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SYNCHRONIZATION OF PERIODIC TRAJECTORIES FOR LINEARLY COUPLED MAP LATTICES WITH DELAYED COUPLING

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Abstract. Synchronization of periodic trajectories of linearly coupled map lattices with delayed coupling is investigated. A quantity d involving the spectra of coupling matrix and the dynamics of an individual node is introduced to analyze the stability of the synchronized periodic trajectory. A sufficient criterion guaranteeing synchronization and de-synchronization of the periodic trajectory is obtained. Dependence of the stability of the synchronized trajectory on the coupling delay is also revealed.

Keywords. Complex dynamical system, delayed coupling, periodic solution, stability, synchronization.

AMS (MOS) subject classification: 34C28, 34H05, 94C15, 94B90

1 Introduction

Linearly Coupled Map Lattices (LCMLs) constitute a large class of dynamical systems with discrete space and time, as well as continuous state (see [4], [6]). The coupled system can be modelled as follows:

$$x_i(t+1) = f(x_i(t)) + \frac{\epsilon}{k_i} \sum_{j\neq i, j=1}^{m} b_{ij}[f(x_j(t)) - f(x_i(t))]$$

where $t \in N$, $x_i(t)$ denotes the state value of node i, $i = 1, 2, \cdots, m$, $f(\cdot)$ is a continuous function, $b_{ij} \geq 0$, $k_i = \sum_{j\neq i} b_{ij}$, and ϵ is the coupling strength.

In many biological and physical systems, coupling delay occurs among nodes in the networks (see [1]). Then, the following LCMLs with coupling delay is considered:

$$x_i(t+1) = f(x_i(t)) + \frac{\epsilon}{k_i} \sum_{j\neq i, j=1}^{m} b_{ij}\Big[f(x_j(t-\tau)) - f(x_i(t))\Big] \tag{1}$$

where τ is the coupling delay.