

## DropSnake and LB-ADSA user manual

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### I. INSTALLATION

ImageJ installation and the plugin installation procedure are described on:

[bigwww.epfl.ch/demo/dropanalysis](http://bigwww.epfl.ch/demo/dropanalysis)

### II. DROPSNAKE

The DropSnake plugin is using a general method to measure contact angles. It is not doing any general assumption and is thus suited to non-axisymmetric or general drops. The contact angle is obtained by a piecewise polynomial fit. The drop reflection may be used to detect the interface and a small tilt in the image.

After opening an image in imagej, the plugin "DropSnake" may be launched from the "plugin" menu. Ensure that the drop in the picture appear above the substrate. (if not, flip it using Image, Rotate, Arbitrarily, 180)

Example of drop picture:



Note that in order to process a new drop image, the plugin must be exited and then restarted with the desired image active.

### A. Main toolbar icons

	Add or move knots
	Delete one knot
	Delete all the knots and curves
	Setting menu
	Resample the blue curve and Snake it
	Accept the evolved curve. Replace the blue curve by the red curve
	Save or display knot position
	Run the snake on an image sequence. Start at the actual frame until the frame specified thereafter.
	Zoom
	Automatic initialization. Create a new 7 knots curve and fast snake it.
	Fast snake. Snake using fast settings. For initialization purposes
	Exit DropSnake
	About DropSnake

Note concerning the fast snake mode: In this mode, the number of knots is not modified and settings are optimized for speed. This snaking mode is oriented at producing good initialization curve for the normal snake procedure.

### B. Typical utilization

- 1) Load an image into imagej. Ensure that it is grayscale.
- 2) Launch the plugin DropSnake.
- 3) Initialize the snake

- Run the fast automatic initialization by pressing on: 
- Or
- When in the Add/move knot mode  , place roughly a few knots on the drop contour (5-10 knots). Please ensure that you define the drop contour starting at the left interface point going along the drop contour until the right interface point. When the last knot has been placed, double click anywhere on the image to close the spline. Once the spline is finalized, the knots positions can be adjusted by drag and drop.

It is recommended to run the Fast Snake on this initialization spline to refine it

