Aberration compensation for objective phase curvature in phase holographic microscopy: comment

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In a recent Letter by Seo *et al.* [Opt. Lett. **37**, 4976 (2012)], the numerical correction of the quadratic phase distortion introduced by the microscope objective in digital holographic microscopy (DHM) has been presented. In this comment, we would like to draw to the attention of the authors and the readers in general that this approach could not be the optimal solution for maintaining the accuracy of the quantitative phase via DHM. We recall that the use of telecentric imaging systems in DHM simplifies the numerical processing of the phase images and produces more accurate measurements.

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The possibility of having quantitative phase imaging (QPI) of microscopic specimens is a need that powers the constant development of digital holographic microscopy (DHM). DHM embraces optical microinterferometry with the digital versatility of processing the recorded holograms. The latter has also provided DHM with tools to get rid of the nuisance produced, for instance, by the aberrations introduced by the imaging systems. Nice results like those presented by K. W. Seo *et al.* [1] can be obtained through this method of alleviating the imperfections or misalignment of the optical systems. However, if there exists a physical approach [2] to minimize that nuisance, why is the use of digital methods so widespread? Maybe the answer to this question is the quickness and versatility provided by the digital world. Even though the numerical is a valid approach, we would like to highlight the trade-off of using a digital *a posteriori* method to correct those problems [3].

It has been proven that the presence of a quadratic phase factor introduced by the imaging system in DHM converts digital holography into a shift variant system [3–5]. This undesired feature hinders the accuracy of the QPI, making its recovery with *a posteriori* signal processing not possible [3]. K. W. Seo *et al.* [1], as other authors, reduce numerically the effect of the quadratic phase in an effort to remove the phase perturbations introduced by the imaging system. However, the numerical elimination of the effects of the quadratic phase factors is challenging and leaves residual errors that are transferred to the final phase image, as has been quantified in reference [3]. In general, these numerical approaches estimate the phase correction factor by some kind of bidimensional interpolation. However, as the imaging system is shift variant, it introduces perturbations on the specimen signal and/or excludes spatial frequencies of the recorded hologram. No signal processing can recover the lost information and/or fully unscramble the information of the object from that of the misaligned or aberranted imaging system. In the best scenario, it reduces the aberrations of the system, leaving some remaining phase perturbations. The residual phase perturbations keep the DHM barely shift variant, which, added to the lost spatial frequencies, ruins the QPI measurements [3]. All of the aforementioned problems can be alleviated if the imaging system is telecentric [2]; the holographic microscope is shift invariant, and then the need for making extra signal processing over the phase images is eliminated or at least is sensibly reduced. Consequently, more accurate measurements could be done.

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