

Extract Object Boundaries in Noisy images



A level set approach is presented to extract interesting object boundaries in noisy images.

Quming Zhou



Introduction

- Snake: A closed contour is represented by a parameterized curve.
 - Smooth contour
 - Initial guess
 - Suffers from the topology and corners
- Level set: Consider $\Phi(x, y, t)$ with a speed function F and extract $\Phi(r(t), t) = 0$



Background

- An implicit form of a closed curve:

$$\Phi(r(x, y), t) = 0$$

By the chain rule,

$$\Phi_t + \Phi_r \cdot r_t = \Phi_t + \nabla\Phi \cdot F\vec{N} = \Phi_t + \nabla\Phi \cdot F \frac{\nabla\Phi}{|\nabla\Phi|} = 0$$

- The movement equation of a close curve:

$$\Phi_t + F |\nabla\Phi| = 0 \quad \text{with} \quad \Phi(x, y, t = 0) = r_0$$



Paper #1 Edge-based Model

- Caselles*: $F = (a + bk) / |1 + \nabla G_\sigma * I|^p$
where k is the curvature of the curve, and $|1 + \nabla G_\sigma * I|^p$ is the edge gradient using a Gaussian filter.
- The stop criterion is the magnitude of the gradient.
- Only detects the objects with edges defined by strong gradients.

*: "A Geometric Model for Active Contour in Image Processing,"
Numerische Mathematik, vol. 66, no. 1, pp. 1-31, 1993.



Paper #2 Region-based Model

- Chan*: $F = \varepsilon k + \log P(I(x, y) | a_{inside}) - \log P(I(x, y) | a_{outside})$
- The stop criterion is the region intensity probability.
- The distribution model may degrade in noisy images.

*: "Active Contour without Edges," *IEEE Trans. Image Processing*, vol. 10, no. 2, pp. 266-277, Feb. 2001.



Paper #3 Motion-based Model

- Paragios*: $F = rM(I_M) + (1-r)H(\nabla I)$
where $M(I_M)$ is the motion detection term
and $H(\nabla I)$ is the tracking term.
- The stop criterion is the motion region.
- It can not be used to segment a single image.

*: "Geodesic Active Contours and Level Sets for the Detection and Tracking of Moving Objects," *IEEE Trans. PAMI*, vol. 22, no.3, pp. 266-280, March 2000.