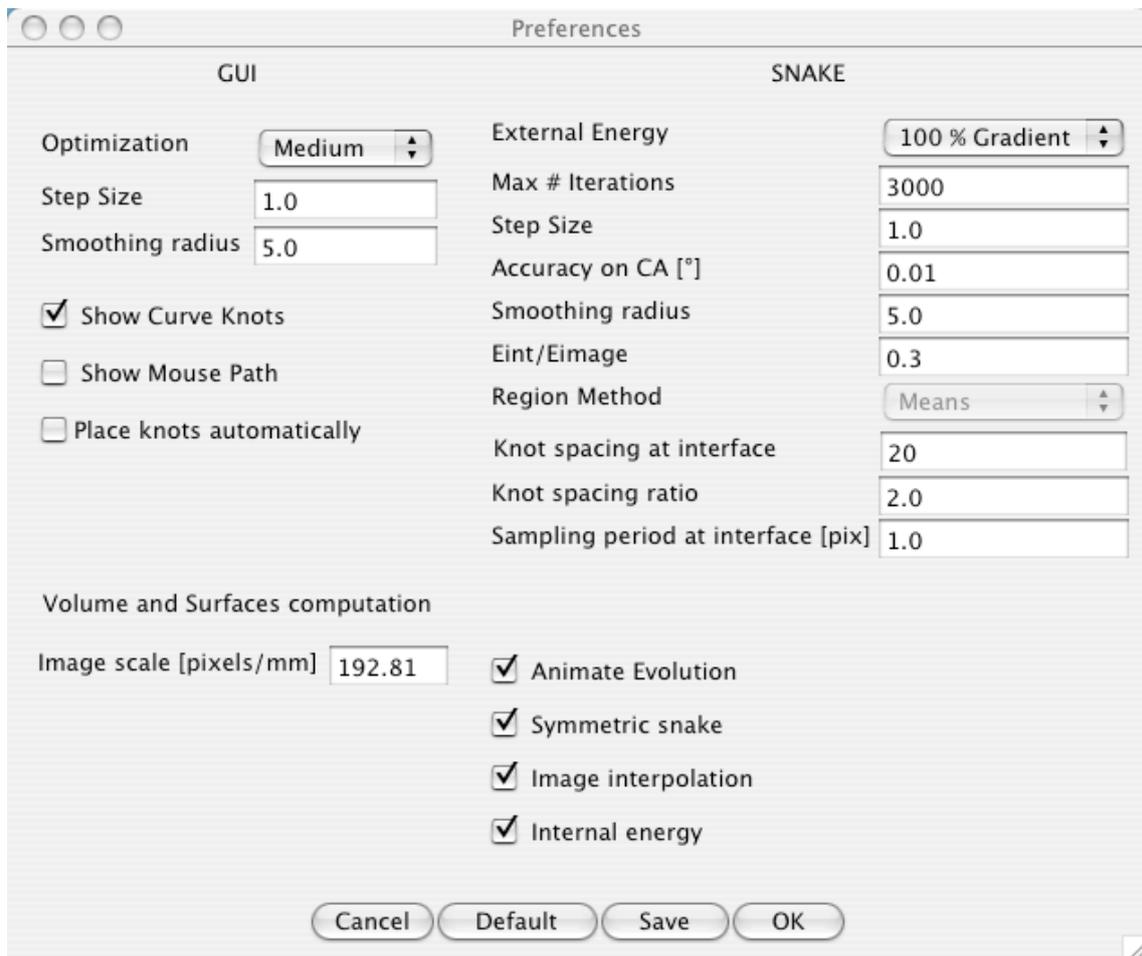


- 4) If the initialization spline is satisfying, go to next step. Otherwise, adjust roughly the blue knots position and run the fast snake on this spline using: 
- 5) Accept the curve by pressing on :  The blue curve will be replaced by the red one.
- 6) Evolve the blue curve by pressing on the snake button: 
- 7) Contact angles are displayed in the image and in the table. Further informations such as the surface of the meridional plane, the contour length of the meridional plane, the contact radius or the interface tilt angle are also available.

Another way of initialization is to enable "Place knots automatically" in the setting menu, and to create a new curve. In this mode, the user must click at the position of the first knot (left contact point) and then follow the drop contour until the last knot (right contact point). A double click define the position of the last knot.

Contact angle is still a tricky parameter to measure and several parameters such as dimensional parameters may influence its measure. Care should be taken when modifying parameters from the setting menu.

### C. Setting menu



#### 1) GUI panel:

a) *Optimization* : When "Place knots automatically" is set, optimization helps user placing knots.

b) *Step size* : Step size in the GUI optimization.

c) *Smoothing radius* : Smoothing preprocessing effected on the image for the GUI optimization.

d) *Show Curve knots* : Display or not the knots on the image.

e) *Place knots automatically* : When set, knots are added automatically when the mouse is displaced. If unset, user should click to place knots

f) *Image scale* : This is used only for dimensional information display, does not affect contact angle or drop detection.

#### 2) SNAKE panel:

a) *External energy*: Define the ratio of region energy and gradient energy. Region energy may have better converging properties, but gradient energy should be used to provide accurate detection.

b) *Max iterations*: Maximum number of iterations when evolving the snake. If reached an error message is displayed

c) *Step size*: Step size in the evolving process. If curve is oscillating, this should be reduced. If knot displacement is too small, this should be increased.

d) *Accuracy on CA*: Contact angle convergence criterium. The evolving process is terminated when the contact angle stay within this range. Recommended: 0.01

e) *Smoothing radius* : Smoothing preprocessing realized on the image before the evolving procedure.

f) *Eint/Eimage* : Ratio of internal energy and image energy. Internal energy is responsible for the elastic comportement of the snake. Image energy allows the snake to stick on the image. Typical value [0.2 ... 0.5], Recommended: 0.3

g) *Region method* : Specify the statistical region method used. Means is recommended

h) *Knot spacing at interface* : Define the ideal distance between two knots at the interface. Typical value [10 ... 40], Recommended: 20

i) *Knot spacing ratio* : Define the inter-knot distance ratio between knots at the interface and knots at the apex of the curve. This parameter allows to place more knots at the interface than on the rest of the drop. Typical value [1.0 ... 3.0], Recommended: 1.0

j) *Sampling period at interface* : Define the sampling period for the minimum knot distance. Best results should be obtained with a distance of 1 pixel. Increasing this value will allow an increase in speed but a loss in accuracy.

k) *Animate evolution* : Display knots during evolution. Faster when not displayed.

l) *Symmetric snake* : If set, the drop is defined with a symmetry between the first and last knot. The first and last knot are then evolved correspondingly. If not set, the first and last knots will be evolved horizontally only.

m) *Image interpolation* : When set, cubic spline image interpolation will be used. Important for accuracy.

n) *Internal energy* : Enable or disable internal energy. Internal energy is responsible for the elastic property of the snake.

