New indicator for the fastest detection of patterns existing in dynamic complex networks of coupled oscillators

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Collective behaviour of complex networks(CN) of coupled oscillators attracts attention of many scientists due to existence of many complex patterns of their dynamic behaviour, as well as applications in many different disciplines of science. One of the possible patterns that is distinguishable in the dynamics of such systems are chimera states – coexistence of coherent and uncoherent oscillators in CN of symmetrically coupled identical oscillators. There exist different methods for chimera states detection, such as strength of incoherence indicator, local order parameter, FFT, average velocity measuring, but all of them have common disadvantage – they require stabilization of the system to detect if chimera state exists. In this article authors present new indicator, based on innovative approach – Directional Lyapunov Exponents(DLE)[1], that allows for fast detection of possibility of chimera state existence before stabilization of the coherent part of oscillators. Such approach, combined with Master Stability Function, allows to perform potentially fastest search of possible chimera states existence for different values of system parameters or initial conditions. Moreover, proposed method has potential to be applied for fast searching of other types of dynamical patterns possible existence. The important fact is that proposed approach is very universal and can be applied for both, symmetrical and non-symmetrical topologies of coupling or for networks of non-identical oscillators. As DLE values, used in proposed method, are obtained from actual state of dynamical system and values of the system variables, therefore, proposed method of fast searching has a huge potential to be applied in experiments.

References

[1] Dabrowski, A., Balcerzak, M., Zarychta, S., Denysenko, V., Sagan, T., & Stefanski, A. (2023). Investigations of complex systems' dynamics, based on reduced amount of information: introduction to the method. Nonlinear Dynamics, 111(17), 16215-16236.

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