



### Problem

 $\succ$  Track a large number of similar-appearance, crowded targets through a low-continuity image sequence.







#### Cell Fiber Fiber Tracking as An Example

- $\succ$  Objective: serial cross-sectioning for 3D micro-structure.
- $\succ$  Track about 500 fibers with similar appearance.
- > Low continuity: Large inter-slice distance for fast imaging and micro-structure characterization.





# Approach

- Kalman Filter framework (Prediction and Correction)
- Main Challenge: multi-target association

predictions detections



# Tracking of Crowded Similar-Appearance Targets from Low-Continuity Image Sequences

Hongkai Yu<sup>1\*</sup>, Youjie Zhou<sup>1\*</sup>, Jeff Simmons<sup>2</sup>, Craig Przybyla<sup>2</sup>, Yuewei Lin<sup>1</sup>, Xiaochuan Fan<sup>1</sup>, Yang Mi<sup>1</sup> and Song Wang<sup>1</sup> <sup>1</sup> University of South Carolina <sup>2</sup> Air Force Research Lab \* indicates equal contribution

### **Our Association Method**

Crowded human

 $\sim 20 \, \mu m$ 

(TPS) bending energy:



Input  $\{\hat{\mathbf{s}}_{p}^{i}\}_{p=1}^{N}$ : N fiber predictions on slice i  $\{\mathbf{o}_q^i\}_{q=1}^{m}$ : *M* fiber observations on slice *i* 

- 1. Cluster predictions to groups by *K*-means.
- 2. FOR each group
- Find initially matched observations using TPS-RPM. Shrink the group by removing outlier matchings with maximum
- TPS bending energy decrease.
- Grow the group by including new matchings with small TPS increase and good consistency (magnitude bending energy and slope angle).
- 6. END FOR
- 7. Group merging by majority voting.



**Clustering: line 1** 





Initial association: line 3



Group growing: line 5

### **Dataset:**

- sparsity (continuity).

## **Experimental Results**



# **Crowd Human Tracking**



Video	Kalman-NN	Kalman-Hung	Kalman-Global	DPNMS[22]	SMOT[10]	CEM[20]	Proposed
Marathon	30.6	34.1	14.1	16.5	3.5	25.9	76.5
Band	14.8	20.4	7.4	16.7	1.9	9.3	74.1

# **Dataset and Code**

http://cvl.cse.sc.edu/project/cvpr2016.html



 $\succ$  Three 100-slice image sequences with dense inter-slice distance  $1\mu$ m from S200 material, amorphous SiNC matrix reinforced by continuous Nicalon fibers. Sparsely sample every C slices to generate image sequences with different

### Ground Truth: manually annotated 1136 3D fibers.

Our association



