On the Use of Piecewise Linear M- and M_0-Functions for Stability Analysis of Nonlinear Composite Hereditary Systems

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Abstract. In this paper, we study Lyapunov stability of nonlinear hereditary composite systems using vector Lyapunov functions method with nonlinear comparison systems, and reduce conservatism of stability condition in previous papers. Moreover, we consider piecewise linear test functions, and derive stability conditions which are easy to examine.
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1 Introduction

Since the first paper by Bailey was published in 1966 [5], composite-system method to analyze stability of large-scale systems was extensively investigated. Excellent surveys of work in this area was presented by Michel and Miller [11], Siljak [21], Araki [4], Vidyasagar [23], and Michel [10]. It was said that stability theory for composite systems reached a reasonably complete and mature level [10]. We agree this as long as we use linear comparison systems; however, we would like to point out that more efforts are needed when we use nonlinear comparison systems to reduce conservatism.

In this paper, we study Lyapunov stability of nonlinear hereditary composite systems using vector Lyapunov functions method with nonlinear comparison systems. Ladde [7], Amemiya [2], Ohta [14], and Ohta, Douseki and Matsumoto [15] tried to reduce conservatism by arrowing the nonlinearity in the test function which determine the behavior of the comparison system. However, unfortunately, the reported results are not easy to check stability conditions because of the nonlinearity of the test function.

In this paper, we derive less conservative stability results. Moreover, we consider the case when the test function is a piecewise linear function and derive