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Application of variational shape models in single cell tracking

The analysis of single cells provides valuable insights into ex vivo cell assays. This is achieved by taking time series of images of cell cultures and analyzing the behavior of the individual cells with respect to migration, division, mitosis and cell-cell interaction.

However, due to the large amount of data complete manual reconstruction of the cell trajectories is not feasible, which indicates a urgent need for automated methods. As computerized approaches lack the highly optimized features of human perception, it is especially the reliability of cell detection and the tracking in the presence of object occlusion and large displacements between single images which represent the major difficulties for individual cell tracking.

We present an essentially novel approach to mitigate these problems using recently developed methods in image processing incorporating prior shape knowledge into the detection of objects. In particular, the problem of object occlusions and blurry object outlines due to noise in the data can be handled by this extension. We adapted the active contour framework with prior shape information to the problem of robust cell detection. The method is able to detect cell shapes more accurately and thus allows for the utilization of refined tracking algorithms using more robust object features for the mapping of cells between images. We further present a direct application of the active contour models to the joint detection and tracking of moving, deformable cells.