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GS Iterative Phase Retrieval Algorithm Based on Fusion of Spatial Phase Gradient Descent and Frequency Domain Amplitude Linear Weighting

Hong Cheng*, Haonan Zheng, Siwei Sun

School of Electronic and Information Engineering Anhui University

Abstract

For the problems of slow convergence and low accuracy of the traditional linear weighted GS iterative phase retrieval algorithm, a GS iterative phase retrieval algorithm based on the fusion of spatial phase gradient descent and frequency domain amplitude linear weighting is proposed. By zero-padding the image, and then applying phase gradient descent in each iteration of the space domain, the algorithm invokes linear weighting in the frequency domain space, thereby avoiding iterative stagnation while ensuring the convergence speed and improving the accuracy of phase retrieval.

Introduction

We usually do not have an intuitive sense of the phase part of light because the human eye or existing imaging devices can only detect the intensity information of light, but cannot record the phase information of light. Phase holds information about the surface profile or depth of an object compared to intensity. It is of great importance to retrieve the phase from the intensity information.

Objectives

- Improve the convergence speed.
- Reduce the influence of noise on the phase retrieval results.
- Improve the accuracy of phase retrieval.

Methods

The algorithm is divided into two major modules, the first module is for zero-padding processing of the image, and the second module is for GS hybrid iteration. The schematic diagram of the algorithm proposed in this paper is shown in Fig. 1.

