Biomedical Imaging Group

People

ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

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CONTENTS

Available Algorithms

The algorithms below are ready to be downloaded. They are generally written in JAVA for the Image/Fiji or for the Icy platform, or in ANSI-C for any platform. Some algorithms are delivered as scripts for Matlab, Maple, or Mathematica. They have written either by students or by the members of the Biomedical Imaging Group. Please contact the author of the algorithms if you have a specific question.
Check the **conditions of use** below.

Plugins for Icy

- **Active Cells**. This is a plug-in for Icy that implements fast active contours for image segmentation. Their representation in terms of spline curves allows for a natural and intiutive manipulation of the active contour through control points. The software allows one to manage several active contours simultaneously, and to keep record of their location and size through the ROI persistence capability of Icy.

- **Active Cells 3D**. This is a plug-in for Icy that implements fast active surfaces for 3D image segmentation. Their representation in terms of spline surfaces allows for a natural and intuitive manipulation of the surface. The software allows one to manage several active contours simultaneously, and to have synchronized 2D and 3D viewers simultaneously.

- **Active Cells SDK**. This is a package for Icy that encapsulates tools to design and implement parametric active contours. The package provides fast 2D and 3D filters for image preprocessing, and a framework to create and evolve snakes defined by a set of control points.

- **Feature Detector**. The Icy Feature Detector plug-in implements a series of optimized contour and ridge detectors. The filters are steerable and are based on the optimization of a Canny-like criterion. They have a better orientation selectivity than the classical gradient or Hessian-based detectors.

- **Moving Blobs Generator**. This plugin generates 2D or 3D time sequences with elliptical objects moving over time in them. Use it to test your cell tracking algorithms.

- **Potts Segmentation**. The plug-in implements a segmentation algorithm based on the Potts model. It works with graylevel, color or vector-valued images. The user can edit segments (e.g. merge or refine) and export the segments to the ROI manager. A quick preview function is available.

- **Stereo Viewer**. This is a plug-in for Icy that implements a stereo vision system. Renders 3D stacks simulating a dual view camera. Each 3D view is rendered in fullscreen in a different monitor.

- **Shape Designer**. This plug-in implements a user-friendly way to design shape-priors for the Active Cells plug-in.

Plugins for ImageJ and Fiji

- **BEEPS**. This ImageJ plugin smoothes an image without altering its edges. The smoothing is applied by the way of a bi-exponential filter, itself realized by a pair of one-tap recursions. It is therefore very fast; moreover, its computational cost is truly independent of the amount of smoothing. Meanwhile, the preservation of edges is obtained by a range filter akin to the range filter found in a bilateral filter.

- **Circadian Gene Expression**. This ImageJ plugin (CGE) is a semi-automatic tool to detect and track moving cell, and to measure the fluorescent protein expression level. CGE extracts the trajectory of the cells by tracking their displacements, makes the delineation of cell nucleus or whole cell, and finally yields measurements of various features, like reporter protein expression level, cell displacement.

- **CosinorJ**. CosinorJ is a Java software tool to quantify circadian oscillatory gene expression profiles. It fits a cycling function to accurate estimate of the period, mesor, accrophase and amplitude of any rhythm signals of chronobiology.

- **DeconvolutionLab**. DeconvolutionLab is a software package (ImageJ plugin) to deconvolve 2D or 3D microscopic images based on the knowledge of the PSF. It implements a variety of deconvolution algorithms: 1) Inverse filter, 2) Regularized inverse filter, 3) Landweber, 4) Threshold Landweber, 5) Tikhonov-Miller, 6) Richardson-Lucy, 7) Richardson-Lucy with TV Regularization. It also includes a convolution tool to generate simulated dataset with additive noise.

- **Drop Shape Analysis**. New method based on B-spline snakes (active contours) for measuring high-accuracy contact angles of sessile drops.

- **E-Snake**. This ImageJ plugin (ESnake) implements a fast parametric active contour for segmenting nearly elliptic objects. ESnake outlines the targets using exponential B-splines, and it allows one to keep record of the curve with the ROI Manager from ImageJ.

- **Extended Depth of Focus**. The extended depth of focus is a image-processing method to obtain in focus microscopic images of 3D objects and organisms. We freely provide a software as a plugin of ImageJ to

produce this in-focus image and the corresponding height map of z-stack images.

- **Fractional spline wavelet transform**. This Java package computes the fractional spline wavelet transform of a signal or an image and its inverse.

- **Image Differentials**. This Java class for ImageJ implements 6 operations based on the spatial differentiation of an image. It computes the pixel-wise gradient, Laplacian, and Hessian. The class exports public methods for horizontal and vertical gradient and Hessian operations (for those programmers who wish to use them in their own code).

- **Local Normalization**. The local normalization tends to uniformize the mean and variance of an image around a local neighborhood. This is especially useful for correct non-uniform illumination or shading artifacts.

