College of Science, Department of Physics

A Novel Approach to Line Detection using Image Integration Method

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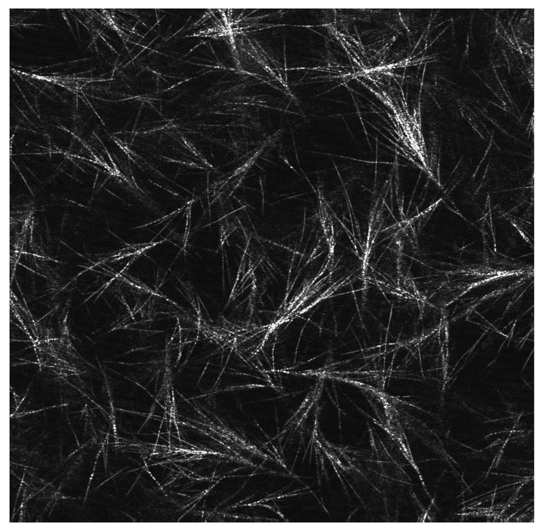
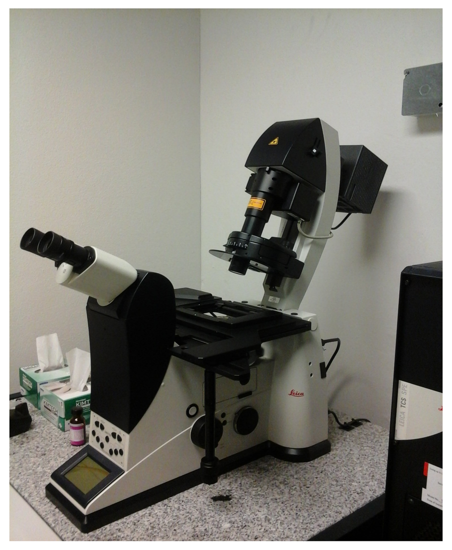
Introduction



Example of a Collagen Image



Leica Confocal Microscope Used in Our Lab produce collagen images

- The purpose of the line detection algorithm is to identify collagen fibers on an image produced by a confocal microscope

- Collagens are fibers that are found in 25% of whole body protein content. They are highly adhesive to cells and can be used as scaffold proteins that can promote cell growth.

- We use collagens to capture cancer cells to study them. In order to understand how cancers behave within the collagen we must identify the fibers on the image and find their translation and orientation.

