

Integrating system for segmenting and tracking fluorescent objects on the image data of growing cell colonies.

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The problem of segmentation and tracking luminescent objects like marker painted walls or nuclei of live cells received significant attention with recent development of the methods of scanning laser microscopy. While widely used image processing techniques from basic filtration plus thresholding to watershed and active contour PDEs. Provide sufficiently reliable results if required error allowance is no better than several percent, for confident tracking of large number of particular cells through long time series one would need to achieve segmentation and tracking accuracy comparable to that of a skilled researcher who process small amounts of data manually. A human researcher would take multiple features of a picture on the screen (shape, size, amplitude, relative local and global disposition of the objects, etc) into account either accepting or rejecting assumptions based on one or two major features or, if uncertain, expanding investigation to involve other possible features, make and check additional assumptions while at each step estimating probability/weight possible decisions until required level of assurance is reached.

The macro managing 'cercell' system is intended to work with a generalized image processing package to provide processing qualities similar to the described above. The structure of the system contains of the following

- A basic vector of features which may include individual and relative properties of the objects
- A vector of assurance level parameters and the corresponding equations relating the feature vector to the assurance level parameters. The equations can be as trivial as identity to as single with an accept/reject threshold.
- Priority order vector listing significance levels of all involved assurance parameters.
- The infrastructure of supplemental methods necessary to extract features, calculate the parameters, etc...
- The learning routine which takes the given data as an input and possible ground truth and outputs the assurance level parameters and the priority order list.
- The main processing routine which after standard predefined steps like initial image processing of the package and learning step finds the assurance levels in the order given by the priority list vector until one of the assurance parameters reaches desired value. A possible result is that the condition is not reached, i.e. a valid output would be uncertain to make decision. For example: can't distinguish a cell from an artifact or two close cells from one or two types of cells, etc.

One of the main goals of the system was to provide an integrating medium interfacing the processing and learning procedures in one flexible package which would segment and track objects at the next level of accuracy and at the same time provide measure of the probability for The decisions made. The package showed excellent results in the case of growing colonies of plant cells (Arabidopsis Thaliana).