# EE367 Project Proposal

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## Motivation

The motivation of this project originates from a subtask of my research work which aims to extract the nanoparticle positions under optical force manipulation as shown in Figure 1. After I obtain the movement information of target nanoparticles, I could cross-validate the ground truth with the result from the simulation work for the Brownian motion. It's important to do the denoise and deconvolution for precise object detection since the Crocker-Grier algorithm [4] that will be used requires accurate brightness value of the target nanoparticles for distinguished detection. Failure to properly reconstruct the target nanoparticles would weaken the classification ability of the algorithm, especially when dealing with massive nanoparticles in the future. Thus, I would like to examine non-local methods [2] (BM3D [3] in particular) and ADMM with proper priors [1] (isotropic total variation in particular) for better performance of feature extraction.

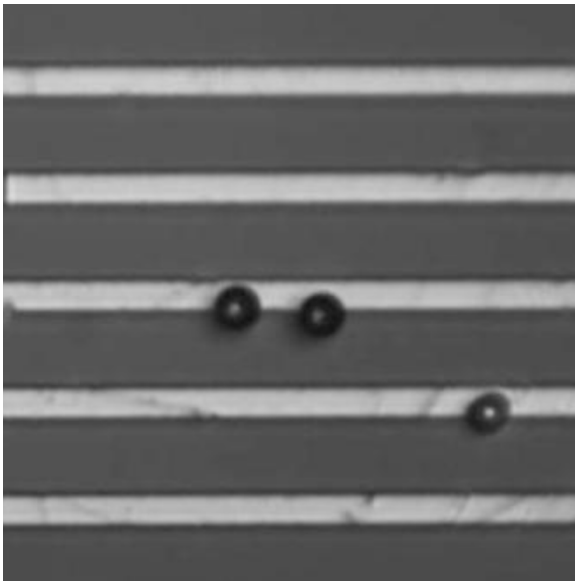

*Figure 1 Experimental video frame (the three circles refer to target nanoparticles where the right-bottom one is a stationary point for unknown reason)*

## Related Work

Non-local methods and ADMM are two of the most popular techniques in the domain of computational imaging. Non-local methods have achieved state-of-the-art performance by exploiting internal correspondences in an image. Take the BM3D for example, it groups similar image patches and collaboratively filters within groups to reconstruct the true image. [3] This method is widely used in commercial camera chip, outperforming those hot neural network approaches. ADMM is another powerful tool in imaging area since it's born in 2011. One of the biggest advantages of ADMM is that it could help disintegrate inverse problems with non-differentiable loss/prior into simple iteration updates [1]. That expands our choice of priors to address on the reconstruction of a variety of images with different properties.

## Project Overview and Goals

Considering the fact that there are several identical target particles in the video frame, non-local means is a perfect candidate to enhance the signal magnitude for the interested target features. I would try to implement non-local method such as BM3D to denoise video frames and compare it with ADMM with proper priors. The metric of comparison to be used will be the number of detected features after applying the Crocker-Grier object detection algorithm under same setting and the baseline is the video without any denoising or deconvolution. The final goal is to achieve an increase in the number of target features extraction with one or more aforementioned methods compared with baseline. If time admitted, it would be great to remove the stationary point from the scene with inpainting techniques [5][6]. This implementation could enable better visualization of the system with massive nanoparticles movement. Also if I could have access to the video of massive nanoparticle optical manipulation, testing would be conducted to evaluate the performance of my approach.

## Milestones and Timeline

Week7 would focus on implementing Crocker-Grier algorithm for baseline feature extraction. Week8&9 would focus on implementing non-local methods such as BM3D and ADMM with proper priors for reconstruction and comparing all results for analysis and improvement. Week10 would focus on preparation for the poster presentation and write the final report.

## Reference


[1] Boyd, Stephen, Neal Parikh, and Eric Chu. *Distributed optimization and statistical learning via the alternating direction method of multipliers*. Now Publishers Inc, 2011.

[2] Buades, Antoni, Bartomeu Coll, and J-M. Morel. "A non-local algorithm for image denoising." *2005 IEEE Computer Society Conference on Computer Vision and Pattern Recognition (CVPR'05)*. Vol. 2. IEEE, 2005.

[3] Dabov, Kostadin, et al. "Image denoising by sparse 3-D transform-domain collaborative filtering." *IEEE Transactions on image processing* 16.8 (2007): 2080-2095.

[4] Crocker, John C., and David G. Grier. "Methods of digital video microscopy for colloidal studies." *Journal of colloid and interface science* 179.1 (1996): 298-310.

[5] Criminisi, Antonio, Patrick Perez, and Kentaro Toyama. "Object removal by exemplar-based inpainting." *2003 IEEE Computer Society Conference on Computer Vision and Pattern Recognition, 2003. Proceedings.*. Vol. 2. IEEE, 2003.

[6] Telea, Alexandru. "An image inpainting technique based on the fast marching method." *Journal of graphics tools* 9.1 (2004): 23-34.