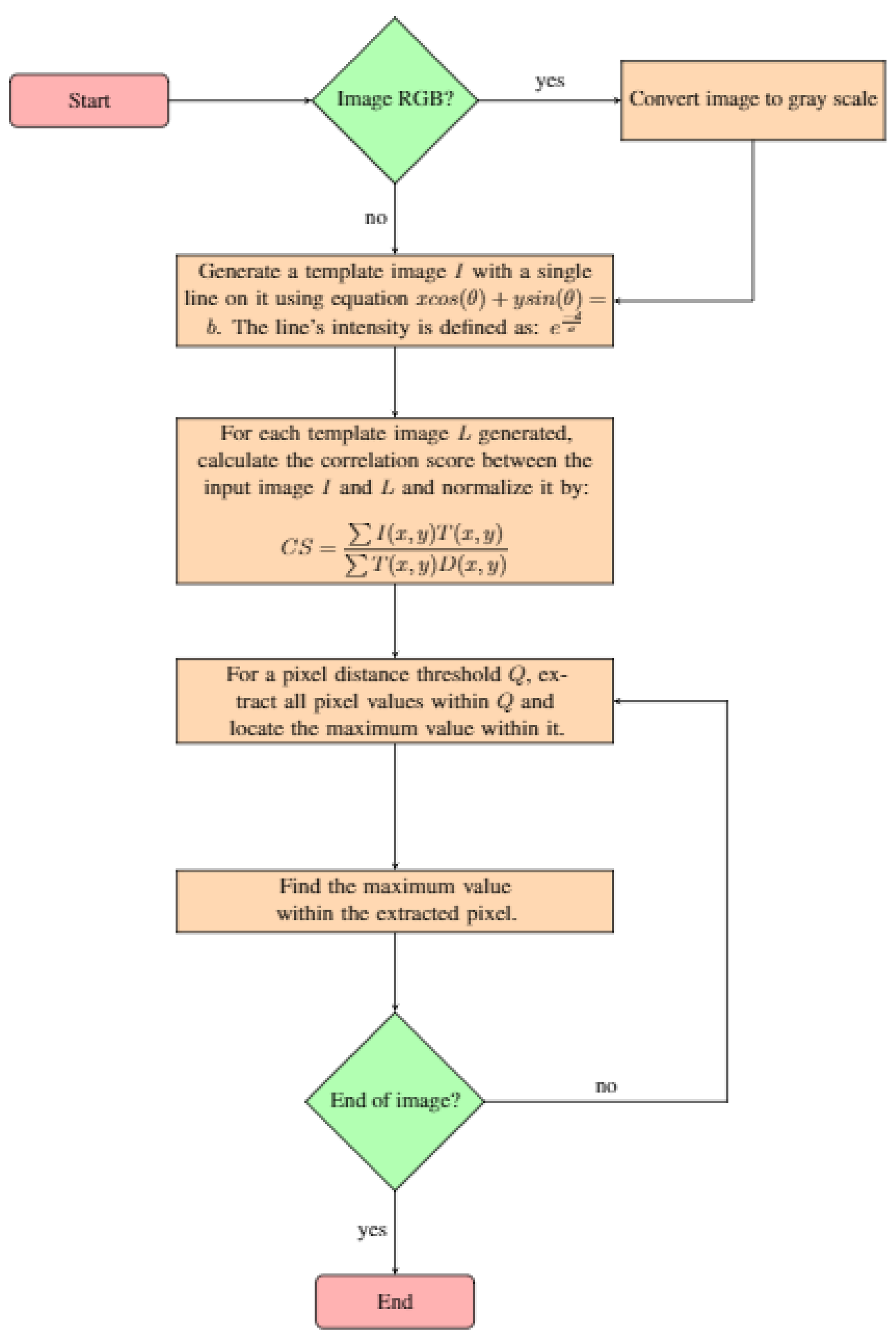
- Confocal microscope images have complex textures and noises. In our case, our images is filled with Gaussian noises

- Existing line detection algorithms such as Hough Transforms requires filters to filter noises out of the image

- The filters can increase computational costs, which can be impractical in our lab because we have limited computational resources.

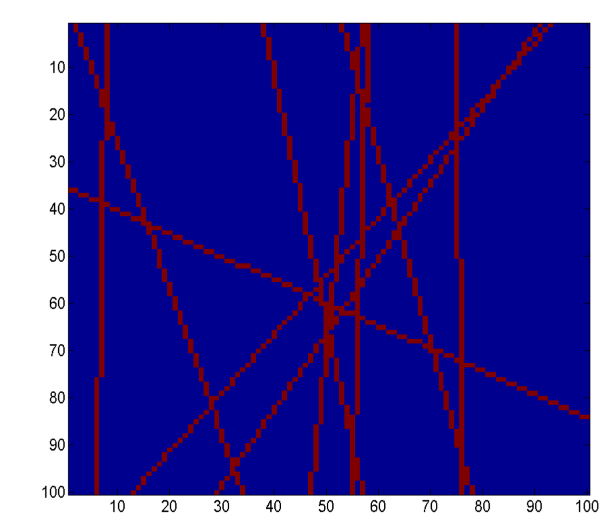
- We develop a novel line detection method that requires no filters to identify lines on images that are filled with Gaussian noises.

