Guided Noise Reduction with Streak Removal for High Speed Perfusion Flat Detector CT

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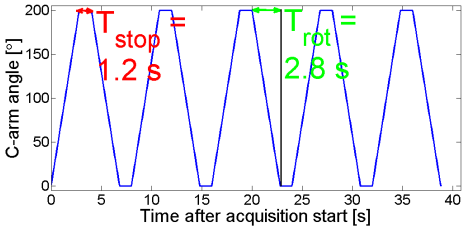
Introduction

- Flat Detector CT Perfusion (FD-CTP) with C-arm systems enables measuring brain perfusion during interventional procedures with full brain coverage
- Novel robotic C-arm systems (Artis zeego, Siemens) with increased rotation speed (100°/ s) enable a high speed scanning protocol for FD-CTP, which provides improved temporal sampling of time-contrast curves (TCCs)

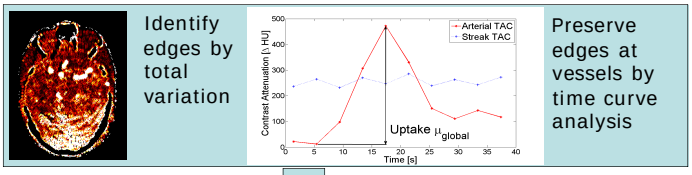
High Speed Scanning Protocol

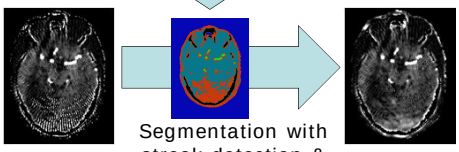


Multi-sweep protocol with ten alternating C-arm forward and backward rotations to acquire TCCs after contrast bolus injection

Noise & Streak Reduction

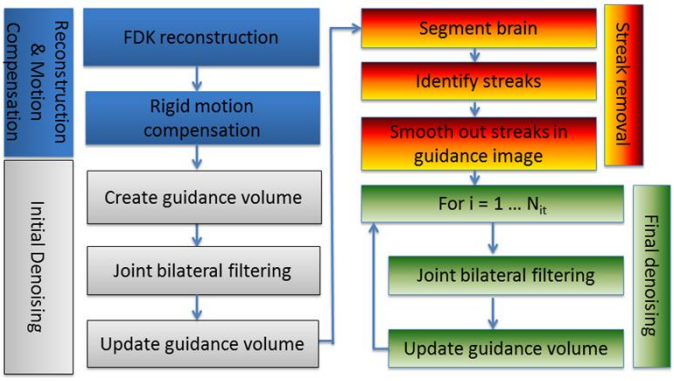
- Challenges:
  - Low contrast-to-noise ratio in brain tissue
  - Streak artifacts due to angular under sampling and patient motion
- Joint Bilateral Filtering [1,2]:
  - Bilateral filtering with a guidance volume for range similarity computation
  - Guidance volume: temporal maximum intensity projection (MIP) of the TCCs
- Streak reduction in guidance image:





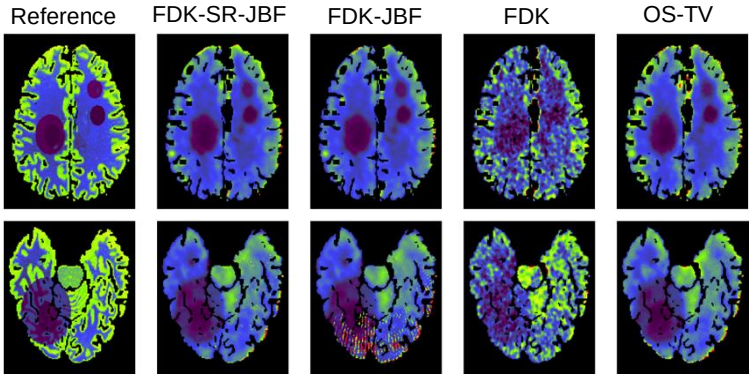
Guidance volume with streaks | Segmentation with streak detection & smoothing | Guidance volume after streak removal

FDK-SR-JBF Algorithm:



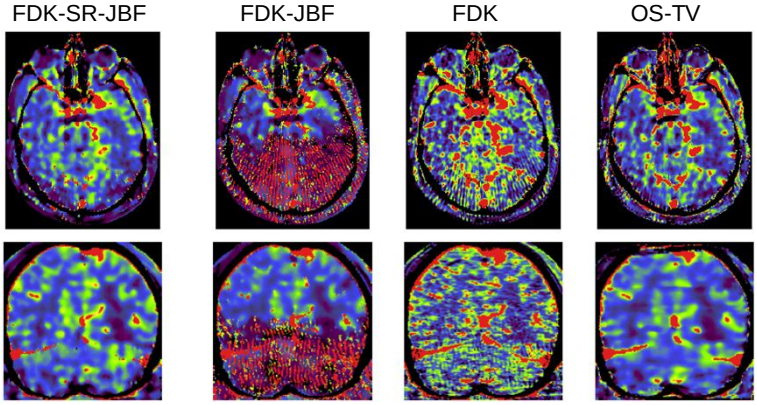
Results

Digital Brain Perfusion Phantom [3] Study (CBF Maps)

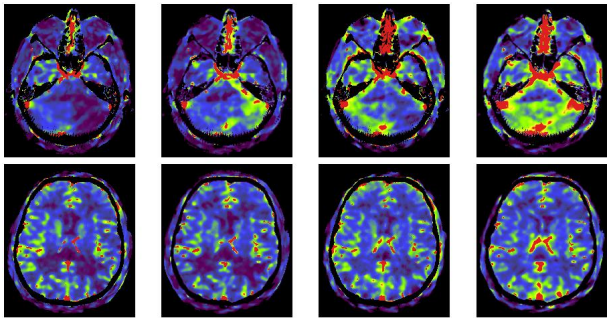


	FDK	FDK-JBF	FDK-SR-JBF	OS-TV
CBF	0.76	0.80	0.83	0.84
CBV	0.63	0.68	0.73	0.75
MTT	0.53	0.77	0.85	0.89
TTP	0.59	0.84	0.88	0.86
Computation Time	23 s	57 s	69 s	1610 s

Patient Study 1 (CBF Maps)



Patient Study 2 (FDK-SR-JBF reconstruction)



Conclusions

- High speed scanning protocol promising technique for flat detector CT perfusion
- FDK-SR-JBF approach for computational fast denoising and streak artifact reduction

References

[1] M. Manhart et al., *Iterative Denoising Algorithms for Perfusion C-arm CT with a Rapid Scanning Protocol*, IEEE ISBI, 2013.
[2] G. Petschnigg et al., *Digital photography with flash and no-flash image pairs*, Proc. ACM SIGGRAPH, 2004.
[3] A. J. Riordan et al., *Validation of CT brain perfusion methods using a realistic dynamic head phantom*, Med Phys, 2011.

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