Cell segmentation using active contour

In biology, often automated computational methods are necessary for determination of for nuclei/cell shape, size and cell count from images. This requires extracting individual cells or the cell boundary (cell segmentation). Segmentation of cell nuclei and cell membrane in a densely packed cell environment is a difficult task. Further, the low image resolution in 3D imaging techniques, signal inference from tissue, creates a more challenging scenario for segmentation. The main objective of this project is to develop a segmentation method to detect the cellular region/cell boundary from 2D images. As can be seen from the images, since the cells are densely packed the membrane of two neighboring cells is harder to separate. However, since the nuclei lie within the cell, the separation of the nuclei are more prominent compared to the membrane. Hence, we propose to first detect the nuclei and propagate the detected contour outwards to merge with the membrane.

The project has two sub-parts as follows.

1. The first step of the project involves detection of the nuclei regions (an enhanced image will be provided). A 2D blob detection and clustering method will be employed to detect the nuclei regions. An approximate nuclei detection is sufficient to initialize the contour.
2. The second goal is to employ active contour based model initiated at the detected nuclei regions (in blue) and is evolved outward simultaneously. The evolution of the active contour model is constrained by the cell membrane (in green) i.e., the contour will evolve until it reaches the membrane or another contour [1, 2] (the final contour is similar to the curve marked in white in Fig. 1).

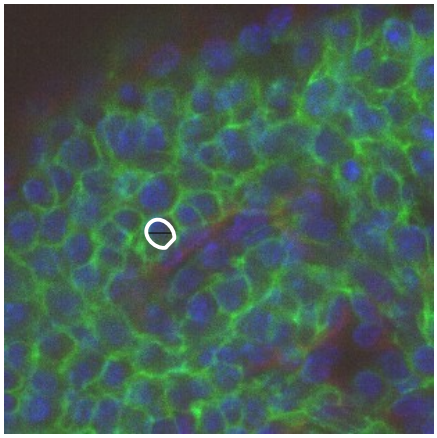

Figure 1: The blue regions denote the cell nuclei and the cell membrane is shown in green

References:

1. Wang, J., et al. "Bact-3D: A level set segmentation approach for dense multi-layered 3D bacterial biofilms." *2017 IEEE International Conference on Image Processing (ICIP)*. IEEE, 2017.
2. Levinshtein, Alex, et al. "Turbopixels: Fast superpixels using geometric flows." *IEEE transactions on pattern analysis and machine intelligence* 31.12 (2009): 2290-2297.