Accepted Manuscript

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PII: S0167-2789(17)30323-8
DOI: https://doi.org/10.1016/j.physd.2018.01.010
Reference: PHYSD 32004

To appear in: *Physica D*

Received date : 13 June 2017
Revised date : 29 December 2017
Accepted date : 15 January 2018

Please cite this article as: D. Ito, T. Ueta, K. Aihara, Bifurcation analysis of eight coupled degenerate optical parametric oscillators, *Physica D* (2018), https://doi.org/10.1016/j.physd.2018.01.010

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Abstract

A degenerate optical parametric oscillator (DOPO) network realized as a coherent Ising machine can be used to solve combinatorial optimization problems. Both theoretical and experimental investigations into the performance of DOPO networks have been presented previously. However a problem remains, namely that the dynamics of the DOPO network itself can lower the search success rates of globally optimal solutions for Ising problems. This paper shows that the problem is caused by pitchfork bifurcations due to the symmetry structure of coupled DOPOs. Some two-parameter bifurcation diagrams of equilibrium points express the performance deterioration. It is shown that the emergence of non-ground states regarding local minima hampers the system from reaching the ground states corresponding to the global minimum. We then describe a parametric strategy for leading a system to the ground state by actively utilizing the bifurcation phenomena. By adjusting the parameters to break particular symmetry, we find appropriate parameter sets that allow the coherent Ising machine to obtain the globally optimal solution alone.

Keywords: bifurcation analysis, degenerate optical parametric oscillators, symmetry-breaking bifurcations

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