

Algorithm	Benchmark
Order Statistic Filter	200 s
Hough Transform	400 ms

Table 1: Benchmark: Hough transform compared to order statistic filter algorithm.

Since the defocused images of seed particles are fuzzy rings, the task of tracking the micron-scale particles is to identify the rings of various sizes on each frame and reconstruct their trajectories. For this project, We have developed a fast algorithm based on Hough Transform for particle tracking. With the help of UFO framework, we implement our new algorithm easily on graphic cards. Compared to old software using order statistic filter algorithm, the performance of our new algorithm is boosted by a factor 500.

The flow of our algorithm is shown in Fig. 1. Standard image processing filters, like local contrast enhancement and noise reduction, are first applied to the input images, then they are sent to Hough Transform filter. In our problem, standard procedure of edge detection before HT does not apply, since the rings are fuzzy and do not have crisp edges. To overcome this problem, we have devised an efficient blob detection algorithm, because the HT votes at the ring center tend to have the shape of blurred blob. Our method is very effective in finding the ring candidates. In order to eliminate the false positives in the candidates, we further use a azimuthal filter, which is a test on the pixel histogram in radius direction respect to the center of candidate ring. Another benefit from using the azimuthal filter is, that the position of the the ring center can be determined to pixel level by fitting histogram around the peak position against a gaussian function.

The UFO framework let us develop software in OpenCL with relative ease and distribute the more computational intensive part on to graphic cards. We have developed GPU kernel programs for all filters apart from the azimuthal test, which is more suitable for execution on CPU cores. Benchmarking on our particle tracking software shows that it takes roughly 400ms to process each frame on a computer with Nvidia GTX Titan GPU cards and Xeon E3-1200 CPU.

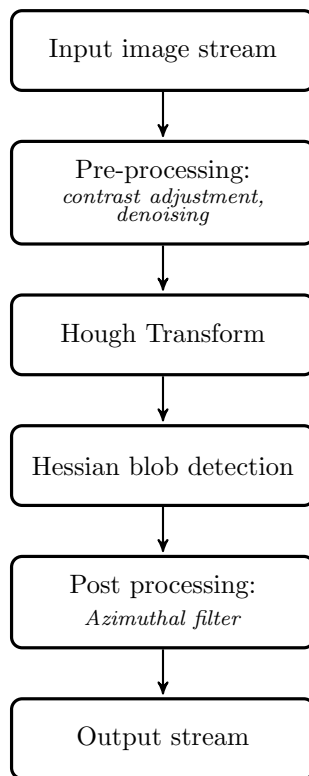


Figure 1: uptv algorithm