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B-Spline Level Set For Drosophila Image Segmentation

Session
TEC-07
Biomedical and Biological Image Processing II

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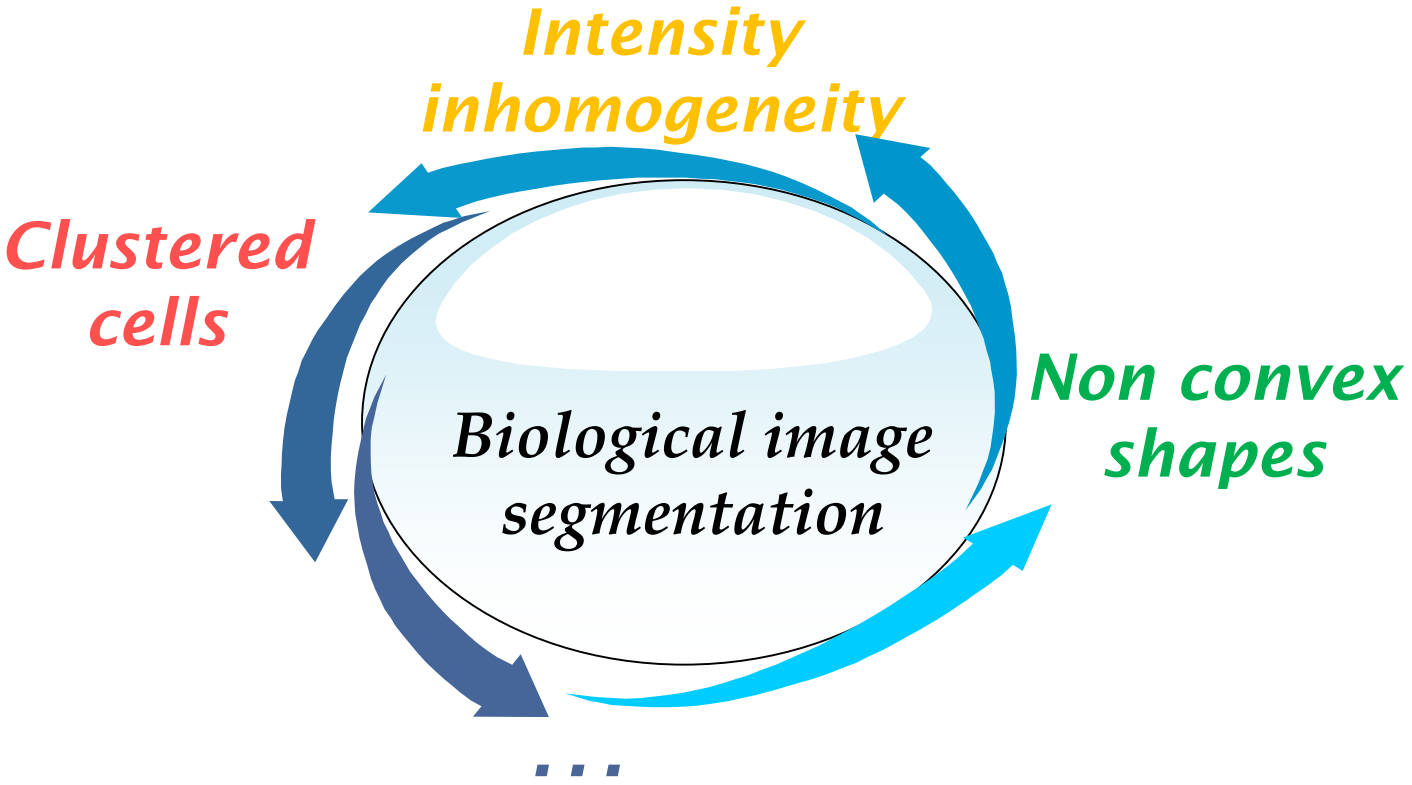
Outline

