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10.4 Enhanced high-temperature microparticle tracking using machine learning

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Material clusters of different sizes are known to exist in high-temperature plasmas due to plasma-wall interactions. The facts that these clusters, ranging from sub-microns to above mm in size, can move from one location to another quickly, and that there are a lot of them, make high-speed imaging and tracking one of the best, effective, and sometimes only diagnostic. A machine learning technique based on neural networks is developed to analyze high-speed videos of high-temperature micro-clusters generated from exploding wires. The neural network utilizes a locally competitive algorithm to generate and optimize a set of dictionaries containing kernels, or bases, for image analysis. Our primary goal is to use this method for feature recognition and prediction of the microparticle motion. Results from machine-generated kernels are compared with physically-motivated kernels, where hand-picked kernels are used in conjunction with machine-generated ones. Our work indicates that machine-learning and supervised machine learning techniques are promising approaches to process large sets of images for high-temperature plasmas and other scientific experiments. Machine learning techniques will be useful to aid the understanding of plasma-wall interaction.

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