

Deep learning for real-time air and marine particle pollution sensing

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“Towards accurate, real-time, low-cost sensing”

1 Motivation

Air

Every year in the UK, exposure to polluting particles causes:

- 16,500 strokes.
- 4,200 lung cancers.
- Alzheimer's disease.



40,000 deaths per year
£20 billion per year

Monitoring of pollution is vital to understand its origins and reduce it. Current sensors can lack accuracy and be expensive.

Water

Impact on marine life due to plastic particles absorbing toxins & entering food chain.



- Microplastics in drinking water.

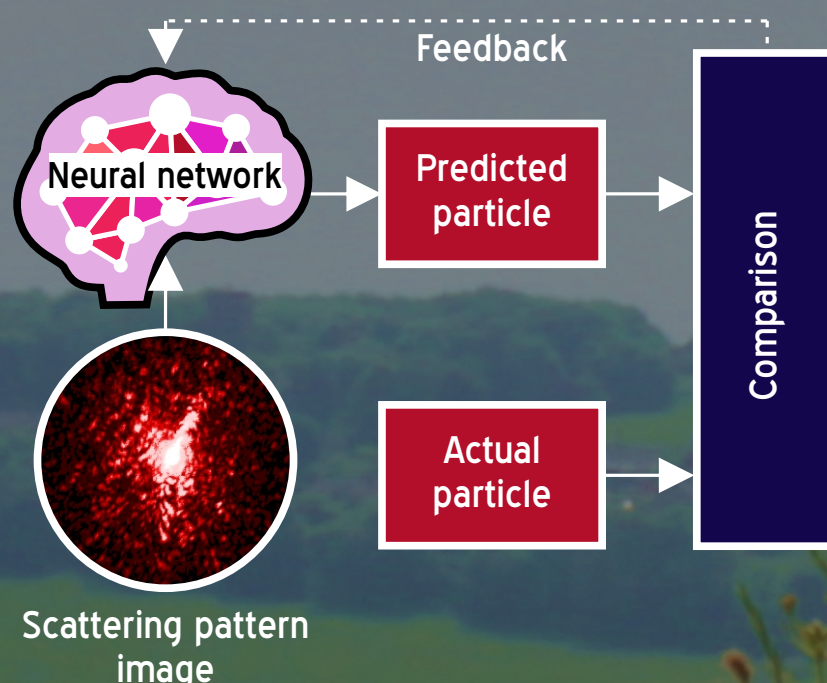
Trillions of microbeads enter the sea per year

3 Experimental setup

- A red laser beam was directed onto diesel, wood ash, pollen particles in air, and plastic particles in water, and the scattered light was imaged by a camera.
- The images were used for training the neural network.

