A NOVEL ALGORITHM FOR ACTIVES CONTOUR MODELS:
ADAPTIVE SNAKES

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Abstract
This work presents a novel algorithm for optimizing deformable contour models. It overcomes an inherent problem of GVF snakes using a dynamic intervention at the curve evolution in a way that is possible to obtain a best fidelity in contour detection. In fact, the substantial difference to the traditional GVF snakes is the definition of a shape particularity merit function. The proposed method solves the problem of the points bunching up on strong portions of the contour and addresses the full extern force concavity achieving. We also show with a set of well-parameterized images that the proposed solution implies in best results in convergence and matching.

1. Introduction
The parametric active contour model known as snakes was first proposed by Kass et al. [1] and has been widely used in image processing and computer vision. These models simulate elastic materials which can dynamically conform to object shapes in response to internal forces, external image forces, and user specified constraints. Grasping [2], and tracking [3] are illustrative applications examples. The snake was originally defined as a curve \( X(s) = (x(s), y(s)), \ s \in [0,1] \) that evolves through the spatial domain of the image to minimize an energy function. The snake has been widely used but your original formulation is inadequate to images with deep concavities and complex geometries and topologies. These questions have been registered and recent works have been proposed in an effort to improve these aspects of the original implementation [4], but they fail in evaluate a global analysis of the optimum inter-distance and the problem is only addressed by the insertion of severe constraints and essentially different formulations [5].

The solution presented here is an adaptive algorithm that uniquely addresses the problem by a global analysis of the optimal inter-distance. The obtained results show that the proposed method greatly enhances the contour detection accuracy.

2. Proposed solution
The proposed adaptation principle is the definition of new optimal point positions along the snake that minimizes a morphological energy function \( \xi(X) \) shown in equation 1.

\[
\xi(X) = \left[ u \frac{\partial}{\partial s} h(X) ds \right]^2 + v h(X) ds \tag{1}
\]

where \( h(X) \) represents the merit function, and \( u \) and \( v \) are user specified constants. The merit function is chosen to have local minima at the interest regions such that the new point position improves the accuracy at the desired portions of the contour. The equation 2 shows a merit function example.

\[
h(x) = \left( \frac{\|x - x_{s,AS}\| + \|x_{s,AS} - x\| - \|x_{s,AS} - x_{s,AS}\|}{\|x_{s,AS} - x_{s,AS}\|} \right)^2 \tag{2}
\]

that is shown in figure 1.

Figure 1 – Merit function (dash) and deformable contour (solid)
3. Experimental results

For two well parameterized synthetic images, figure 2 presents a comparison between the traditional GVF snakes formulation [6] and the adaptive proposed algorithm to a poor snake (30 points). As we can see in two cases, the proposed algorithm significantly enhances the contour detection performance.

4. Conclusions

The experimental results show that the proposed algorithm needs fewer points than the traditional snake formulation and is uniquely able to address the extern force concavity achieving capability.

Its low processing time is also an important aspect to be considered in recognition scheme of vision systems.

5. References


