Curvelet-based snake for multiscale detection and tracking of geophysical fluids

Jianwei Ma

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Abstract

- The proposed approach first identifies a consistent fluid mass by a curvelet-based GVF snake, and then establishes the motion correspondence of the snaxels between successive frames by a constructed so-called semi-T or comp-T multiscale motion estimation method based on geometric wavelets. Furthermore, combinations of TV regularization and cycle spinning techniques effectively recover the false matches.

Two main branches of mathematical image processing

- PDE-based methods (optical flow,nonlinear diffusion, TV, etc.)
- Computational harmonic analysis (Fourier, wavelets, curvelets, etc.)

- Statistics,…

Wavelets (20 years)

- J. Morlet (Geophysicist), A. Grossman (Physicist)
- Y. Meyer — mathematical framework
- I. Daubechies — practical wavelets
- S. Mallat — fast algorithm
- R. Coifman, V. Wickerhauser — wavelet packets
- W. Sweldens — second-generation wavelets
- D. Donoho, B. Silverman — statistical wavelets

Problems of traditional wavelets

- Problem 1. Shift variance and poor directional selectivity
- Problem 2. Pseudo-Gibbs artifacts
- Problem 3. **Line singularities**

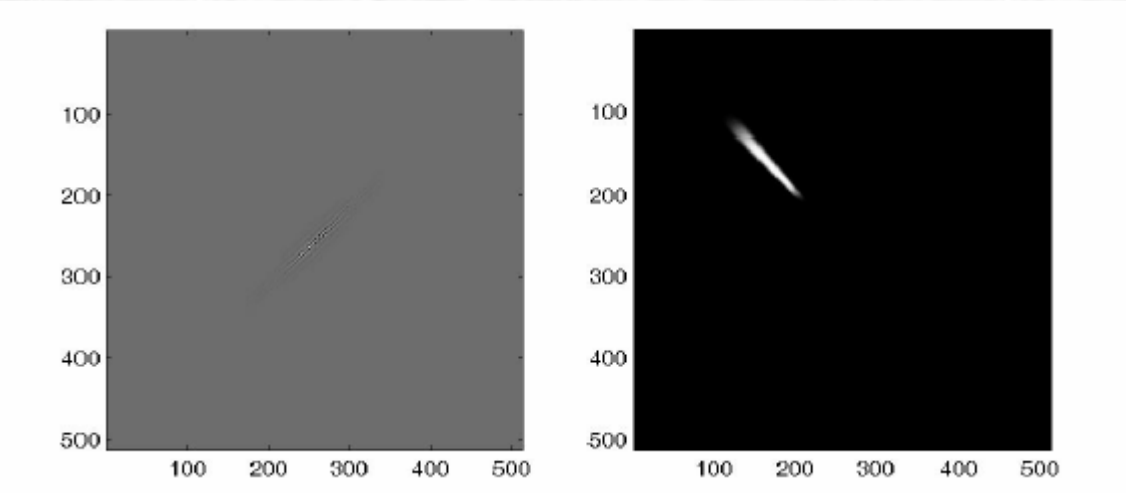
Geometric wavelets

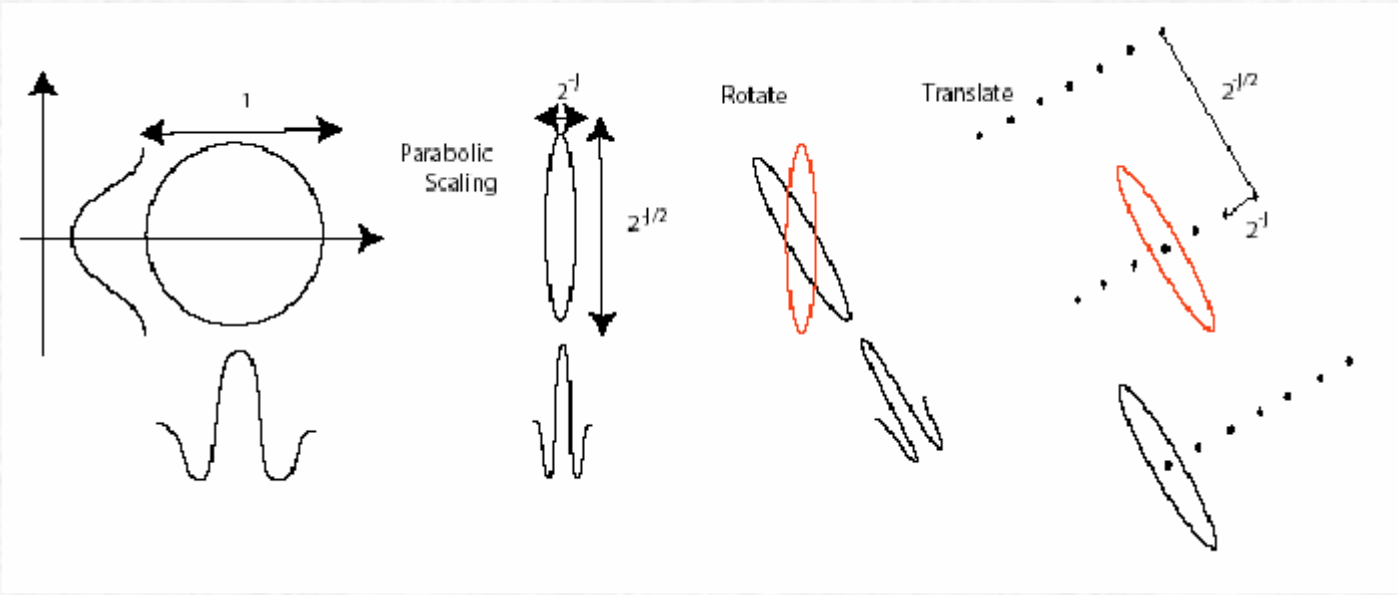
- Ridgelets
- Stanford, ETH, J. Ma et al (complex ridgelet, NFFT-based ridgelet)
- Wedgelets
- Contourlets
- Curvelets
- Bandelets

adaptive,wavelet warpping along the geometic flow

Curvelet

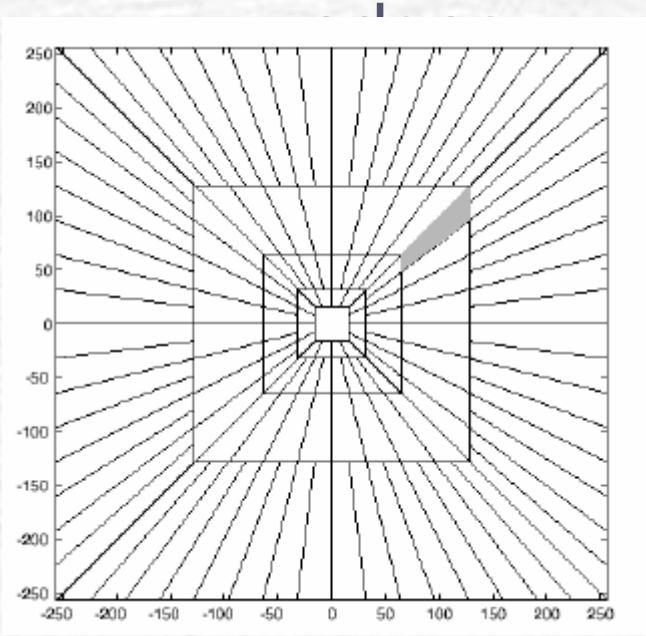
- An optimal representation of object with *C2* singularities.




1
Parabolic
Scaling
2^{-j}
$2^{-j/2}$
Rotate
Translate
$2^{-j/2}$
2^{-j}

Digital curvelet transform

- Discrete curvelet tiling of the frequency plane. The support is ‘parabolic’ pseudo-polar



