Machine Learning Assisted Particle Size and Type Classification Using Wavelength-Dependent Scattering Patterns

Sinan Genc, Kutay Icoz, and Talha Erdem

Electrical Electronics Engineering, Abdullah Gul University, Kayseri, Turkey

The presence of microplastics in oceans and water supplies have increased to critical levels within the last decade [1]. In addition to the huge mass of plastics in the seas, additional contribution to water pollution comes from our chemical wastes including toothpaste, detergents, cosmetics etc. All these pollutants end up in seas or clean water sources, which eventually affects the sea life but also the human health via the water consumption and the food chain [2]. Slowing down the microparticle pollution in water first relies on identifying and tracking these particles in a cost-effective manner so that the microparticles can be easily detected before they accumulate. To address this challenge, in this study, we investigated the scattering patterns of different microplastic samples at different concentrations in aqueous samples. By analyzing these scattering patterns obtained using blue, green, and red low-power lasers, we show that it is possible to classify the microparticles particles in terms of their size, concentration, and first time for the material type in a liquid sample thanks to random forest algorithm that accomplish the limited theoretical calculations.

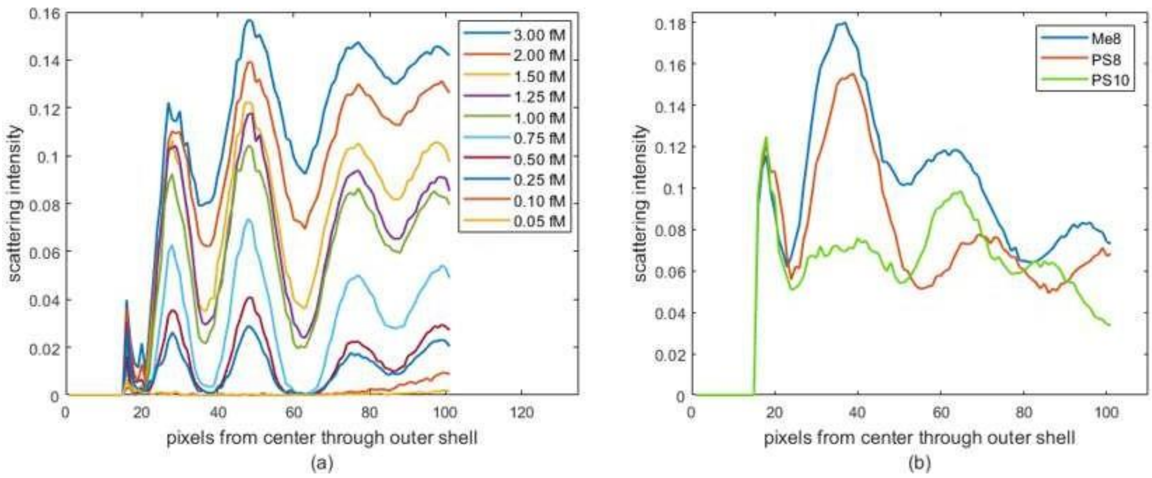

Figure 1: (a) Scattering behavior of 8 um Me samples under green laser with increasing concentration (b) scattering behavior of three different microplastics under red laser with 1.50 fM concentration.

The aim of all these experiments was to show that the scattering patterns change for different type and size of the microplastics in liquid samples. As presented in Fig. 1(a), for the same excitation wavelength and material at the same size (green laser operating at 520 nm and 8 um-sized Melamine microparticles) the distance of the observed peaks and valleys from the center does not have any concentration dependence; nevertheless, the scattering intensity increases very strongly as the particle concentration increases. Especially the average intensities of the pixels, farthest away from the center turn out to be clear indicators of the microparticle concentration in water. In Fig. 1(b), we employed a red laser operating at 650 nm to record the scattering patterns of these particles all at 1.50 fM. The comparison between the melamine and polystyrene particles having the same size reveals peaks at different distances from the center and at different intensities originating from the different refractive indices of these particles.

[1] Lindeque P. K. et al., *Are we underestimating microplastic abundance in the marine environment? A comparison of microplastic capture with nets of different mesh-size*, Environmental Pollution, 265, 2020

[2] Grant-Jacob J.A. et al., *Particle and salinity sensing for the environment via deep learning using a Raspberry Pi*, Environ. Res. Commun., 1, 2019