Cooperative Agreement U01EB018758

Task-driven dynamic beam modulation for high-performance, low-dose CT

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Disclosures

NIH Support:
U01EB018758 (Stayman)
R21CA219608 (Stayman)
R01EB018996 (Zbijewski)
R01EB017226 (Stelowdien)

Current and Former Academic-Industry Partnerships and Research Relationships:
- Elekta AB
- Carestream Health
- Siemens Medical
- Philips Healthcare
- Varian
- Varian Medical Systems
- Canon Medical Systems
- Fischer Imaging
- Medtronic

Funding Overview

U01 Research Project Cooperative Agreement

Supports discrete, specified, circumscribed projects to be performed by investigator(s) in an area representing their specific interests and competencies

Used when substantial programmatic involvement is anticipated b/w awarding Institute and Center

PAR-12-206: Decreasing Patient Radiation Dose from CT Imaging: Achieving Sub-mSv Studies

Study Section: NIH-NIBIB ZEB1 OSRD M1 S: Low-Dose CT Imaging (U01)

Grant: U01EB018758 Task-driven dynamic beam modulation for high-performance, low-dose CT

Team:
- Johns Hopkins University
  - School of Medicine and Engineering
  - Biomedical Engineering
- PI: Web Stayman
- Engineering: Jeff Siewerdsen, Wojtek Zbijewski
- Radiology: Satomi Kawamoto

Submission History:
- July 2013: Request for Budget <$500k/year
- Aug 2013: Letter of Intent to Submit
- Sept 2013: Grant Submitted
Clinical Motivation/Significance

NIH Initiative for dose reduction in CT

- February 2011 NIBIB/NIH to identify possible steps that could be taken to reduce the average patient exposure from each CT exam to less than 1 mSv.
- Suggested improvements in data acquisition, image reconstruction, and optimization processes as important research areas.
- Engagement of users, investigators, and manufacturer communities would be important to achieving the implementation of reducing patient radiation exposure.
- General agreement that achieving the lowest possible patient radiation exposures from CT scans would require a multi-faceted approach.

Relevant Prior Experience/Preliminary Data

- Web Stayman
  - Iterative Reconstruction/Analysis
  - System Design (CBCT)
  - System Modeling
  - Jeff Siewertsen
  - Imaging Physics
  - System Design (CBCT)
  - Image Quality Analysis
- Wojtek Zbijewski
  - Imaging Physics
  - Iterative Reconstruction
- Satomi Kawamoto
  - Diagnostic Radiologist
  - Abdominal Imaging

Specific Aims

**Aim 1:** Develop dynamic beam modulation hardware for integration into diagnostic CT scanners.

**Aim 2:** Create a reconstruction framework for dynamically modulated CT acquisition.

**Aim 3:** Develop a performance prediction framework for dynamically modulated CT.

**Aim 4:** Develop strategies for driving patient- and task-based beam modulations.

**Aim 5:** Assess patient- and task-specific beam-modulated CT.
**Key Outcomes**

- Task-Driven Fluence-Field Modulated CT Framework
- Prospective Optimization of Acquisition and Reconstruction
- Anatomical Model
- Diagnostic Task
- Imaging System Model
- Performance Prediction
- Acquisition Parameters
- Reconstruction Parameters
- Phantom Stimulus
- Task Function
- Task and Phantom Definition
- Fluence Field Design

**Key Outcomes**

Standard FFM vs Task-Driven FFM

Detectability Maps

- 69% Dose Reduction Potential
- 44% Dose Reduction Potential

G. J. Gang, J. H. Siewerdsen, and J. W. Stayman, "Task-driven optimization of fluence field and regularization for model-based iterative reconstruction in computed tomography", IEEE Transactions on Medical Imaging (Special Issue on Low-Dose CT), 36(12), 2424-35 (December 2017)

**Future Directions**

Specific to this project
- Advance to patient studies
- Understand other clinical application (e.g., Volume-of-Interest imaging)

Directions with similarities to this project
- Imaging performance analysis for newer data processing methods (e.g., machine learning)
Grant Advice for AAPM Members

General Advice
- Tell the story
  - Why is this research necessary?
  - Why is this the best possible team to do it?

Responding to Program Announcements
- NIH is telling you what they want to fund.
- Talk with your Program Officer
  - Is your idea a good match to the announcement?
  - Is the NIH “excited” about the idea?

Regarding U01 Mechanism (for this grant)
- Increased reporting requirements (e.g., semiannual reports, annual NIH meetings)
- Careful milestone planning