

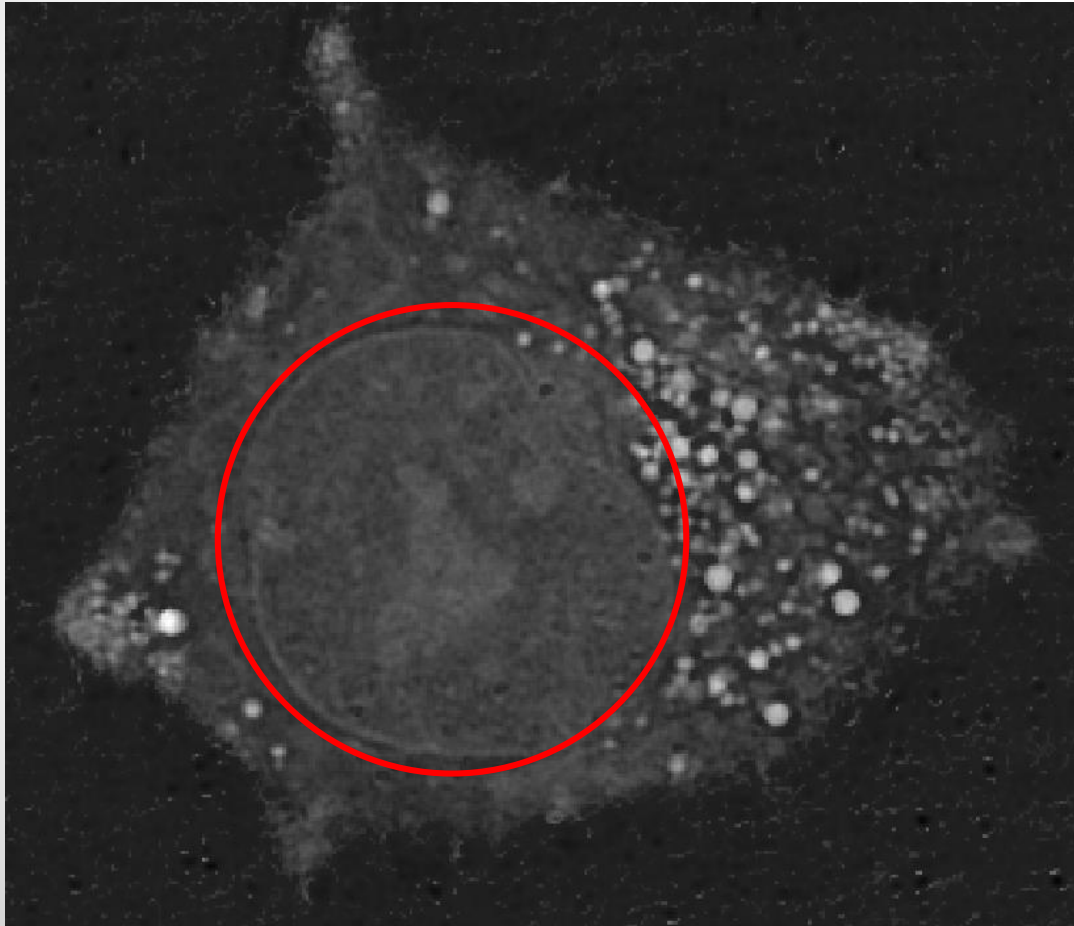
Quantitative 3D Nuclei Modeling based on Shape Prior Segmentation