Correlation Analysis Algorithm

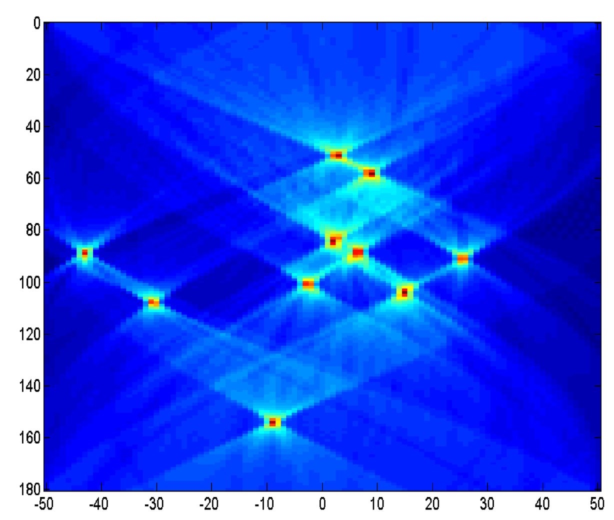


Results

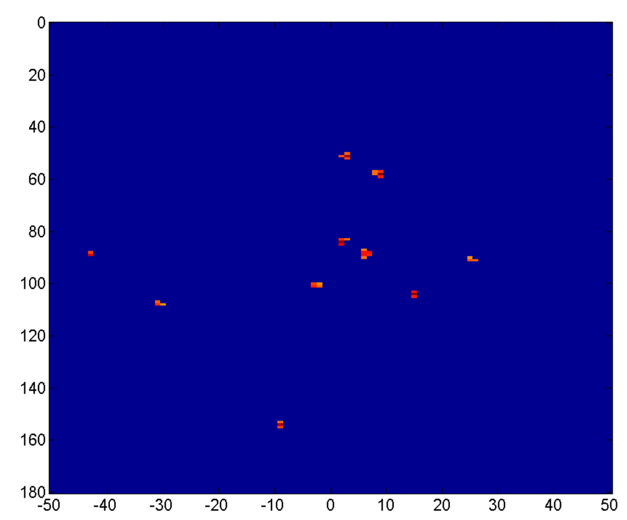
Sample Correlation Analysis of an Artificial Image



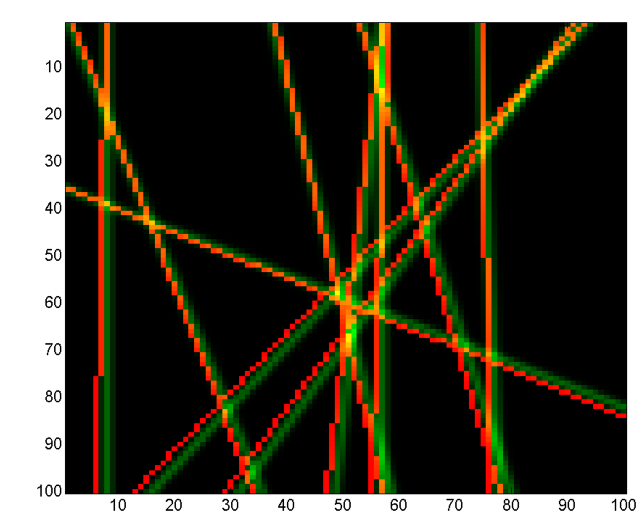
This is a sample of the test image we used to test our program. It is a 100 x 100 pixels image with ten lines on it. The lines are generated using Bresenham Line Generation Algorithm. We use Bresenham's Line Algorithm because it is easy to generate 100 similar images for testing purposes.



This is the correlation map produced with the test image. The horizontal axis represent the translations b of the line and the vertical axis represent the angle Θ of the line. We selected Θ to be between 0 to 180 degrees and b from –50 to 50 for our test cases. Our sigma intensity is 1.

