4-D CARDIAC C-ARM COMPUTED TOMOGRAPHY

Two Approaches to Dealing with Angular Undersampling

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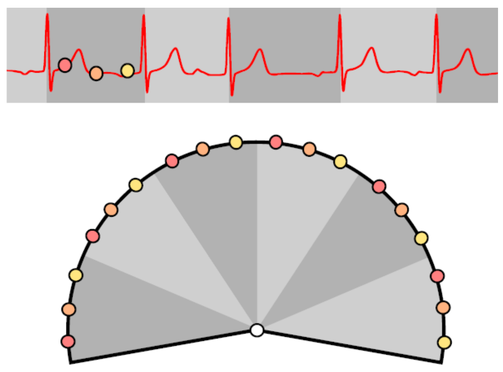
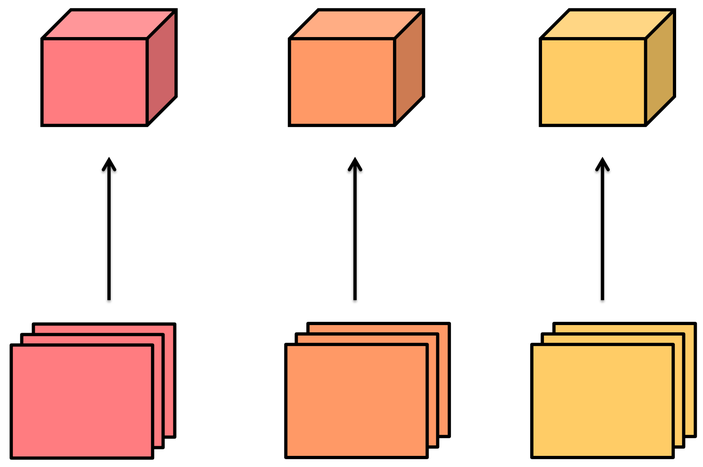
Electrocardiogram Gating

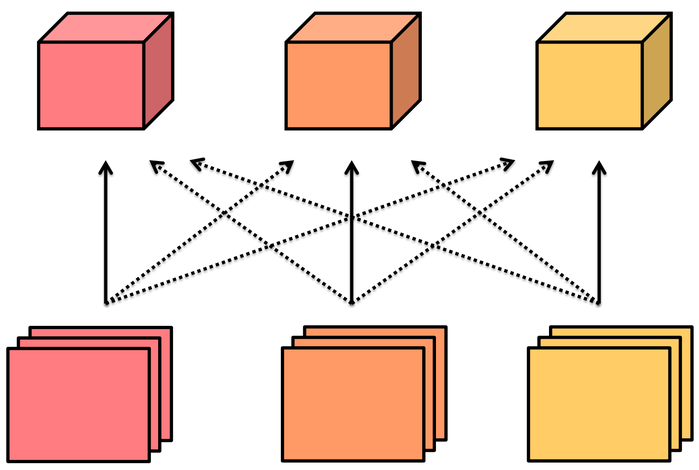


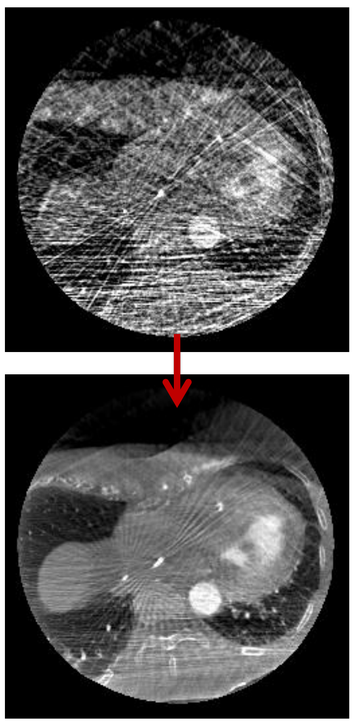


Abstract

C-arm CT-based interventional assessment of cardiac function could prove highly useful. However, for clinically feasible scan protocols, time-resolved reconstruction is extremely challenging due to massive angular undersampling of the trajectory. We show two ways to effectively utilize all available data and thereby improve image quality: Non-rigid motion compensation and temporally regularized reconstruction.

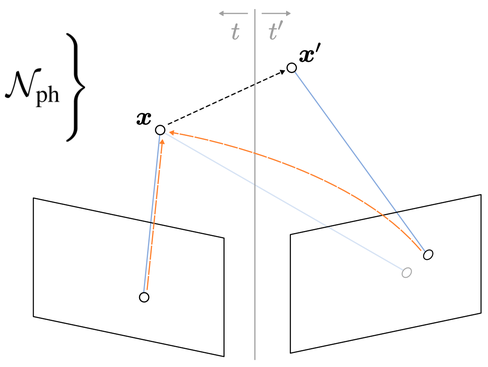
Motion Compensation
(in Analytical Reconstruction)