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Problem

- 3D Eukaryotic cell image

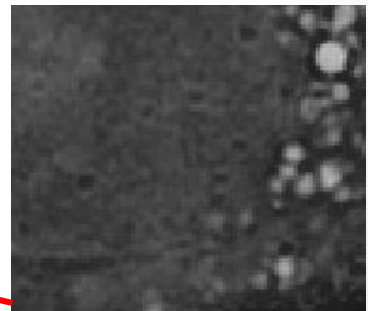
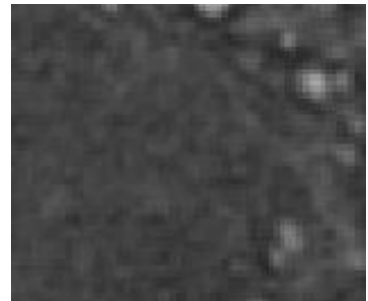
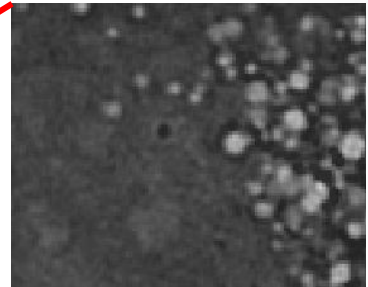
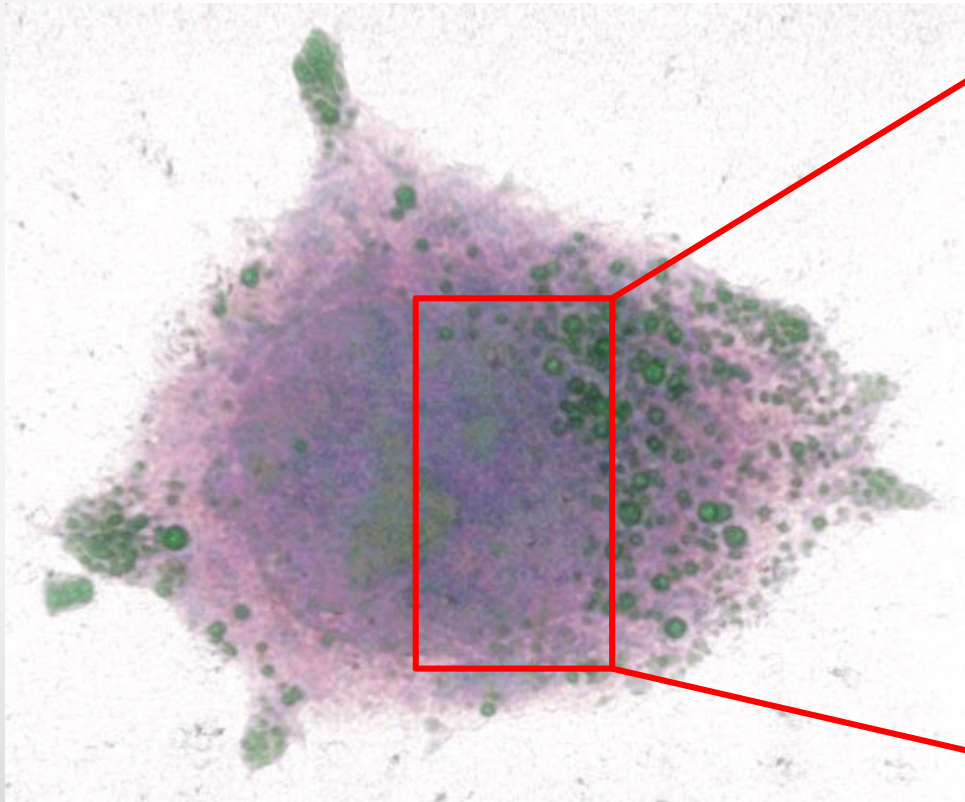


- Cell membrane
- Cell nucleus
- Cell organelle

Quantification of the shape of the cell nucleus is important in clinical pathology

