Automating the Detection of Actin Stress Fibers

Michael Carnell¹, Vanessa Sequeira², Renee Whan¹, Peter Gunning².

¹Biomedical Imaging Facility, University of New South Wales, Sydney, Australia, 2052
²School of Medical Sciences, University of New South Wales, Sydney, Australia, 2052

Email: m.carnell@unsw.edu.au

Keywords: Stress Fibers, Image Segmentation

Since its discovery just over 70 years ago, actin has been shown to be central in a variety of cellular processes. As a dynamically remodeling scaffold it supports the plasma membrane actively shaping cell morphology. Internally its polymerisation can supply propulsion for vesicle transport, or in tandem with myosin can cause constriction for cell division. Its purpose in forming a network of various types of bundled cables, collectedly known as stress fibers, is less clear. Elucidating if, and what, their roles are in cell motility, adhesion maturation and/or extracellular matrix remodeling still require further investigation. Unfortunately the lack of a robust means to qualitatively or quantitatively evaluate changes in these complex filamentous arrangements is impeding the rate of further progress.

Commonly, detecting objects of varying sizes in noisy images is accomplished by employing scale-space methodologies. These techniques determine local area topology by convolving the image with a scale-normalised Laplacian of a Gaussian at different scales. Whilst very effective at detecting object size, and because at its core the technique is based on image smoothing thus decreasing its sensitivity to noise at larger scales, it does suffer some shortcomings when applied to stress fiber detection. Typically stress fibers are very thin structures, sometimes being only a pixel in width, making detection at such a scale very sensitive to noise. The spatial densities of fibers within the cell also make it likely that when convolved at an appropriate scale another fiber may encroach within the kernel window resulting in mistakes in pixel classification. We have developed a new method based on the scale space principle that requires little user input, except for imposing a limit on scale ranges, and is more robust against high fiber density and fiber crossings events.