Topic: Quantum surface metrology
Location: The University of Nottingham

There is an urgent need in materials science and manufacturing engineering to devise fast and accurate methods for surface metrology, able to resolve complex geometries, especially high-slope features at submicrometre scales. When measuring the topography of surfaces with complex geometry, the spacing of the points in an image must be considered, along with the ability to accurately determine the heights of features. In other words, the optical lateral resolution must be considered in conjunction with the ability of the system to transfer surface amplitudes. Preliminary studies have revealed that quantum detectors can efficiently resolve both the axial and angular separation of two point sources in sub-wavelength imaging, however, there remains a conceptual and technical gap to bring these ideas into fruition for actual surface reconstruction.

In this project the student will undertake a detailed analysis of a quantum surface measurement system by theoretically modelling a discrete grid of quantum dot emitters distributed on the surface of complex (virtual) objects, and a reconfigurable array of detectors feeding into a linear interferometer. The student will make use of prior information (the nominal design data) and regular Bayesian update methods to optimise the measurement setup, including optimising the configuration of the detectors and the aperture. This analysis will return an object surface reconstruction model plus uncertainties of that model as output (the posterior). These theoretical simulations will inform future designs for quantum-enhanced optical measuring instruments.

The project will be supervised by Dr Samanta Piano, from the Manufacturing Metrology Team (MMT). MMT is an international and diverse team that thrives on openness and cooperation – students work in teams to achieve joint goals in a friendly but professional cohort.

The position is available for UK candidates, but EU or International applicants who can pay the difference between the Home and International Fees would also be welcome to apply. Candidates must possess or expect to obtain, a high 2:1 or 1st class degree in science, engineering or computer science, or other relevant discipline.

Supervisor: Dr Samanta Piano

Dr Samanta Piano is Assistant Professor in Metrology and deputy director of the Manufacturing Metrology team at the University of Nottingham (UoN). Her research interests concern the development of innovative and unconventional optical techniques and 3D probing systems for high-precision coordinate metrology to be used in industrial applications. She is currently investigating how artificial intelligence approaches can be used for camera calibration in 3D measurement systems. She is a former Marie Curie and UoN Advanced Research Fellow who has contributed to several forefront areas of experimental condensed matter physics, materials science, atomic and optical physics, metrology and nanotechnology. She has published in international peer reviewed journals, including three papers in the prestigious Physical Review Letters, one in Applied Physics Letters, and six refereed book chapters. She is currently co-supervising five PhD students, working on novel optical measurement techniques, defects in additive manufacturing and machine learning techniques for 3D optical measurements.

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