SEGMENTATION OF ADJACENT CELLS IN A C. ELEGANS EMBRYO USING A MULTI-COMPARTMENT ACTIVE CONTOUR

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Active contours - a.k.a snakes - are popular models for the segmentation of biological structures. They consist in an initial closed curve that evolves towards the boundary of the object of interest. The evolution is driven by the minimization of an application-dependent energy term.

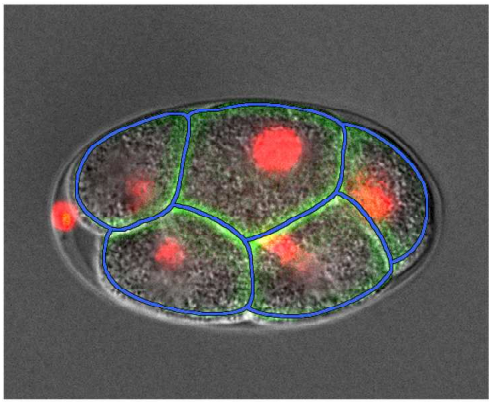

Figure 1: A C. elegans embryo in a light sheet fluorescence microscopy image. Red: nuclei; Green: membranes; Blue: snake.

We present a framework to automatically segment a compact cluster of cells in a C. elegans embryo in 2D light sheet fluorescence microscopy images. For such a purpose, we designed a multi-compartment active contour to fit a structure composed of several adjacent cell membranes. We take advantage of subdivision schemes: for each compartment we recursively apply a refinement process to an initial set of few points to produce a continuous limit curve. The final multi-compartment curve is then deformed in a global manner using a suitable ridge-based energy attracted by the fluorescent membranes. We automatize the initialization of the snake by constructing a Voronoi diagram around the labeled nuclei. This framework has several advantages: 1) the coherent structure of the multi-compartment curve is maintained even on membranes with low or missing fluorescent information. It avoids the leaking problem which afflicts classical image-processing methods; 2) it requires few parameters (i.e., control points), which results in faster optimization and better robustness; 3) the user can intuitively interact with the curve by modifying some control points.
We validated our framework both on synthetic and real fluorescence microscopy images showing that our algorithm is robust to dim staining and to high levels of noise.

We implemented this framework as a user-friendly plugin for the bioimaging software package Icy.