Documentation for ELPAC – S – VF

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Important Files:

- elpac_batch.m
  - Used for batch processing of images for vector field (VF) augmentation
- elpac_GUI.fig
  - Launches the ELPAC GUI

Two uses for this software:

1. For image feature augmentation using VFs, use the elpac_batch.m file for batch operations or elpac_GUI.fig for single image operations.
2. For image segmentation via active contours, use the ELPAC GUI using the elpac_GUI.fig file.

Instructions for elpac_batch.m for batch image feature augmentation using VFs

This file is intended to be used for batch augmentation of vector field (VF) features into images.

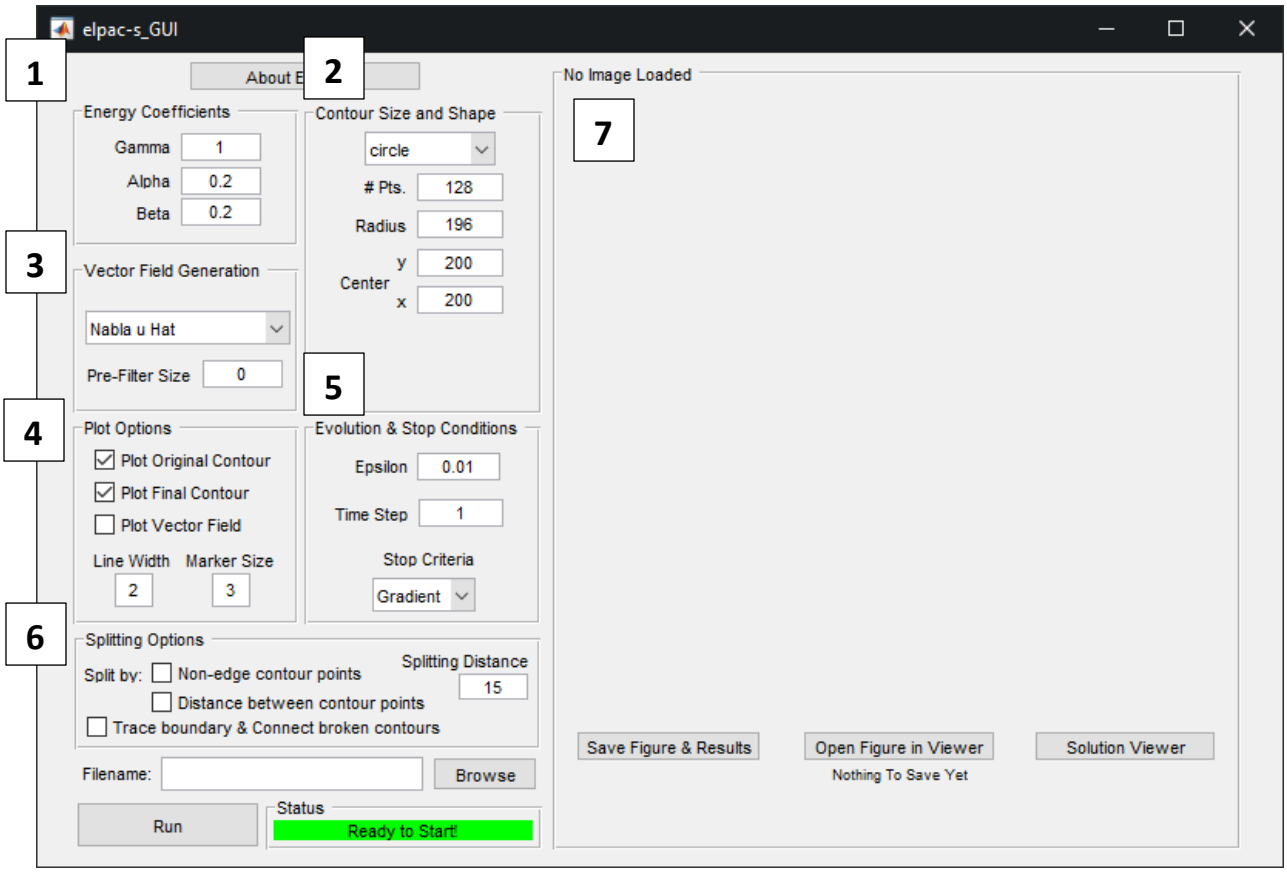
The following is the format to use in MatLab:

```
elpac_batch(inFolder,outFolder,fileType,vf,dimX,dimY,noise)
```

The accepted parameters are explained below:

