Tracking of Crowded Similar-Appearance Targets from Low-Continuity Image Sequences
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Problem
➢ Track a large number of similar-appearance, crowded targets through a low-continuity image sequence.

Fiber Tracking as An Example
➢ Objective: serial cross-sectioning for 3D micro-structure.
➢ 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

Our Association Method
➢ Group-wise mapping with homeomorphism/Thin-Plate Spline (TPS) bending energy:

\[ f: \text{non-rigid 2D transform} \]

TPS Bending Energy: \( \phi(f) = \int |f(x) + L(f(x))| \, dx \, dy \)

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

Dataset:
➢ 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 sparsity (continuity).
➢ Ground Truth: manually annotated 1136 3D fibers.

Experimental Results
Crowd Human Tracking

TPS Bending Energy:

Initial association: line 3

Group shrinking: line 4

Group growing: line 5

Dataset and Code
http://cvl.cse.sc.edu/project/cvpr2016.html