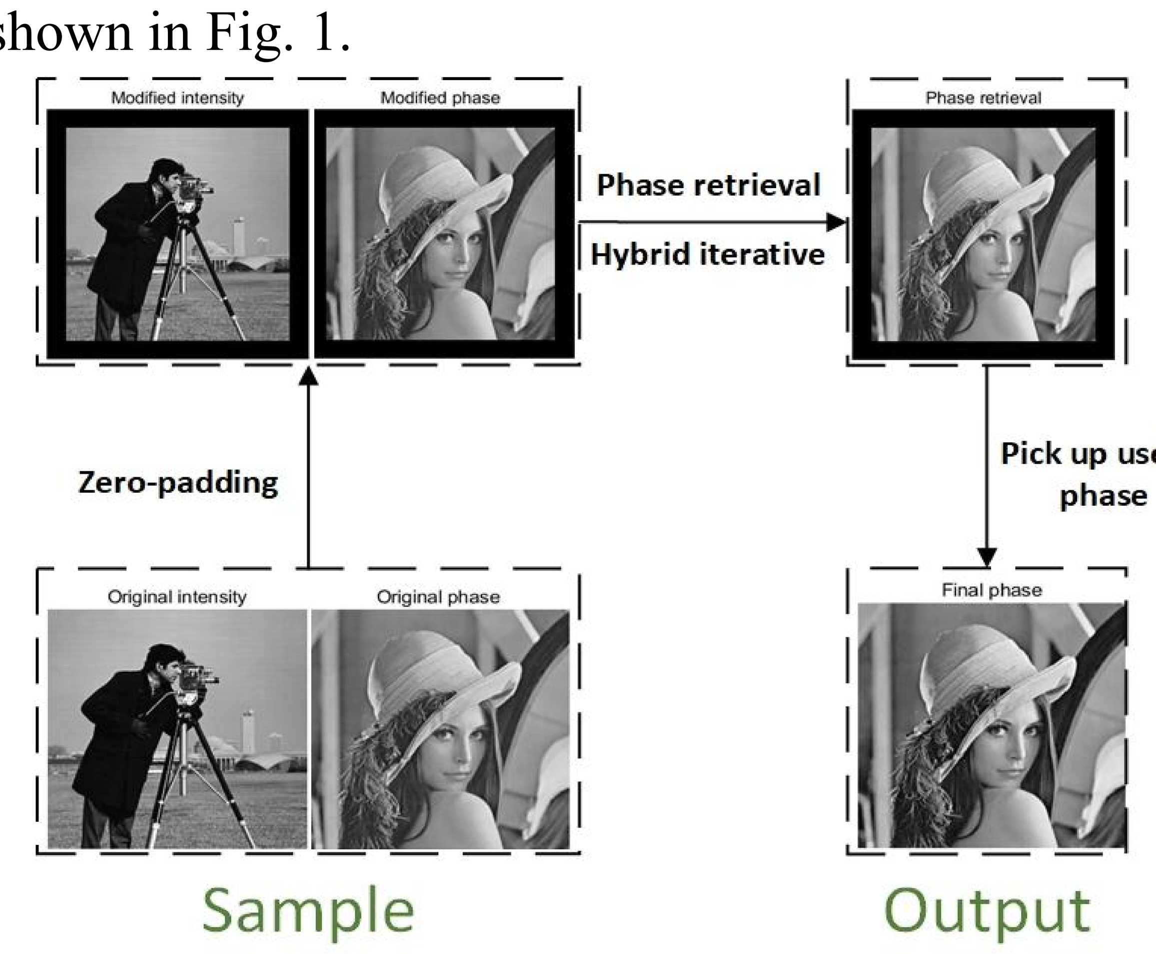

Fig. 1. Schematic diagram of the algorithm

The flow chart of the GS hybrid iterative module algorithm is shown in Fig. 2.

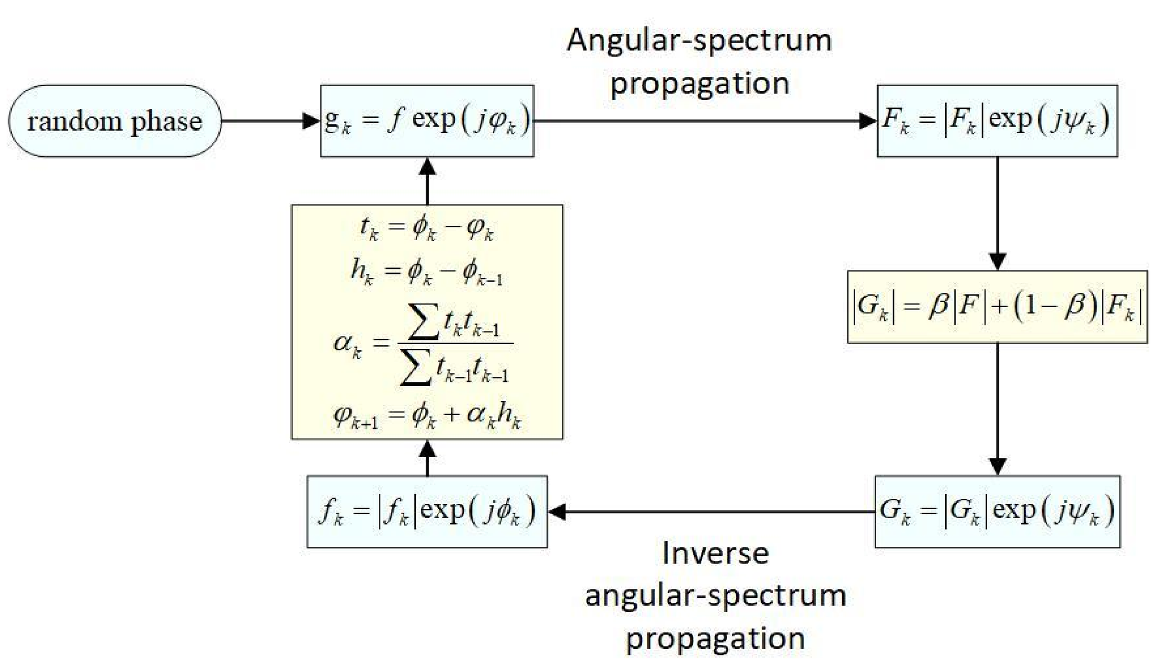

Fig. 2. Flow chart of GS hybrid iterative module algorithm

Result

Fig. 3 shows the comparison results under different methods.

