Cell Density Estimation from a Still Image for In-Situ Microscopy

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On-line automatic cell density estimation (cell count) with no risk of culture contamination
Cell density estimation algorithm

1) Capture a digital cell image $I$
Cell density estimation algorithm

2) Compute the local variance at each pixel position using a 3x3 window
Cell density estimation algorithm

3) Classify the pixels into pixels of the cell clusters and pixels of the background by applying a Maximum-Likelihood thresholding algorithm
Cell density estimation algorithm

4) Eliminate isolated white pixels by applying a 5x5 median filter

5) Eliminate regions whose image area is less than 0.05% of the total image area
Cell density estimation algorithm

6) Estimate the average cell radius $R_k$ of each cluster $k$ by maximizing the variance of the circular Hough transform of the edges inside the cluster

$$\sigma(H(R_k))^2 \geq \sigma(H(r))^2 \forall \ r = 1, 2, \ldots$$
Cell density estimation algorithm

7) Compute the number of cells $D_k$ of each cluster $k$ as the quotient between the area of the cluster $A_k$ and the area of a circle of radius $R_k$

$$D_k = \frac{A_k}{\pi R_k^2} \times 0.765$$
Cell density estimation algorithm

8) Compute the total cell density $D$ of the image $I$

$$D = \sum_{k=1}^{K} D_k$$
Experimental results

Manually determined cell density (solid line)
Automatically estimated cell density (dashdot line)
Experimental results

- Processing time: **15.88s**
- Absolute error: **6.27%**
- Cell density estimates similar to those obtained with off-line techniques up to cell densities of **5x10^6 cells/mL**
Conclusions

- Reliable cell density estimation even though cells build clusters in the scene
- Cell density estimates similar to those obtained with off-line techniques up to cell densities of $5 \times 10^6$ cells/mL
- For higher cell concentrations the 3D shape of the clusters must also be estimated and taking into account for cell density estimation