Framework

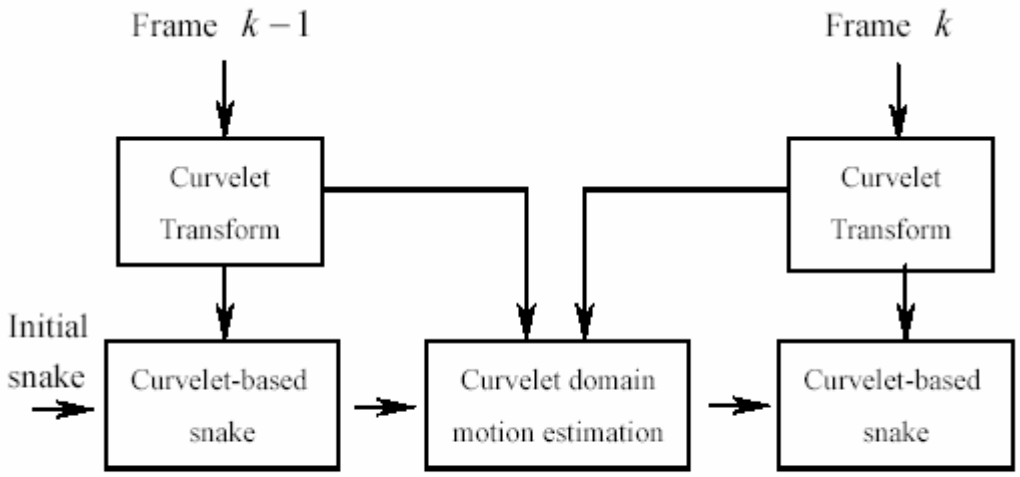
