar coefficients between the SPECT percentile ventilation and all three methods, with slightly higher correlation between SPECT and the density-based method.

We appreciate the inclusion of our method in their study and their demonstration of the validity of our approach. However, we also noted that the authors used our method in the study but without referencing to our work, and the paper is vague regarding the origin of this method. This may be an oversight as our paper was published in the proceedings of World Congress on Medical Physics and Biomedical Engineering and may not be readily accessible.

We also believe that the authors were slightly in error, as the original Jacobian-based method, called ‘analytic Jacobian’ in this paper, uses the Jacobian of the transformation that maps image \(I_0\) to image \(I_1\) to estimate the local volume change (Reinhardt et al 2008). First-order partial derivatives of the vector displacement function are the elements in the Jacobian.
matrix. As our method does not use the derivative of the transformation matrix, our method is not a Jacobian method. Our method is a brute force geometric calculation method. The volume calculation is basically the sum of six tetrahedrons which are originally defined by eight voxel vertex positions in expiration and then deformed in inspiration. For each tetrahedron, volume $V = (b - a) \cdot [(c - a) \times (d - a)] / 6$, where $a, b, c, d$ are the vertices as vectors, which is simple and easy to derive. A Jacobian is a mathematically well-defined term, and does not need the adjective such as analytic or geometric. There is only one Jacobian and clearly having two types of Jacobian methods does not make sense. The authors of the paper used a matrix derivation and the logic: if $A \approx B$ and $B = C$, then $A = C$, to show that our method is a Jacobian method. We believe that this derivation is farfetched and irrelevant to the topic of the paper. It may confuse readers. We agree that the calculations by the Jacobian method and our geometric method are close to each other. But it is common sense that different methods may arrive at the same result.

References


Reinhardt J M, Ding K, Cao K, Christensen G E, Hoffman E A and Bodas S V 2008 Registration-based estimates of local lung tissue expansion compared to xenon CT measures of specific ventilation Med. Image Anal. 12 752–63