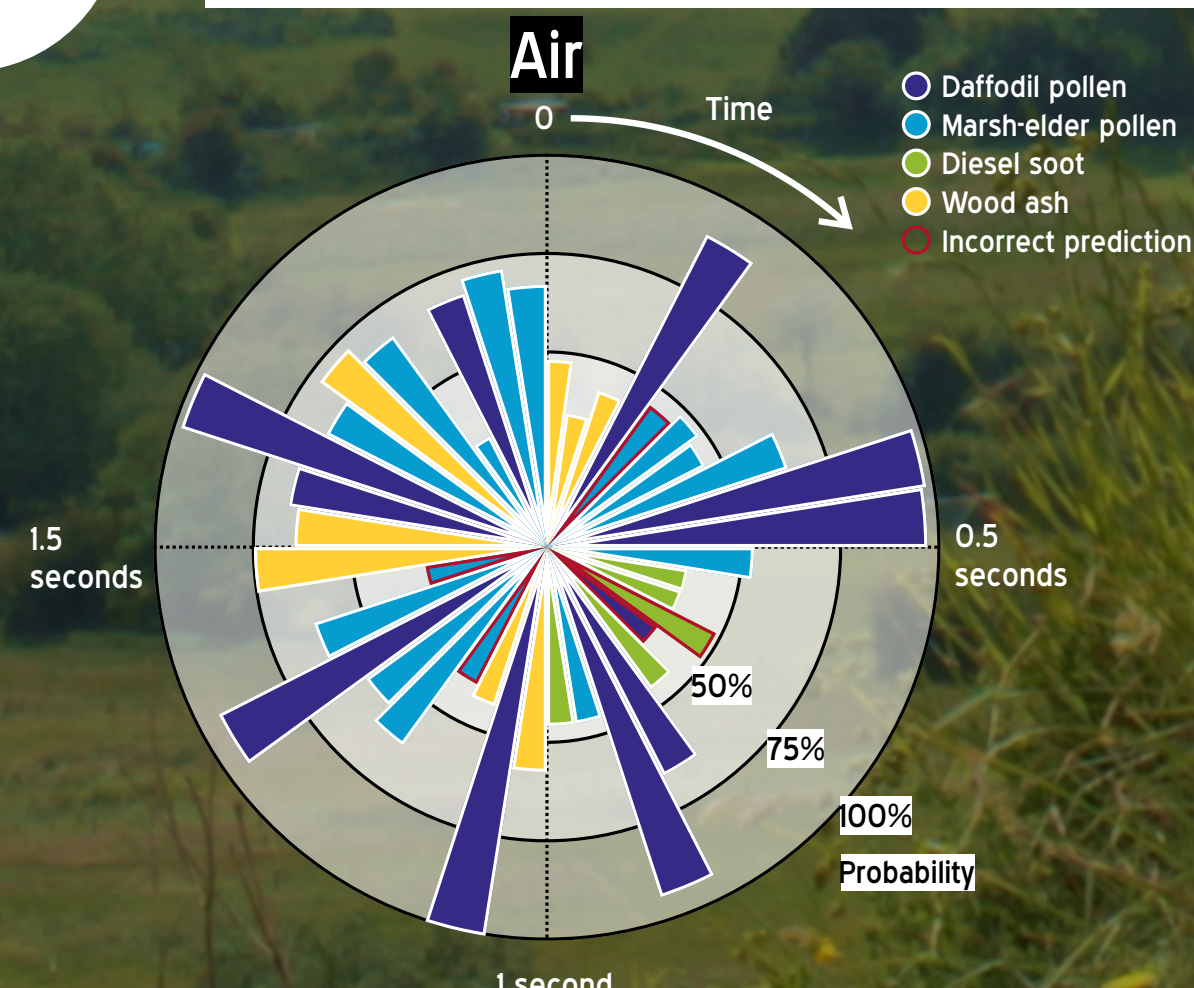
4 Training neural network

- Scattering patterns were used as an input for the neural network, which was trained to predict the material and number of particles.
- Once trained, the neural network was used in real-time for particle pollution classification.



