

Analysis of Intravital Microscopic Images of Rolling Leukocytes

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This presentation condenses seven years in the development of image analysis techniques for rolling leukocytes observed *in vivo*. Rolling leukocytes are activated white blood cells. The motion, shape, flux, number and position of these cells give important indicators of the inflammatory process. The image-derived parameters are vital to validating anti-inflammatory drugs and to understanding the basic mechanism of inflammatory diseases such as atherosclerosis and arthritis. To date, these image features are typically derived manually due to the difficulty associated with intravital image clutter, noise, occlusion, instability, poor contrast, contrast changes and shape deformation. With collaborator Klaus Ley, M.D. (La Jolla Institute and UCSD), the Virginia Image and Video Analysis laboratory has developed specialized tools for enhancement, registration, segmentation, detection and tracking for intravital images of rolling leukocytes.

After discussing the diffusion-based enhancement methods used, we put forth the automated registration technique that allows leukocyte detection and tracking in a moving field of view (where the microscope stage is translated electronically). The second portion of the talk focuses on novel cell detection methods for intravital microscopy. The methods include a level set solution, the gradient inverse coefficient of variation (GICOV) technique, and the more recent Poisson inverse gradient approach.

The third part of the talk details the tracking methods used for rolling leukocytes. The methods used are divided into two categories: active contour approaches and particle filter approaches. The innovations associated with active contour methods are the shape-size constrained active contour, the motion gradient vector flow technique and the fast computation via the vector field convolution method. With the particle filter research, we detail the ability to handle occlusion, the constraints for affine shape transformation and the joint model that allows multiple leukocyte tracking.

For both the detection and tracking methods, data are presented that show the efficacy of the techniques and video demonstrations are given.

Finally, real-time image analysis and the trade-offs involved with hardware implementation are discussed. New directions in the cellular image analysis area including high content screening and collaborative hardware-software co-design are also examined.