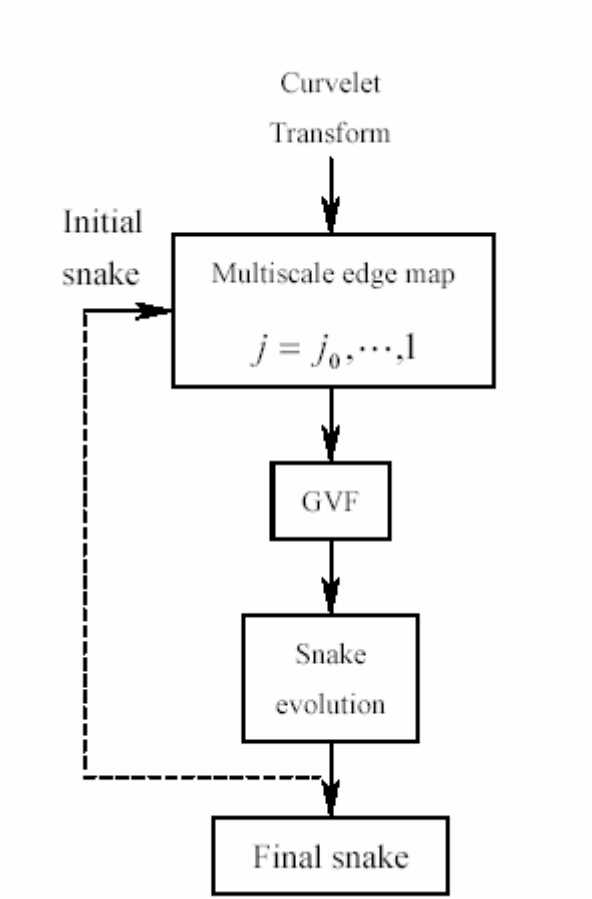
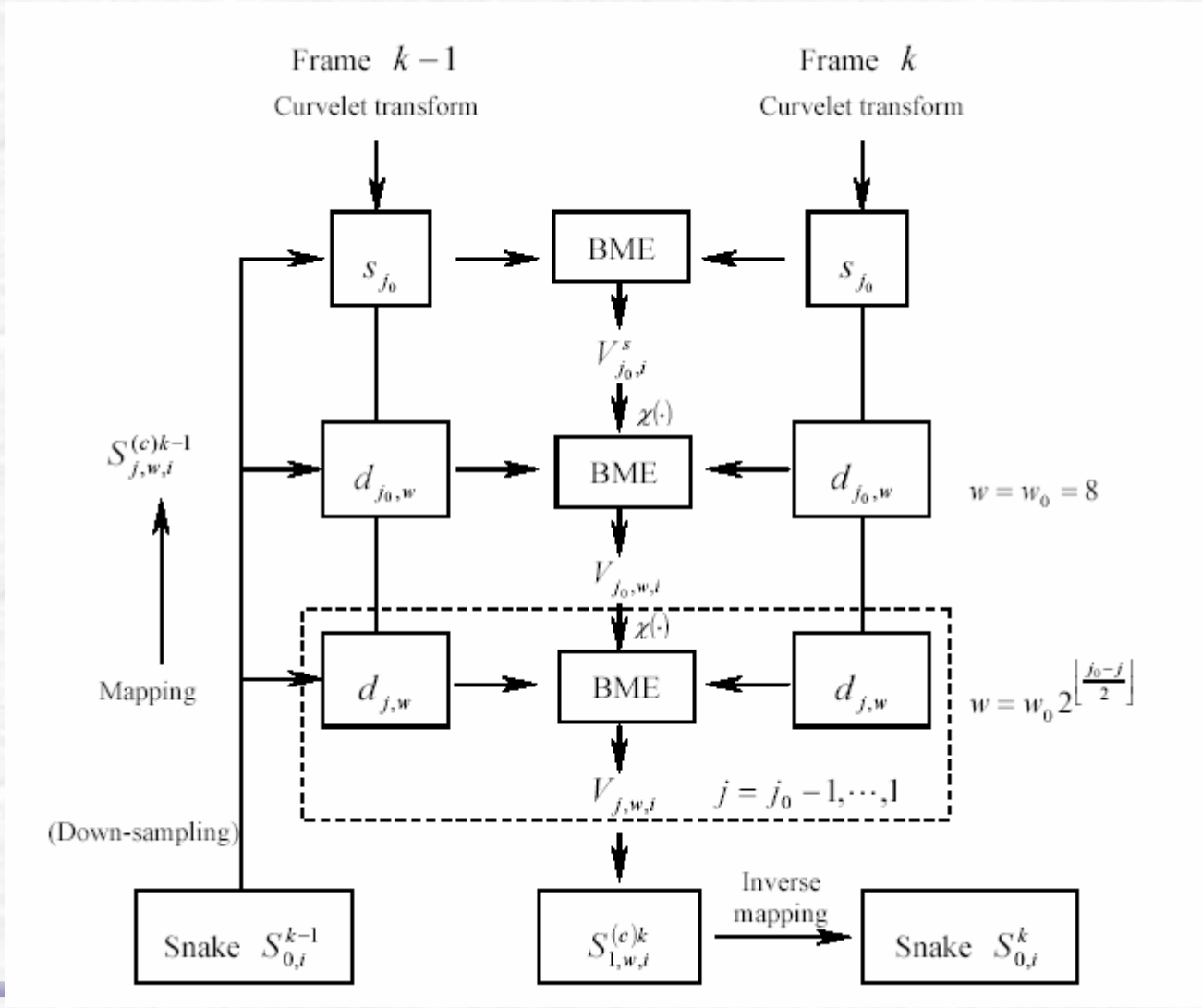


