Lecture notes: Active contours (continued)

The last lecture introduced the basic concepts of an active contour, along with simple energy terms. These can be applied in a number of interesting frameworks depending on the constraints of the problem. This lecture discusses several possibilities.

Rubber band model. Active contours are commonly initialized outside the shape of interest, and then use internal forces to **shrink** towards the final desired location. Thus, they operate like a rubber band that is first opened wide and then allowed to contract.

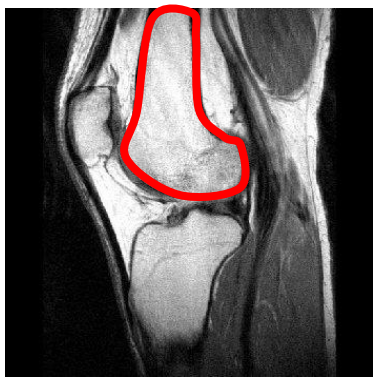
initial contour

final contour

Balloon model. For some problems, it is more convenient to start inside an object and have the contour **expand**. This operation mimics a balloon. For example, consider the following image of a knee. Suppose you wanted to segment an interior portion of the join. There are several strong edges inside the knee that could cause a shrinking contour to become stuck at the wrong local minima. Starting from the inside and growing offers a cleaner path to the desired local minima and hence an easier segmentation.

MRI of knee

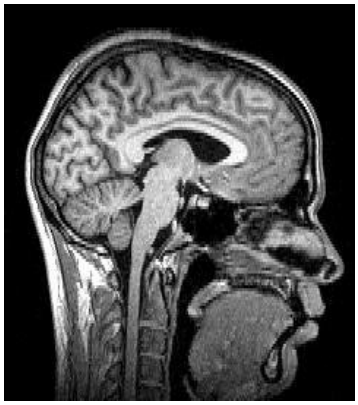
initial contour

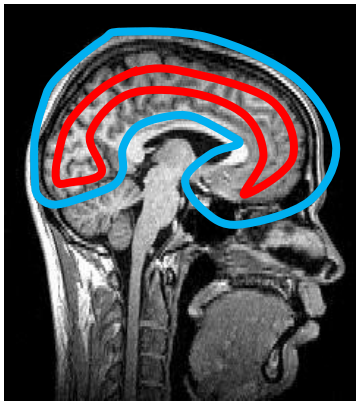


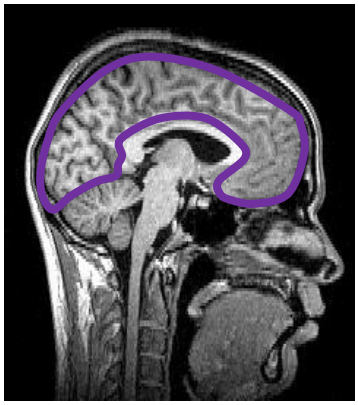
final contour

Ringed model. Another approach is to start with **2 initial contours**, one outside the object of interest, and one inside. The external contour uses a contracting internal energy, while the interior contour uses an expanding internal energy. Both contours include an additional term that prevents them from moving past each other. If the contours become stuck at local minima but have not yet reached each other, then

the weight of the contract and/or balloon energy terms can be increased to force them to continue moving, until they reach each other.


MRI of head


initial contours


final contour

Template model. If the object being tracked has a known shape, then an internal energy can be formulated that tries to **maintain that shape.** The idea is similar to a deformable template. For example, consider a human eye. It has an oval shape that can be used to define the likely motion of the contour points. Each contour point can be associated with a vector. Motion can be constrained to move along that vector, or weighted more heavily to move along that vector and less heavily to move off that vector.

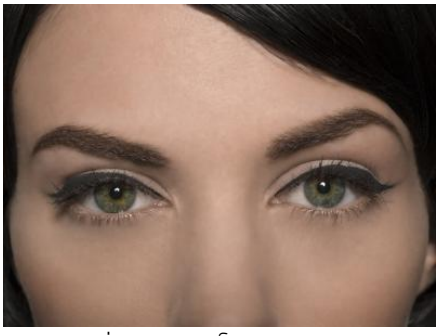
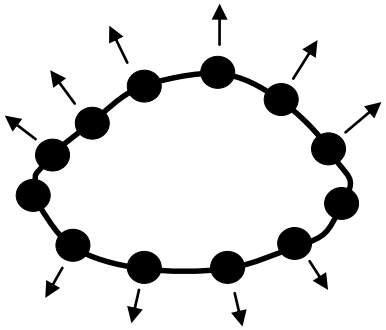


image of eyes


eye contour model

Contour tracking. Active contours can be helpful for tracking a shape through a video sequence. The initial contour for the first frame of video is supplied manually by a human user. For subsequent frames, the final contour position from the previous frame is used for the initial contour position for the next frame.

The previous two ideas can be combined. They have been applied extensively to problems involving the tracking of humans, including face tracking, lip tracking, body motion tracking, and hand tracking. A casual search of youtube will find several video demonstrations, some of which will be shown and discussed in class.