Introduction

- Quantitative data and statistics on mitochondria, present in the cell, are sought by biologists in order to quantify and understand the mitochondrial degradation during apoptosis, as well as fusion and fission processes.

- Mitochondrion:
  - double (outer, inner) membrane
  - folded inner matrix
  - cristae

Some currently unsolved problems are [1]:

- What controls the total surface area in a mitochondrion?
- Can the structure of the matrix be linked to the control of mtDNA, the location of protein synthesis, and/or the shape of the mitochondrion itself by means of its internal structural elements?

- An automated segmentation algorithm will provide an accurate, objective and fast quantitative information on the shape, the structure and the spatial distribution of mitochondria in subcellular regions.

Challenges in Segmentation

- Poor contrast, non-uniform illumination
- Close lying, attached and/or non-separable objects
- Non-parametric texture

Figure 1. Mitochondrial morphology

Figure 2. Segmentation Approach

Preprocessing
- Noise removal, non-uniform illumination, contrast enhancement...

Edge-based marker function
- a-priori based texture analysis...

Region-based morphological reconstruction, watershed...

segmented image

Figure 3. HeLa cell with normal mitochondrial morphology [2]

- Next step is to determine the location of the mitochondrion and to extract its boundaries.
- Especially problematic when encountering close lying or overlapping mitochondria, where the additional classification step is necessary for the determination of the correct object boundaries.

Preliminary Results

- Multi-stage segmentation approach is composed of preprocessing, object localization and texture analysis.
- Localization is based on a-priori assumption of mitochondrial morphology of interest.
- Preprocessing consists of contrast enhancement, structural noise removal and compensation for the uneven illumination.

Discussion

- Current texture analysis is partly edge-based and therefore error prone as the quality of extracted edges depends on the quality of the preprocessing operation.
- The choice of suitable markers for watershed segmentation is highly constrained. The generalization to all EM images containing mitochondria is under development.

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