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Simultaneous Measurement of Displacement and Roll Angle of Object

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Abstract : Laser interferometers are now widely used for length and displacement measurement. In conventional methods, the optical path difference between two mirrors, one of which is a reference mirror and the other is a target mirror, is measured, as in Michelson interferometry, or two target mirrors are set up and the optical path difference between the two targets is measured, as in differential interferometry. In these interferometers, the two laser beams pass through different optical elements so that the measurement result is affected by the vibration and other effects in the optical paths. In addition, it is difficult to measure the roll angle around the optical axis. The proposed interferometer simultaneously measures both the translational motion along the optical axis and the roll motion around it by combining the retroreflective principle of the ball lens (BL) and the polarization. This interferometer detects the interferogram by the two beams traveling along the identical optical path from the beam source to BL. This principle is expected to reduce external influences by using the interferogram between the two lasers in an identical optical path. The proposed interferometer uses a BL so that the reflected light from the lens travels on the identical optical path as the incident light. After reaching the aperture of the He-Ne laser oscillator, the reflected light is reflected by a mirror with a very high reflectivity installed in the aperture and is irradiated back toward the BL. Both the first laser beam that enters the BL and the second laser beam that enters the BL after the round trip interferes with each other, enabling the measurement of displacement along the optical axis. In addition, for the measurement of the roll motion, a quarter-wave plate is installed on the optical path to change the polarization state of the laser. The polarization states of the first laser beam and second laser beam are different by the roll angle of the target. As a result, this system can measure the displacement and the roll angle of BL simultaneously. It was verified by the simulation and the experiment that the proposed optical system could measure the displacement and the roll angle simultaneously.

Keywords : common path interferometer, displacement measurement, laser interferometer, simultaneous measurement, roll angle measurement
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