



Stabilising Active Contours: An Application to Tracking

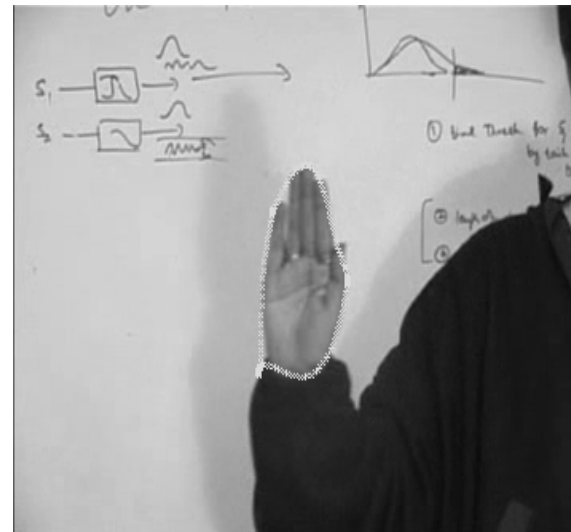
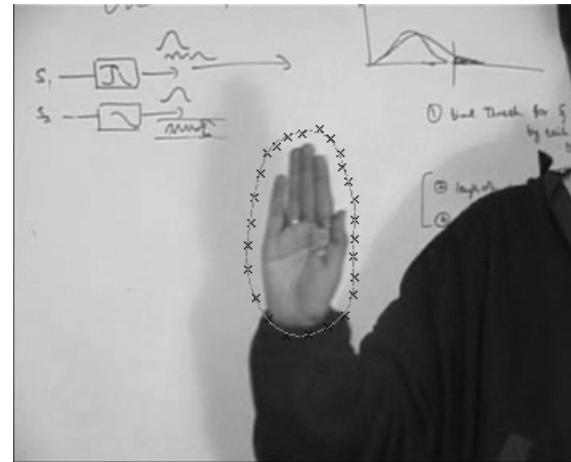
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Active Contours Overview

- Closed Curves
- Curve Evolution controlled by image properties
- Smoothness Constraint



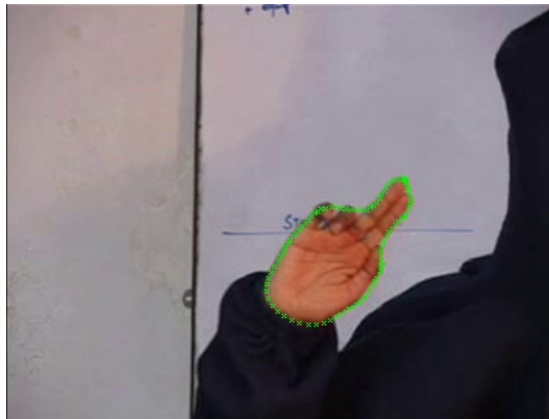
[Active Contours: Classification]

- Parametric Contours: B Splines, Fourier Descriptors etc.
- Faster Computation
- Easier to implement
- Open curves possible
- No topological change possible without special efforts
- Geometric Active Contours: Level Set Implementation
- Topological Change Handled
- Slow Computation
- Difficult to implement

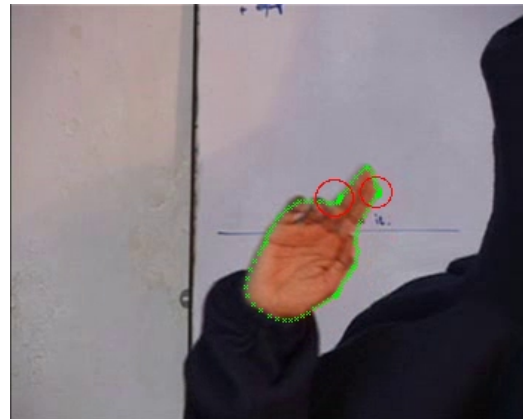
[Problem with Parametric Curves]

- Curve Point Spacing uneven during evolution
- B Splines form local loops
- Poor Segmentation
- Bigger Problems in Tracking.....

