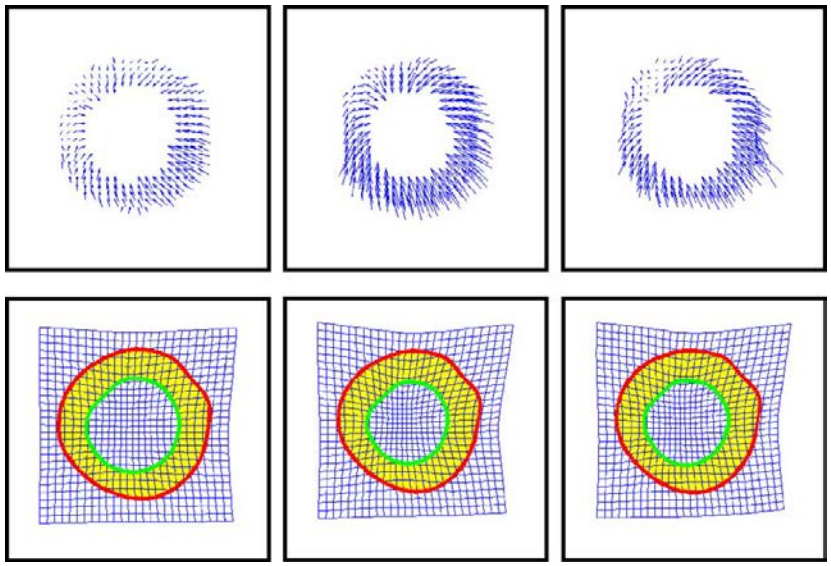

Our research group specializes in image analysis techniques such as image segmentation and motion tracking. Current projects include tracking cells observed in vivo, segmenting neurons, finding sinkholes in remotely sensed imagery, tracking military targets in clutter, segmenting the myocardial border in ultrasound and MR images, and seeking new ways or retrieving images by content. Theoretical interests include diffusion algorithms that utilize partial differential equations, scale space theory, active contours (snakes), level set theory, optimization techniques for image processing, and image morphology. Below are several sample project descriptions.

# Virginia Image & Video Analysis Group


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"Pushing pixels, segmenting the world and tracking things that move."

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## Automated Analysis on InSAR Images

We are investigating the applicability of new commercial remote sensing technology to detect and monitor sinkholes, settling bridges and landslides. Proposed solutions are based on the combination of new millimeter-radar (InSAR) and novel image analysis algorithms developed at UVa. These automated methods for analyzing the images are being developed and tested in a selected region in Virginia. The end product of the research will be a suite of software tools that can be used by the state departments of transportation across the U.S. to automatically detect problems from satellite imagery.

## Leukocyte Detection & Tracking

Leukocytes which accumulate in unwanted areas such as healthy tissue and joints can result in heart disease and arthritis. Studying leukocyte behavior assists in the design of drugs to treat diseases such as Crohn's disease, stroke, multiple sclerosis, and atherosclerosis. We have developed an algorithm which utilizes diffusion hough and gradient inverse coefficient of variation to automatically to detect the positions of leukocytes in a video which allows for tracking. Counting the number of cells that pass through a given line per unit time or velocity is a reliable predictor of inflammation intensity.

## Ultrasound Denoising

Speckle, a form of multiplicative, locally correlated noise, plagues imaging applications such as medical ultrasound image interpretation. For images that contain speckle, a goal of enhancement is to remove the speckle without destroying important image features. We have developed a partial differential equation (PDE) approach to speckle removal called speckle reducing anisotropic diffusion (SRAD). The PDE-based speckle removal approach allows the generation of an image scale space without bias due to filter window size and shape. SRAD not only preserves edges but also enhances edges by inhibiting diffusion across edges and allowing diffusion on either side of the edge. Additionally, SRAD is adaptive and does not utilize hard threshold to alter performance in homogeneous regions or in regions near edges and small features.

## Vector Field Convolution

Snakes, or active contours, have been widely used in image processing applications. Typical roadblocks to consistent performance include capture range, noise sensitivity, and poor convergence to concavities. We have developed a novel external force for active models called vector field convolution (VCF) to address these problems. VCF has not only a large capture range and ability to capture concavities, but also reduced computational cost, superior robustness to noise and initialization, flexibility of changing the force field.

## Multi-Cell 3D Tracking with Adaptive Acceptance Gates

Manually tracking a collection of hundreds of cells in a 3D space is an arduous task. Therefore a method to automate the detection and tracking of these cells was devised to precipitate the extraction of pertinent information regarding the motion and interaction sequences. In a medium containing dendritic cells and T cells, this information includes statistics on the change in speed, direction of movement, tortuosity, confinement ration, motility, and interaction durations.

## RECENT RESEARCH DEVELOPMENTS

- Developed the first automated method of detecting sinkholes using remotely sensed imagery.
- Designed an algorithm to segment neurons from 3D confocal microscopy.
- Published first technique for matching neurons based on spatial position and hierarchy.

## RECENT GRANTS

- NSF-Image Analysis for the Neurome
- DARPA-Content-based Image Retrieval for Visual Media Reasoning
- DOT-Sinkhole Detection and Bridge/Landslide Monitoring for Transportation Infrastructure by Automated Analysis of Interferometric Synthetic Aperture Radar Images

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