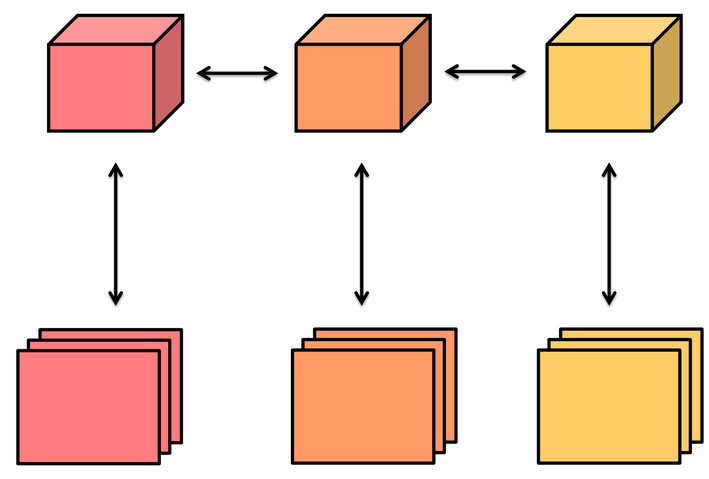
$$M^* = \left\{ \underset{M_{t\to t'}}{\operatorname{argmin}} \left[\mathcal{D}\left(I^{t'}, M_{t\to t'} I^{t} \right) \right] : t, t' \in \mathcal{N}_{\text{ph}} \right\}$$

$$I^* = \left\{ I^t : A^{t'} M_{t\to t'} I^t = P^{t'};\ t, t' \in \mathcal{N}_{\text{ph}} \right\}$$

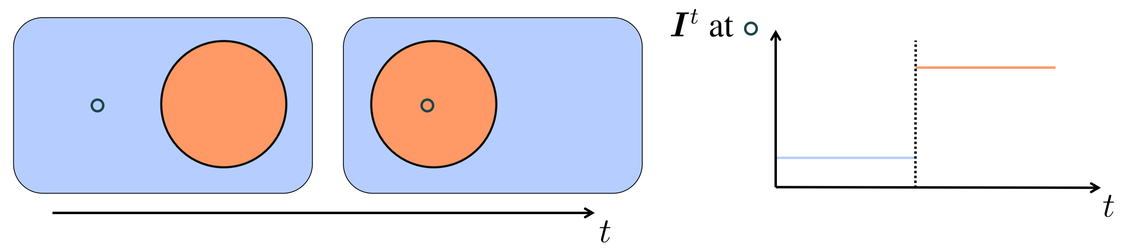


- **Optimization problem: Non-rigid registration**
  - Computationally expensive
  - Requires (and enforces!) a motion model
- Familiar visual characteristic
- Reliance on preliminary reconstruction

Temporal Regularization
(in Algebraic Reconstruction)

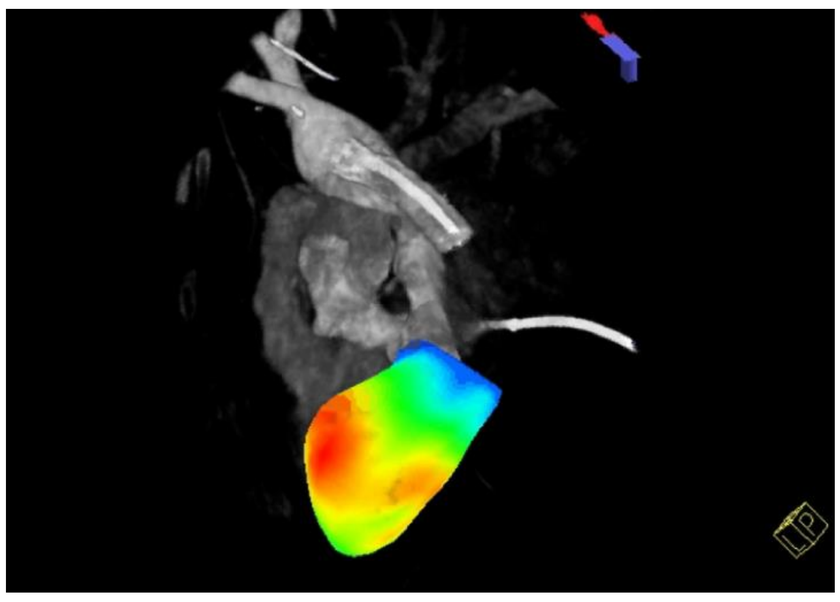


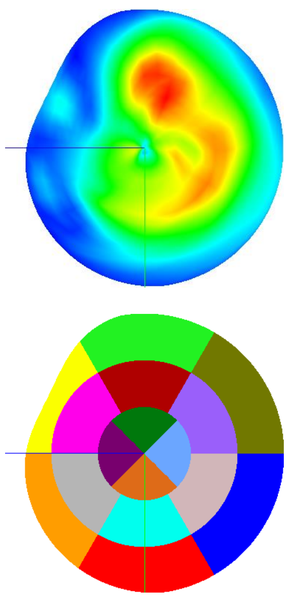
$$\operatorname{argmin}_{I} \ \|AI - P\|_2^2 + \lambda_{\text{s}} \cdot \|I\|_{\text{sTV}} + \lambda_{\text{t}} \cdot \|I\|_{\text{tTV}} + \iota_{\mathbb{R}_+}(I)$$



- **Optimization problem: Reconstruction**
  - Expensive, but “embarrissingly parallel”
  - Requires (and enforces!) an image model
- Somewhat “cartoon-like” appearance
- Trade-off: Resolution vs. smoothness

Application: Interventional Analysis And Visualization of Cardiac Function





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