A Mass Conservation Based Optical Flow Method for Cardiac Motion Correction in 3D PET Data

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Cardiac Motion and Partial Volume

Motion Correction on 3D PET/CT Data with Optical Flow Algorithms

Coronal slice through non-attenuated PET
1 h. p. i., $^{18}$FDG, CHD patient

Cardiac motion

Ungated data
Large blur, low noise
(Problem in plaque imaging)

One phase
Small blur, high noise
Motion Correction on 3D PET/CT Data with Optical Flow Algorithms

Step 1: Gating

ECG signal

Series of images reconstructed from cardiac gated PET acquisition
Mass conservation in cardiac data

\[ \text{Mass Conservation} \]

\[ \text{div}(I \cdot V) = -I_t \]

\[ \nabla I \cdot V + I \text{div}(V) = -I_t \]

\[ E = \min \int \left( (\text{div}(I V) + I_t)^2 + \alpha \left( |\nabla u|^2 + |\nabla v|^2 + |\nabla w|^2 \right) \right) dx dy dz \]
Step 2: Motion Estimation
Motion Correction on 3D PET/CT Data with Optical Flow Algorithms

Visual result

Cardiac phases

All gates deformed to Diastole
Motion Correction on 3D PET/CT Data with Optical Flow Algorithms

Visual result

One phase
Small blur, high noise
Noise 36

Ungated data
Large blur, low noise
Noise 25

All phases motion corrected
Small blur, low noise
Noise 22
Quantitative results on patient data

Data:

14 patients with known CHD
cia. 4 MBq/Kg body weight $^{18}$F-FDG
Scan time ca. 15 minutes, 1:15 hours post injection
Listmode acquisition on Siemens Biograph 16 scanner

Quatification methods:

Correlation of ROI (40x40x40) with target phase
Myocardial thickness. FWHM of Gaussian fit to line profile
Mean activity in blood pool in LV
Quantitative results 1: Correlation of end-systolic gate with target phase

![Graph showing correlation coefficient for each patient before and after motion correction.](image)
Quantitative results 2: Myocardial thickness

![Myocardial thickness chart](image-url)
Quantitative results 3: Mean activity in blood pool
To conclude:

A method for cardiac motion and partial volume correction was presented.

The results on patient data show that the motion was corrected precisely.

Thank you