CELL NUCLEI SEGMENTATION IN GLIOMA HISTOPATHOLOGY

COLOR DECOMPOSITION BASED ACTIVE CONTOURS

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CONTRIBUTION: COMPUTERIZED HISTOPATHOLOGICAL IMAGE ANALYSIS

- We are developing a computational pathology system for the analysis of glioblastoma multiforme (GBM) from brain tumor pathological images.
- We utilize a mathematically well-defined segmentation method combining nuclear staining and color decomposition based features.
- The applications are in nuclei segmentation for feature extraction and devising an accurate classification system for disease stage classification [1].

NUCLEI SEGMENTATION BY ACTIVE CONTOURS

We use the chromaticity-brightness (CB) decomposition of a given multi-channel image $\mathbf{I}$, which provides

- The intensity or brightness $B : \Omega \rightarrow [0, L]$ computed as $B = |\mathbf{I}|$, where L is the maximum intensity value, and
- The chromaticity channels $\mathbf{C} = (C^1, C^2, C^3) : \Omega \rightarrow \mathbb{S}^2$ where $\mathbb{S}^2$ is the unit sphere in $\mathbb{R}^3$.

We then use the convex formulation of the traditional vector valued Chan and Vese method [2]. This is equivalent to solving the following minimization problem [3]:

$$\min_{0 \leq u \leq 1, \mathbf{c} \in \mathbb{R}} \mathcal{E}(u, \mathbf{c}) = \int_{\Omega} |\nabla u| + \int_{\Omega} (\lambda_N F_N + \lambda_C F_C) u \, dx \quad (1)$$

where $\lambda_N \geq 0$, $\lambda_C \geq 0$ are the tunable parameters for the brightness and total chromaticity feature fitting terms respectively.

Nuclear channel-based feature fitting: To reduce the color variation across slides and to obtain nuclear staining information we utilize here a decomposition matrix provided in [4],

$$F_N(x, \mathbf{c}) = [(DI - d^{fg})^2 - (DI - d^{bg})^2] \quad (2)$$

Chromaticity based fitting: The chromaticity channels exhibit in-homogeneous and spatially varying nature. We utilize a sum of chromaticity fitting terms,

$$F_C(x, \mathbf{c}) = \sum_{i=1}^3 [|C^i - c_{in}^i|^2 - |C^i - c_{out}^i|^2] \quad (3)$$

WEBSITE AND MORE INFORMATION

- Download the poster @ figshare.com: <http://dx.doi.org/10.6084/m9.figshare.1588805>
- Project page: <https://goo.gl/FzxcPC>

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FEATURE FITTING AND SEGMENTATION RESULTS

Our segmentation method obtains better nuclei segmentation using different image feature channels.

(a) Low grade glioma input image. (b) Decomposed nuclear channel DI . (c-e) Chromaticity channels (C_1, C_2, C_3). (f) Our proposed active contour based segmentation result.

Comparison of different automatic segmentation methods on high grade glioma.

ADVANTAGES AND CURRENT WORK

- ✓ Chromaticity – Brightness decomposition based fast active contour segmentation scheme.
- ✓ For a color image of size $2k \times 2k \times 3$, the proposed scheme takes 20 seconds to get the final segmentation result (40 iterations for the split Bregman method).
- ✓ We are currently evaluating our nuclei segmentation approach for disease stage classification and feature extraction [1].

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