Docket #: S14-171

A method for tracking moving sources with PET

Stanford researchers at the Pratx Lab have developed a new trajectory reconstruction method for tracking moving sources labeled with positron-emitting radionuclides using PET. This method reconstructs the time-varying position of individual sources directly from raw list-mode PET, thereby bypassing conventional image reconstruction entirely.
Proof-of-concept experiments show that low-activity and fast-moving sources can be reliably tracked in vivo with 2 mm accuracy. This method can be applied for tracking of single cells in vivo, real-time tracking of a moving tumor during radiotherapy, and estimation of respiratory breathing in 4D-PET.

Figure

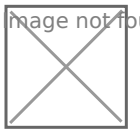

Figure description - Single-source tracking. List-mode PET data from a point source (1, 10, 100, 1000 Bq) moving at 5 mm/s in an S-like pattern was reconstructed using standard MLEM (top row) and the novel trajectory reconstruction method (bottom row). This result indicate that the invention can track a moving source better than can be achieved using conventional ML-EM.

Stage of Research

- **Proof-of-concept** - Monte Carlo simulations (GATE) show that this algorithm can track a single cell inside a small-animal PET system with 2 mm accuracy provided that the activity of the cell (Bq) is greater than twice the square of its velocity (cm/s).
- Applying method to tracking multiple sources in parallel.

Applications

- **In vivo cell tracking:**
  - Cell-based therapies for cardiac and neural tissue regeneration and cancer immunotherapy
  - Preclinical research tool to study biological processes such as cancer metastasis
  - Small animal research for drug development
- **4D PET/CT imaging** – estimation of respiratory breathing
- **Radiation Therapy** - real time tracking of a moving tumor

Advantages

- **Real time**
- **Accurate** – can track moving sources with higher localization accuracy and up to higher velocities and lower activities
- **Novel concept** - First proposed method to reconstruct the motion of a source directly from PET measurements, without forming an image
- **Can be extended** to track multiple moving sources in parallel

Publications

- Ouyang, Y., Kim, T. J. & Pratx, G. "Evaluation of a BGO-Based PET System for Single-Cell Tracking Performance by Simulation and Phantom Studies." *Mol Imag* 15 (2016).
- Lee, K.S. Kim, T.J. and Pratx, G. 2015 "Single-Cell Tracking With PET Using a Novel Trajectory Reconstruction Algorithm", *IEEE Medical Imaging*. Vol 34 (4), pp. 994-1003.
- Jung, K.O., Kim, T.J., Yu, J.H. *et al.* "Whole-body tracking of single cells via positron emission tomography", *Nature Biomedical Engineering*. **4**, 835-844 (2020).

Patents

- Issued: 9,962,136 (USA)

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