

MICA@SFU

Collaborators

- TRIUMF
- MS/MRI
- BC Cancer Agency
- Lion's Gate Hospital
- Center for Imaging Science
- University of Columbia
- Hospital for Joint Diseases/New York University Medical Center
- Vancouver General Hospital
- Pacific Parkinson's Research Centre

Awards

- CRV 2005 Best Paper
- MIP 2007 Presentation Scholarship
- SPIE 2007 Best Paper Nomination
- MSFHR Senior Graduate Studentship

Funding

NSERC, CIHR, CFI, BCKDF, MITACS, Pacific Alzheimer Research Foundation

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Websites

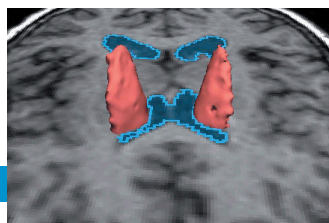
mial.fas.sfu.ca
www.css.sfu.ca/sites/mcl

Anatomical and functional medical imaging modalities are allowing clinicians and scientists to peer inside the human body and provide a wealth of information indispensable for understanding, modeling, diagnosis and treatment of diseases. The number of medical images acquired on a daily basis has grown, finer details are captured with larger image sizes, and the dimensionality of images has increased from two dimensional scalar images to dynamic 3D multi-valued fields. This results in image data that cannot be effectively and accurately processed with traditional visual inspection techniques. The development of computational tools for medical image analysis therefore has tremendous value and is the focus of research at MICA.

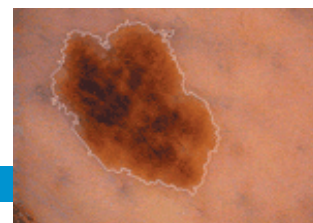
Our research goals are motivated by different clinical applications related to neurological, musculoskeletal, cardiac diseases and oncological studies, including multiple sclerosis, Parkinson's, shoulder maladies, tumour localization, etc. We work with local, national, and international clinical collaborators, who provide motivation, image data, and feedback. The overarching theme of our research is the design of computational algorithms for extracting clinically relevant information from medical images with varying dimensionality and complexity, including scalar, vector, tensor, spatial and time-varying 2D and 3D image data, and of different modalities, including MRI, CT, Ultrasound, PET, SPECT, fMRI, and DT-MRI.

Some of the areas our research encompasses include:

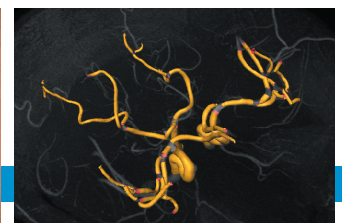
- **Image processing:** image filtering, image enhancement, noise reduction, edge detection.
- **Image segmentation:** identifying anatomical structures of interest in medical images for quantification and visualization.
- **Image registration and shape matching:** fusion of medical images of different modalities; establishing correspondence between images and shapes.
- **Shape analysis:** developing methods for 3D shape representation, modeling anatomical shape variability and detecting shape abnormalities.
- **Support for diagnosis and treatment:** develop computer-human interfaces to support more efficient radiology workflow; study telehealth and surgery applications.
- And many more...



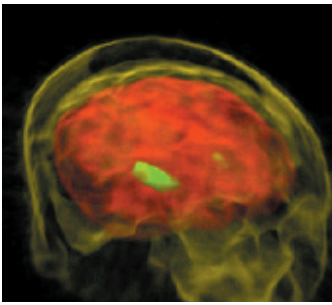
Analysis of brain atrophy



Skin cancer diagnosis



Vascular segmentation

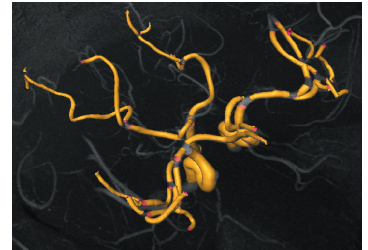


Visualization of time-varying Image data.

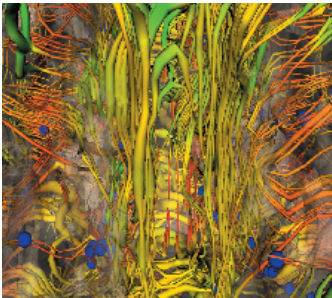
Analysis of Time-Varying Medical Image Data: Dynamic functional imaging allows observation of metabolic changes in tissue well before structural changes are visible. We are developing techniques that incorporate physiological parameters, clustering, segmentation, visualization, and user-interaction. Our software allows users to probe Time-Active-Curves, perform nonlinear dimensionality reduction, and design transfer functions for visualization.

Noise reduction in MR Images: We work on ways to compute the phase error at each pixel in a complex-valued MR image for noise reduction. Given that a complex-valued MR image, estimating the phase error at each pixel is a difficult problem. We have proposed a new scheme based on iteratively applying a series of non-linear filters until the output of these filters converge to a stable estimate.

Artificial life modeling for image analysis: We have developed deformable organisms that are specifically designed for segmentation, visualization, and analysis of tree-like and tubular anatomical structures. These organisms are equipped with models of geometrical bodies, physical deformation capabilities, cognitive models, and perception capabilities.



Vascular segmentation obtained using our deformable organisms.



DT-MRI visualization

Analysis and Visualization of DT-MRI: DT-MRI provides data about the diffusion properties of water molecules in the tissue and fibre orientation. Classical image processing, segmentation, and visualization techniques can not be simply applied to these images. We extended “Graph Cuts” to DT-MRI and developed an algorithm to visualize fibre tracts using stream tubes, which in turn use an adaptive seeding strategy.

Please visit our websites for details on our other exciting projects.

Preparing for MICA research

Undergraduate students considering joining the MICA research group as research assistants or graduate students will be well served by a strong background in mathematics, statistics, computing science, and upper level courses focusing specifically on medical computing and biomedicine. The following SFU courses were recommended by current graduate students in our group. Although it may be unrealistic to take all of the listed courses as part of your undergraduate training, we recommend that you take as many of them as your academic plan permits, according to your interests.

Area	SFU Courses
Medical Computing and Biomedicine	CMPT 340, 418, 419, 441; ENSC 370, 374, 476
Probability theory, stochastic processes, statistical data analysis	MATH 348; ENSC 328; STAT 101, 270, 285, 302, 330, 350, 380, 450
Data structures, algorithms and complexity	CMPT 212, 225, 275, 307, 308, 405, 406, 407
Computer graphics and scientific visualization	CMPT 361, 363, 412, 414, 461, 467
Modeling, simulation and optimization techniques	MATH 308, 309, 408
Calculus, ODE's, PDE's and Applications	MATH: 242, 251, 252, 310, 418, 467, 470
Linear algebra, graph theory, and discrete mathematics	ENSC 380; MACM 201, 316, 409, 416; MATH 232, 240, 338, 343, 345, 419, 445

In addition, acquiring the following skills will be useful in conducting MICA projects:

- Object-Oriented software design/development/ modeling
- Programming in C++, Java, ITK
- Working with Maple, Matlab, Mathematica, and SPSS or other equivalent statistics program
- Using visualization tools like Amira, VolView, etc.