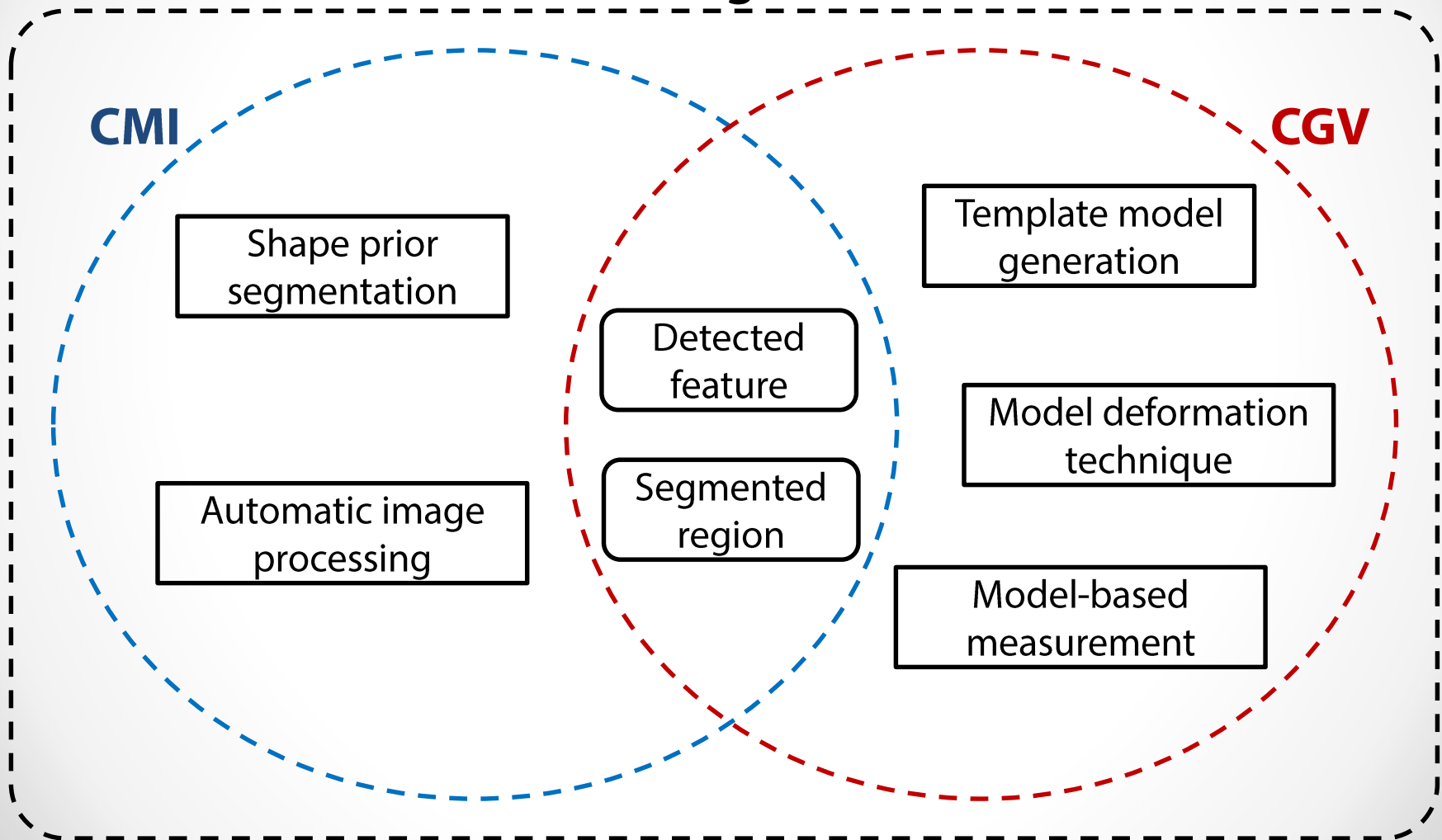
Problem

- Vague boundary of the nuclear membrane
 - Can cause **incomplete** segmentation result

