Generation of Collinear Superimposed Orbital Angular Momentum Modes Using a Phase-only Grating

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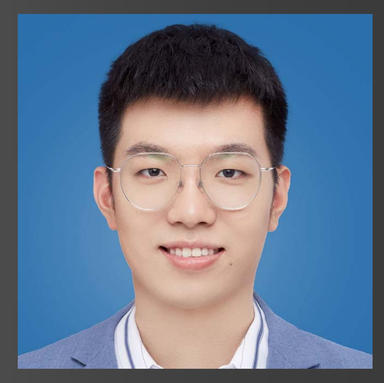

Abstract

In this paper, an Orbital Angular Momentum (OAM) generation method based on Adapted Mutation Particle Swarm Optimization (AM-PSO) algorithm is proposed. Based on the traditional iterative algorithm, the AM-PSO algorithm simultaneously generates multiple OAM modes with higher iterative efficiency. The simulation results show that 20 evenly spaced OAM modes are generated through a phase-only grating with high diffraction efficiency and low relative root mean-square error (R-RMSE).

Introduction

Compared by the traditional OAM multiplexing system, the system using a phase-only grating to generate multiple OAM modes is more simple and cost lower. However, due to the transmission function of superimposing multiple OAM modes is in complex form. The phase-only grating can only approximate the expectation transmission function. The difference is expressed by R-RMSE function. Therefore, the problem to be solved by the generation algorithm is to make the error smaller when generating simultaneously as more modes as possible, so the undesired mode power will be smaller.

The Principle of AM-PSO Algorithm

The proposed AM-PSO algorithm is used to simultaneously generate 20 evenly spaced OAM modes. The flow chart is shown in Figure 1. Based on the traditional iterative algorithm, AM-PSO algorithm adopts the multi-value mutation operator-based adaptive mutation method to effectively jump out of the local position and locate the better position in the global, thus improves the effect of the iterative algorithm.

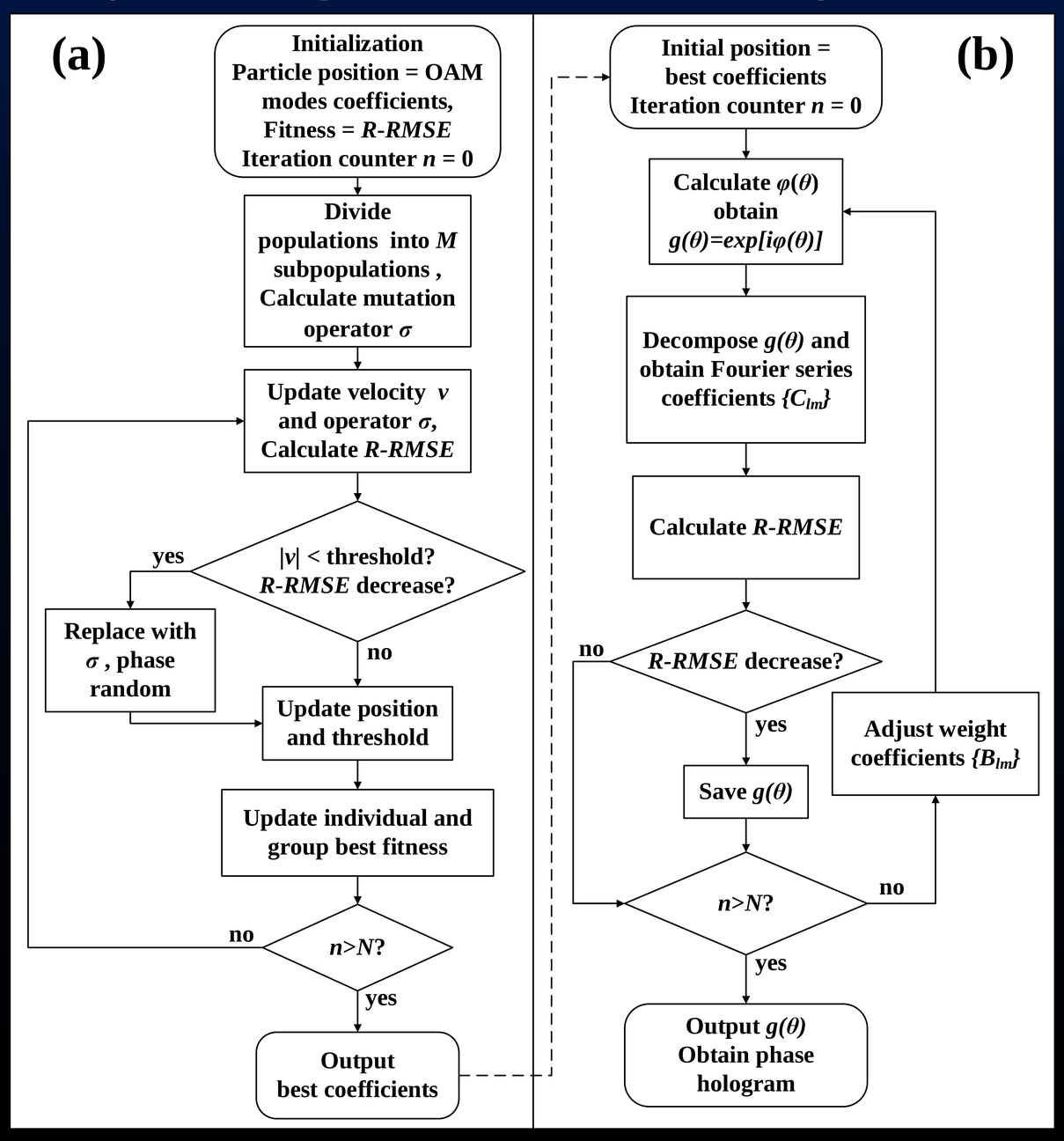

Figure 1. The AM-PSO algorithm flow chart.

