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Adaptive, nonlinear synchronization of a Duffing oscillator with unknown parameters

Jacek Kabziński

Abstract: For many years, the Duffing oscillator was investigated intensively as a benchmark of a chaotic system which is able to demonstrate all phenomena of chaos. Contemporarily oscillating systems that exhibit Duffing-like behavior are present in many areas: MEMS, laser technique, wireless power harvesters and many others. Therefore, the problem of controlling a Duffing system becomes more and more practical. A general tracking control problem is solved for a chaotic system (Duffing oscillator) with unknown parameters. We consider additional requirement that the tracking error must remain inside an imposed hard constraint. We compare several techniques like barrier Lyapunov functions or nonlinear state transformation applied in the adaptive backstepping scheme. Several system properties are investigated and benefits coming from state variable constraints are discussed. The same approach may be used for chaos synchronization and chaotification.

[1)] Jacek Kabziński, Professor: Institute of Automatic Control, Lodz University of Technology, Stefanowskiego 18 22, Lodz, Poland (PL), jacek.kabzinski@p.lodz.pl.