1. Introduction



1. Introduction

Segmentation algorithms

- DNA, F-actin and GFP-Rac are used for nuclei and cytoplasm detection
- Fuzzy C-means based Multi-Threshold segmentation and Sharpening technology
- Watershed algorithm based on simulation of flooding process
- Deep-Learning with different Network Structures

Outline

2. Problem statement

However

Most of algorithms cited above are based on the discrete level set function

How to overcome this problem ?

requires a periodical re-initialization step to reshape the contour which increases the computational cost

Continuous representation of level set function using the B-spline coefficients is proposed

Outline

3. B-spline Level Set for Image Segmentation

The key idea of the B-spline level set is

- Expressing the level set ϕ as a linear combination of B-spline coefficients

$$\phi(x) = \sum_{K \in \mathbb{Z}^d} c[k]\, \beta^n\left(\frac{x}{h} - k\right)$$

- The energy function J is minimized with regard to B-spline coefficients c_i

$$\nabla_c J = \frac{\partial J}{\partial c[k]} = \int_{\Omega} \omega(x)\, \beta_h^n(x - hk)\, dx$$

3. B-spline Level Set for Image Segmentation

Given by

$$\omega(x) = \left(\lambda_{in}(f(x)-\mu_{in})^2 - \lambda_{out}(f(x)-\mu_{out})^2 - \nu div\left(\frac{\nabla\phi(x)}{|\nabla\phi(x)|}\right)\right) \times \delta(\phi(x))$$

Active Contour model

Chan Vese model is used for B-spline level set implementation

Partioning the image into two regions with piecewise constant intensity

3. B-spline Level Set for Image Segmentation

- Global control over the entire computational domain of the level set
- Deal with noisy images
- Efficient Implementation
- Less computational cost

Outline

4. Segmentation Results

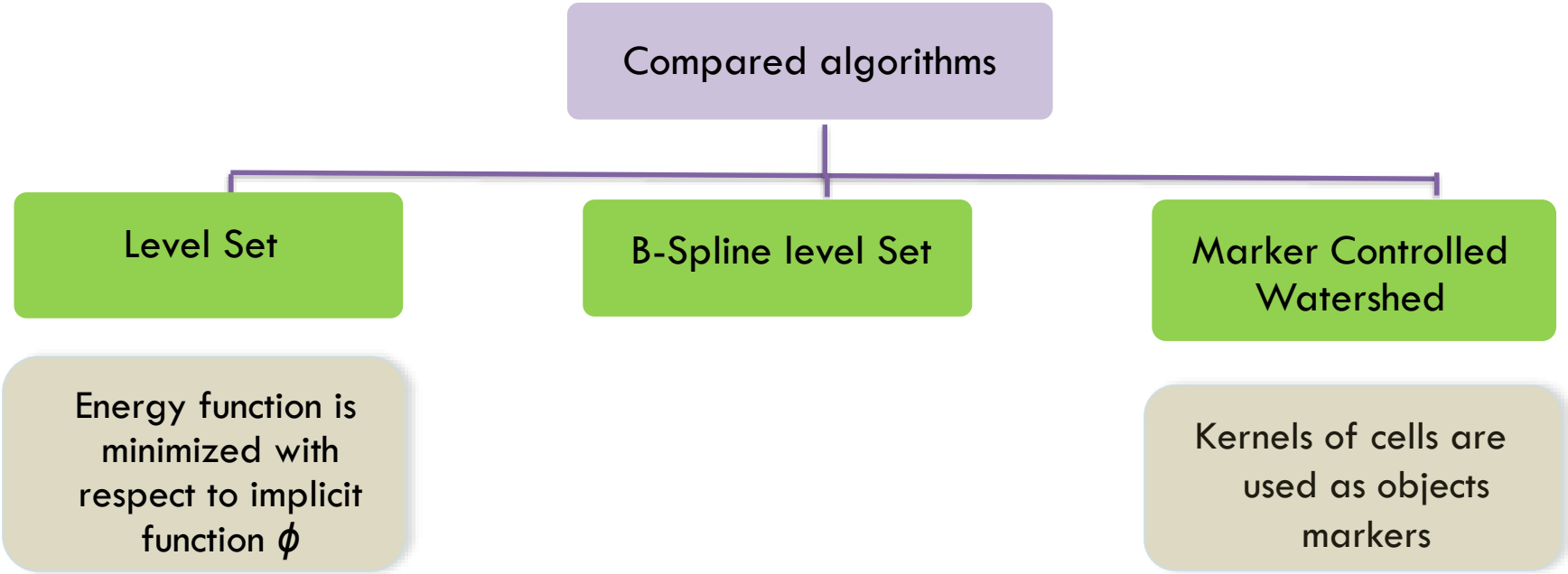
- Drosophila RNAi experiments.
- Presence of locally low contrast values
- Large number of cells to be segmented
- Clustered cells.

