VADL

ACTIVE CONTOURS

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An active contour or snake could be understood as an elastic rubber band which is iteratively adjusted to satisfy shape preferences evolving the contour to fit exact object boundary. First, we must choose or give an initial model (curve) near the desired object to be segmented. It could be as simple as a circle or rectangle. That curve changes its form looking for minimizing a cost function or energy function, which determines how good a contour configuration is. Then we seek new configuration that minimizes that cost function.

The total energy of the snake could be defined as: $E_{total} = \int_0^1 [E_{internal}(C(s)) + E_{image}(C(s)) + E_{constraints}(C(s))]ds$. Being the curve $C(s) = [x(s), y(s)]$ where $s \in [0,1]$, meaning the starting and final point of the curve.

- $E_{internal}$ has to do with the curve shape, favoring smooth shapes, contours with low curvature.

$$E_{internal}(C(s)) = \frac{\alpha(s)|C_s(s)|^2 + \beta|C_{ss}(s)|^2}{2}$$

Being C_s the first order derivative of the curve, C_{ss} the second order derivative, α the penalization coefficient of elasticity of the curve and β the penalization coefficient of rigidity of the curve. The terms α and $\beta \in [0,1]$, lower values (close to 0) would let more freedom to elasticity and rigidity; the higher the value, the lower the freedom.

- E_{image} has to do with how well the curve is attracted toward different image features such as edges, lines, texture gradient, etc.

$$E_{image}\big(C(s)\big) = M * E_{line} + E_{edge} + E_{term}$$

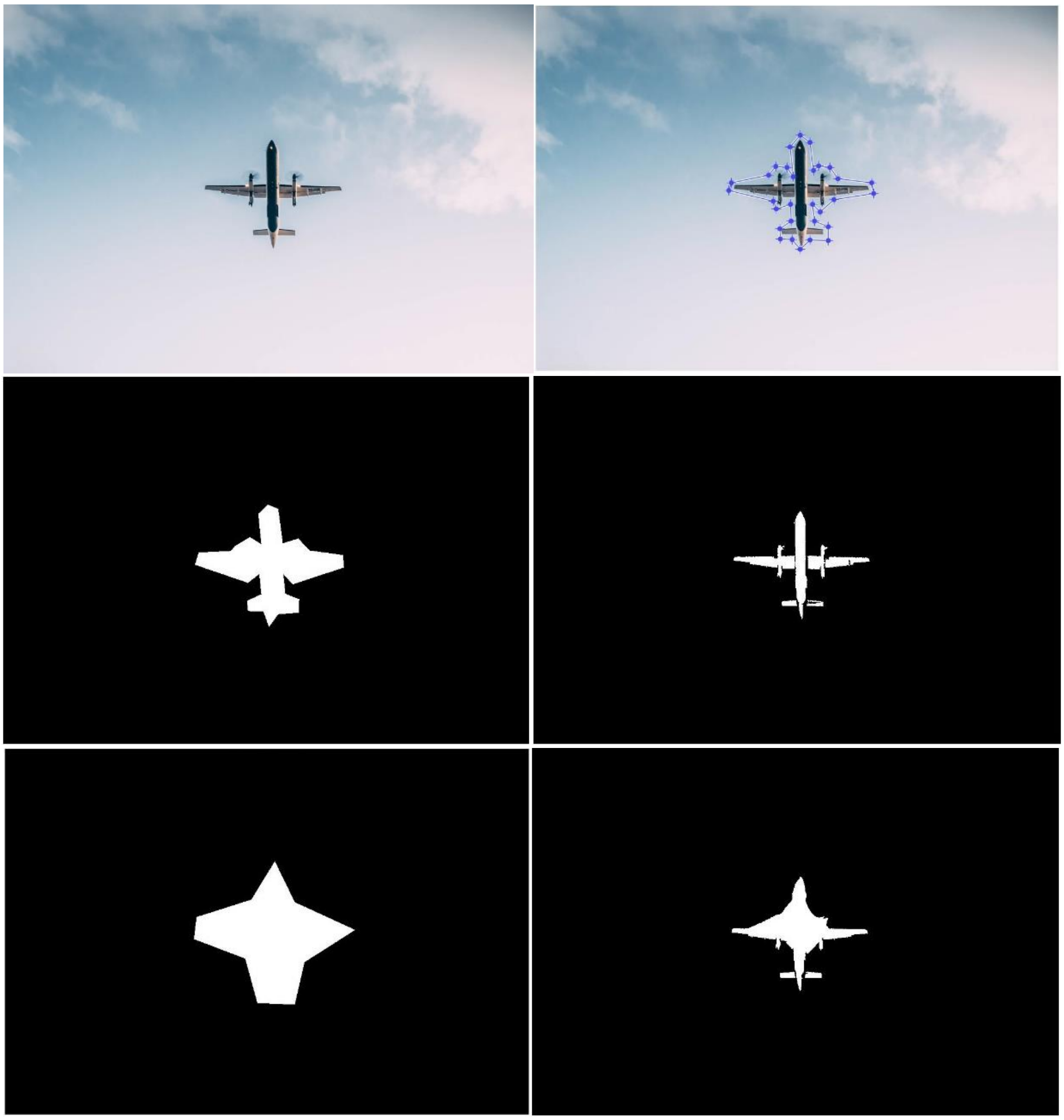
E_{line} depends on the intensity values covered by the curve, where $M = \{1, -1\}$, which means if M=1, the curve will be attracted to darkest values and if M=-1, to lightest ones. E_{edge} depends on the image gradients, the curve evolves to object boundaries. E_{term} depends on the curvature, minimizing this energy, the curve evolves to segment endings and corners.

- $E_{constraints}$ considers additional constraints, such as penalizing loops in the curve, moving too far away from the initial position, etc. Generally, this term is not used.

As possible advantages of active contours, they're useful to track and fit non-rigid shapes as well as they adapt very well to any subjective contour. On the contrary, we can see as cons the fact that several parameters of the energy function must be set well based on prior information and the initial curve we provide must be near true boundary, we cannot choose whatever area we want. Overall, these are not problematic drawbacks we cannot cope with.

As seen in class, this active contour technique could be useful for situations in which we want to have a faster and accurate foreground segmentation and tracking. If there were any mistake, then we would correct them manually.

To play with active contours, I tried a simple example in Matlab in which the goal is to obtain a segmented foreground of an image. In this case, I have used as image a plane in the sky in order to facilitate the segmentation. The procedure is the following: we create a mask on the original image connecting points where we consider the boundaries of the foreground object are and then we apply the Matlab function active contour, configuring the original image, the mask, the number of iterations and the method.



As we can see, the better the mask (the better we connect points along the boundaries of the object) the better the segmented foreground object.