(a) Initialization process by AM-PSO (b) Traditional iterative process

Results

The AM-PSO algorithm solves the problem of initializing the coefficients of OAM modes. As shown in Figure 2, by compare with the existed algorithms, AM-PSO converges faster in limited iteration steps of initialization process. Figure 3 shows the OAM spectrums generated by different algorithms. It can be concluded that the spectrum with AM-PSO is more consistent with the desired spectrum. Therefore, the AM-PSO algorithm shows a favorable performance for generating multiple OAM modes.

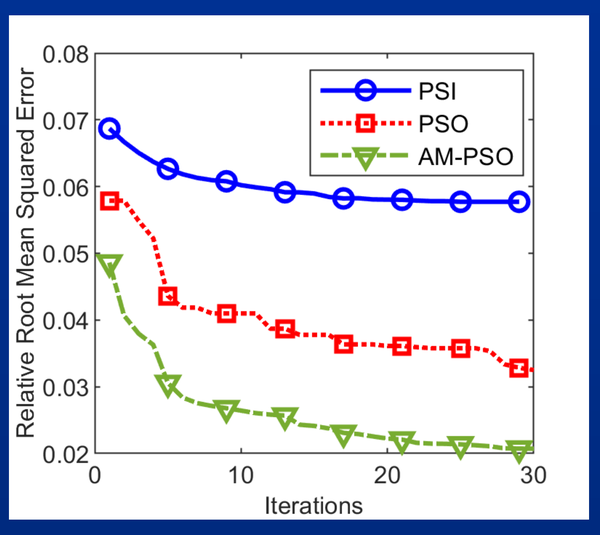

Figure 2. The iterative curve in initialization process.

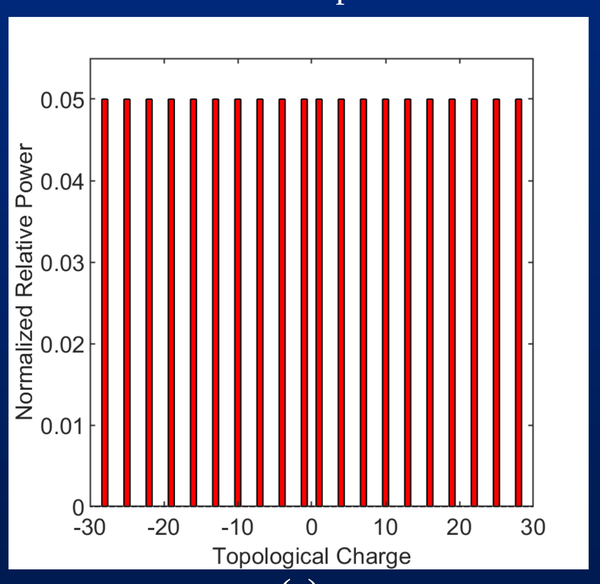

Figure 3. The OAM spectrum by iterative algorithms.

(a) The desired OAM spectrum (b) Lin's algorithm (c) PSI (d) AM-PSO

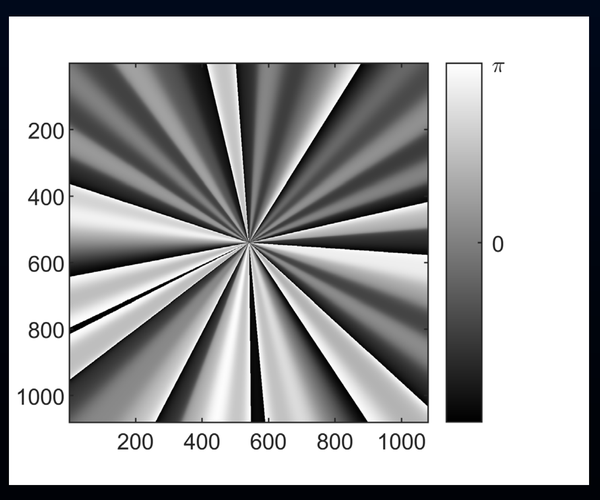

Figure 4. The phase hologram with $L=\{-28,\ldots,-4,-1,1,4,\ldots,28\}$

Figure 4 shows the phase hologram by AM-PSO. By using it, the superimposed vortex beam with corresponding topological charge can be generated.

Conclusion

We propose an OAM generation method based on AMPSO algorithm to generate collinear superimposed OAM modes.

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