Hybrid Method for Prior Image Reconstruction in Cardiac Cone-Beam Computed Tomography

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The Wisconsin Alumni Research Foundation (WARF) is seeking commercial partners interested in developing a method to enable cardiac cone computed tomography using current cardiac flat panel detectors.

Overview

The X-ray source and radiation detector in a conventional computed tomography (CT) system are rotated on a gantry so that the angle at which the X-ray beams intersect the object constantly changes. In a “cone beam” arrangement using a C-arm system and small flat-panel detector, the focal spot of the X-ray source and the detector define a cone-shaped beam of X-rays. If a subject is not fully covered by the cone beam, the view is said to be “truncated.” When the subject is human body, measuring non-truncated cone beam projections requires a detector too large to be considered practical.

In standard image reconstruction theories, the sampling rate used in acquiring image data must satisfy a requirement known as the Nyquist criterion to reconstruct an image from truncated segments, and no specific prior information is needed. However, in instances where prior information about the desired image is available, an image can be reconstructed even if a set of data does not satisfy the Nyquist criterion.

In practical interventional cardiology, an X-ray C-arm system with a small flat-panel detector provides a field-of-view that is barely sufficient to cover the entire heart. Therefore, each cone beam projection acquired using the system is truncated. Given that prior information on the desired image is generally unavailable, it is inherently difficult to form a satisfactory 3-D computed tomography image in this situation. A method to produce a suitable prior image for use in image reconstruction methods such as prior image constrained compressed sensing (PICCS) methods is needed in the field of cardiac imaging.

The Invention

UW-Madison researchers have developed a method for producing a prior image from truncated cone beam projection data such that quality images can be reconstructed using methods such as PICCS. This image reconstruction method is applicable to cardiac cone beam X-ray computed tomography.

The image reconstruction method uses a set of truncated cone beam image data obtained using cardiac flat panel detectors to reconstruct a high quality image in two steps. In the first step, an iterative algorithm is used to reconstruct a prior image from the truncated data without the use of ECG gating, a technique used to trigger image acquisition with a patient’s ECG signal. In the second step, the reconstructed prior image is used in a PICCS algorithm to reconstruct each individual cardiac phase. The objective function of the PICCS algorithm is modified to incorporate the conditions used in the first step to overcome data truncation. Together, the method comprises a hybrid PICCS algorithm that enables computed tomography with cardiac cone beam X-ray projections resulting in satisfactory reconstructed imagery.

Applications

- Image reconstruction from truncated cone beam projection data
- Cardiac cone beam X-ray computed tomography

Key Benefits

- Eliminates image artifacts due to data truncation in cardiac imaging with cone beam X-ray computed tomography
- Enables prior image reconstruction for further use in a PICCS algorithm

Additional Information

For More Information About the Inventors

- Guang-Hong Chen

Related Technologies

- For more information about PICCS, see WARF reference number P08127US.

Tech Fields

- Medical Imaging : CT

For current licensing status, please contact Jeanine Burmania at jeanine@warf.org or 608-960-9846