Time-averaged digital speckle pattern interferometry for investigation of art objects surfaces

Leszek Krzemień and Michał Łukomski

Jerzy Haber Institute of Catalysis and Surface Chemistry, Polish Academy of Sciences,
ul. Niezapominajek 8, 30-239 Kraków, Poland

The development and practical evaluation of a laboratory built, out-of-plane digital speckle pattern interferometer (DSPI) are reported. The instrument was used for non-invasive, non-contact detection and characterization of early-stage damage, like fracturing and layer separation, of painted objects of art. A fully automated algorithm was developed for recording and analysis of vibrating objects utilizing continuous-wave laser light. The algorithm uses direct, numerical fitting or Hilbert transformation for an independent, quantitative evaluation of the Bessel function at every point of the investigated surface. The procedure does not require phase modulation and thus can be implemented within any, even the simplest, DSPI apparatus. The proposed deformation analysis is fast and computationally inexpensive. Diagnosis of physical state of the surface of a panel painting attributed to *Nicolaus Haberschrack* (a late-mediaeval painter active in Krakow) from the collection of the National Museum in Krakow is presented as an example of an in situ application of the developed methodology. The test performed in the conservation studio showed that noisy environment, although affected the quality of the results increasing uncertainty of the reconstructed maps of surface vibrations, was not an obstacle to detect and characterize damage areas on a real work of art with sub-micrometer accuracy. It has been shown that the methodology, which offers automatic analysis of the interferometric fringe patterns, has a considerable potential to facilitate and render more precise the condition surveys of works of art.

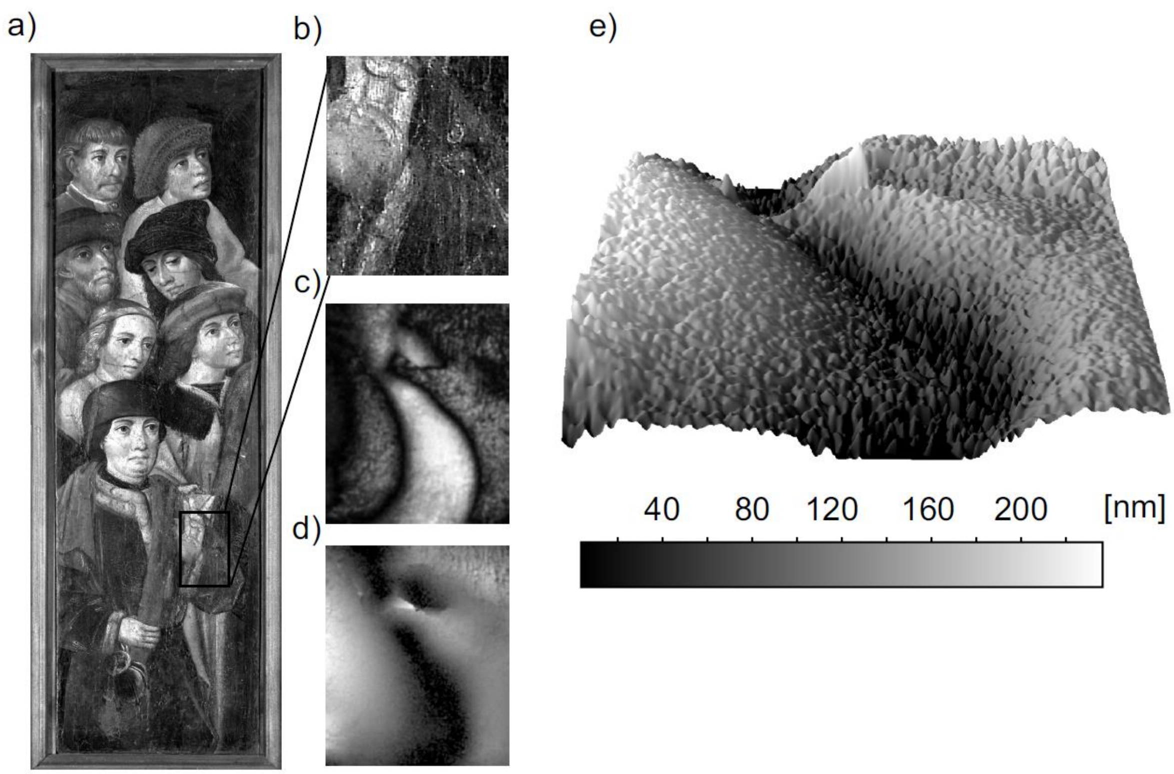

Figure 1. Analysis of the sound-induced (7.6 kHz) vibration of a decorative layer delaminated from a wooden support in central part of the investigated painting, (a) photograph of the painting; (b) magnification of the analysed area (c) raw interferogram; (d) two-dimensional map of vibration amplitude (e) enlarged and presented in 3D.

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