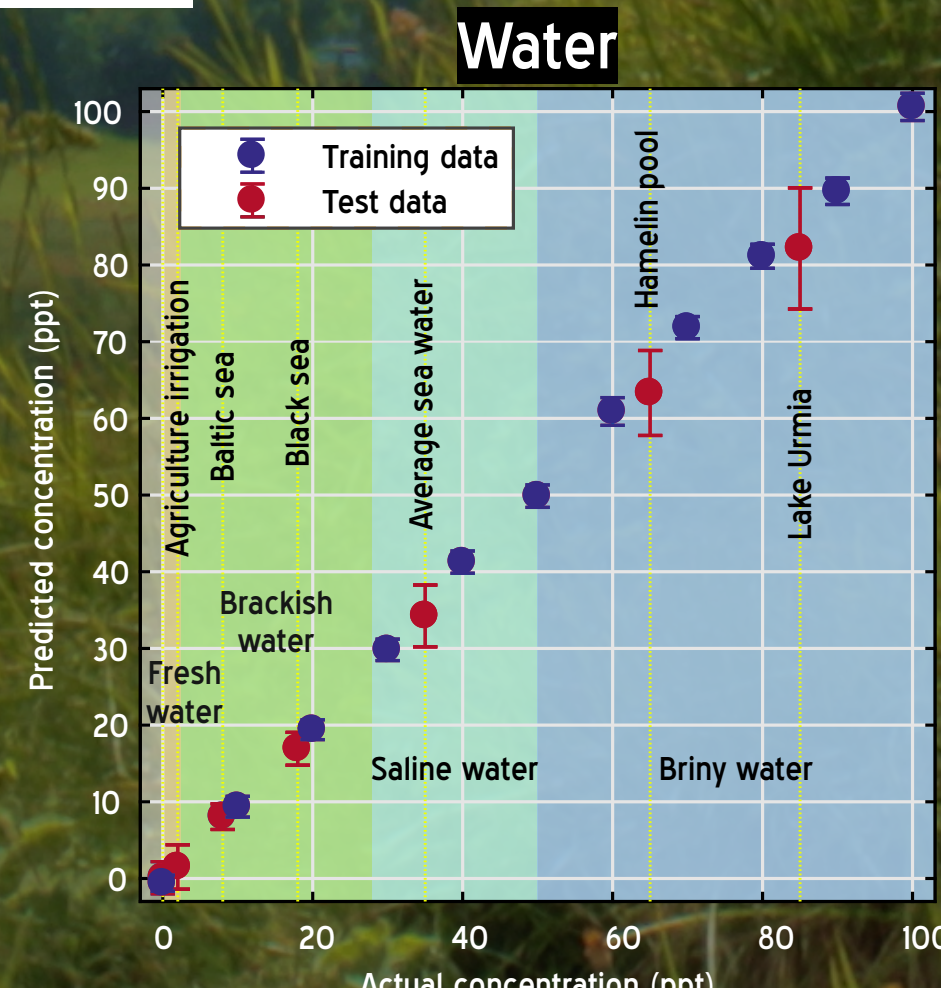
5 Real-time detection

Air



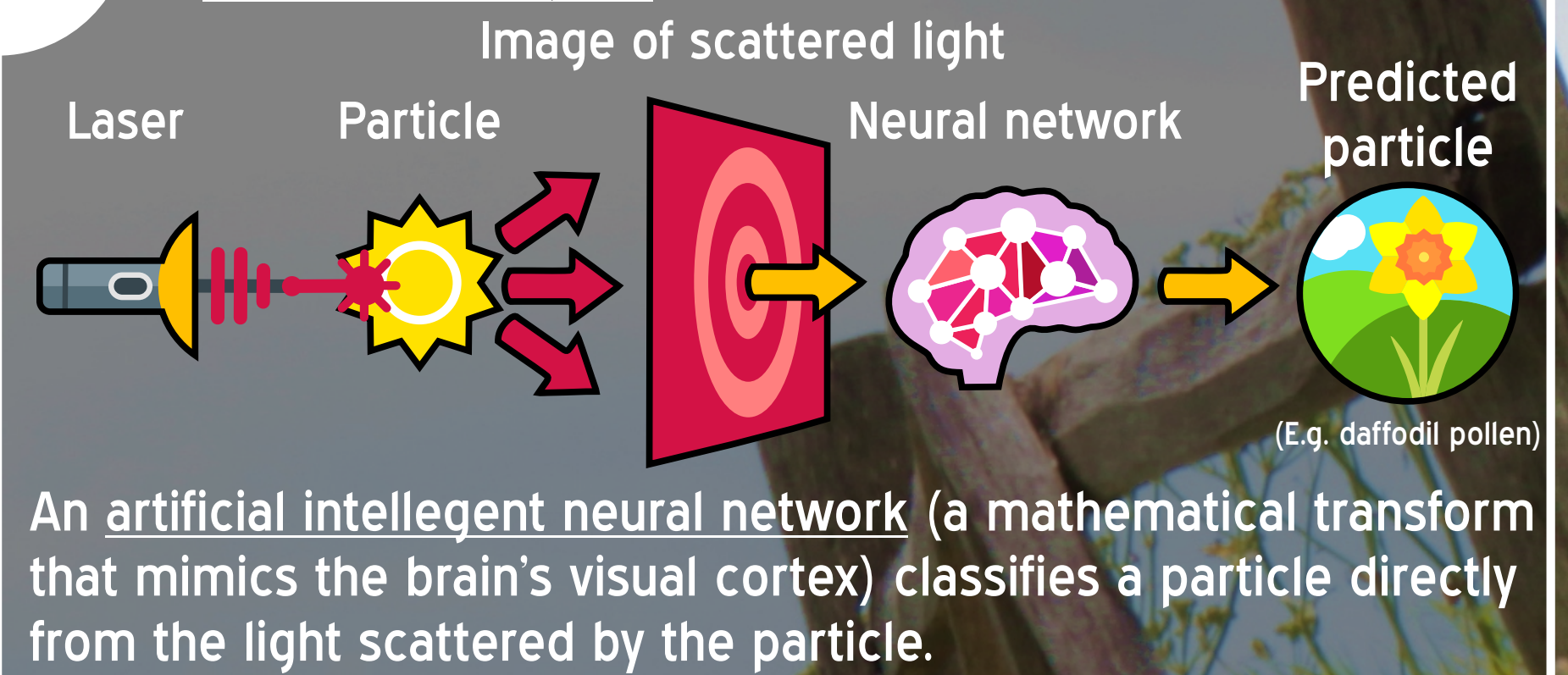
Real-time sensing of pollen, diesel and wood ash particles. Most likely particle type with its probability of prediction as a function of time².

