Playing with pollen grain structure using latent space

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Abstract: Pollen grains have evolved over time, shaped by environmental and ecological factors. These grains come in a variety of sizes and have nano-scale structures. Their morphology, which can take forms such as trilobal, spherical, or hexagonal, and have a variety of surface features like apertures, are vital for processes like germination. The surface of pollen grains can possess unique features such as spikes that enable them to adhere to various modes of transport, such as bee legs, bird feathers or animal fur, and help them navigate through the air on appendages that look like airplane wings or balloons. Their structure offers insights into plant adaptive strategies and assists in species identification. In addition, morphological changes in pollen grains can occur due to dehydration, while climatic conditions over time can facilitate evolutionary morphological changes in a species. Therefore, pollen grain imaging is a critical technique as it provides 2D and 3D morphological information, offering key insights into pollen evolution, and even the health of crops and the environment. However, modelling and understanding the structure of pollen grains using analytical methods can be laborious and challenging. Advances in graphics processing units (GPUs) and deep learning algorithms have facilitated large-scale, data-driven research. Convolutional neural networks (CNNs) have been deployed across palynology, automating pollen identification, and contributing to fields like agriculture, botany, and climate science. The Style Generative Adversarial Network (StyleGAN), a type of generative neural network, creates and modifies synthetic images, controlling specific aspects through the manipulation of the latent space. In palynology, StyleGAN can be used to generate synthetic images of pollen grains, allowing for the exploration of characteristics such as size and shape. This could potentially unlock further understanding of palynological relationships from an evolutionary perspective. This paper employs deep learning, specifically style transfer, to investigate the latent 'w-space' of pollen grain microscope images, generating synthetic images. This could enhance our ability to analyse a variety of pollen types, broadening our understanding of plant evolution and ecology.

What will audience learn from your presentation?
(Try to list 3-5 specific items)

From the presentation, the audience will learn:

- The application of deep learning, specifically StyleGAN, in generating synthetic images of pollen grains.
- The potential of deep learning in automating pollen identification and contributing to fields like agriculture, botany, and climate science.
- The potential of exploring characteristics such as size and shape in generated images to unlock further understanding of palynological relationships.

The audience can use this knowledge to:

- Understand the potential of deep learning in the field of palynology.
- Apply similar techniques in their research or work, especially if they are involved in fields like agriculture, botany, and climate science.
- Explore the use of StyleGAN in other areas of research.

This presentation can help the audience in their job by:

- Providing them with a new perspective on how to apply deep learning in their field of work.
- Offering a practical solution to automate the process of pollen identification, which could simplify their job if they are involved in related fields.
- Providing new information that could assist in design problems, especially in the design of experiments or studies involving pollen grains.

Other faculty could use this research to expand their research or teaching by:

- Incorporating the techniques presented in this research into their curriculum.
- Using the findings of this research as a basis for further studies in the field of palynology or deep learning.

The benefits of this research include:

- Potentially unlocking further understanding of palynological relationships from an evolutionary perspective.
- Enhancing our capacity to analyse a variety of pollen types.

Biography of presenting author (should not exceed 100 words)

Dr. James A Grant-Jacob is a Senior Research Fellow at the Optoelectronics Research Centre, University of Southampton, who has a diverse research portfolio, including high harmonic generation, laser fabrication, DNA sequencing, imaging, and AI. He has over 170 publications, including collaborations with NASA on laser manufacturing for greenhouse gas detection. Utilizing NVIDIA grants, he's improved laser-based processes through deep learning. In 2019, he presented his AI-based particle pollution detection research at STEM for BRITAIN in the UK Houses of Parliament. He's collaborated with companies like Dyson and institutions like Southampton General Hospital.

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