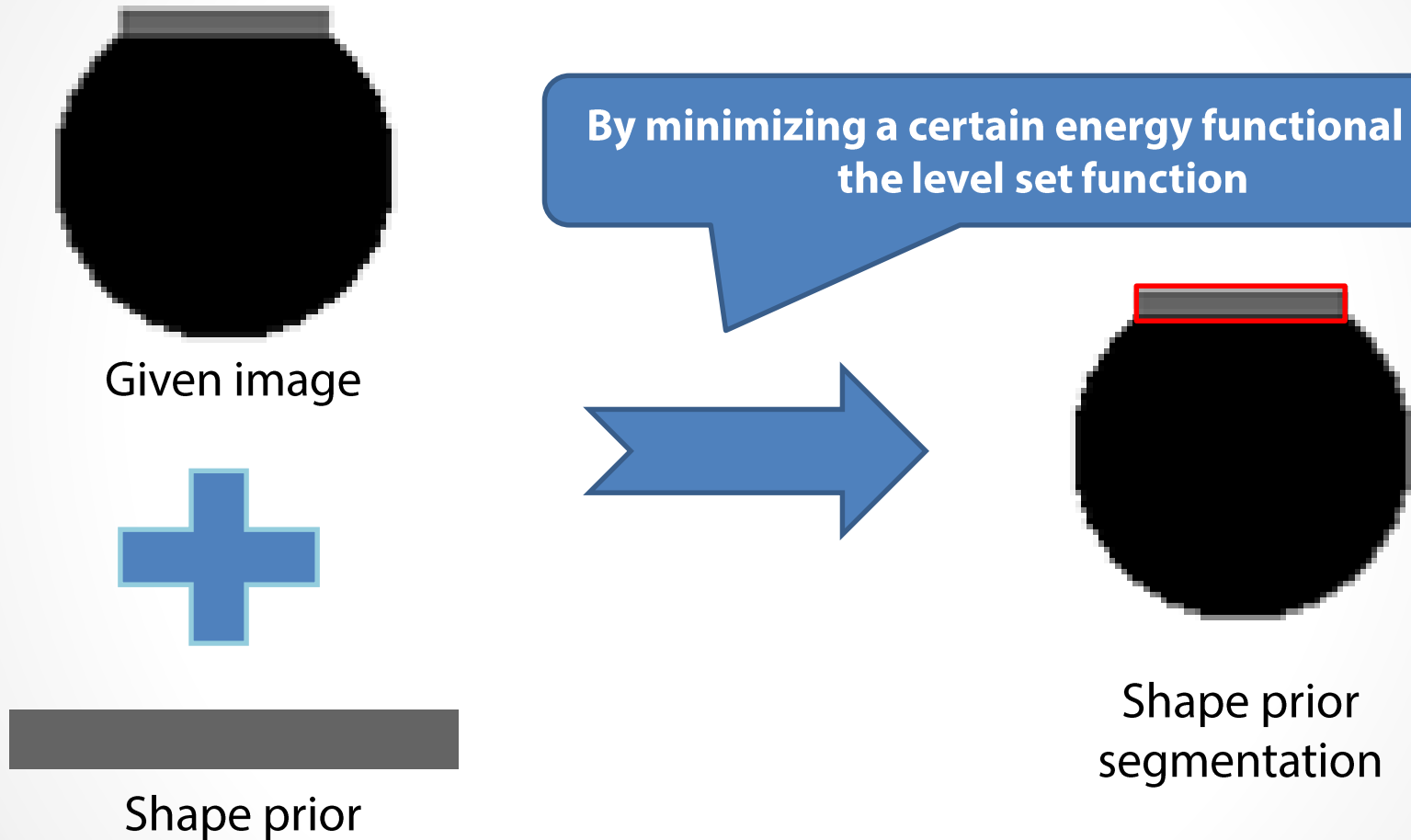


Overview

Quantitative 3D Nuclei Modeling



Shape Prior Segmentation



Chan & Zhu: Level set based shape prior segmentation (2005)

Shape Prior Segmentation

- Energy functional for Shape Prior Segmentation

ϕ : Level set function for whole segmentation

ψ : Level set function for shape prior segmentation

$$\begin{aligned}
 E(\phi, \psi, c_1, c_2, c_3, c_4) &= \int_{\Omega} (u - c_1)^2 H(\phi) dx + \int_{\Omega} (u - c_2)^2 (1 - H(\phi)) dx \\
 &\quad \text{: Chan-Vese Segmentation} \\
 &+ \lambda \int_{\Omega} \{ (u - c_3)^2 H(\psi) + (u - c_4)^2 (1 - H(\psi)) \} H(\phi) dx \\
 &\quad \text{: Shape Prior Segmentation} \\
 &- \mu \frac{\int_{\Omega} \phi(x) (1 - H(\phi)) H(\psi) dx}{\int_{\Omega} (1 - H(\phi)) H(\psi) dx}. \\
 &\quad \text{: Energy term for attraction } \psi \text{ to } \phi
 \end{aligned}$$

