JOINT CARDIAC AND RESPIRATORY MOTION CORRECTION FOR CORONARY PET/CT IMAGING: A FEASIBILITY STUDY

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Abstract

Coronary artery disease (CAD) or atherosclerosis is the leading cause of mortality in industrialized nations.

• Coronary Artery Disease (CAD) or Atherosclerosis is the leading cause of mortality in industrialized nations.

• Positron Emission Tomography (PET) is a non-invasive imaging modality that provides the necessary functional information needed to detect such plaque. Computed Tomography (CT) images reinforce PET information with high resolution anatomical information.

• Severe blurring artifacts due to respiratory and cardiac motion in PET. Dynamic PET resolution: 8-10 mm

• Current static PET resolution is 5-6 mm. Size of coronary vessel plaque is 2-3 mm.

Motivation

Problem Statement

• Inflammation vs. FDC uptake (Reivich et al. JACC 2006)

- Evidence that there is a direct correlation between the radiotracer absorption and atherosclerotic inflammation and macrophage concentration.

• PET listmode data is binned into cardiac phases/timeframes:

- Summing across rows yields:

- Inter-frame cardiac motion; Intra-frame respiratory motion.

Main features of CSTAR

- Image based analysis: Post-reconstruction processing.
- Use of all acquired data, resulting in SNR preservation.
- Sequential correction of cardiac and respiratory motion.

CSTAR: Cardiac Shape Tracking and Adjustment for Respiration

= Subsampling matrix,
= Blurring matrix due to the imaging system,
= Cardiac motion in PET,
= Blurry vector due to the imaging system,

\[ \hat{\mathbf{x}} = S \mathbf{b}_{\text{resp}} W_{\text{card}} B_{\text{resp}} \mathbf{S} + \eta = S \mathbf{b}_{\text{resp}} MB + \eta + \hat{\mathbf{y}} \]

Where \( S \) = Subsampling matrix, \( B_{\text{resp}} \) = Blurring matrix due to the imaging system, \( W_{\text{card}} \) = Cardiac motion matrix, \( \mathbf{b}_{\text{resp}} \) = Matrix representing motion blur due to patient's respiration, \( \hat{\mathbf{y}} \) = vector of cardiac+respiratory motion,

\[ R(z) = \frac{1}{2} \| S \mathbf{b}_{\text{resp}} W_{\text{card}} B_{\text{resp}} \mathbf{S} z \|_2^2 + \alpha_2 \| \mathbf{D} x \|_2^2 + \alpha_1 \| \mathbf{b}_{\text{resp}} \|_2^2 \]

References


