

A Comparative Analysis of Centrosome and Soma Migration in Neurons

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https://info.ornl.gov/sites/rams09/r_boerner/Pages/default.aspx

Inspiration

- Relationship discovered between certain diseases and abnormal neuronal migration
- Neurons found to migrate in utero or early years of development

Background

- St. Jude Children's Research Hospital used fluorescent proteins to highlight certain parts of the neurons in cerebellum and retina.
- Ryan Kerekes of Oak Ridge National Laboratory used MATLAB with the Image Processing Toolbox to generate an algorithm that detects and tracks the centrosomes.

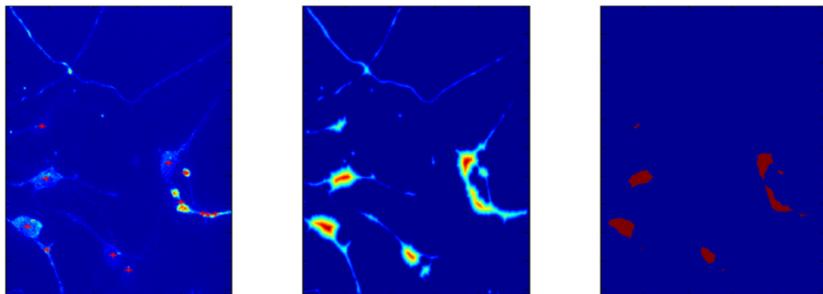


Fig. 2 (left) An image after a rotationally symmetric Gaussian lowpass filter is applied. (center) The image after thresholding for intensity and distance from the center of an object. (right) The segmentation of the somas based on regions being larger than a certain radius.

Results

- Centrosomes move at an average speed of $0.1 \mu\text{m/s}$
- Somas move at an average speed of $0.03 \mu\text{m/s}$
- Minimal movement due to chemicals added before imaging (Fig. 3)

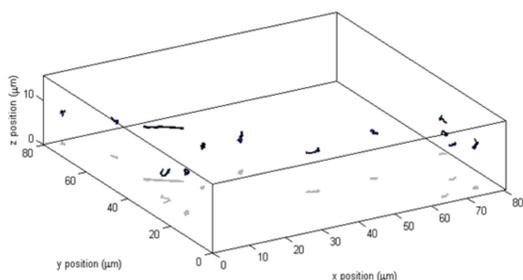


Fig. 4. A three dimensional plot of centrosome movement in the x-, y-, and z-directions.

References

- "ORNL, St. Jude track neurons to predict and prevent disease." *The Oak Ridger*, 30 March 2009, sec. A3.
- R. A. Kerekes, S. S. Gleason, N. Trivedi, and D. J. Solecki, "Automated 3-D tracking of centrosomes in sequences of confocal image stacks," submitted to *EMBC '09*, Minneapolis, 2009.

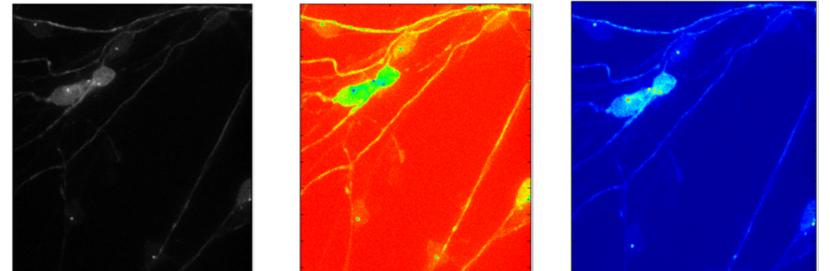


Fig. 1. These images are different color schemes of the same field. The use of a color schemes different from the first grayscale image helps to see more details.

Research Objectives

- Evaluate image enhancement for analysis purposes (Fig.1)
- Create programs to detect and track neurons
- Analyze images (Fig. 2)
- Develop relationship between centrosome and soma migration patterns

Methods

- Constructed a code using MATLAB with Image Processing Toolbox to segment and track the somas
- Compared the migrations of the centrosome and soma using Microsoft Excel

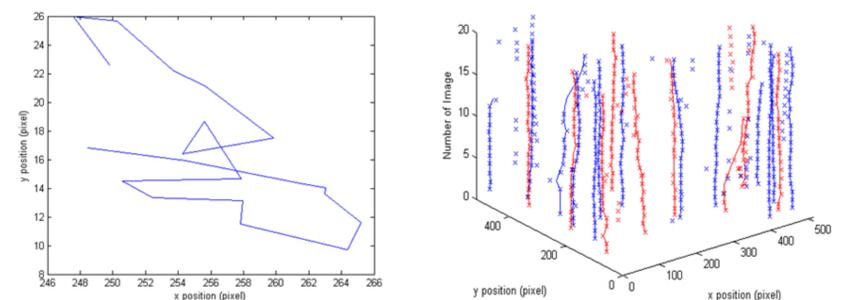


Fig. 3. (left) This graph is the plot of the motion of the soma throughout the various timeframes. Each pixel corresponds to $0.15 \mu\text{m}$. (right) The graphs are 3D images of the detections and tracks of somas and centrosomes. The red marks the soma tracks and the blue corresponds to the centrosome tracks. The images were taken over 16 seconds.

Future Work

- Analysis of neuron migration in three dimensions (Fig. 4)
- Study and track actin movement
- Recognize patterns of behavior between neuron migration and specific diseases
- Build techniques for the alteration or prevention of abnormal neuron migration