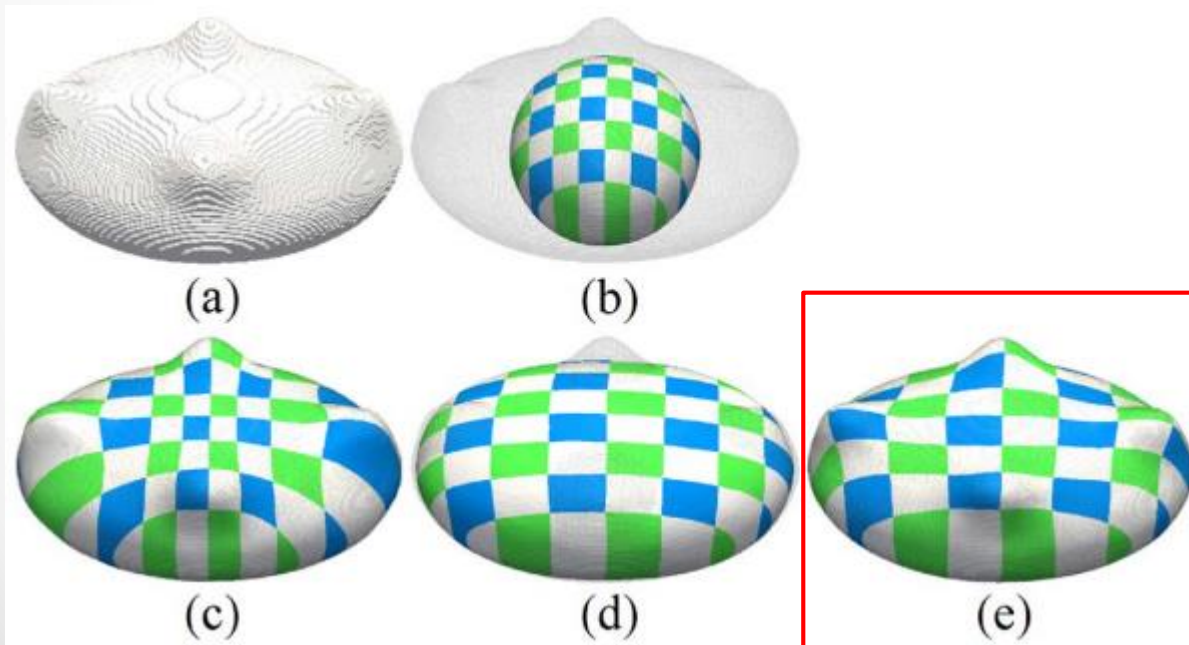
Shape Prior Segmentation

- Advantage of Shape Prior Segmentation
 - Segmenting **meaningful objects** from images when the objects are **occluded** by other objects or some parts of them are in **low gray contrasts** or even **missing**



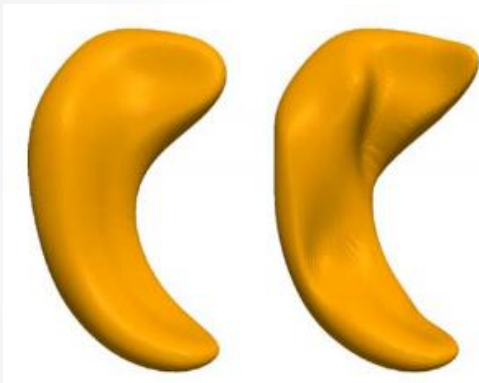
Progressive template surface deformation

- Template initialization
- Non-rigid model deformation
- Local shape detail restoration

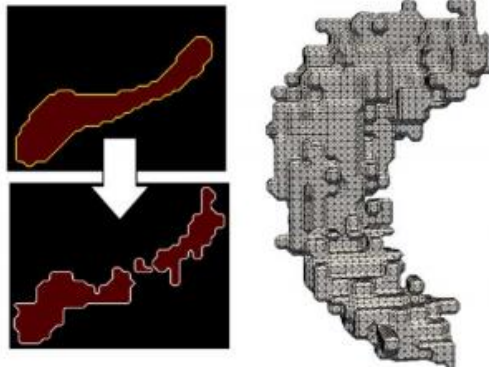


Progressive template surface deformation

- Advantage of surface deformation
 - Work well with imperfect segmentation in terms of robustness



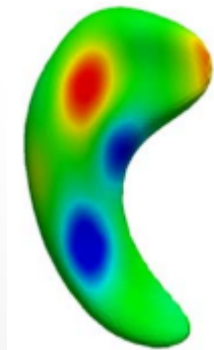
Synthetic data
Original(left) deformed(right)



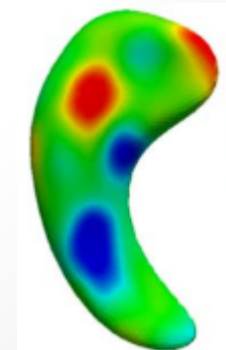
Add noise



*Generated model using
surface deformation*



*Visualization of
regional shape deformation
from original synthetic data*



Tentative plan

- May ~ July
 - Development of automatic segmentation technique
 - Template model construction
 - Development of model deformation technique
- September
 - Progress report
- October ~ November
 - Wrap up for core-technique
 - Quantitative measurement
- December
 - Validation

THANK YOU 😊