FINE SEGMENTATION USING GEOMETRIC ATTRACTION-DRIVEN FLOW AND EDGE-REGIONS

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ABSTRACT

In the segmentation problems to extract objects from an image to make, for examples, 3D VR (virtual reality) contents or to estimate sizes of objects, a key issue is fine segmentation which means that the objects can be extracted without visual loss of detailed shapes. Our research is motivated by making 3D VR contents of commercial products. It makes an e-catalog that customers can browse a product in three dimensional virtual space on internet markets. A common way of making a 3D VR content starts from taking hundreds of photographs of a product with different view angles in a photo studio. The most difficult step is to extract the product from a background without visual loss of detailed shapes. The images taken in the studio have well-known difficulties in segmentation problems even though they usually have simple background colors and small amount of noises such as JPEG artifacts. These mainly come from lighting conditions in the studio and complex shapes of products. Most of lighting conditions make shadows which cause weak boundaries between objects and the background. More serious weak boundaries are produced by a reflection on some parts of an object due to bright lighting conditions and properties of materials of the object. It changes colors of objects into almost white which is normally used as a background color. In addition, there are other difficulties; shapes of objects can be highly non-convex.

There have been a lot of boundary-based segmentation algorithms. The snake model in [1] has been a foundation of curve evolution based on the minimization of an energy. The geodesic active contour model was introduced in [2] as the minimization of a weighted length. Although the model has many advantages over the classical snake, it has drawbacks such as dependence on positions of initial curves, incapacity for capturing weak boundaries when an image has both weak and strong boundaries, and slow convergence in non-convex boundaries. Numerous modifications of the snake model and the geodesic active contour model have been developed to address these drawbacks. In [3], gradient vector flow was proposed for a fast convergence to the non-convex boundaries. In [4], a curvature vector flow was introduced to overcome a limitation of [3] for segmenting highly non-convex shapes. In [5], the region-aided geometric snake was proposed for more robust detection of weak edges. If an object in an image has both weak boundaries and highly non-convex shapes, most of boundary-based segmentation algorithms suffer from capturing such boundaries all around the object. Even though they capture the boundaries, it is not enough to be a fine segmentation for extracting the detailed object from an image.

In this talk, we propose a fine segmentation algorithm for extracting objects in an image, which have both weak boundaries and highly non-convex shapes. There are two main con-

cepts, geometric attraction-driven flow (GADF) and edge-regions, which are combined to detect boundaries of objects in a sub-pixel resolution. Since an image is a two dimensional manifold, we obtain GADF by comparing two lengths of curves along the direction of the largest change in the manifold. Edge-regions contain most of edges. We compute inward fluxes in the gradient field of a strength of edges to obtain such regions by which we construct initial curves close to boundaries of objects. Since the orientation of GADF near boundaries of objects points to edges from each side of the boundaries regardless of strength of edges, we can segment the objects by solving a simple advection equation of curves in the flow. It naturally solves problems of a slow convergence near highly non-convex boundaries and a leakage over weak edges. According to the purpose of segmentation, for examples, fine extraction of objects or measurement of sizes of objects, we additionally propose a local region competition algorithm to obtain perceptible boundaries which are used for extraction of objects without visual loss of detailed shapes. We have successfully accomplished the segmentation of objects from images taken in the studio. Our algorithm can be applied to other kinds of segmentation problems by taking the appropriate strategy for selecting the edge-regions. An example is to extract aphids from images of soybean leaves. We may count the number of aphids that live on the sampled leaves and obtain an exact size of each aphid. With those information, farmers can get the appropriate time to dust powder.

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