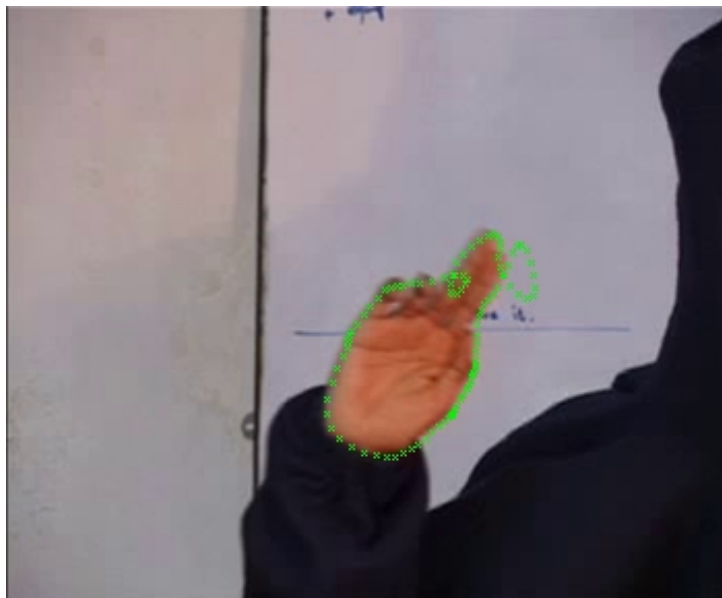
[Problem: Rapid Motion of Target]



Frame 27

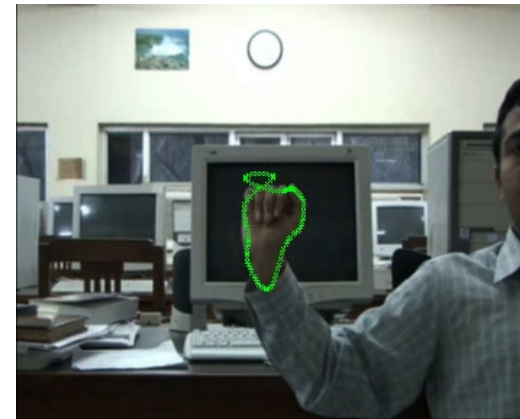
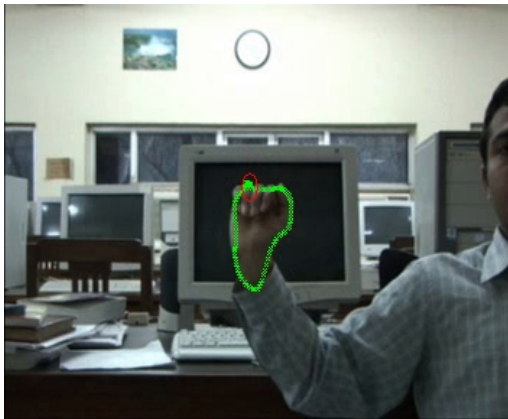
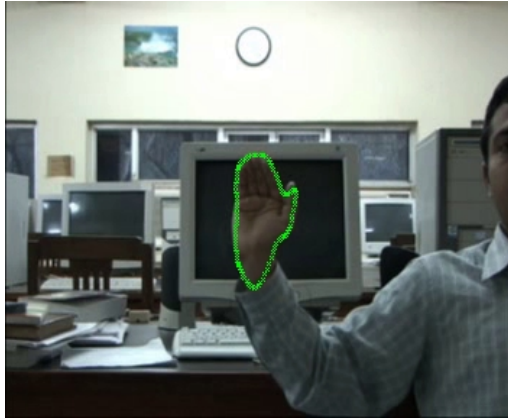


Frame 30



Frame 31

[Rapid Shrinking of Target]



[Common Approaches]

- Insertion and deletion of control points
- Ignore nearby points
- Re-initialise the curve periodically

Disadvantages:

- Computationally expensive
- Unexpected Curve Shape Change

Curve Evolution Equation: General Form

- Minimise Energy functional defined on image
- Image features: High Gradients, Region Based Models
- General Equation Form: $C_t = \alpha \vec{T} + \beta \vec{N}$

[Curve Evolution Cont.]

- Normal Force: β
- Changes Shape of Curve
- Gets most attention

[Evolution Equation Cont.]

- Tangential Force: α
- Re-parameterises Curve
- Important in Parametric Curves
- Usually neglected or ignored

Curve Speed Parameter Variation

- Curve Speed Parameter: $g = |C_p|$
- Important: Controls spacing of points during discretisation
- Speed Parameter varies as:

$$g_t = -g\kappa\beta + \alpha_p$$

[Proposed Solution]

- Ideal: Arc length Parameterisation $g=1$
- Assume $g=K$ (Constant)
- Derive tangential force by solving:

$$\alpha_p = K - g + g\kappa\beta$$

- Solution forces g at each point towards a constant K

[Tracking using Contours]

- ❑ Slower Compared to regular geometric shape models
- ❑ Shape Prior handled naturally
- ❑ Applications in medical image processing, gesture analysis etc

