Exploiting optical chaos for speckle reduction in double pass imaging

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The Double pass (DP) imaging technique is a diagnostic method used to obtain an overall estimation of the optical quality of an eye, containing information on scattering as well as higher order aberrations [1]. This is achieved by measuring the point spread function of the eye by recording the image of a point source on the retina, i.e., a collimated light beam enters the eye, passes the ocular media, is reflected at the retina, passes through the ocular media again in reverse direction and is recorded after exiting the pupil. DP images are usually suffer from speckle noise, if no action is taken against it. Is this work we study the use of semiconductor optical chaos for speckle reduction in this application.

For this, we first study the use of optical chaos for reducing speckle in a full-field imaging setup. We obtain optical chaos from a semiconductor laser diode by subjecting it to different amounts of optical feedback as well as modulating its pump current, with the aim of reducing the coherence length of the source and thus reducing speckle formation [2]. For example, the speckle contrast C, within the white circle of Fig. 1 is reduced from $C = 0.41$ to $C = 0.30$ simply by subjecting the laser diode to optical feedback, where $C = \sigma_I / \langle I \rangle$, with the mean intensity of the pattern $\langle I \rangle$,and its standard deviation σ_I [3].

Once we have found feedback parameters for best speckle reduction, we will apply the chaotic source in a DP imaging experiment.

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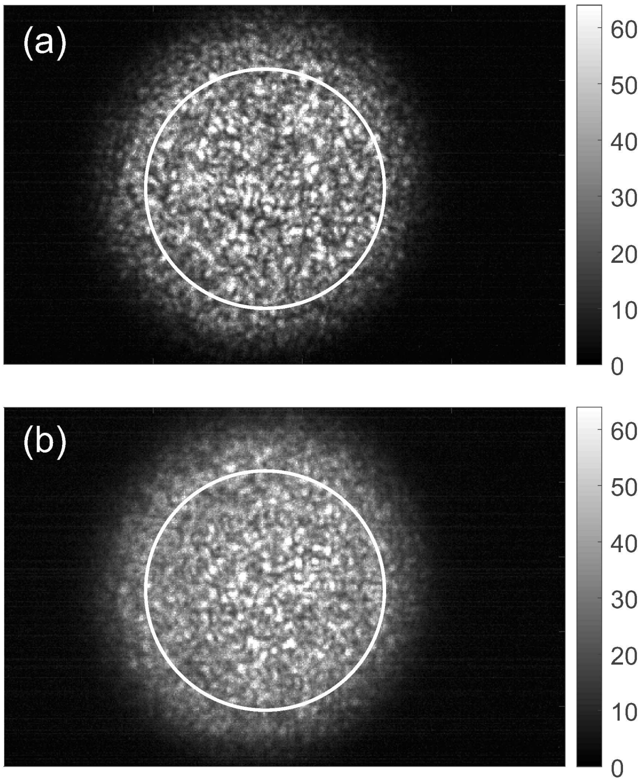

Fig. 1. Speckle patterns with intensity shown in gray-scale (arbitrary units). Source: laser diode. (a) No feedback. (b) With optical feedback.