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# Increased and Reduced Synchronization between Discrete-Time Chaotic and Hyperchaotic Systems

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**Abstract:** In this paper, by combining generalized synchronization (GS) and inverse generalized synchronisation (IGS), new schemes for increased and reduced synchronization between different dimensional discrete-time systems are proposed. Based on the Lyapunov stability theory, two control laws are proposed to prove the co-existence of GS and IGS between the general three-dimensional drive map and the two-dimensional response map in 3D and 2D, respectively. Numerical simulation has confirmed the findings of the paper.

**Keywords:** *discrete chaos; generalized synchronization; inverse generalized synchronisation; co-existence; Lyapunov stability.*

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## 1 Introduction

Chaotic discrete–time systems have received a considerable attention over the last two decades due to their many applications in secure communications [1]. One of the most studied aspects in discrete-time chaotic systems is the synchronization of chaotic systems. Synchronization refers to the addition of a set of control parameters to the controlled chaotic system and adaptively updating the controls so that the states become synchronized [2–4]. Throughout the years, many studies have considered the synchronization of discrete–order chaotic and hyperchaotic systems including [5–7]. One of the most exciting synchronization types is the generalized synchronization (GS). It refers to the existence of a functional relationship between the drive states and the response states. Instead of the conventional definition of synchronization, which stipulates that

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