

Figure . Representative collagen patterns observed in human breast cancer tissue sections demonstrating the heterogeneous nature of collagen structure. Wavy (A) and straight (B). Dense (C) and well defined (D). Thick bundles (E) and thin strands (F). Discontinuous (G) and continuous (H). Crossing (I) and parallel (J). Scale bar is 10 microns.

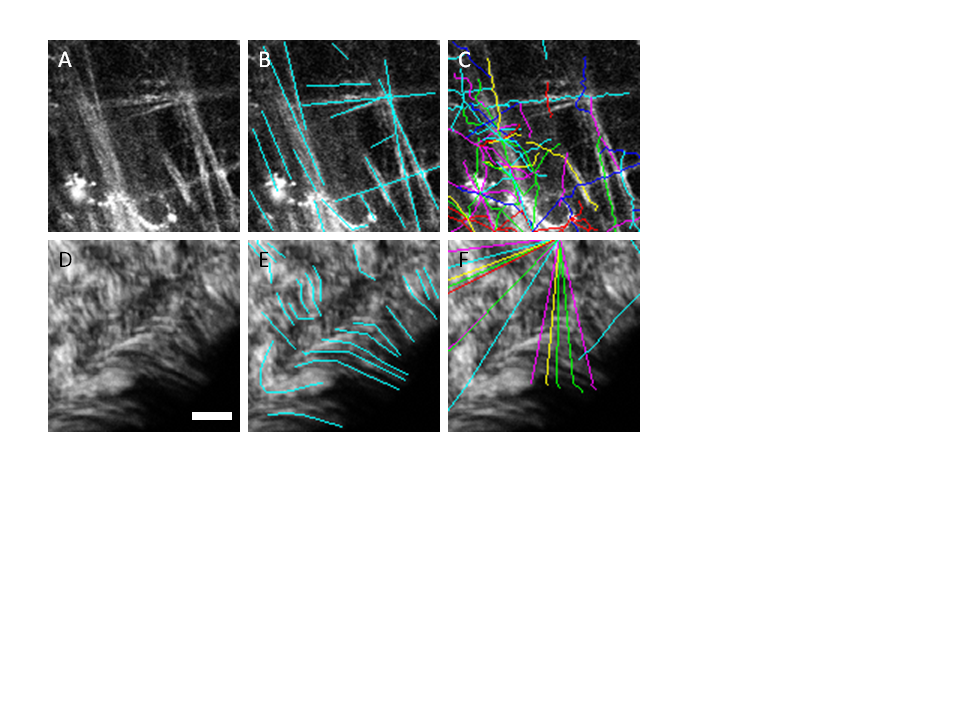


Figure . Fibers extracted by the FIRE algorithm alone without preprocessing. A and D are the original images, B and E show manual segmentations of the fibers, D and F show the automatic fiber segmentations that are extracted by the FIRE algorithm and show many falsely segmented fibers. Scale bar is 25 microns.