Fig. 2. Flow chart of the curvelet-based tracking

Curvelet-based GVF snake



Curvelet-based motion estimation (comp-T)

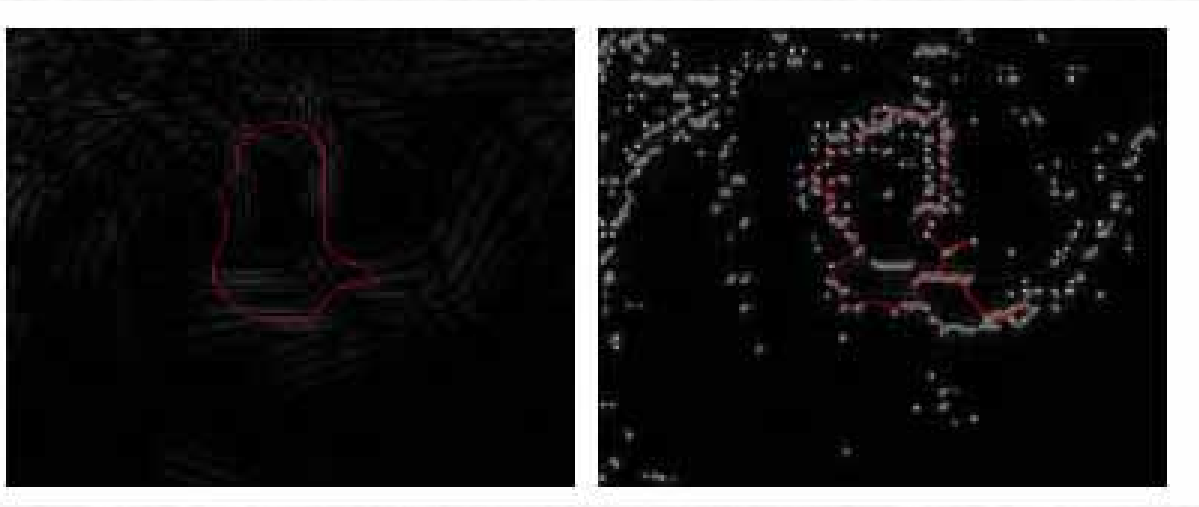


- TV

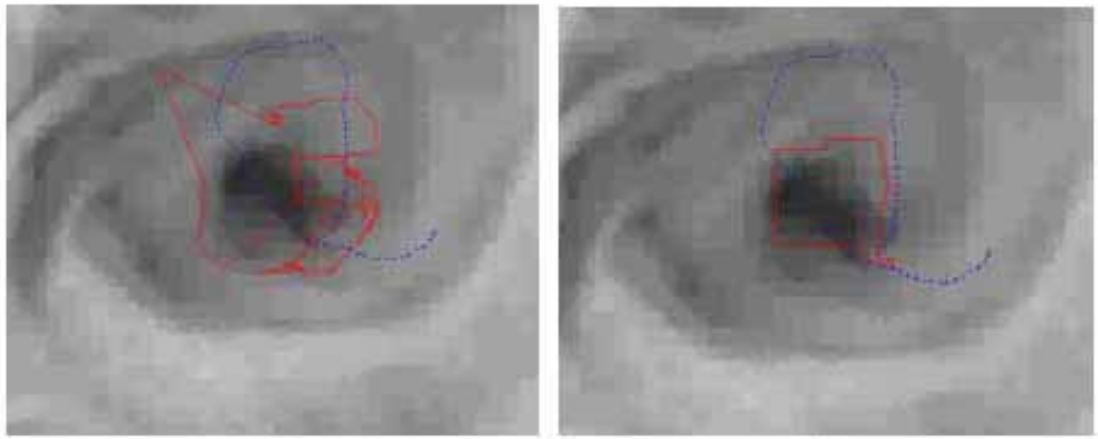
$$TV(V) := \int |\nabla V(x)| dx$$

- Cycle spinning

Curvelets vs Wavelets



TV



(a) (b)

Fig. 10. Estimated snake using the conventional BME without TV (a) and with TV (b).

