

Active Contour Models (Snakes)

5.1 Overview

The active contour model algorithm, first introduced by Kass et al., deforms a contour to lock onto features of interest within in an image [27]. Usually the features are lines, edges, and/or object boundaries. Kass et al. named their algorithm, "Snakes" because the deformable contours resemble snakes as they move.

Given an approximation of the boundary of an object in an image, an active contour model can be used to find the "actual" boundary. Active contour models should be able to find the intracranial boundary in MR images of the head when an initial guess is provided by a user or by some other method, possibly an automated one.

An active contour is an ordered collection of n points in the image plane:

$$\begin{aligned} V &= \{v_1, \dots, v_n\} \\ v_i &= (x_i, y_i), i = \{1, \dots, n\} \end{aligned} \quad (5.1)$$

The points in the contour iteratively approach the boundary of an object through the solution of an energy minimization problem. For each point in the neighborhood of v_i , an energy term is computed:

$$E_i = \alpha E_{int}(v_i) + \beta E_{ext}(v_i) \quad (5.2)$$

where $E_{int}(v_i)$ is an energy function dependent on the shape of the contour and $E_{ext}(v_i)$ is an energy function dependent on the image properties, such as the gradient, near point v_i . α and β are constants providing the relative weighting of the energy terms.

E_i , E_{int} , and E_{ext} are matrices. The value at the center of each matrix corresponds to the contour energy at point v_i . Other values in the matrices correspond (spatially) to the energy at each point in the neighborhood of v_i .

Each point, v_i , is moved to the point, v_i' , corresponding to the location of the minimum value in E_i . This process is illustrated in Figure 5.1. If the energy functions are chosen correctly, the contour, V , should approach, and stop at, the object boundary.

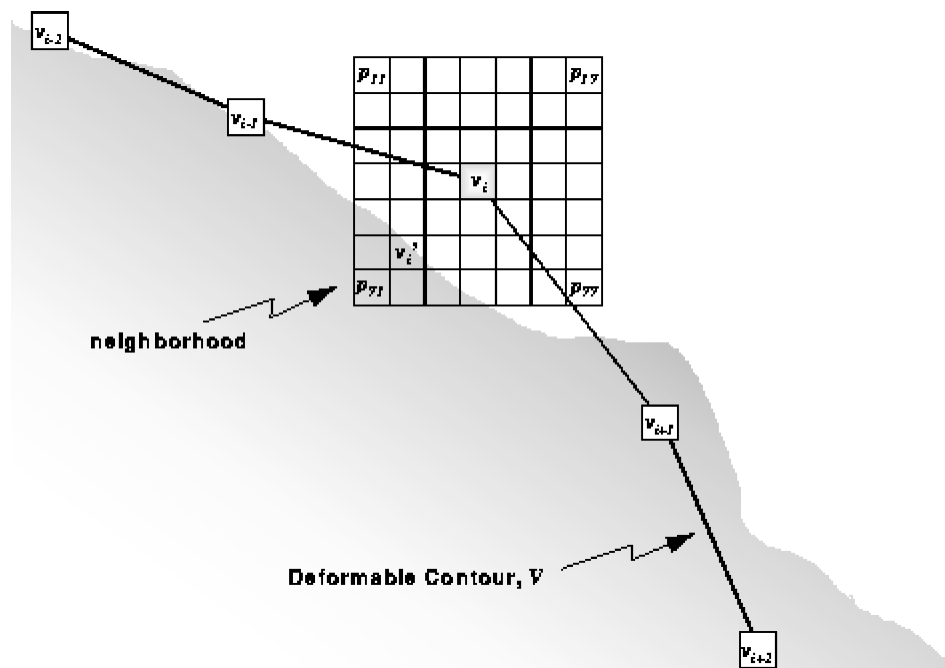


Figure 5.1: An example of the movement of a point, v_i , in an active contour. The point, v_i' , is the location of minimum energy due to a large gradient at that point.