Residual Interpolation for Micropolarizer Array Patterns of Polarization Image Sensors

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Abstract

In this paper, we have applied residual interpolation to low-resolution polarized images of different micropolarizer patterns for division of focal plane (DoFP) polarization image sensors. We observed the polarization accuracy recovery through visual evaluation of intensity, degree of linear polarization (DoLP) and angle of linear polarization (AoP) images and found that residual interpolation works well on a 4-micropolarizer pattern of a rooster image.

Introduction

Polarization [1, 2] is an important fundamental property of light. We get polarization information from Stokes parameters (S_0, S_1, S_2) captured by a division of focal plane (DoFP) polarization image sensor at each imaging frame. Fig.1 shows a 4-micropolarizer (MP), 3-MP and 2-MP pattern. In the 2-MP pattern, the blank spaces show that no MPs are used.

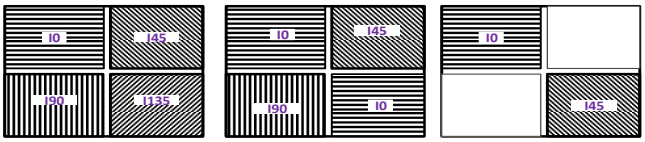

Fig. 1. Different MP patterns: (a) Equally weighted MP patterns with four different micro-polarizers; (b) Patterns with three micro-polarizers; (c) Patterns with two micro-polarizers.

Results and Analysis

Fig.2 shows true high-resolution intensity, degree of linear polarization (DoLP) and angle of linear polarization (AoP) images of a rooster. In the DoLP image, black levels show a low degree of linear polarization and white levels show a high level of DoLP. For the AoP image, from the color bar, an AoP from 0 to 180 degrees is shown by the change in colors.

Fig.2. The true high-resolution image of a rooster

Fig. 3 shows the intensity, DoLP and AoP of the original image in the first column, and those of 4-MP, 3-MP and 2-MP pattern recovered images after residual interpolation (RI) [3– 5] are presented in the second, third and fourth columns, respectively. According to the visual evaluation, RI works well in terms of lost polarization information recovery on the 4-MP pattern.

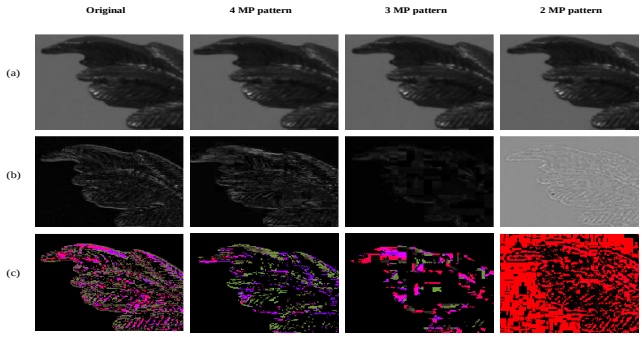

Fig 3. The true high-resolution image and comparison of MP patterns for (a) intensity, (b) DoLP and (c) AoP.

Conclusion

We tested residual interpolation on low-resolution images for a DoFP polarization image sensor. The proposed algorithm is tested for 4-, 3- and 2-MP array patterns of CMOS polarization image sensors. We checked the algorithm's results by visual evaluation, and it was clearly demonstrated that residual interpolation works well on a 4-MP array for both the DoLP and AoP of a rooster image.

Acknowledgements

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References

1. D. H. Goldstein, *Polarized Light*, CPC press, 3rd edition, 2010.
2. V. Gruev, "Fabrication of a dual-layer aluminum nanowires polarization filter array," *Opt. Express* **19(**24), 24361–24369 (2011).
3. l.D. Kiku, Y. Monno, M. Tanaka, and M. Okutomi, "Residual interpolation for color image demosaicking," in *2013 IEEE International Conference on Image Processing*, Melbourne, (IEEE, 2013), pp. 2304–2308.
4. Y. Monno, D. Kiku, S. Kikuchi, M. Tanaka and M. Okutomi, "Multispectral demosaicking with novel guide image generation and residual interpolation," in *IEEE International Conference on Image Processing* (IEEE, 2014), pp. 645–649.
5. W. Ye and K. K. Ma, "Color image demosaicing using iterative residual interpolation," *IEEE Trans. Image Processing* 24(12), 5879–5891 (2015).