#### D. Cautions

- 1) The tilt detection is limited to small angle values.

- 2) Sufficient space between the drop contour and the image contour should be kept. (i.e. the image should not be cropped too near to the drop contour in order to avoid border problems)

### III. LOW BOND AXISYMMETRIC DROP SHAPE ANALYSIS

The LBADSA method is based on perturbation solution of the axisymmetric Laplace equation. It is thus suited to drops that are under the only force of gravity on an horizontal substrate. The use of this global model result in very accurate contact angles.

After opening an image in imagej, the plugin "LBADSA" may be launched from the "plugin" menu.

Note that in order to process a new drop image, the plugin must be exited and then restarted with the desired image active.

#### A. Main menu

1) *Drop Parameters:* Before running the optimization procedure to find the drop profile on the image, the user should roughly initialize the drop parameters. The drop parameters may be adjusted using sliders. The checkboxes under the "Optimize" column allow the user to specify if each parameter should be optimized or not.

a) *b:* radius of curvature of the drop at the apex in pixel dimension.

b) *c:* capillary constant of the liquid used is  $m^{-2}$ . *c* is given by:

$$c = \frac{\Delta\rho g}{\gamma}$$

A few liquids are preset in standard conditions. More liquids may be added by editing the file "liquids.txt" in the plugin folder.

c) *x0, y0:* Coordinates of the apex.

d) *h:* Drop height in pixel dimension. The drop height is defined by the vertical distance from the interface plane to the drop apex.

e) *d:* reflection height. This setting is always set to the maximum, unless some undesired artifacts appear in the place of the reflected contour.

The relative approximation gives an idea of the validity of the model.

#### 2) *Drop Properties:*

a) *Contact angle (canvas):* This is the contact angle represented by the actual canvas.

*b) Contact angle subpixel:* This is the resulting contact angle after an optimization. This contact angle is obtained using double precision for the drop parameters. Consequently, this contact angle should be considered after an optimization rather than the one from the canvas.

*c) Drop Volume:* The drop volume.

*d) Drop Surface:* Surface of the liquid-gaz interface of the drop.

*e) Surface of contact:* Surface of the interface liquid-solid.

The Volume and Surface informations necessitates a proper value of the scale in the settings menu.

### 3) Optimization:

*a) Region Energy:* Region energy may be used when the drop mean pixel value and the non-drop mean pixel values are known and adequately set in the setting menu. It may provide good convergence properties, however it should always be used in conjunction with the gradient energy to obtain accurate detection.

*b) Gradient Energy:* The gradient energy is the default energy to use when optimizing. It should give very accurate results.

## B. Settings menu

*c) Smoothing Sigma:* standard deviation of the gaussian filter applied to the image.

*d) Scale:* Scale of the image. This parameter is used during optimization and should be correctly set to obtain accurate results.

*e) Convergence criterium on CA:* Contact angle precision of the optimization procedure.

*f) drop mean pixel value:* not mandatory. used by the region energy only.

*g) non-drop mean pixel value :* not mandatory. used by the region energy only.

## C. Typical utilization

- 1) Load an image into imagej. Ensure that it is grayscale.
- 2) Launch the plugin LBADSA.
- 3) Ensure that the image scale is correctly set under the "settings" menu.
- 4) Choose the liquid capillary constant.
- 5) Adjust roughly the canvas to the drop profile. First the apex position, then the drop height and the radius of curvature at the apex.
- 6) launch optimization using gradient energy by pressing on "Gradient energy"

- 7) If the optimization result is satisfying press on "table" to add the drop properties into a table.

#### *D. Cautions*

- 1) The substrate is supposed to be horizontal and the camera to be correctly aligned. A tilt in either of these may bring inaccurate results.
- 2) It is highly recommended to use known capillary constant liquids. Automatic detection of this parameter with spherical shape drops is inaccurate and may result in a less accurate contact angle determination.