DIGITAL HOLOGRAPHIC INTERFEROMETRY IN THE LONG-WAVE INFRARED RANGE FOR MEASURING LARGE DEFORMATIONS OF SPACE COMPONENTS UNDER THERMAL-VACUUM TESTING

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Digital holographic interferometry (DHI) in the long-wave infrared (LWIR) spectral range has been used recently for many applications. It combines CO2 lasers with microbolometer arrays based thermal imagers for recording the holograms. The advantage of the long wavelength is that reconstructed objects are larger than what can achieve similar setups in the visible. Also deformations of objects can be obtained through phase interferograms calculated by the difference of phases reconstructed by DH at different instants. The distance between fringes in such interferograms is proportional to the wavelength used. With LWIR wavelengths 20 times larger than visible ones, LWIR DHI is able to measure deformations/displacements 20 times larger and is 20 times less sensitive to environmental perturbations. We will review several achievements in the field.

The first system developed was meant for measuring the deformation of large submillimeter aspheric reflectors used in space missions. The latter undergo large temperature variations (from -150 °C to +80 °C) from ambient, yielding to deformations which can be as large as 250 µm. Moreover the large scale thermal-vacuum facilities in which these specimens are placed for such testing do not allow high stability for applying visible light DHI for measuring such deformations in good conditions. Therefore LWIR DHI seemed best suited than visible DHI. Another advantage of LWIR DHI is that large objects can be observed, since the reconstructed holographic image size is proportional to the ratio between the laser wavelength and the pixel pitch. This ratio is typically 7 times larger in LWIR than in visible. A first DH interferometer was developed to prove the capability of LWIR DHI on a parabolic reflector of 1.1 meter diameter. Th