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Abstract: Mathematical research breakthroughs, in the domain of image processing filters, were recently accomplished by combining non-local means smoothing operations with polynomial regression techniques. We show how inherently noisy speckle interferograms can benefit from these methods, which have been shown to achieve near-optimal noise removal, while maximally preserving edge information corresponding to phase jump locations in optically captured phase fields.

INTRODUCTION

Images produced by an interferometric speckle capture system are inherently noisy, and the phase information is naturally wrapped onto the range $-\pi$ to $+\pi$. The reconstruction of the unknown multiples of 2π necessitates reliable identification of phase jumps. In this work, we apply recent advances in mathematically researched approaches [1] to image filtering, which focus particularly on edge location preservation in the context of excessively noisy images.

EXPERIMENTAL METHODS

We experimented with a range of non-local means based methods reviewed in [1], and compared their performance against a variety of input images. We report here on two methods [1, 2] in particular, which gave promising results when applied to speckle images.

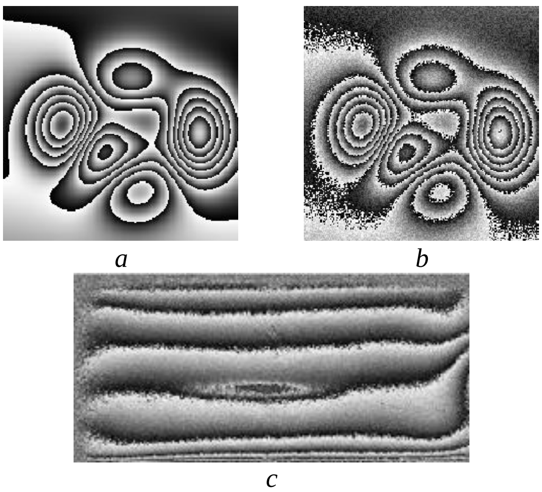

Fig. 1: Input interferograms employed for performance testing. Noise-free simulated (a), simulated noisy (b), and optically captured interferograms.

Method [2] makes use of a Yaroslavsky filter. Method [3] employs polynomial regression in conjunction with non-local means smoothing [1]. To demonstrate filtering performance, we use two input images shown in Fig. 1.b and Fig. 1.c, which represent simulated and optically captured speckle interferograms, respectively.

RESULTS AND DISCUSSION

We note that method [3] gives better performance overall against both simulated and optically captured images, Fig 2. Method [2] does have interesting features, nevertheless, such as allowing for an external "oracle" to identify edge locations. It also appears to preserve local features better such as the elliptical fringe near the centre of Fig 2.c.

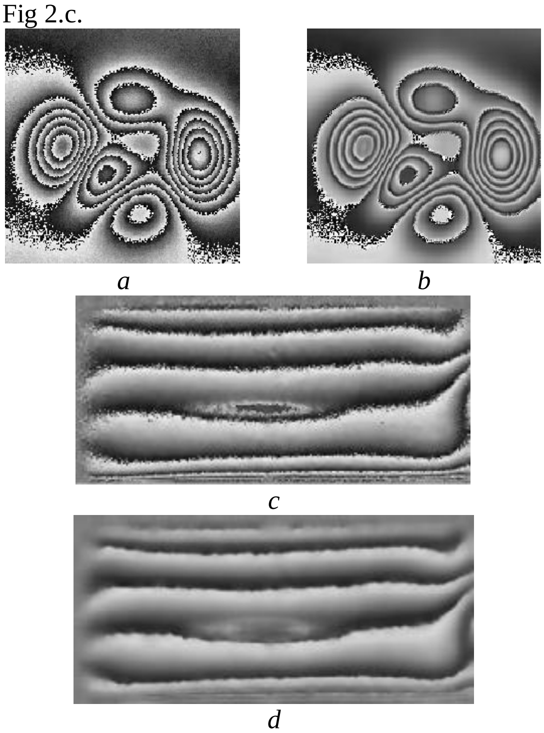

Fig. 2: (a) and (b)are results of applying [2], [3] to Fig 1.b, and (c), (d) are results of applying [2], [3] to Fig 1.b.c, respectively.

CONCLUSION

We explored a range of recently developed image processing method, which employ statistical techniques to achieve improved noise removal, while preserving edge location information. We reported on the results obtained against two methods showing promisingly good performance. It would be worth exploring [2] further by constructing a hybrid filtering mechanism, taking advantage of recently developed machine-learning pattern recognition based techniques [4] to act as the phase discontinuity location identification oracle.

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