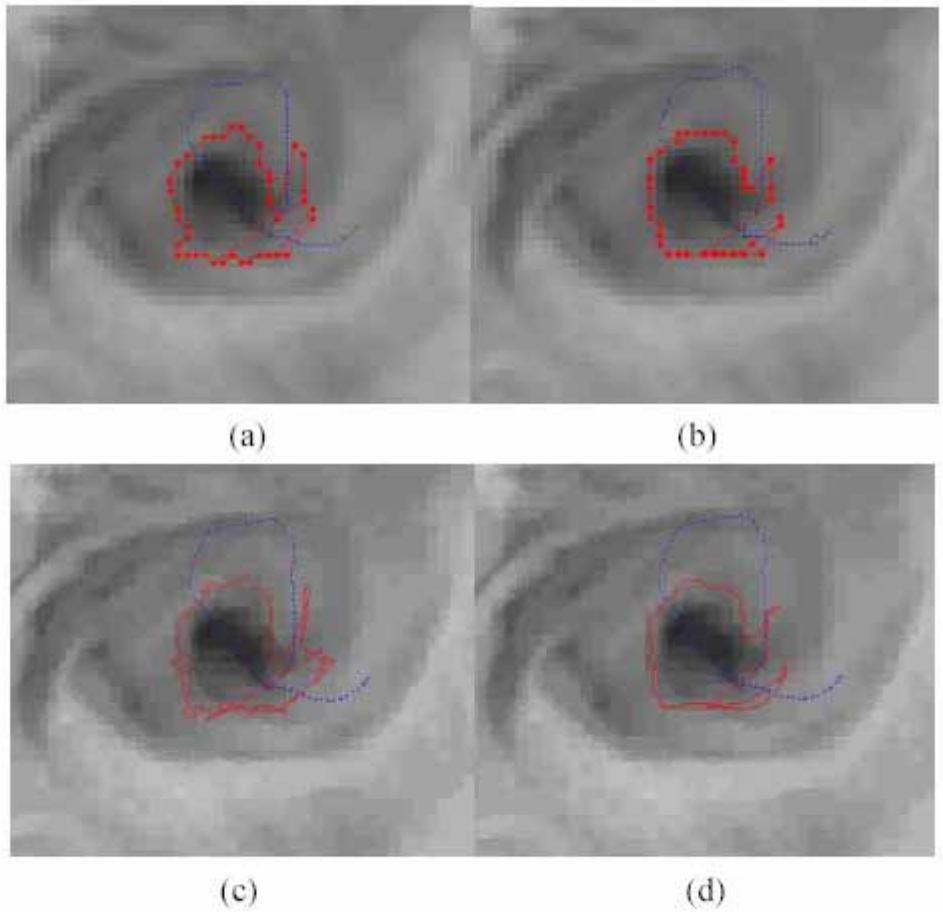
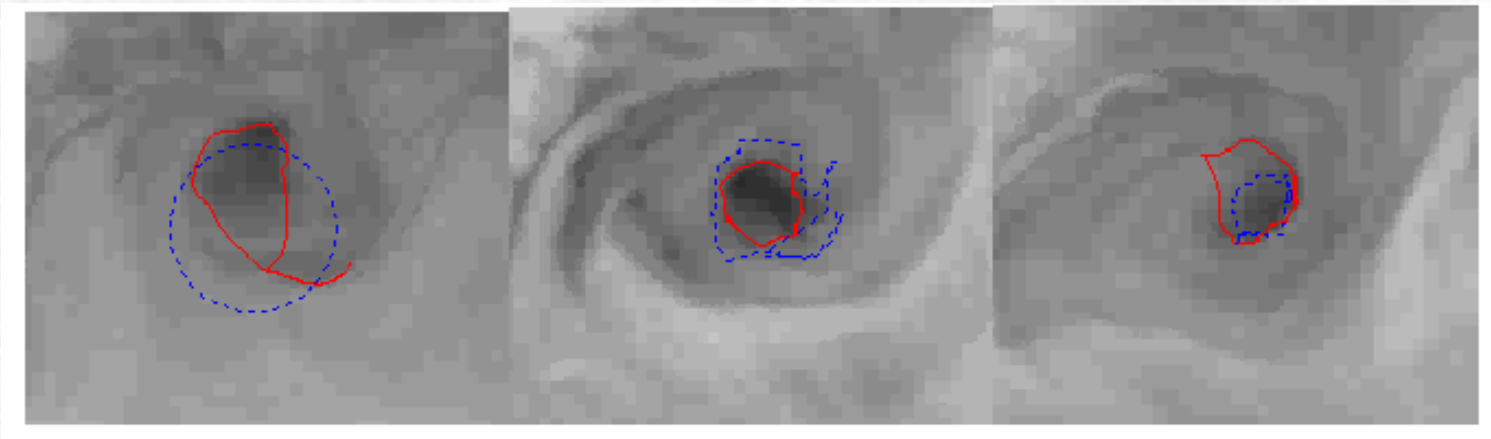
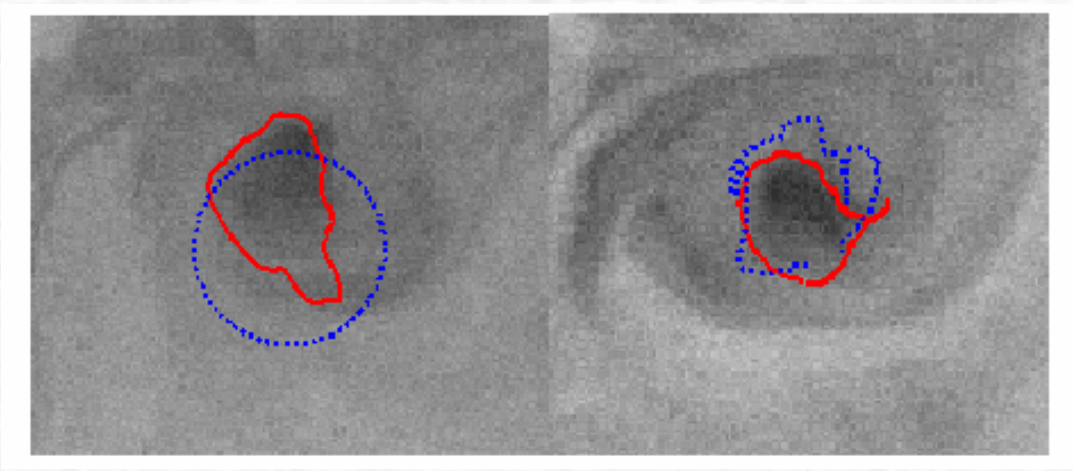


Fig. 13. Estimated results using comp-T without TV (upper row) and with TV (lower row).

Tracking



Tracking for noisy images



The End

Thanks for your attention