Tunable Synthetic Wavelength Speckle Interferometry

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Optical contouring with DSPI (Digital Speckle Pattern Interferometry) has been used for many years in industrial applications such as high accurate mechanical testing, wavefront reconstruction and shape of steep objects measurement. In this work we present a novel method to generate contour fringes through a synthetic wavelength using a multimode red diode laser. The synthetic wavelength originated from the wavelengths λ_1 and λ_2 is given by $\lambda_s = \lambda_1\lambda_2/(\lambda_1 - \lambda_2)$ and was obtained with an ECDL (External Cavity Diode Laser). A proper alignment of the external cavity generates a dual emission of the diode laser. The illumination of an object with two different wavelengths with a DSPI interferometer generates speckled images covered with interference fringes according to the wavefront shape. Since the contour interval of the interference pattern corresponds to $\lambda_s/2$, changes in a few nanometers of the laser emission correspond to an extended large range of possible synthetic wavelengths ranging from tens of micrometers to some millimeters. The possibility of changing the contour interval makes this interferometer a useful tool enabling to set the desirable interference patterns for many specific applications. The results show the extended range of this interferometer with the interference pattern of a lens with synthetic wavelengths ranging from 40 μm to 4,3 mm.