CDS

TECHNICAL MEMORANDUM NO. CIT-CDS 97-007
May, 1997

"A Stability Criterion for Systems with Nuetrally Stable Modes and Deadzone Nonlinearities"

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May 14, 1997

Abstract

Stability analysis is considered for feedback interconnections of deadzone nonlinearities with linear systems that has a neutrally stable mode. Such systems do not have a unique equilibrium point and the standard techniques from passivity and Lyapunov theory cannot be applied. A stability criterion that generalizes the Popov criterion for this class of systems is derived in this report and several examples will prove its applicability.

1 Introduction

Stability of linear time invariant systems in feedback interconnection with various nonlinearities have been studied extensively in the litterature, see for example, [1, 4, 6, 8, 9]. The case when the linear system is neutrally stable and when the nonlinearity is in the sector $[0, k]$ for some $k > 0$ is particularly hard. Such systems are often called critical in the absolute stability litterature. This term refers to the fact that such systems often are on the dividing line between unstable and (locally) exponentially stable systems. Neutral stability of a linear system means that there are simple modes on imaginary axis. This is a common situation in control applications where the integrator in a PI regulator corresponds to such a neutraly stable mode.

We will focus our attention on systems with a deadzone nonlinearity. We consider the simplest possible case with a single-input single-output linear time

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