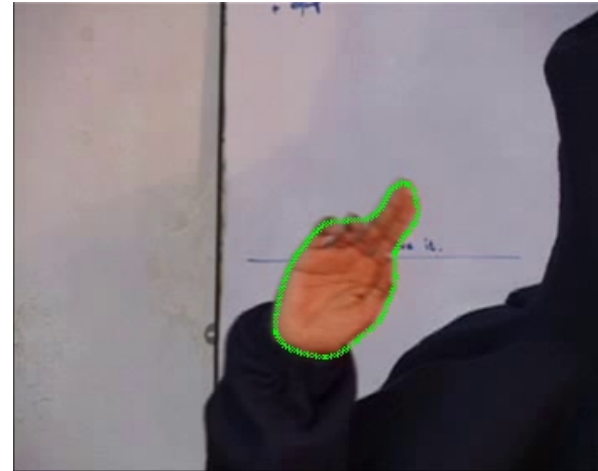
[Parametric Contour: B Splines]

- Local Basis and Control
- Few Control Points describe the curve
- Fast implementation
- Smoothness built in

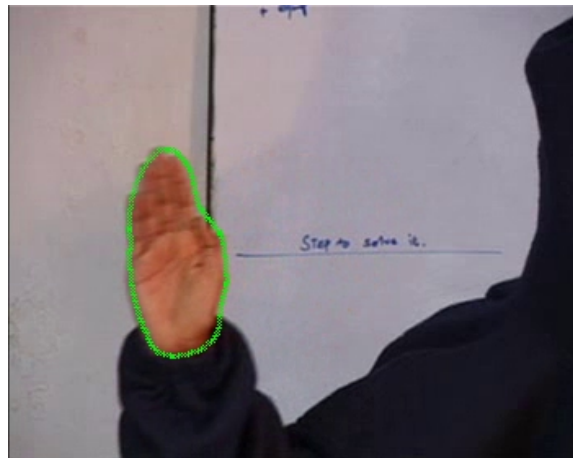
[Results]



Frame 26

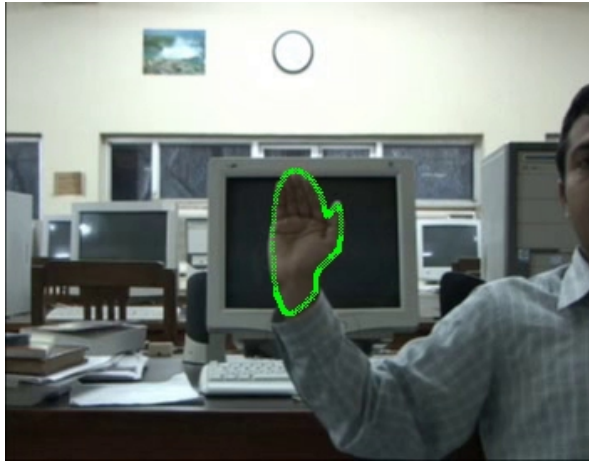


Frame 30

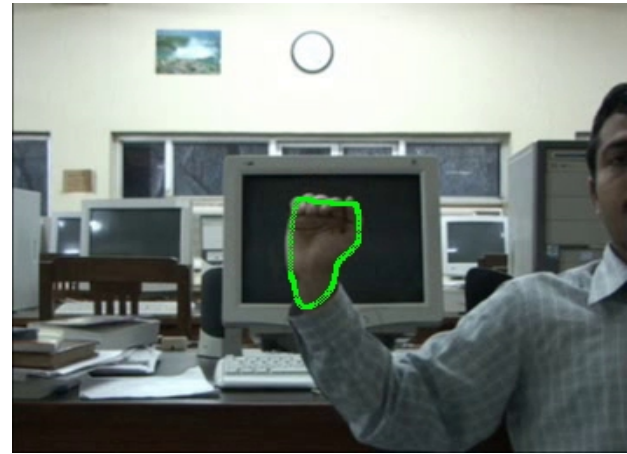


Frame 41

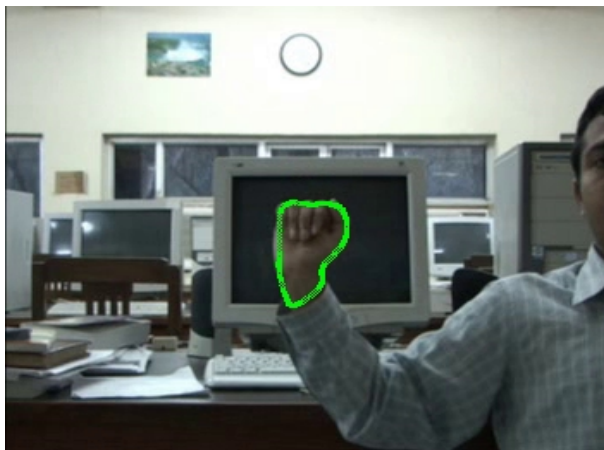
[Results Cont..]