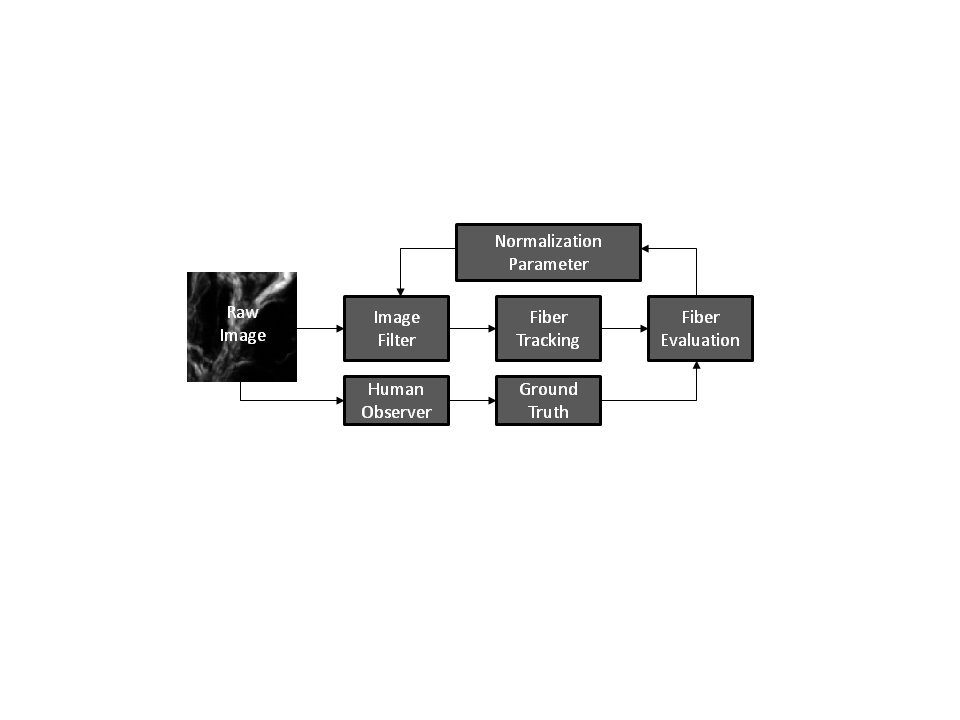


Figure . Diagram of the approach for quantitative collagen analysis showing the iterative process for optimizing the performance of a single image processing filter for fiber tracking. The raw image is processed by the image filter using an initial normalization parameter, the result of which is sent to the FIRE fiber tracking algorithm. Automated fiber extractions are compared against manually performed fiber extractions. Several normalization parameters are evaluated and one optimal parameter was selected for each filter that optimized the fiber evaluation result.

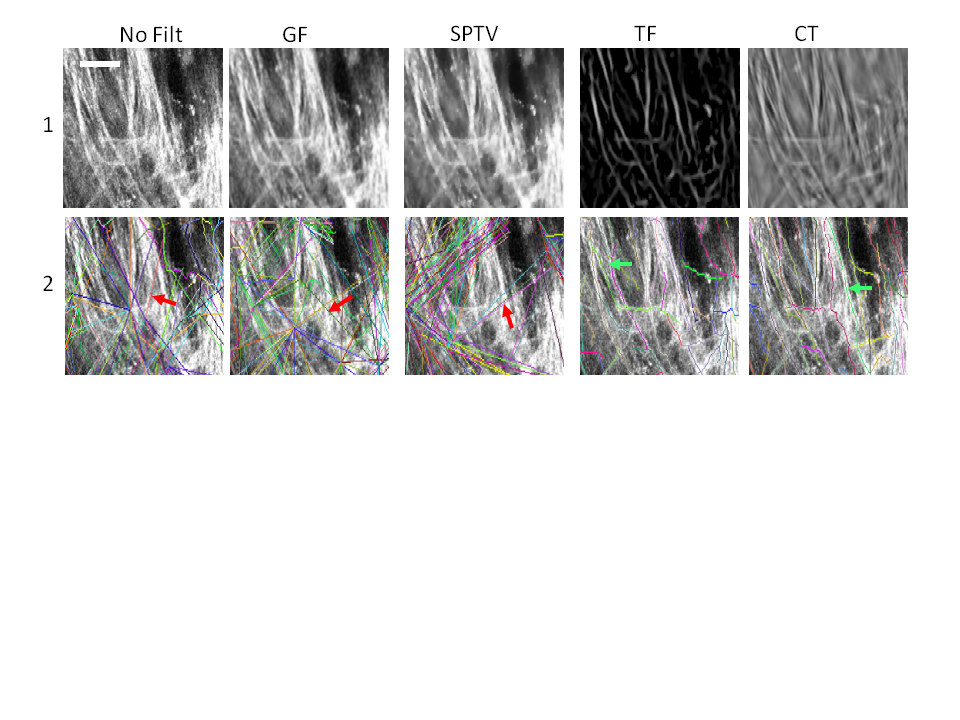


Figure . Output of the image processing techniques (row 1) and output of the fiber tracking algorithm (row 2) for a single test case. The first column is without a filter, column 2: GF, column 3: SPTV filter, column 4: TF, and column 5: CT. Scale bar is 25 microns.