- **MIJ**. MIJ offers the missing link between two imaging software: ImageJ/Fiji and Matlab. The goal of the package mij.jar is to provide static methods to exchange images and volumes. MIJ allows also to access to all built-in functions of ImageJ and to third-part plugins of ImageJ. MIJ is integrated in Fiji with a super-easy script to use it.

- **MonogenicJ**. This ImageJ plugin performs multiresolution monogenic analyses of 2D images. It extracts wavelet-domain features that characterize the local orientation, the phase and the dominant frequency of an image patch at various levels of resolution.

- **MosaicJ**. This Java class for ImageJ performs the assembly of a mosaic of overlapping individual images, or tiles. It provides a semi-automated solution where the initial rough positioning of the tiles must be performed by the user, and where the final delicate adjustments are performed by the plugin.

- **NeuronJ**. This Java class for ImageJ was developed to facilitate the tracing and quantification of neurites in two-dimensional (2D) fluorescence microscopy images. The tracing is done interactively based on the specification of end points; the optimal path is determined on the fly from the optimization of a cost function using Dijkstra's shortest-path algorithm.

- **OrientationJ**. The aim of this ImageJ plugin is to characterize the orientation and isotropy properties of a region of interest (ROI) in an image, based on the evaluation of the structure tensor in a local neighborhood. OrientationJ has four functionalities: visual representation of the orientation, quantitative orientation measurement, making distribution of orientations and corner detection (Harris Corner)

- **Ovuscule**. The purpose of this ImageJ plugin is to detect elliptical bright blobs in images and to quantify them. It allows one to keep record of their location and size.

- **PixBleach**. PixBleach is a ImageJ plugin which fits fluorescence photobleaching decay in the temporal sequence for every pixels. Three common decal models are available: the mono-exponential, the bi-exponential, and the stretched exponential. Bleach rate (time-constant) and other fitted parameters can be visualized as 32-bit image and exploited for further analysis.

- **PixFRET**. The ImageJ plug-in PixFRET allows to visualize the FRET between two partners in a cell or in a cell population by computing pixel by pixel the images of a sample acquired in three channels.

- **Point Picker**. This Java class for ImageJ allows the user to pick some points in an image and to save the list of pixel coordinates as a text file. It is also possible to read back the text file so as to restore the display of the coordinates.

- **PSF Generator**. PSF Generator is a piece of software that allows to generate and visualize various 3D models of a microscope PSF. The current version has five different models: the Gaussian model, the simulated defocus, the scalar-based diffraction model Born & Wolf, the scalar-based diffraction model with 3 layers Gibson & Lanni, and finally, the vectorial-based model Richards & Wolf.

- **PureDenoise**. The purpose of this ImageJ plugin is to propose a high-quality denoising algorithm of multidimensional fluorescence microscopy images (2D+t, 3D or color).

- **Resize**. This ImageJ plugin changes the size of an image to any dimension using either interpolation, or least-squares approximation.

- **RodCellJ**. RodCellJ is freely available to the community as a package of several ImageJ plugins to simultaneously analyze the behavior of a large number of rod-shaped cells in an extensive manner. The integration of different image-processing techniques in a single package, as well as the development of novel algorithms does not only allow to speed up the analysis with respect to the usage of existing tools, but also accounts for higher accuracy.

- **SheppLogan**. The purpose of this ImageJ plugin is to generate sampled versions of the Shepp-Logan phantom. Their size can be tuned.

- **Snakuscule**. The purpose of this ImageJ plugin is to detect circular bright blobs in images and to quantify them. It allows one to keep record of their location and size.

- **SpotCaliper** SpotCaliper is a wavelet-based image-analysis software providing a fast automatic detection scheme for circular patterns (spots), combined with the precise estimation of their size. It is implemented as an ImageJ plugin with a complete user interface. The user is allowed to edit the results by modifying the measurements (in a semi-automated way), extract or load data, or do further analysis. The fine tuning of the detections includes the possibility of adjusting or removing the original detections, as well as adding further spots.

- **SpotDistance** This ImageJ plugin determines intra-nuclear 3D cross-distances between fluorescent spots

in multi-channel z-stack of image.

- **SpotTracker** This ImageJ plugin is a robust and fast computational procedure for tracking fluorescent markers in time-lapse microscopy. The algorithm is optimized for finding the time-trajectory of single particles in very noisy image sequences.

- **StackReg**. This Java class for ImageJ performs the recursive registration (alignment) of a stack of images, so that each slice acts as template for the next one.

- **SteerableJ**. This ImageJ plugin implements a series of optimized contour and ridge detectors. The filters are steerable and are based on the optimization of a Canny-like criterion. They have a better orientation selectivity than the classical gradient or Hessian-based detectors.
  See also the Icy plugin: **Feature Detector**.

- **Steerable Wavelets Transform Toolbox**. A complete parametric framework and set of JAVA tools for computing steerable wavelet frames in 2-D.

