Snakes

Active Contour Models

Motivation

Vision tasks- mostly autonomous bottom-up processes

- Propagate mistakes to higher levels
- Rigidly sequential

•Goal: provide sets of alternative solutions

•Choice amongst these alternatives

- High level well-developed mechanism
- User interaction
- Interact with contour model to push towards the desired local minima

Snakes

- Active contour models
  - dynamic, exhibit hysteresis
  - Energy minimization framework
  - Image contours: lines, edges, subjective contours
- Controlled continuity splines
- Under the influence of
  - Internal splines forces
  - Image forces
  - External constraint forces

Snake's Energy function

- Position of the snake $v(s) = x(s) + y(s)$
- $E_{snake} = \int [E_{int} v(s) + E_{image} v(s) + E_{con} v(s)] ds$
- Internal - piecewise smoothness
- Image - push towards image features
- External - put near desired local minima

Internal Energy

$$E_{int} = [\ \alpha(s)\ |v_s(s)|^2 + \beta(s)\ |v_{ss}(s)|^2\ ]\ /2$$

- First order term: membrane, α(s):elasticity
- Second order term: thin plate, β(s):stiffness

- If α(s)=β(s)=0, we allow breaks in the contour

- Corners- second order discontinuous

External Constraint Forces

Springs – add $-k(x1-x2)^2$ to E_{con}

Volcano – $1/r^2$ repulsion force

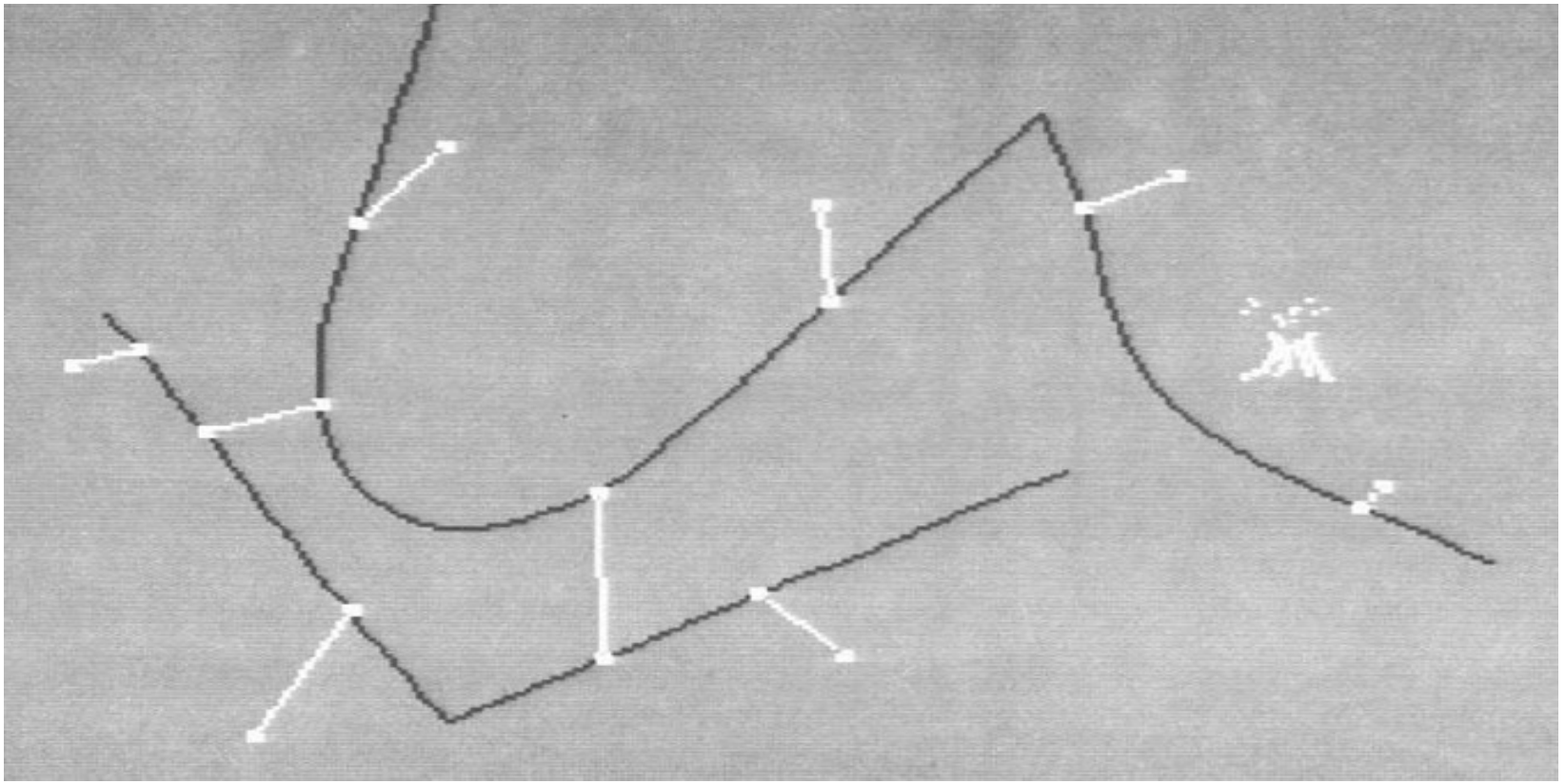


Image Forces

$$E_{image} = w_{line} E_{line} + w_{edge} E_{edge} + w_{term} E_{term}$$

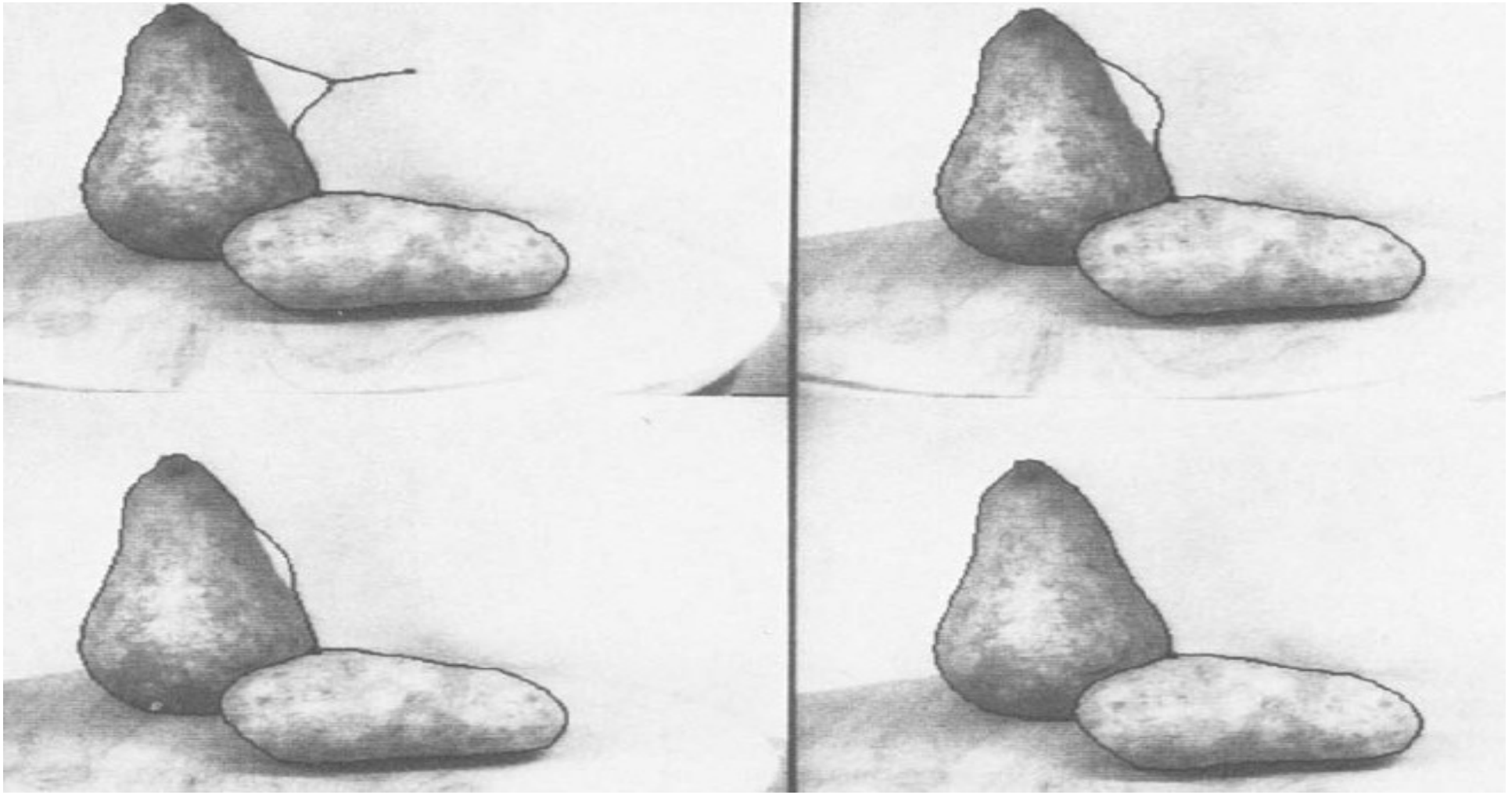
Line Functional:

