

How to build muscle

Image and data analysis of myofibrillogenesis

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Introduction

Striated muscle cells contain bundles of so-called myofibrils. These are characterized by highly regular periodic units called sarcomeres, each bordered by two Z-discs. It is an open question as to how the first periodic structures are formed during the development of the muscle (see reference).

To analyze the self-assembly process and answer this question, Francine Kolley (and co, reference) developed an image analysis algorithm that detects emerging periodic patterns based on autocorrelation functions along myofibrils. Using a steerable filter to determine local nematic order, the algorithm was applied primarily to images of *Drosophila* (fruit fly) muscle. To make it more applicable to myofibrillogenesis in human muscle cells, we have modified the algorithm (list changes?). The analysis of human data is more complex compared to fly data, and presents challenges such as... (elaborate on challenges, 2-pics side by side?).

On this poster, we show the application of the algorithm to myofibrillogenesis in human muscle cells and demonstrate its effectiveness with images illustrating key steps.

Image Preprocessing

To get optimal results when applying the steerable filter to the image, several steps have to be taken:

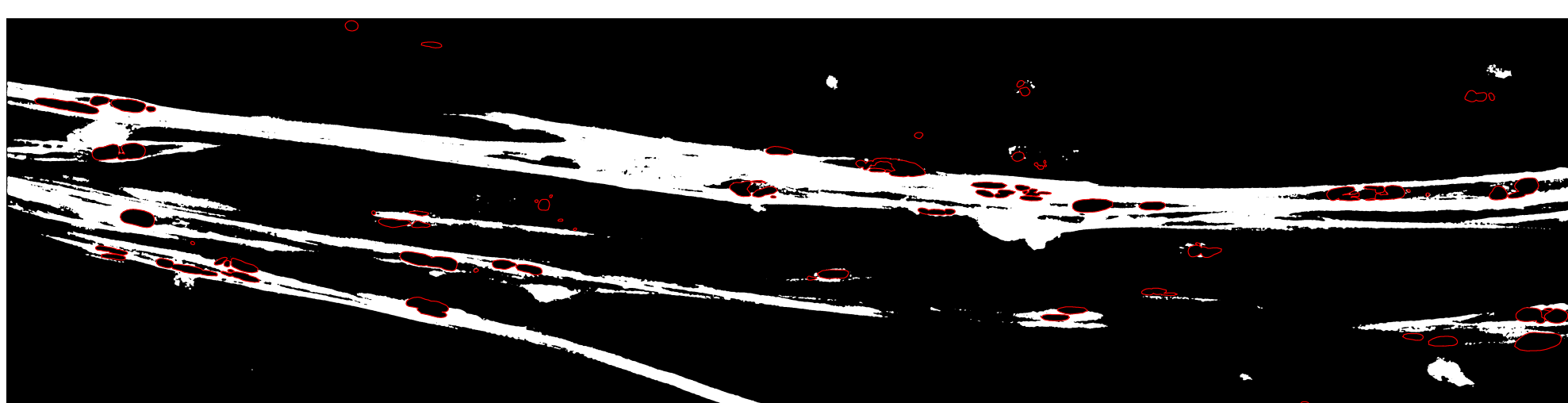
1. Create a binary mask

- (a) Create a binary mask based on a threshold value t_{mask} for the pixel

$$\text{intensity } I: I \rightarrow \begin{cases} 1 & I < t_{\text{mask}} \\ 0 & I \geq t_{\text{mask}} \end{cases}.$$

- (b) Apply a Gaussian filter with standard deviation σ_{gb} to reduce noise that might interfere, e.g. with ridge detection.
- (c) Exclude areas that overlap with nuclei: Therefore, we use a pretrained model *2D_versatile_fluo* from the *stardist* (ref) model to detect nuclei in the corresponding image. Afterward, we subtract the these regions from the mask.

Raw Mask ($t_{\text{mask}} = 350$), $\sigma_{\text{gb}} = 2$)



2. Create a binary mask for quadratic regions of interest (ROI)

- (a) Select the size of these ROIs and crop the dimension of the images to multiples of it.
- (b) Pad the edges of the images.
- (c) Create a binary mask for ROIs based on a threshold value t_{ROI} for the

$$\text{percentage of white pixels in the ROI } p_{\text{white}}: I \rightarrow \begin{cases} 0 & p_{\text{white}} < t_{\text{ROI}} \\ 1 & p_{\text{white}} \geq t_{\text{ROI}} \end{cases}.$$

ROI Mask (size = 30, $t_{\text{ROI}} = 0.3$)