Drosophila images

What kind of images are used in this work ?

- Dimension : 686×518 pixels
- Image Preprocessing : Local Normalization
- Source :Valrose institute of Biology (iBV)

4. Segmentation Results



4. Segmentation Results

In this work:

- Results are presented for fixed parameters
- Results are presented for varing parameters h and initialization
- Results are presented for noisy images

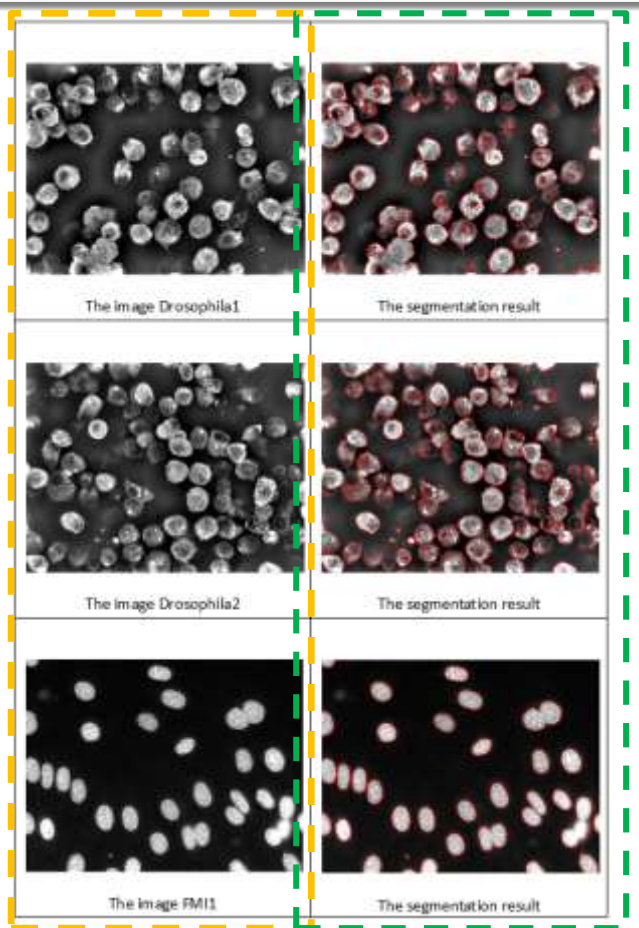
4. Segmentation Results

Fixed Parameters

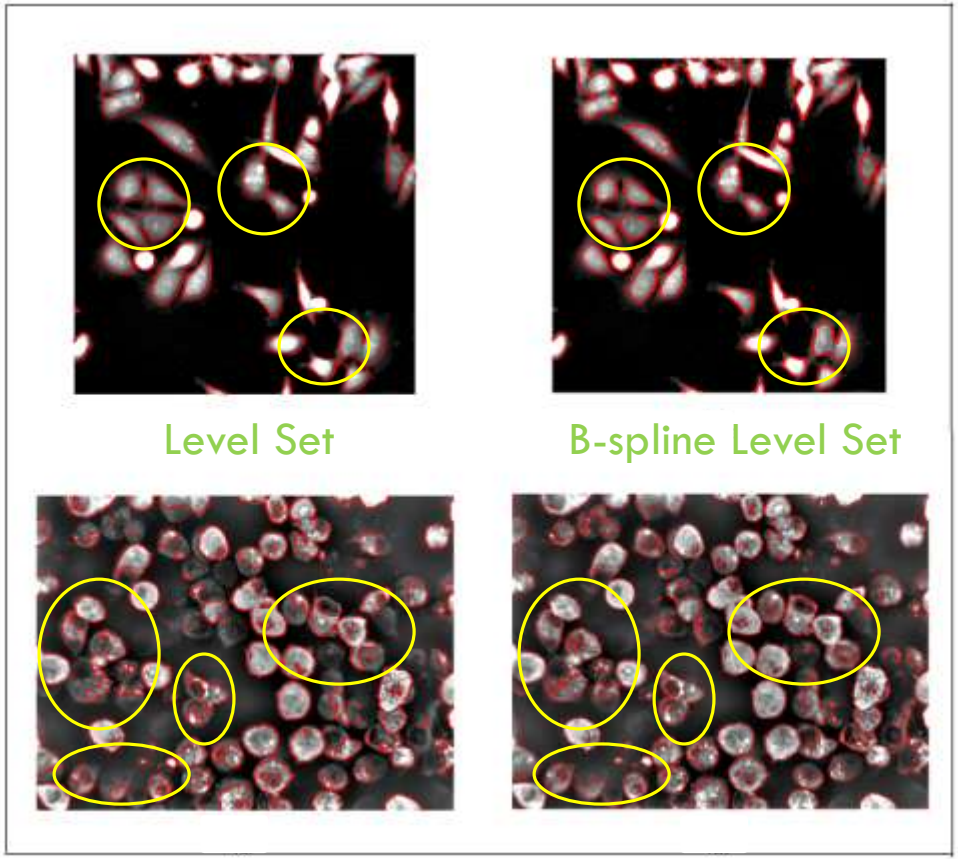
Results are presented for the same initialization and a fixed h

4. Segmentation Results

Good segmentation performance is clearly noticed



4. Segmentation Results



FMI 2

Superiority of the B-spline level set

Drosophila 2

4. Segmentation Results

DICE

- Calculates the degree of similarity between the segmented image and the ground truth.
- Ground truth are given with manual segmentation (provided by biologist)
- 1== identical regions 0 ==different regions

4. Segmentation Results

	B-spline level set	Level set	Marker Controlled Watershed
Drosophila 1	0.7861	0.7279	0.6501
Drosophila 2	0.7422	0.6423	0.6819
Drosophila 3	0.7993	0.6999	0.6975
Drosophila 4	0.7423	0.6256	0.6422
FMI2	0.7648	0.6698	--