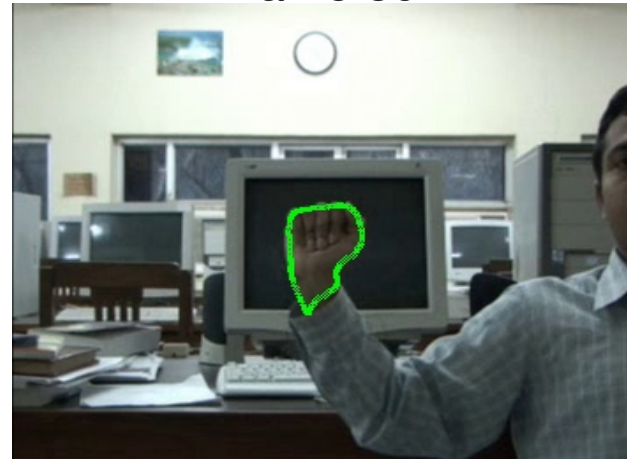
Frame 77



Frame 80

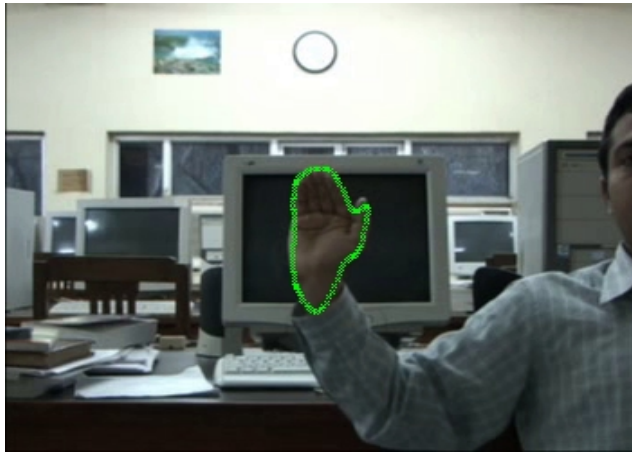


Frame 83

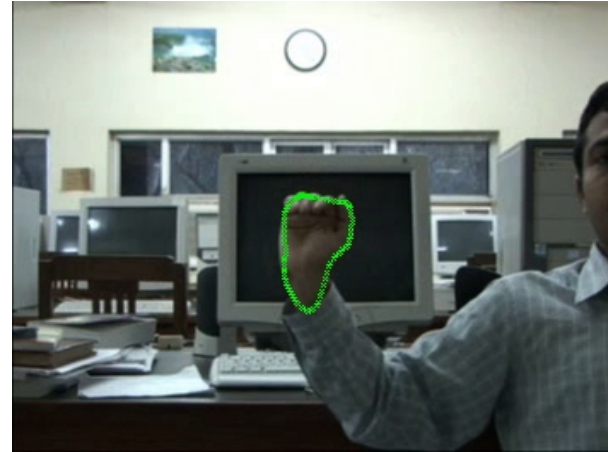


Frame 85

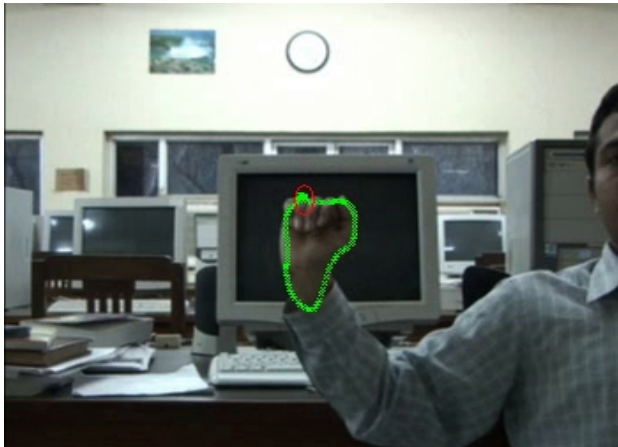
[Rapid Shrinking of Target]