$$E_{line} = I(x,y)$$

- Sign of w_{line} decides light vs dark lines

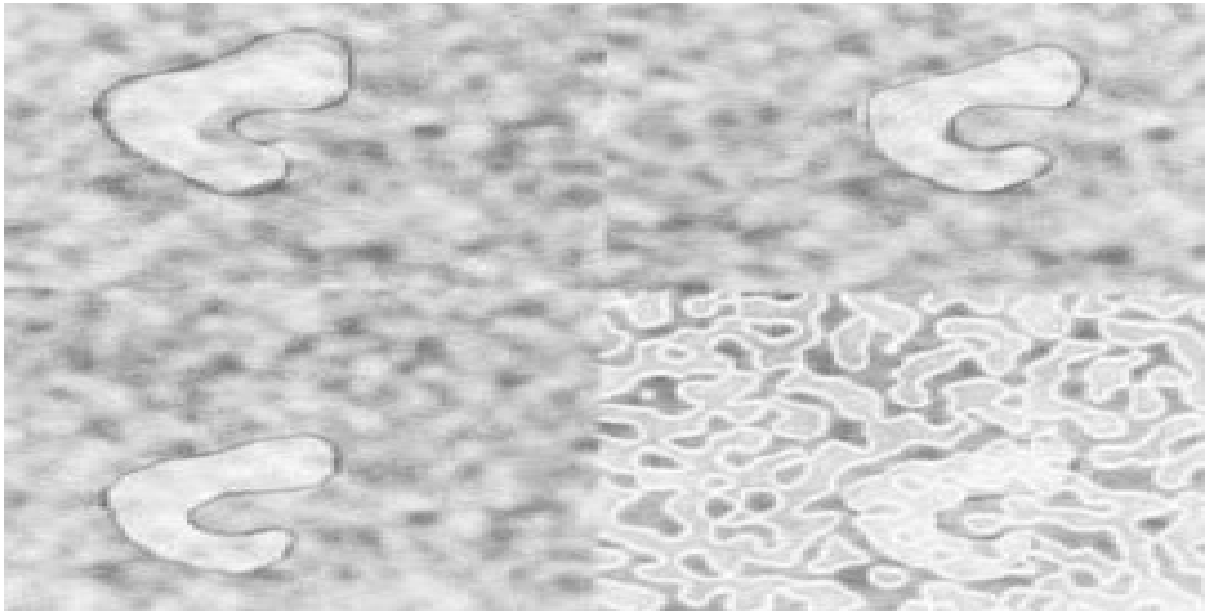
Image Forces (cont...)