Water

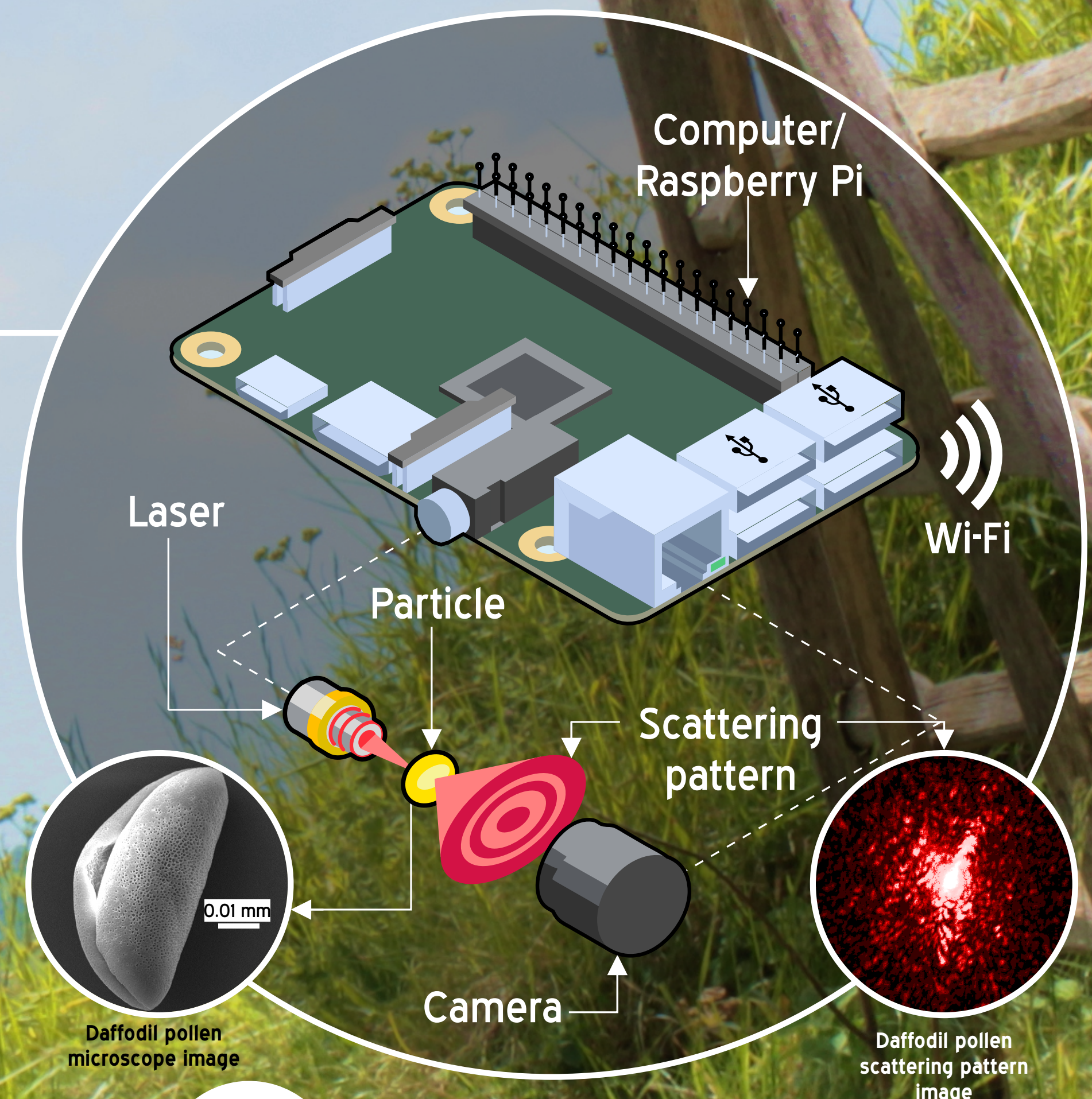


Detecting 0.008 mm plastic particles in water, with the average prediction accuracy of water salinity presented.

2 Concept



An artificial intelligent neural network (a mathematical transform that mimics the brain's visual cortex) classifies a particle directly from the light scattered by the particle.



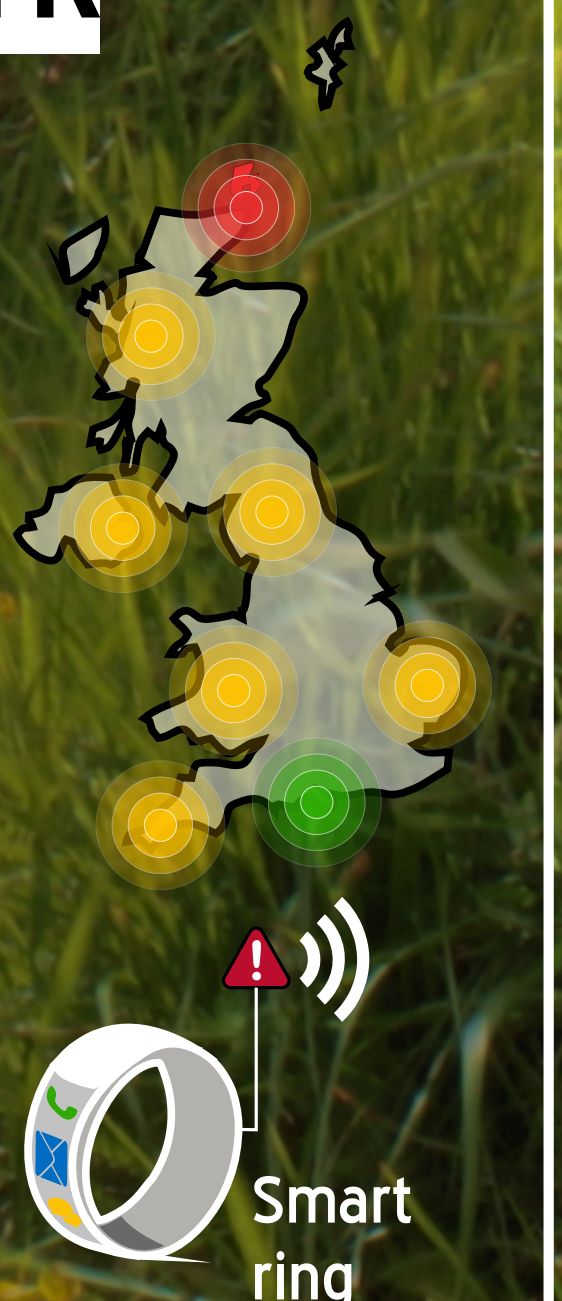
6 Future work

Nationwide sensors:

Developing a network of sensors over the country, such as on lampposts and in marine areas, which send data to the cloud and allow a live map of particle pollution to be viewed online.

Wearable technology:

- Rings, watches, headphones.
- Air pollution monitor with alerts.
- Hay fever alerts.
- Personalised.



References

- Holgate, S. "Every breath we take", Royal College of Physicians, 2016
- Grant-Jacob, J. A. et al (2018) Opt. Express, 26 (21), 27237-27246.

Acknowledgements

- EPSRC
- BBSRC
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