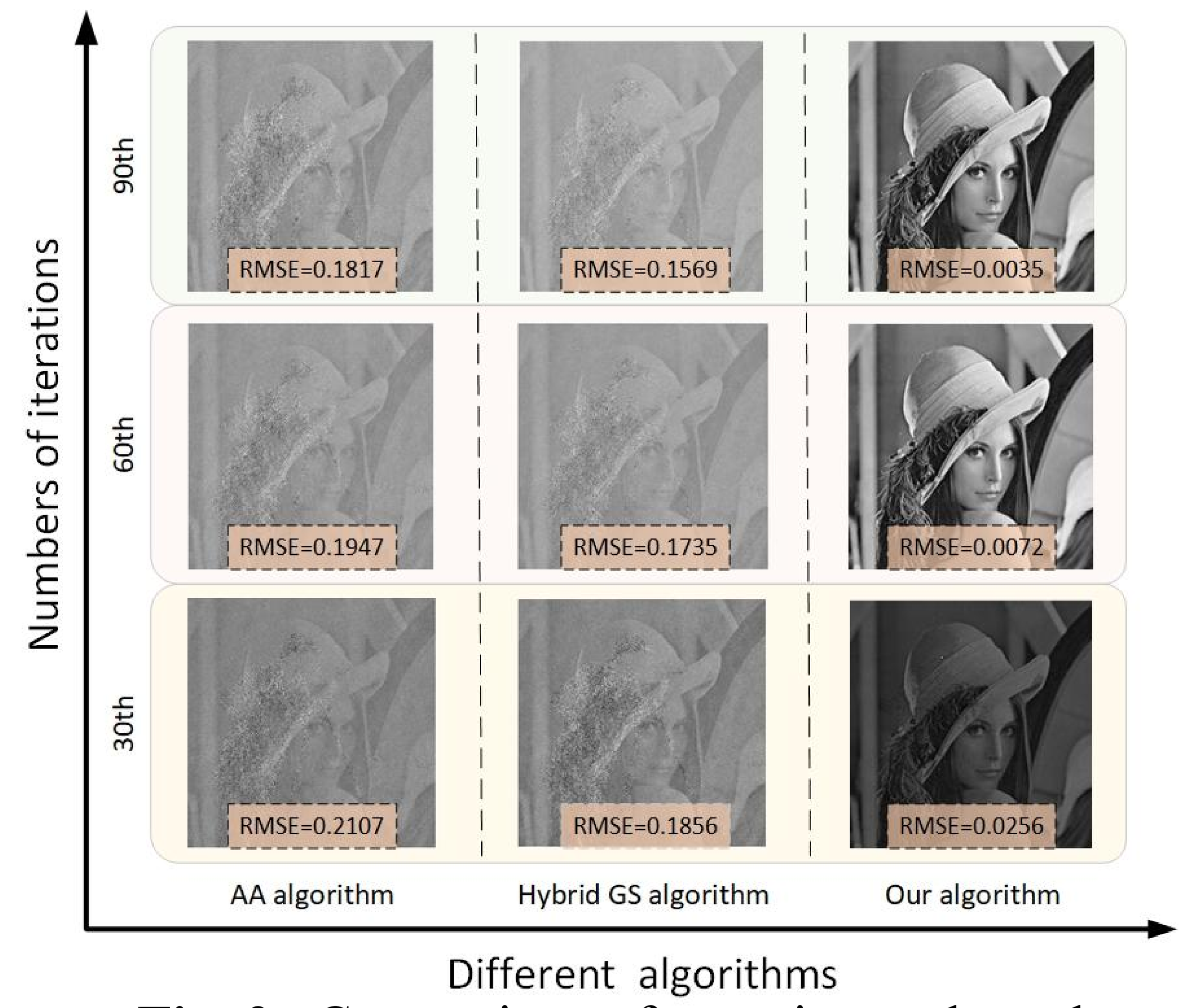

Fig. 3. Comparison of experimental results

From the experimental results, the Adaptive-additive algorithm is still blurred after 90 iterations and the RMSE value is 0.1817. The retrieved phase of the GS hybrid iterative algorithm without the zero-padding process is also blurred at the same number of iterations, and the RMSE value is 0.1569. The algorithm proposed in this paper can achieve high retrieval accuracy after 90 iterations, and its RMSE value is 0.0035.