- Edge Functional : gradient magnitude

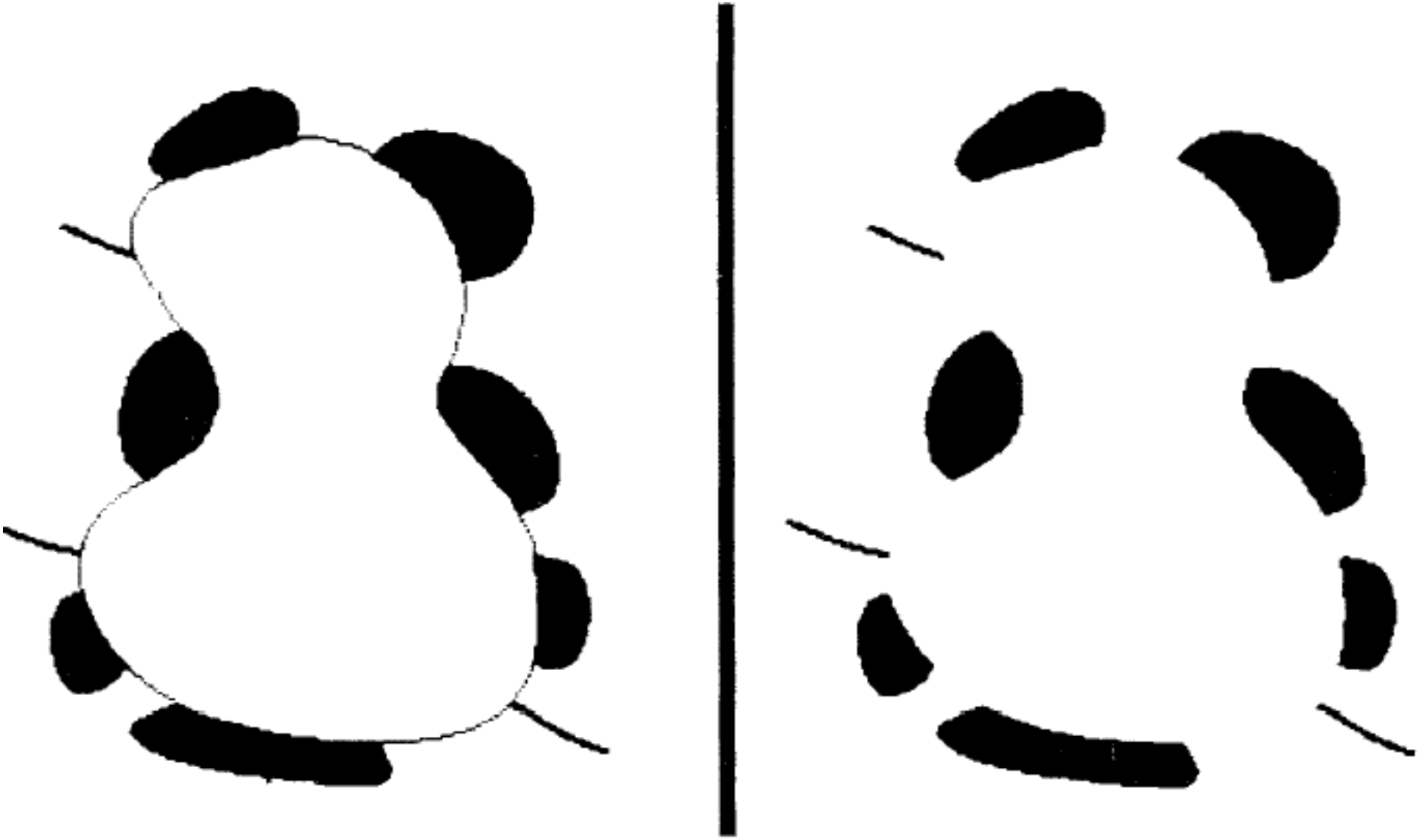


Scale Space

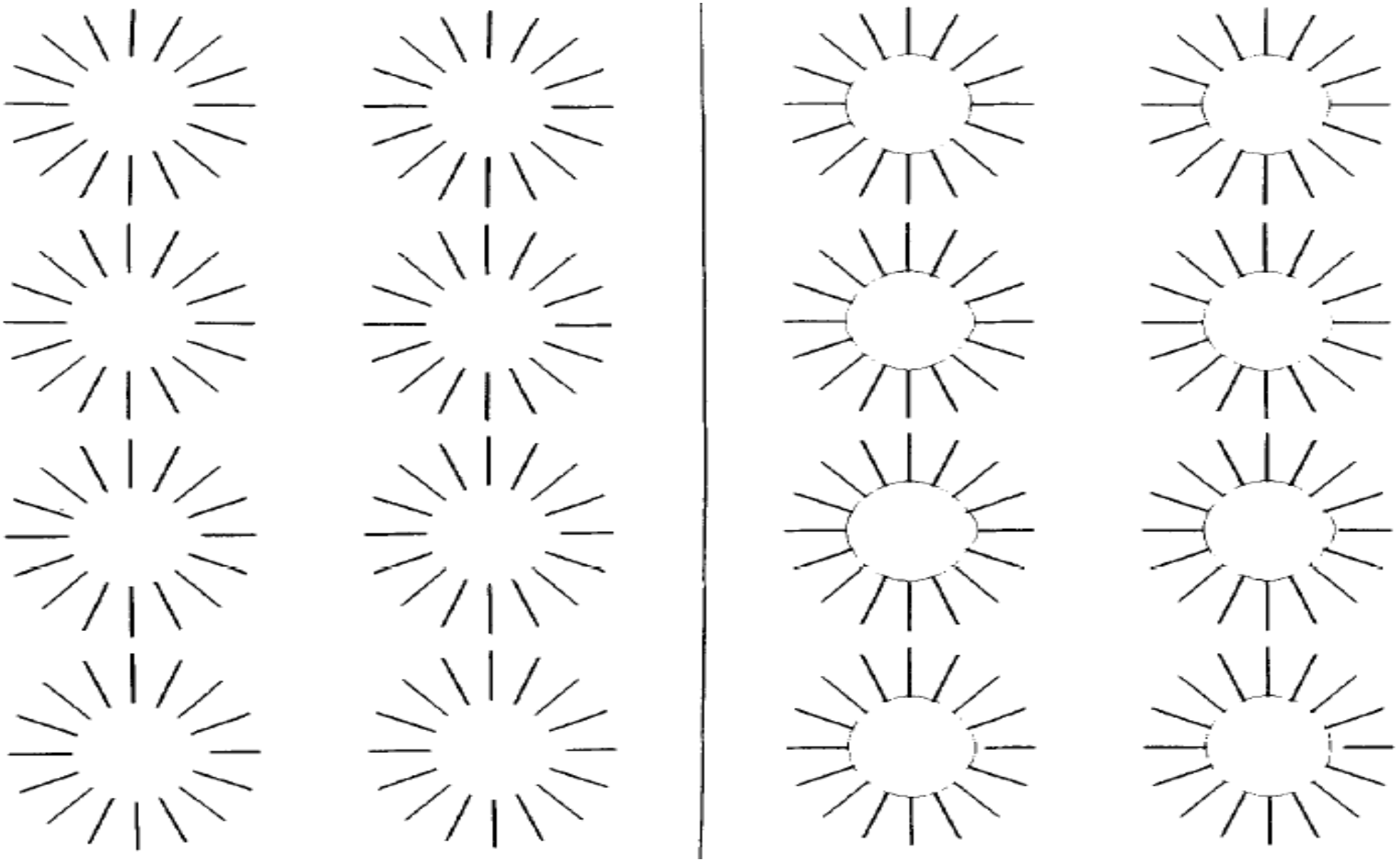
- Spline energy term
  - pulls neighboring parts of snake to continue a feature
- Scale Space
  - Hierarchy of segments at different scales
  - Start at coarse scale, move to finer



