Purpose:
To develop a total-variation (TV) based compressive sensing image reconstruction algorithm using a set of limited-angle projections by applying a prior image information to enhance the image quality and anatomic information of current Four‐dimensiona Digital Tomosynthesis (4D-DTS). In the iterative algorithm, both TV regularization and Bspline deformation field are included to accurately reconstruct 4D-DTS images in order to reduce imaging dose.

Methods:
For 4D Cone Beam Computed Tomography (4D-CBCT), images of different phases share similar anatomical struture, and their difference can be used as sparseness prior in the 4D-DTS reconstruction. The Bspline tensor transforms the reference image to fit the target image, and is regulated by TV penalty terms in the cost function of the unconstrained optimization problem. Nonlinear conjugate gradient method is applied to solve the unconstrained problem.

Results:
Several phase pairs of 4D-CBCT are used examples. With voxel per region sets 50, the algorithm can have the most similarity with the target image with the fastest convergence. By decreasing Bspline resolution, the deformation will be become more flexible while losing some accuracy of registration. The similarity between target image and resulted image can be tuned by regularization factor, which will enable us to determine how much additional information is needed to build the new image volume.

The integrated built CPU and GPU platform provides the acceleration tools of forward/backward projection and Bspline coefficients calculation for large-scale 4D-CBCT data in the iteration process, which is 100 times faster than using only software method.

Conclusions:
The performance of the algorithm is determined by two built-in parameters in the algorithm: Bspline Resolution and Regulization Factor, whose tuning can favor different edge and resolution performances or fidelity and similarity to the target measurements, and also determine the flexibility and accuracy during the registration.

Funding Support, Disclosures, and Conflict of Interest:

Research sponsored by Varian Medical System.