Image reconstruction of pollen grains from their scattering pattern using deep learning

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Airborne pollution particulates are associated with approximately 40,000 deaths per year in the UK[1]. Specific types of particulates are thought to be more toxic to people with certain conditions[2], and hence precise identification of the numbers and types that are airborne at any particular place or time is a key strategy in reducing adverse health effects within the population. A specific example, and one that is used as the motivation for this work, is the effect of pollen grains on individuals who may have allergies to none, some, or all types of pollen[3].

In order to categorise pollen grains that are airborne across populated areas, a rapid and precise sensing system is required that includes all imaging and computational components, and that is also small, low-maintenance and low-cost. As standard optical microscopy approaches for imaging and characterising micron-sized structures require costly setups, a lensless imaging approach is more suitable. However, lensless approaches such as phase retrieval are generally computationally intensive, and hence not appropriate for a low-cost sensor. Accordingly, here we demonstrate the capability of deep learning for rapid lensless image reconstruction from the scattering patterns of a variety of pollen grains.

Specifically, we extend work on using deep learning to identify the type of pollen grains from scattering patterns[4,5], by using a conditional generative adversarial network (cGAN)[6] to generate 50x magnification images of pollen grains directly from their scattering patterns.

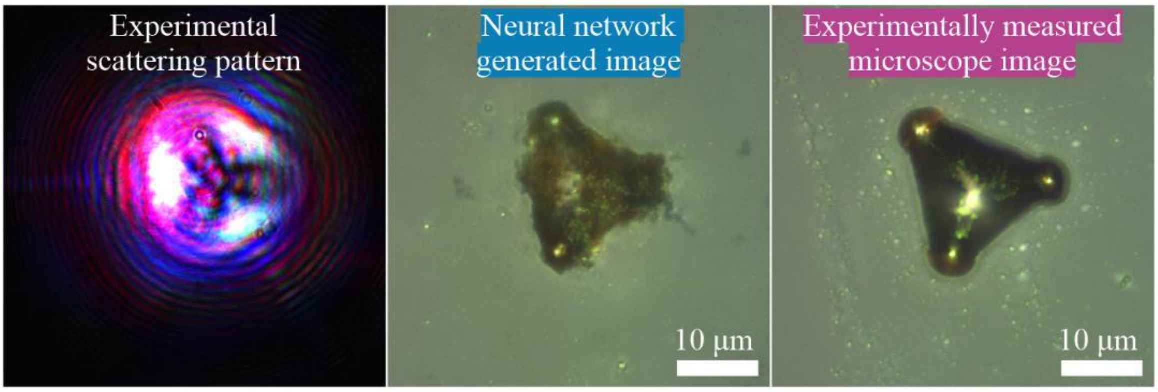

Figure 1. High-resolution image reconstruction.

[1] Holgate S T 2017 *Clin. Med.* **17** 8–12

[2] Kelly F J et al. 2012 *Atmos. Environ.* **60** 504–26

[3] Gruzieva O, et al. 2015 *Allergy* **70** 1181–3

[4] Grant-Jacob J A, et al. 2018 R *Opt. Express* **26** 27237–46

[5] Grant-Jacob J A, et al. 2019 *J. Phys. Photonics* **1** 44004

[6] Mirza M et al. 2014 *arXiv Prepr. arXiv1411.1784*