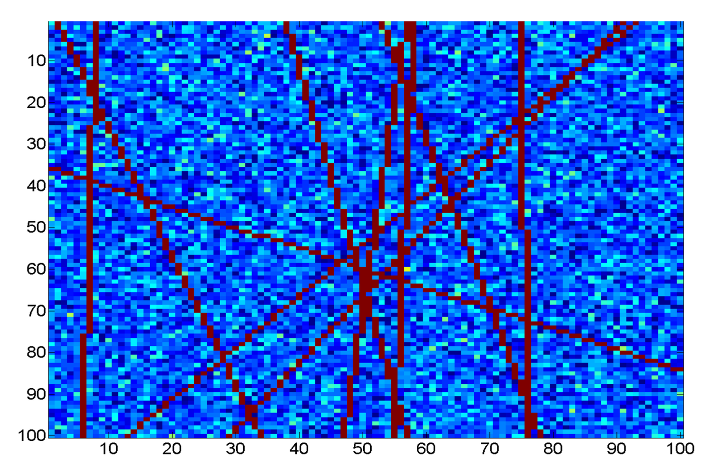


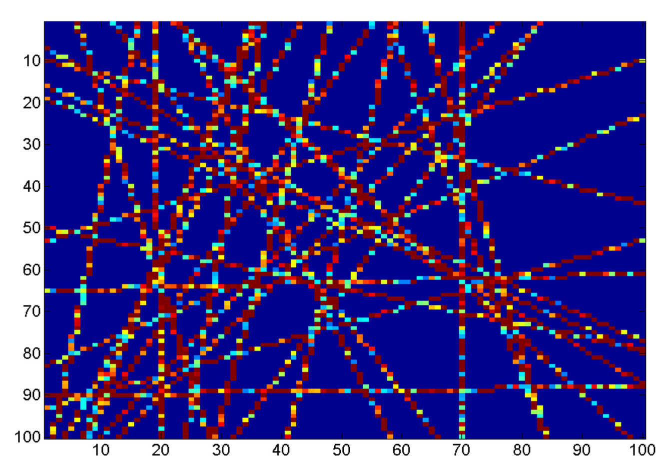
This is the correlation map for our noisy image. After generating the correlation map, we filtered the correlation map to remove peaks below 40% of the highest value of the correlation map. Our pixel distance threshold for the peak finding algorithm is 2 pixels.

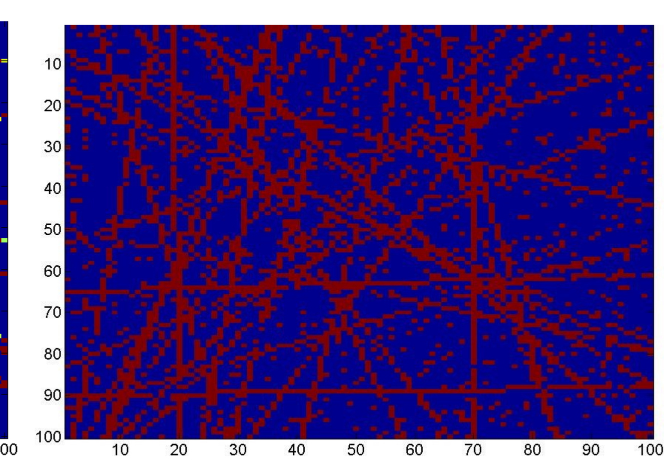


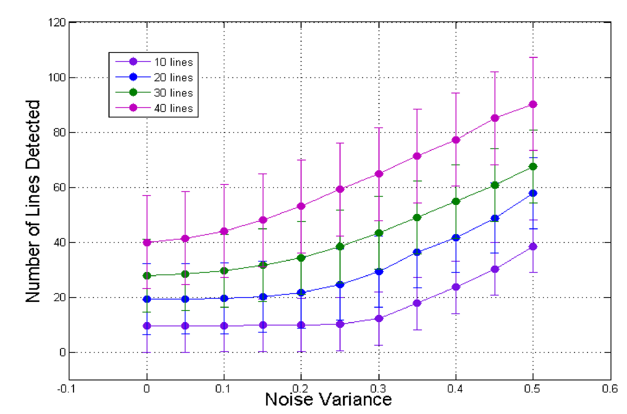
The orange line represents the line that was on our test image. The green line represents the lines detected by our algorithm. We decide to make the algorithm plot on the original image without noise to show that our algorithm correctly detects the lines on our original test image.

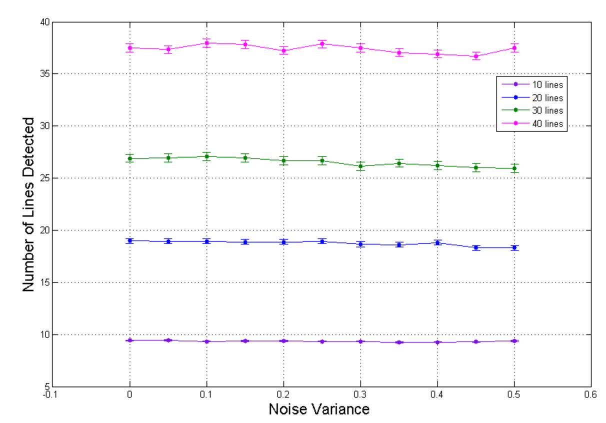
Line Detection Results under different noise types