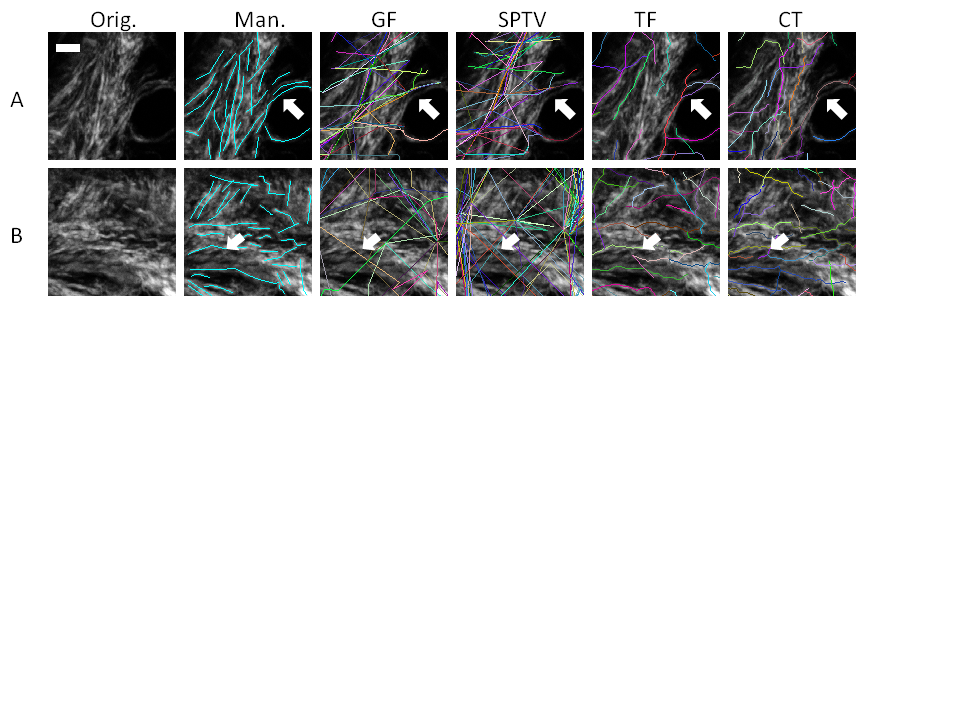


Figure . Two test cases (A&B), showing different processing methods in each column. The original image (column 1) is shown overlayed with a manual segmentation (column 2), GF (column 3), SPTV (column 4), TF (column 5), and CT filter (column 6) where each filter is followed by FIRE fiber extraction. Scale bar is 25 microns. 

Figure . F-measure, recall, and precision results comparing the automated segmentation techniques to the manual segmentations of three independent raters, for 25 test cases, representing a total of 9290 fiber evaluations. The error bars indicate the standard deviation between average F-measure, recall and precision scores of each of the raters. Recall is the fraction of relevant fibers that were found. Precision is the fraction of fibers found that were relevant. F-measure is the harmonic sum of recall and precision.

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Figure . Demonstration of automated fiber segmentation feature extraction in an in-vivo mouse model for breast cancer. A mammary window was placed immediately superficial to a palpable mammary tumor and the collagen microenvironment was imaged 8 and 12 weeks of age. Automated fiber extractions are shown overlaid on representative images from the 8 (A) and 12 (B) week time points. The bar graph (C) shows the ratio of the number of wavy fibers to total fibers found in the image. Fibers are labeled wavy if the distance along the fiber divided by the distance between fiber endpoints was greater than 1.08. Error bars indicate one standard deviation of the computed average wavy-fractions between the 3 images analyzed for each time point. Scale bar is 25 microns.