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Optical Interferometry for Non-Contact Measurement of Nanometer Scale Displacement and Remote Sensing

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Abstract

Optical interferometry plays a crucial role in the field of non-contact measurement and remote sensing. Laser-based optical interferometry can measure even the nanometer-scale displacement that occurs on a rough surface, making it invaluable in non-destructive testing and diagnostics. The use of light offers distinct advantages, as it does not require physical contact with the target structure or object being examined. This not only reduces the risk of contamination, often associated with contact-based measurements, but also extends its applicability to the remotely located objects. When the displacement being measured is small compared to the laser's wavelength, it is well-known that the measurement heavily depends on the initial phase of the system, and the direction of the displacement is not clearly determined. This presentation aims to highlight the diverse fields benefiting from non-contact measurements enabled by optical interferometry and introduces the optical I-Q method, which can overcome the challenges of conventional interferometric systems. Furthermore, we discuss ongoing trial studies aimed at remotely detecting nanometer-scale displacements occurred on non-specular surfaces, such as paper or concrete, positioned several meters away. These advancements have significant potential, including the assessment of partial discharge in a gas-insulated switchgear (GIS). We also explore the trial of non-contact ultrasound image acquisition through the use of laser-ultrasound.

Keywords: Interferometer, Noncontact measurement, Sensor, Laser ultrasound