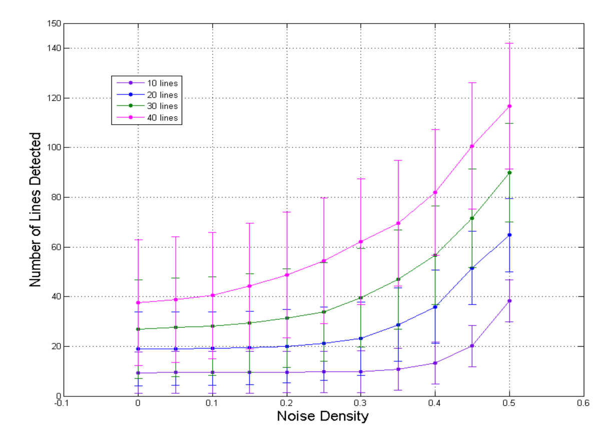






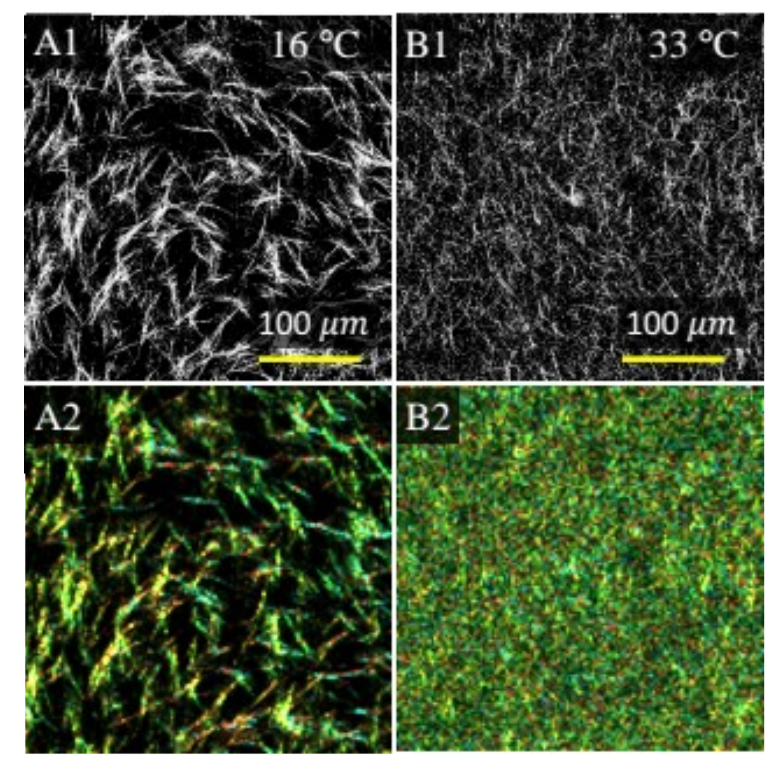






We tested our algorithm with images filled with three types of noise: Speckle, Gaussian, and Outlier noise. The image on the top left is a sample of an image filled with Gaussian noise, the one in the middle is an example of an image filled with Speckle noise, and the image on top right is a sample of an image filled with Outlier noise. The graph below each image represent the numbers of lines detected by the algorithm as we increase each noise variance. We selected Θ to be between 0 to 180 degrees and b from –50 to 50 for our test cases and again filtered the correlation map to remove peaks below 40% of the global maximum of the correlation map. We found that the general trend for the Gaussian and Outlier noise graphs to be increasing while the Speckle graph seems to remain relatively even.

Correlation Analysis on Collagen Images



We applied our algorithms to real collagen growth images. The images' sizes are 8 x 8 pixels. The detection result proves our prediction from our ideal line cases. In figure A1, we used a correlation analysis with a slightly higher correlation threshold compared to B1. For both A1 and B1, we selected Θ to be between 0 to 180 degrees with a step size of 1 degree and b from –2 to 2 pixels with a step size of 1 pixels . After the correlation analysis, we plotted our result onto a template image that is drawn by our algorithm and is an artificial replica A1 and B1. We then overlay the replicas onto A1 and B1 to generate A2 and B2. The way the replicas are generated using the correlation analysis algorithm.

Conclusion

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References

Oregon State UNIVERSITY