- `inFolder`
  - Specifies the folder to read in images from. (*Example: 'E:\Research\siim-isic-melanoma-classification\train'*)
- `outFolder`
  - Specifies the folder to save VF augmented images to. (*Example: 'E:\Research\siim-isic-melanoma-classification\train_out'*)
- `filetype`
  - Specifies the file type of the images to read from. (*Example: '*.png'*)
- `vfType`
  - Specifies the type of VF to generate over the image.
  - Possible Options:
    - `gaussian` `gradient` `laplacian` `schrodinger`
    - `v hat u` `v hat phi` `v hat psi`
    - `Nabla u Hat` `Nabla Phi Hat` `Nabla Psi Hat`
  - See papers [1 - 4] for more information about the following: *gaussian, gradient, laplacian, and schrodinger.*
  - See paper [6] for more information about the following: *Nabla u Hat, Nabla Phi Hat, and Nabla Psi Hat.*
  - See paper [5] for more information about the following: *v hat u and v hat phi.*
- `dimX`
  - Specifies the size of x dimension of output image.
- `dimY`
  - Specifies the size of y dimension of output image.
- `noise`
  - Can be set to 0 or 1. Specifies that noise will be generated in the image(s).

Instructions for ELPAC GUI (launch elpac_GUI.fig in MatLab)



Within the ELPAC GUI window, you will see the following sections:

1. Energy Coefficients
2. Contour Size and Shape
3. Vector Field Generation
4. Plot Options
5. Evolution & Stop Conditions
6. Splitting Options
7. Image and Result Viewer (blank until image loaded)

Part 1: Energy Coefficients

The explanation of these coefficients can be found in more detail in the related papers [1 - 4]. In general, these coefficients affect the evolution characteristics of the evolving contour and can be adjusted for better or worse segmentation results.

Part 2: Contour Size and Shape

These options will change the size and shape of the initial contour. Change as needed for the desired initial contour to be evolved toward the object(s).

Part 3: Vector Field Generation

The dropdown lists different VFs available in the current version. See the papers [1 - 7] for details on each type of VF available.

The option "Pre-Filter Size" changes the window size of a Poisson smoothing filter. This can be used to help smooth noisy images to improve segmentation.

Part 4: Plot Options

These options change the items visible in the result viewer. You can choose to see the initial or final contour(s) or the vector field as desired. Once an image is loaded and the process is completed, you will see the results in the result viewer on the right side of the GUI window.

Line Width and Marker Size change the how the contour(s) are displayed.

Part 5: Evolution and Stop Conditions

These options change how the contour is stopped on the boundaries of objects. Please see [1 - 4] for a more detailed description. In general, "epsilon" changes the size of the edge gradient on which the contour stops. Larger epsilon causes the contour to stop on less defined edges, while smaller epsilon causes the contour to stop on more well defined edges.

Stop Criteria changes how to detect boundaries by different forms of edge detection. See [1 - 4] for more details.

Part 6: Splitting Options

These options are disabled by default. The work [4] describes in more detail the splitting process. Enabling these options will cause the contour to be split into multiple contours based on two conditions: 1. if a point is on an edge or not or 2. if two points are sufficiently distant from each other. Change these options to segment multiple objects and produce more desirable results if needed.

Part 7: Image and Result Viewer

This part of the window (the right side) is blank until an image is loaded. Once the "Run" button has been pressed, the process will begin. The results (if no errors are encountered), will be displayed over the loaded image.

There are three buttons to use to either view or save the results shown.

1. Save Figure & Results will generate a MatLab fig and parameter txt file saved to the current directory.
2. Open Figure in Viewer will open an additional MatLab window allowing more exploration of the results.
3. Solution Viewer will display a 3D view of the solution over which the VF is generated.

References

[1]. Bowden, A., Sirakov, N.M. Active Contour Directed by the Poisson Gradient Vector Field and Edge Tracking. J Math Imaging Vis, 2021, https://doi.org/10.1007/s10851-021-01017-3

[2]. Bowden, A. & Sirakov, N. M. (2015). Applications of the Euler - Lagrange Poisson Active Contour in Vector Fields, Overcoming Noise, and Line Integrals. Differential Equations and Dynamical Systems – Series B.

[3]. Bowden, A., Todorov, M. D., & Sirakov, N. M. (2014). Implementation of the Euler-Lagrange and Poisson Equations to Extract One Connected Region. AIP Conference Proceedings, 1629(1), 400-407.

[4]. A. Bowden, Implementation of a Splitting Finite Difference Scheme to Segment Images with the Solution to the Poisson and Schrodinger Equations, Master's thesis, Texas A&M Univeristy - Commerce (2014).

[5]. Igbasanmi, O., Sirakov, N.M., Bowden, A., CNN for Efficient Objects Classification with Embedded Vectors Fields, in printing by the Springer book series, Studies in Computational Intelligence, Electronic ISSN 1860-9503, Print ISSN 1860-949X, Best Paper Award

[6]. N.M. Sirakov, A. Bowden, M. Chen, L.H. Ngo, M. Luong, Embedding vector field into image features to enhance classification, Journal of Computational and Applied Mathematics, Vol. 441, 2024, 115685, ISSN 0377-0427, https://doi.org/10.1016/j.cam.2023.115685, https://www.sciencedirect.com/science/article/pii/S0377042723006283

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