

dosimetry needs to be revised because of the recent introduction of ICRP-103 approach in which the tissue weighting factor for breast is 0.12 compared to being 0.05 in ICRP-60.

Measurements on organ absorbed dose, using a female adult humanoid phantom and TLD, have been performed. Patient effective doses are presented for the use of Tc99m as internal irradiation and SPECT/CT as transmission irradiation with the use of tissue weighting factors from ICRP-103 recommendations.

Results show that patient effective dose is dominated by the CT irradiation and the patient total effective dose is just less than 3 mSv for different imaging protocols and different surgical procedures. This patient effective dose is comparable to annual background radiation level.

Nuclear medicine physicians should be aware of the increase in the patient effective dose in using SPECT/CT instead of conventional Co-57 flood source as transmission source.

OP 063

Friday, May 18, 2012

11:30-13:30, Hall 4

Segmentation of cardiac SPECT images by active contour without edge model

Nazgol Monshizadeh^{1*}, Mohammad Hoshtalab¹, Farshid Babapour-Mofrad¹, Mahasti Amoui²

¹Faculty of Engineering, Science and Research Branch, Islamic Azad University, Tehran, Iran.

²Nuclear Medicine Department, Shahid Beheshti University of Medical Sciences, Tehran, Iran

Introduction: Myocardial perfusion scintigraphy (MPS) provides a reliable assessment of coronary artery disease. Nuclear medicine imaging techniques such as Single Photon Emission Computed Tomography (SPECT) can contribute significantly to estimate cardiac volumes and left ventricular ejection fraction. Extracting the LV borders in SPECT images is a crucial and challenging task that is required in MPS procedure.

Methods: We propose a hybrid technique for LV segmentation in cardiac SPECT images based on active contour model. Major steps of the proposed techniques are as follows: (1) initialization (2) segmentation. We introduce a morphology-based operation to automatically estimate the initial boundaries. In this regard, the images are initially binarised with an Otsu's thresholding. Then, by a skeleton-process we extract the longest line that is equidistant to the LV borders. In the segmentation steps, We employ the initial boundaries to estimate the final contour a novel active contour without edge model based on Mumford-Shah function.

Results: The proposed algorithm was evaluated in the presence of 10 cases. All images were obtained with e.cam single-head SPECT system manufactured by SIEMENS that equipped with a low-energy high resolution collimator. Segmented images were compared with manually outlined contours. Experimental results reveal the effectiveness of the proposed method.

Conclusion: The results show that the active contour without edge model outperforms the active contour with edge stopping model for automated segmentation of SPECT coronary artery images.

OP 064

Saturday, May 19, 2012

16:00-17:30, Hall 4

A proximal splitting algorithm for TV-regularized PET image reconstruction

Abolfazl Mehranian^{1*}, Arman Rahmim², Mohammad Ay^{1,3,4}

¹Research Center for Science and Technology in Medicine, Tehran University of Medical Sciences, Tehran, Iran

²Department of Radiology, School of Medicine, Johns Hopkins University, Baltimore, USA

³Department of Medical Physics and Biomedical Engineering, Tehran University of Medical Sciences, Tehran, Iran

⁴Research Institute for Nuclear Medicine, Tehran University of Medical Sciences, Tehran, Iran

Introduction: Model-based iterative image reconstruction algorithms play a pivotal role in quantitative positron emission tomography (PET). For PET measurements that are pre-corrected for accidental coincidences or acquired in sufficiently high count rates, the statistical variability can be appropriately modeled by a Gaussian distribution. This distribution approximates the underlying Poisson distribution and thereby results in the well-known penalized weighted least-squares (PWLS) reconstruction algorithm. In this study, we proposed a proximal splitting-based

algorithm for the PWLS image reconstruction of PET data to address two challenges encountered by the previously proposed algorithms such as separable- paraboloidal-surrogates accelerated with ordered-subsets (SPS-OS) and preconditioned conjugate gradient. First, the weighting matrix of the PWLS objective usually makes its Hessian shift-variant and its gradient large-Lipschitz. Consequently, surrogate functions end up with high curvatures and gradient-based algorithms with small step-sizes, leading to slow convergence. In addition, preconditioners, used to speed up the convergence, would poorly act on the resulting shift-variant and ill-conditioned Hessian matrix. The second challenge arises when using non-smooth penalty functions such as anisotropic total variation (TV), which is not continuously differentiable and thus not amenable to optimization with gradient-based algorithms.

Methods: To deal with these challenges in TV-PWLS objective functions, we derived a proximal preconditioned gradient (PPG) algorithm using proximal forward-backward splitting, which decouples the penalty function and thus improves the objective's condition number. Chambolle's dual formulation was also utilized for the non-differentiable TV regularization. To reduce the stair-casing effect of the TV, we also studied the continuously differentiable Huber penalty.

Results: We simulated PET imaging in a scanner with parallel strip-integral geometry for five noise realizations with $5E+06$ counts and 10% random coincidence rate. In TV regularization, we evaluated the normalized root-mean-square error (NRMS) and convergence performance of the proposed algorithm. We also compared it for Huber regularization with the SPS-OS algorithm in terms of NMRS and also elapsed computation (CPU) time after a global convergence declared by a tolerance of $1E-03$. The results showed that our algorithm outperforms its counterpart in NRMS (12.61% vs. 13.77%) and CPU time (14.78 vs. 67.35 sec).

Conclusion: We proposed a proximal splitting-based algorithm for TV and Huber regularization in the PWLS image reconstruction of PET and demonstrated that our algorithm outperforms the state-of-the-art SPS-OS algorithm in terms of both image quality and algorithmic complexity.

OP 065

Friday, May 18, 2012

11:30-13:30, Hall 4

A fast dedicated software for creation of SPECT projections in non-uniform objects based on Klein-Nishina equation

Faraz Kalantari^{1*}, Hossein Rajabi¹, Mohsen Saghari², Alireza Emami-Ardekani²

¹Department of Medical Physics, Tarbiat Modares University, Tehran, Iran

²Research Institute for Nuclear Medicine, Tehran University of Medical Sciences, Tehran, Iran

Introduction: Monte Carlo (MC) is the most common method for simulating virtual SPECT projections. The main drawback of MC is its poor efficiency and long computation time. In a real MC simulator that simulates a SPECT imaging, only one event from one million tracing can be detected. In this research, we introduced a model based method considers the effect of non-uniform attenuation, scattering and imaging system response for fast creation of noise free SPECT projections.

Methods: SIMIND MC simulator was used just to trace photons from their emission point (P_0) to their last interaction point inside the object (P_S). For primary photons P_0 and P_S have the same coordinates. This MC tracing takes less than 10 seconds for 10,000,000 tracing. The rest of process was completely analytical. We know that more than 95% of scattered photons that are registered in a 15% energy window width are first order scatters. Therefore the scattering points were considered as secondary emission points. Projecting these scattering map, results in creation of scatter projections. However the weight associated by each scatter point is different and non-isotropic. Having the point of emission and point of interaction, and also the position of gamma camera, the scattering angle was analytically determined. The associated weight that represents the scattering probability at that angle was determined by Klein-Nishina equation. Finally this scattering map inside the object was blurred to model system response and attenuated radon transform was applied to create SPECT projection in different angles. NCAT cardiac phantom with ^{99m}Tc-MIBI distribution was used as our non-uniform object. Our results were compared with projections acquired by SIMIND MC Simulator.

Results: Compared with other scatter estimating methods consist of dual energy window, triple energy window and simple convolution based methods, a perfect fit between modeled and MC simulated projections of phantoms was observed ($R^2 > 0.98$).