Bilateral Filtering of fMRI Data

Camellia Mitra, Sri Medha Juloori
School of Medical Science and Technology
(IIT Kharagpur)
Kharagpur, India
camellia.mitra321@gmail.com
juloorisrimedha4@gmail.com

***Abstract*—In image processing, bilateral filtering is an adaptive filtering method that has been used to smooth images while maintaining edges. We introduce a class of adaptive filtering methods for bilateral filtering of fMRI data in this study. Instead of averaging activities in regions that maximize correlation with a BOLD model, these methods average activities in consistent regions. The ability of bilateral filtering to maintain edges over conventional low-pass filtering is one of its main benefits. Given that sharp edges are frequently associated with active regions, this is significant for the processing of fMRI images. Here two modified range filters have been proposed for better filtering of fMRI data. The method was tested and has shown promising results.**

Keywords*—*fMRI, Bilateral Filtering, Low pass Filtering, adaptive,

I. Introduction

Bilateral filtering, sometimes referred to as nonlinear Gaussian filtering, is a nonlinear filtering method that eliminates noise without compromising crucial structural elements like edges. A typical linear low-pass filter averages pixels that are near to one another in order to eliminate noise. However, this kind of averaging eliminates sharp edges. This issue is resolved by bilateral filtering, which also considers the fact that the pixels to be averaged should have values that are close to one another in addition to being geographically close.

As a result, the spatial filter and the range filter can be multiplied to create the filter kernel in each neighborhood. Whereas the range filter is based on the variation in image intensity, the spatial filter is based on spatial distance. Use the enter key to start a new paragraph. The appropriate spacing and indent are automatically applied.

Bilateral filter kernel = Spatial Filter Kernel (Fs) x Range filter kernel(Fr)

$$F_r\,(x,\,\Delta x) = h(I(x+\Delta x)-I(x))$$

fMRI: Functional magnetic resonance imaging (fMRI) is a non-invasive neuroimaging technique that measures brain activity by detecting changes in blood flow. When a brain region is active, it consumes more oxygen, which is delivered by blood. fMRI uses a powerful magnetic field and radio waves to track the changes in blood flow, which are then used to create a map of brain activity.
There are several uses for fMRI, such as:
Brain mapping: fMRI is a useful tool for mapping the functions of the various brain areas.
Presurgical planning: By locating key brain regions and avoiding them, fMRI can be utilised to plan brain surgery.

II. Method

Two different modifications done on range filter.

1. Signal range filter(F1), that deals with pixels close to each other

   F1=Fs x Frs (Frs- signal range filter)

$$F_{rs}(\mathbf{x},\mathbf{\Delta x}) = e^{\frac{-\left\|\mathbf{B}^T\hat{\mathbf{s}}(\mathbf{x}+\mathbf{\Delta x})-\mathbf{B}^T\hat{\mathbf{s}}(\mathbf{x})\right\|^2}{2\sigma_{rs}^2}}$$

2. Anatomical range filter(F2), deals with pixels that has close intensity values.

   F2=Fs x Fra (Fra- Anatomical range filter)

$$F_{rs}(\mathbf{x},\mathbf{\Delta x}) = e^{\frac{-\left\|\mathbf{B}^T\hat{\mathbf{s}}(\mathbf{x}+\mathbf{\Delta x})-\mathbf{B}^T\hat{\mathbf{s}}(\mathbf{x})\right\|^2}{2\sigma_{rs}^2}}$$

3. Proposed Method

   F3=Fs . Frs . Fra

III. Results

Improved activation detection performance compared to low pass filter.

The regions detected as active using the proposed methods appear to follow anatomical structures more closely than those detected using ordinary low pass filtering. Our obtained result has been depicted in Figure 1

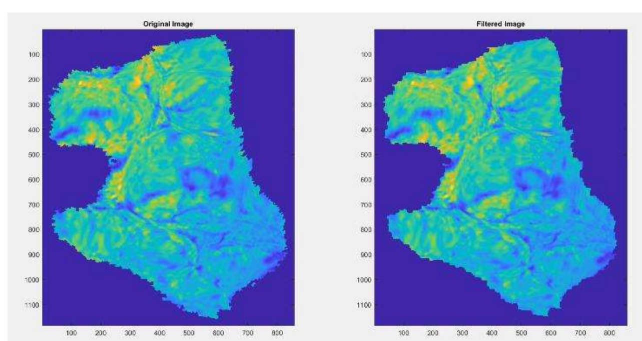

Figure 1

IV. Conclusion

The proposed adaptive bilateral filtering method for fMRI data takes into account local signal similarities, as well as local anatomical similarities. This method mainly deals with fMRI data in resting phase of the brain. More research is required to be done on fMRI data, when the brain is actively performing.

V. References

[1] J. Rydell, H. Knutsson and M. Borga, "Bilateral Filtering of fMRI Data," in IEEE Journal of Selected Topics in Signal Processing, vol. 2, no. 6, pp. 891-896, Dec. 2008, doi: 10.1109/JSTSP.2008.2007826.