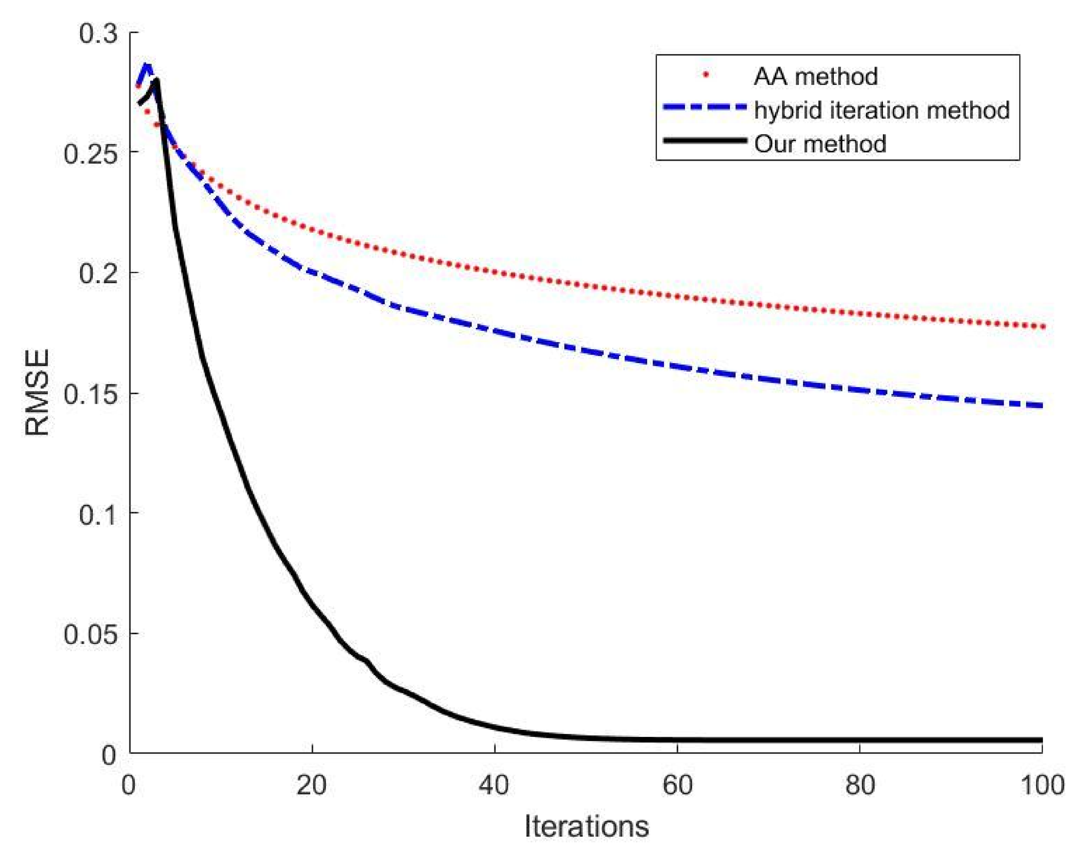

Fig. 4. Curve comparison of RMSE values

Fig. 4 gives the RMSE comparison curves of the above three algorithms after retrieval through 100 iterations. In the above figure, the horizontal axis represents the number of iterations and the vertical axis represents the root mean square error. The error curves of the three algorithms are shown by red dots, blue dotted lines, and black solid lines, respectively. Compared with the above two methods, the algorithm proposed in this paper converges faster and with higher accuracy.

Conclusion

In this paper, we propose a GS iterative phase retrieval with the fusion of spatial domain phase gradient descent and frequency domain amplitude linear weighting to address the problems of slow convergence speed and low accuracy of the traditional linearly weighted GS iterative phase retrieval algorithm. The algorithm not only improves the convergence speed but also improves the accuracy of phase retrieval. The comparison of the experiments in this paper illustrates the superiority of the algorithm proposed in this paper.

References

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安徽大學