PET/SPECT Quantification at Camperdown

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Quantification in PET and SPECT

Radiotracer (Bq) → Radiopharmacy

Projections
Counts
PET images
kBq/cc

Correction
Reconstruction

Kinetic model

Biological parameters:
- Density of receptor

Biologists:
Interpretation of the biological parameters

Deriving accurate radiotracer concentration images from the acquired counts

Extracting physiologically meaningful values from reconstructed PET or SPECT images

Challenges:
- Random/scatter events, photon attenuation → standard correction techniques
- Low spatial resolution (~1.2 mm pre-clinical scanners, ~5 mm human scanners)
- Statistical noise (PET/SPECT are photon counting techniques)
- Motions (breathing/cardiac motions, random motions)
- Multitudes of acquisition configuration and parameters, and also reconstruction methods and parameters that are left to the end user.
Performance characterisation and optimisation of the SPECT module

Characterisation of the performance obtained with the different available collimator plates. Characterisation of the reconstruction methods and optimisation for an improved image quality.

IEEE NSS-MIC 2012
WMIC 2012
Performance characterisation and optimisation of the PET module and validation of a Monte Carlo simulation tool

NEMA NU 4-2008 Validation and applications of the PET-SORTEO Monte Carlo simulations platform for the geometry of the Inveon PET preclinical scanner

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IEEE NSS-MIC 2012
WMIC 2012
SNM 2013
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Figure 6. Transverse slices of a reconstructed simulated [¹¹C]Raclopride study showing the uptake in the brain at 4 different times. The resulting BP map at the same transverse slice is shown on the right side, in which the Striatum is distinguishable.
Fast screening of the tracers produced by Camperdown

Optimisation/validation of dual mice acquisition protocol in PET
2 PET scanners + dual mice acquisition: possibility to image 4 mice at the same time.

1. Protocol optimisation using Monte Carlo simulations

2. Actual data

Transverse view
- 10-minutes scan
- 1 hour post i.v.
- ID = 8.5 MBq

Coronal view

Submitted to IEEE NSS-MIC 2013
Image resolution recovery and denoising

Simulated PET time series (pre-clinical scanner)

Actual rat PET data ($^{18}$F-FDG)

→ Improved absolute quantification
→ Increased statistical power
→ Reduction of the noise (SD) by a factor of 5.

Oral presentation at IEEE, NSS-MIC, Oct 2012
Kinetic modelling and parameter estimation

Physiological information:
- Receptor density
- Rate of metabolism
- Efflux
- Perfusion

Slide adapted from Lammertsma
Thank you!