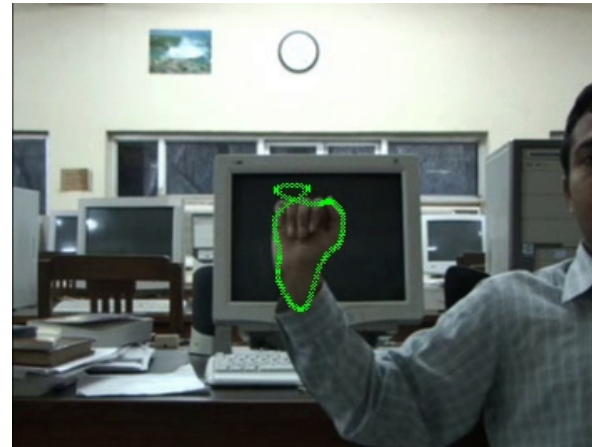
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Frame 80

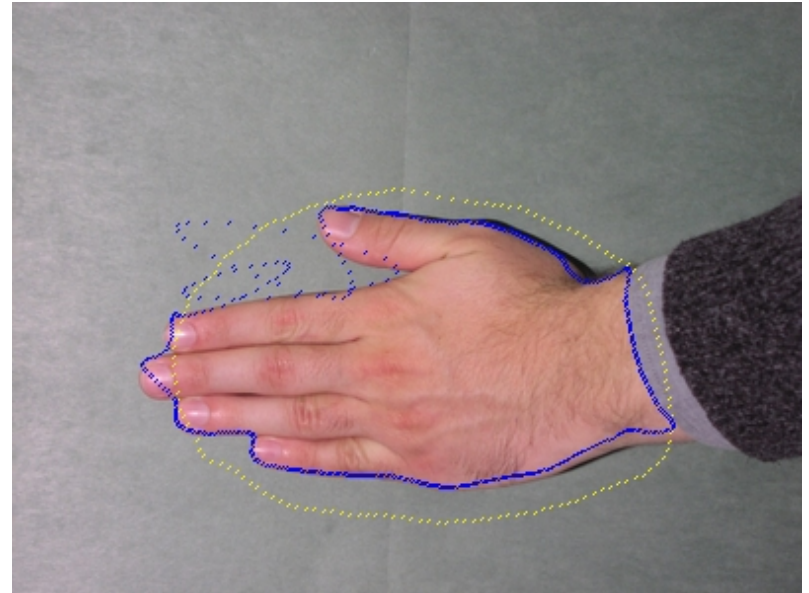
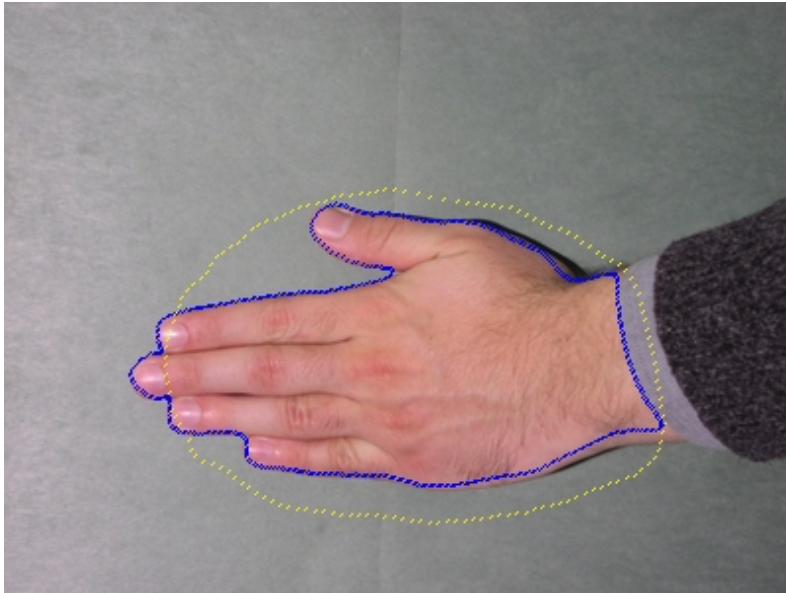


Frame 82



Frame 83

[Results Cont...]



[Video Sequence]



[Advantages]

- Fast and Direct Computation
- Good Numerical Stability

Other Terms Proposed in literature

- Delingette(CVIU,2001) : $\alpha = \mathbf{g}_p$
- Assumption: Normal Term is negligible
- Mikula, Sevcovic(Comp. and Vis. In Sci, 2005)
- Computationally Heavier

[Other terms Cont.]

- Jacob, Blu, Unser (PAMI, 2004)
- Energy functional affects normal term
- Shape may change

[Future Work]

- Theoretical Proof of Proposed Stabilising Equation

[

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Thank You