Denoising Microscopy Images in Voltage Imaging Videos

Overview and Feasibility of Traditional Denoising Methods

Author: Radosław Majer | Supervisors: Dr. Nergis Tömen, Alejandro Castañeda García

What are the traditional, non-deep learning denoising methods used for denoising biomedical and microscopy data, and how do they perform in terms of preserving signal integrity and suppressing noise in voltage imaging?

Background

Voltage imaging is an emerging microscopy technique that can make neuroscientific research very prominent. The general idea of voltage imaging is optical observation of the action potential (neural impulse), which is a quick biological event. This is done by observing fluorescent indicators. The speed of the event enforces the image acquisition to be very fast (1000Hz). The little time to deliver photons leads to an image being extremely noisy. That is the reason why there is a need for computational denoising. This research attempted to investigate how well traditional denoising algorithms, such as different types of blur or diffusion, perform in denoising such videos.

What traditional video denoising methods are there and which ones can be used for denoising voltage imaging videos?

- Gaussian filtering - standard blurring method, used in MRI, CT
- Bilateral filtering - edge preserving blur, used in brain imaging
- Anisotropic diffusion - edge preserving algorithm, used in MRI and confocal microscopy
- Wavelet filtering - signal decomposition, used in EEG and microscopy
- Total Variation minimization - suppresses high frequency signals, used in MRI and PET

How can the suitability of a denoising method be evaluated for voltage imaging?

- Structural Similarity Index - verifies perceived quality and structure of the objects on the image
- Signal-to-Noise Ratio - indicates the amount of noise in the video, extensive use in medical imaging

How do the traditional methods perform in denoising voltage imaging videos?

	SSIM	tSNR	Worst tSNR
No Filter	0.30	11.07	8.75
Gaussian Filter	0.33	23.38	23.32
Bilateral Filter	0.33	23.49	19.41
Anisotropic Filter	0.30	25.30	25.04
Wavelet Filter	0.32	14.05	13.52
TV Minimization	0.29	50.65	49.24