Comment on "Single-shot speckle reduction in numerical reconstruction of digitally recorded holograms"

Jonathan Maycock,[1,*] Bryan Hennelly,[2] and John McDonald[3]

[1] *Neuroinformatics Group and Cognitive Interaction Technology Center of Excellence, Bielefeld University, Bielefeld, Germany*[†]

[2] *Department of Electronic Engineering, National University of Ireland, Maynooth, Maynooth, Co. Kildare, Ireland*

[3] *Department of Computer Science, National University of Ireland, Maynooth, Maynooth, Co. Kildare, Ireland*

compiled: May 21, 2015

We comment on a recent Letter by Hincapie *et al.* [Opt. Lett. 40, 1623 (2015)] [1] in which the authors proposed a method to reduce the speckle noise in digital holograms. This method was previously published by us in Maycock [2] and Maycock and Hennelly [3]. We also wish to highlight an important limitation of the method resulting from the superposition of different perspectives of the object/scene, which was not addressed in their paper [1].

OCIS codes: (090.1995) Digital holography; (030.6140) Speckle; (030.4280) Noise in imaging systems.
http://dx.doi.org/10.1364/XX.99.099999

In 2012 Maycock [2] (pages 202-203 and 225-228) introduced the idea of the incoherent addition of intensity distributions obtained from reconstructing different spatial regions of a Fresnel hologram, in order to reduce speckle in reconstructions of digital holograms. This is identical to the method that was proposed by Hincapie *et al.* [1] in their recent Letter and involves splitting a digital hologram into smaller non-overlapping sub-holograms, followed by numerical propagation in the form of a discrete implementation of the Fresnel transform. Finally, the reconstructed intensity distributions are averaged to reduce the speckle content. In their letter they omit an important limitation of the method which was discussed in [2]. It concerns the fact that each of the sub-holograms provides a different perspective of the object/scene under consideration. The angular perspective associated with a given sub-hologram is defined by the line connecting the center of the sub-hologram with the relevant point in the scene. It is clear that simply taking a superposition of these reconstructions can introduce corruptive effects on the resulting reconstruction. We note that this effect becomes increasingly obvious for larger holograms for which the sub-holograms can reconstruct appreciably differing perspectives. In [2] and [3] we also investigated the effect of the method on both resolution, which is determined by the dimensions of the sub-hologram, and edge preservation [4]. The decision was taken not to investigate the method further due to the problems regarding multiple perspectives already discussed. We note that this problem does not exist for the discrete Fourier filter method described in [5] where the reconstructed digital hologram is subject to different bandpass filters before adding the resulting uncorrelated intensity distributions to reduce the speckle content.

References

[1] D. Hincapie, J. Herrera-Ramrez, and J. Garcia-Sucerquia, Opt. Lett. **40**, 1623 (2015).

[2] J. Maycock, *Improving reconstructions of Digital Holograms*, Ph.D. thesis, National University of Ireland, Maynooth (2012).

[3] J. Maycock and B. Hennelly, *Improving reconstructions of digital holograms: Speckle reduction and occlusions in digital holography* (LAP LAMBERT Academic Publishing, 2014).

[4] F. Sattar, L. Floreby, G. Salomonsson, and B. Lovstrom, IEEE Tran. on Image Proc. **6**, 888 (1997).

[5] J. Maycock, B. M. Hennelly, J. B. McDonald, Y. Frauel, A. Castro, B. Javidi, and T. J. Naughton, J. Opt. Soc. Am. A **24**, 1617 (2007).

* Corresponding author: jmaycock@techfak.uni-bielefeld.de

† This research was supported by the German Research Foundation (DFG) within the Cluster of Excellence EXC 277 "Cognitive Interaction Technology (CITEC)" at Bielefeld University and by Science Foundation Ireland (SFI) under Basic Research Grant 04/BR/0342.