Subjective Contour

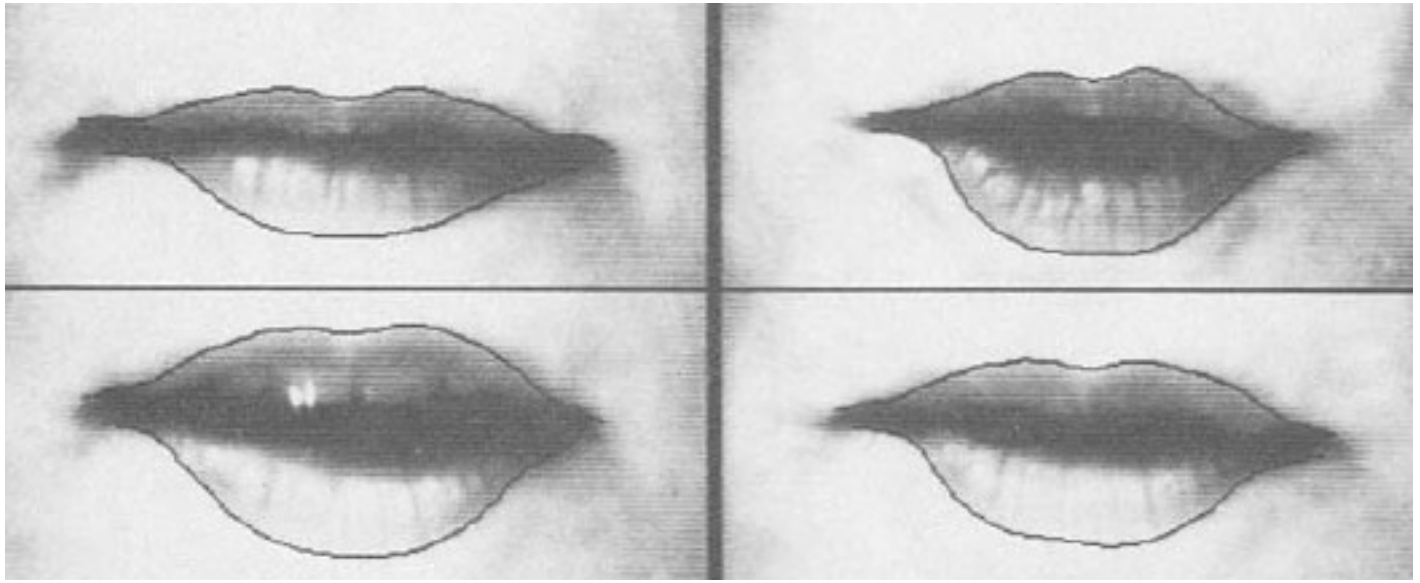


Hysteresis



Stereo and Motion

- Stereopsis
  - Disparity gradient limit
  - $E_{stereo} = [v_s^L(s) - v_s^R(s)]^2$
- Motion
  - Rapid motion- flip to different local minima
-



Pros and Cons

- Pros-
  - Integrate image information, desired contour properties and knowledge based constraints
  - Applications to other vision problems
- Cons
  - Sensitive to initial location
  - Can handle topologically simple objects

Questions...