- **TurboReg**. This Java class for ImageJ performs the registration (alignment) of two images. The registration criterion is least-squares. The geometric deformation model can be translational, conformal, affine, and bilinear.

- **UnwarpJ**. This Java class for ImageJ performs the elastic registration (alignment) of two images. The registration criterion includes a vector-spline regularization term to constrain the deformation to be physically realistic. The deformation model is made of cubic splines, which ensures smoothness and versatility.

- **WingJ**. WingJ is an open-source Java application using ImageJ. WingJ allows to automatically infer a model of the morphological structure of the developing Drosophila wing from confocal fluorescence images. In addition it provides valuable information on the morphology of wing, using a parametric structure model for systematic spatial quantification of gene expression.

- **Watershed**. This Java plugin is able to segment an image using the watershed algorithm by directly flooding graylevel images. This implementation is in contrast with the classical approach working on the distance map image obtaining after thresholding. The grayscale watershed segmentation is useful to segment particles in contact when the model of shape is unknown a priori.

Matlab

- **Binary Compressed Imaging**. This Matlab package implements the forward model as well as the reconstruction of the binary compressed imaging.

- **Continuous-Time ARMA Identification**. A Matlab package for estimating Gaussian continuous-time ARMA parameters from sampled data. No sampling interval constraints are imposed.

- **Fractional spline and fractals**. A Matlab package is available for computing the fractional smoothing spline estimator of a signal and for generating fBms (fractional Brownian motion). This spline estimator provides the minimum mean squares error reconstruction of a fBm (or 1/f-type signal) corrupted by additive noise.

- **Fractional spline wavelet transform**. A Matlab package is available for computing the fractional spline wavelet transform of a signal or an image and its inverse.

- **Generalized Daubechies wavelets**. This is a set of Matlab routines for computing generalized Daubechies wavelet filters.

- **MLTL deconvolution** This Matlab package implements the MultiLevel Thresholded Landweber (MLTL) algorithm, an accelerated version of the TL algorithm that was specifically developped for deconvolution problems with a wavelet-domain regularization.

- **MRI Phantom** This package is a collection of Matlab functions that implements analytical multi-channel MRI simulations of realistic phantoms.

- **MRI Simulation and Reconstruction** This package is a collection of Matlab functions that provides 1) analytical and rasterized multi-channel MRI simulations of realistic phantoms and 2) a collection of basic and state-of-the-art reconstruction methods including an efficient wavelet-based non-linear one. Demonstration and testing scripts are included. A detailed documentation is provided.

- **OWT SURE-LET Denoising** This Matlab package implements the interscale orthonormal wavelet thresholding algorithm based on the SURE-LET (Stein's Unbiased Risk Estimate/Linear Expansion of Thresholds) principle.

- **Symmetric Exponential B-spline**. A Matlab package for calculating symmetric exponential splines: Sobolev reproducing kernels, B-splines and interpolation functions.

- **Steerable wavelets**.
  1. Generalized Riesz-Wavelet Toolbox for Matlab. Functional framework for the design of tight steerable wavelet frames in 2D.
  2. Generalized Riesz-Wavelet Toolbox for Matlab in 3D. Functional framework for the design of tight steerable wavelet frames in 3D.
  3. Steerable wavelets in 2D. Circular Wavelets. A complete parametric framework and set of matlab tools for computing steerable wavelet frames in 2-D. Specific designs include Simoncelli's pyramid, Marr

and monogenic wavelets, Prolate spheroidal wavelets, and curvelets.

- **WSPM** Wavelet-based statistical parametric mapping, a toolbox for SPM that incorporates powerful wavelet processing and spatial domain statistical testing for the analysis of fMRI data.

ANSI C

Most often, the ANSI-C pieces of code are not a complete program, but rather an element in a library of routines.

- **Affine transformation**. This ANSI-C routine performs an affine transformation on an image or a volume. It proceeds by resampling a continuous spline model.

- **Registration**. This ANSI-C routine performs the registration (alignment) of two images or two volumes. The criterion is least-squares. The geometric deformation model can be translational, rotational, and affine.

- **Shifted linear interpolation**. This ANSI-C program illustrates how to perform shifted linear interpolation.

- **Spline interpolation**. This ANSI-C program illustrates how to perform spline interpolation, including the computation of the so-called spline coefficients.

- **Spline pyramids**. This software package implements the basic REDUCE and EXPAND operators for the reduction and enlargement of signals and images by factors of two based on polynomial spline representation of the signal.

Mathematica

- **E-splines**. A Mathematica package is made available for the symbolic computation of exponential spline related quantities: B-splines, Gram sequence, Green function, and localization filter.

Maple

- **Hex-splines** A novel spline family for hexagonal lattices. A Maple 7.0 worksheet is available for obtaining the analytical formula of any hex-spline (any order, regular, non-regular, derivatives, and so on).

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