DICE coefficient for Drosophila images and FMI 2

4. Segmentation Results

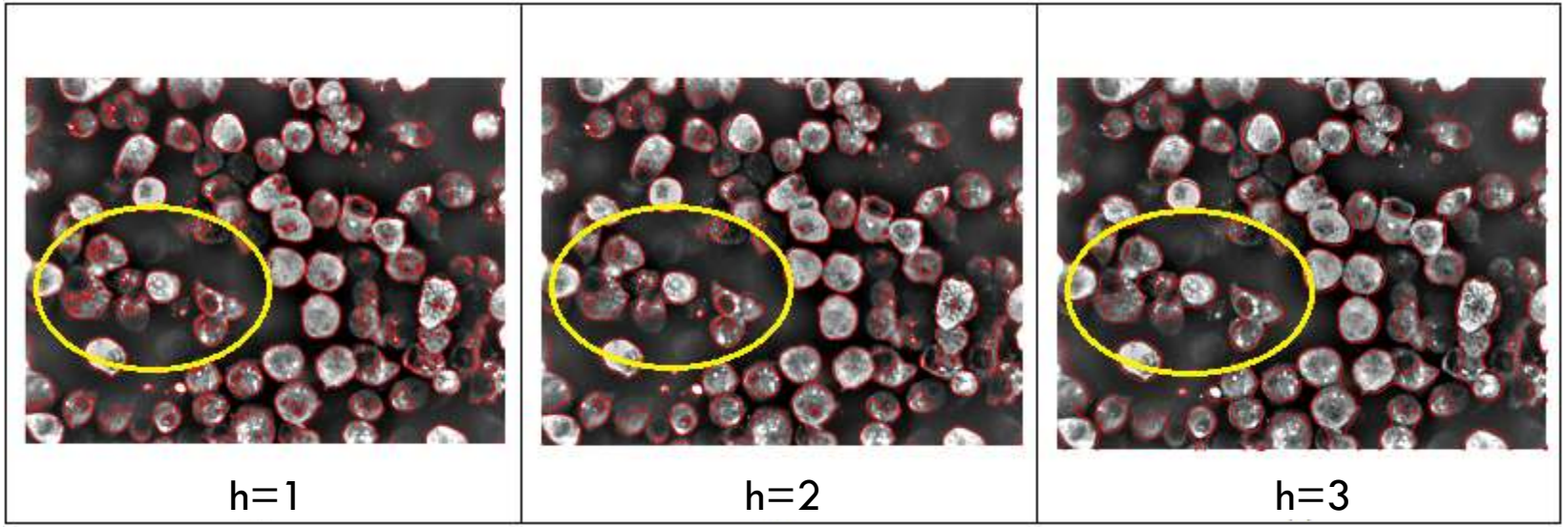
Varing Parameters

Results are presented for varing values of parameters scale h and initialization

4. Segmentation Results

Scale h

h controls smoothing of level set
With increasing h, the high level of smoothing makes cells blurry



4. Segmentation Results

Initialization

The final result of the evolution is obtained through a simple inversion of the expansion coefficients

Same results can be obtained using diverse initial contours

The B-spline allows a flexible initialization

4. Segmentation Results

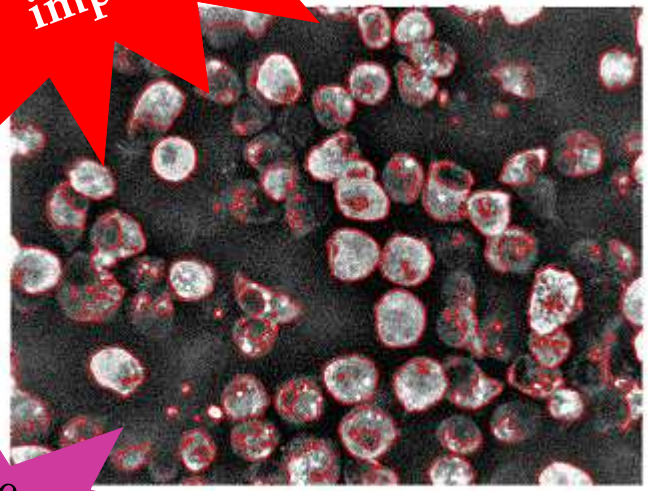
Noisy Images

What about noisy images ?

