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# Vessel Enhancing Diffusion

Release 1.00

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## Abstract

Recently, an implementation of the Vessel Enhancing Diffusion (VED) algorithm [3] using the Insight Toolkit (ITK) framework [2] has been proposed by Enquobahrie et al.[1]. In this paper we present an alternative implementation, for two reasons. First, in this implementation all the main functionality of the algorithm, including eigensystem, vesselness and tensor calculation and PDE discretization using a forward Euler scheme are now grouped together in one single class. Although this may come at the cost of code-reusability, it improves readability and enables application specific code optimization. The second reason is the criterion of reproducibility. Source code, test environment and example data of the paper [3] are provided.

Latest version available at the [Insight Journal](http://hdl.handle.net/1926/9999) [ <http://hdl.handle.net/1926/9999> ]  
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The following class is provided: `VesselEnhancingDiffusion3DImageFilter<PixelType>`, which is templated over the pixeltype of the input image. The output image has the same pixeltype as the input image. Internally, the calculations are carried out in float precision and can be set differently by replacing the typedef `Precision` in the header file. A simple example using default parameter settings (see the header file for their values) is as follows:

```
typedef itk::VesselEnhancingDiffusion3DImageFilter<short int> VT;  
VT::Pointer v = VT::New();  
v->SetInput(reader->GetOutput());  
v->SetDefaultPars();  
v->Update();
```

Applied to the CTA data provided with this submission, gives the following result (Figure 1).

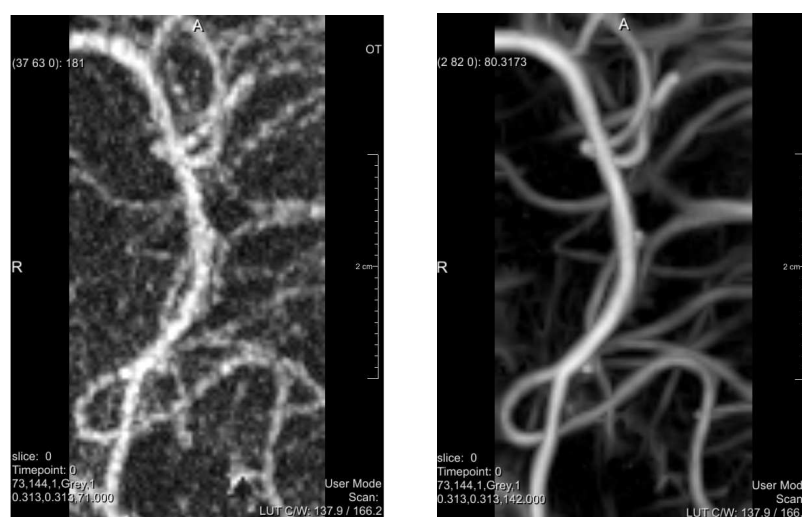


Figure 1: Part of the cerebral vasculature visualized with CT angiography at low mAs setting (left) and the results after VED filtering with default parameter settings (right). Both figures are maximum intensity projections and shown at the same window width and level settings.

## References

- [1] A. Enquobahrie, L. Ibanez, E. Bullit, and S. Aylward. Vessel enhancing diffusion filter. *Insight Journal*, 2007. ([document](#))
- [2] L. Ibáñez, W. Schroeder, L. Ng, and J. Cates. *The ITK Software Guide*. Kitware, Inc., second edition, 2005. ([document](#))
- [3] Rashindra Manniesing, Max A Viergever, and Wiro J Niessen. Vessel enhancing diffusion: a scale space representation of vessel structures. *Med Image Anal*, 10(6):815–825, Dec 2006. doi: 10.1016/j.media.2006.06.003. URL <http://dx.doi.org/10.1016/j.media.2006.06.003>. ([document](#))