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Anti-Synchronization of Novel Coupled Van der Pol Conservative Chaotic Systems via Adaptive Control Method

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Abstract: Chaos theory has a lot of applications in science and engineering. This paper first details the qualitative properties of the forced Van der Pol chaotic oscillator, which has important applications. Since its introduction in the 1920's, the Van der Pol equation has been a prototype model for systems with self-excited limit cycle oscillations. The Van der Pol equation has been studied over wide parameter regimes, from perturbations of harmonic motion to relaxation oscillations. It has been used by scientists to model a variety of physical and biological phenomena. In this paper, we announce a novel 4-D coupled Van der Pol conservative chaotic system and discuss its qualitative properties. We show that the Lyapunov exponents of the novel 4-D Van der Pol conservative chaotic system are $L_1 = 14.6,\ L_2 = 0,\ L_3 = -0.46$ and $L_4 = -14.14.$ Thus, the Maximal Lyapunov Exponent (MLE) of the novel conservative chaotic system is obtained as $L_1 = 14.6,$ which is very large. This shows that the novel Van der Pol conservative chaotic system is highly chaotic. The Kaplan-Yorke dimension of the novel 4-D Van der Pol conservative chaotic system is determined as $D_{KY} = 4.$ This shows the high level complexity of the novel 4-D Van der Pol conservative chaotic system. We also derive new results for the anti-synchronization of the novel coupled Van der Pol highly chaotic systems via adaptive control method. The main results are proved using Lyapunov stability theory. MATLAB plots are shown to illustrate the phase portraits of the novel 4-D coupled Van der Pol conservative chaotic system and the global chaos anti-synchronization of novel 4-D Van der Pol conservative chaotic systems.

Keywords: Chaos, chaotic systems, Van der Pol oscillator, coupled oscillator, highly chaotic system, adaptive control, chaos anti-synchronization, stability.

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