4. Segmentation Results

No significant impact

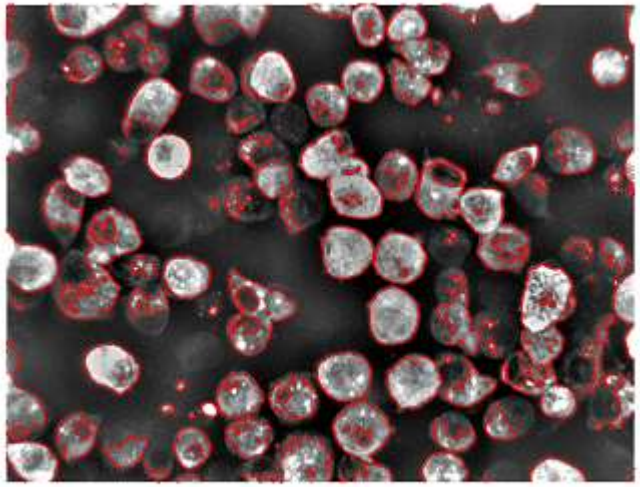
Drosophila 2



Dice
0.6644

Dice= 0.6423 for level set

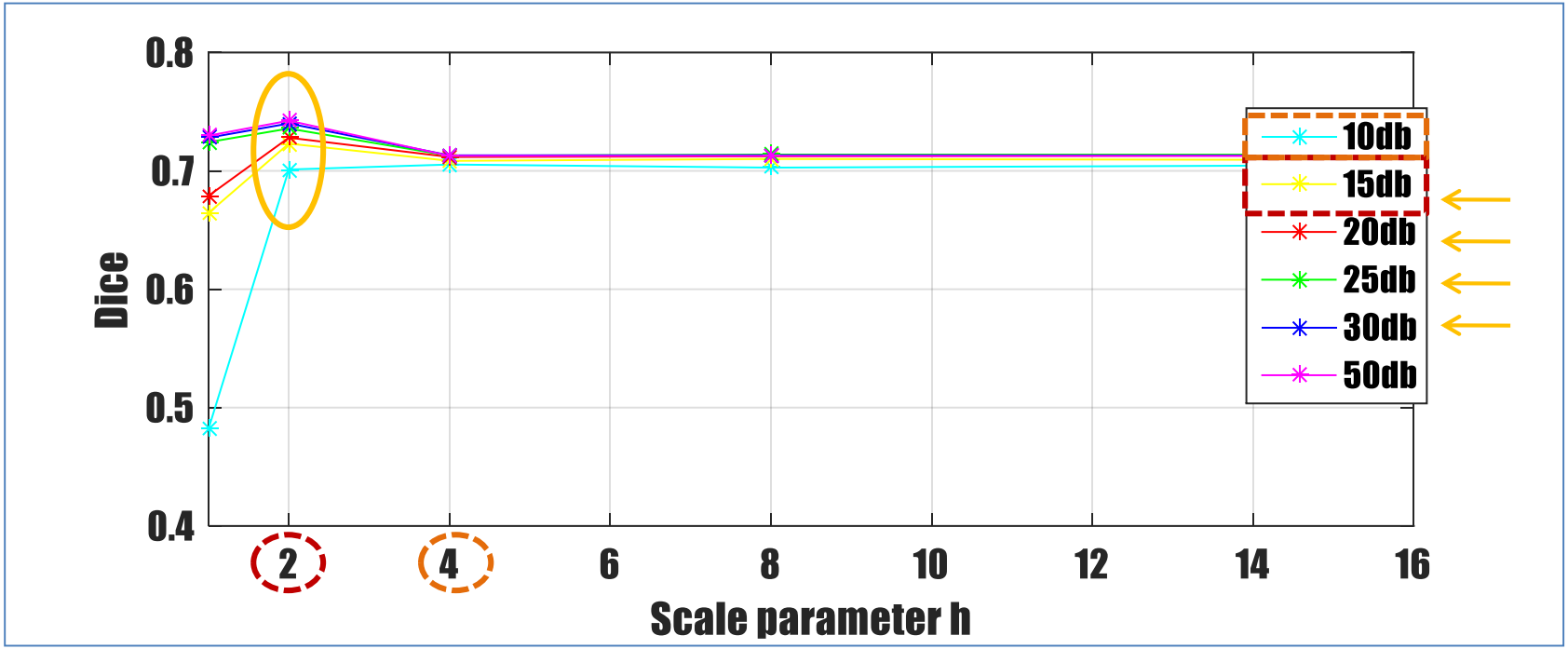
15 db



Dice
0.7400

30 db

4. Segmentation Results



DICE coefficient as a function of the scale parameter for varying noise levels

Outline

5. Conclusion et perspectives

Conclusion

1

Improved version of B-spline level set is proposed based on Chan-Vese model

2

Takes in consideration intensities inhomogeneity Within Drosophila images

3

B-spline level set outperforms the conventional level set and Marker Controlled Watershed

5. Conclusion et perspectives

PERSPECTIVES

1. Using different model
2. Preprocessing and postprocessing steps
3. Using other evaluation metrics

Thank you for your attention

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