

DEVELOPING AND AUTOMATING TIME DELAY SYSTEM STABILITY
ANALYSIS OF DYNAMIC SYSTEMS USING THE MATRIX LAMBERT W
(MLW) FUNCTION METHOD

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ABSTRACT

Stability analysis of time-delayed (TD) systems is not easy to conduct since the addition of delays within a dynamic model results in irrational system equations. Traditional TD analysis methods involve adding approximations into the system model to represent these delays. Adding approximations can make the system equations rational, but will drive stable TD systems to instability as approximate accuracy is improved. A more advanced method would be an invaluable tool for simplifying the stability analysis procedure for TD systems. A new method for analyzing TD system stability without adding TD approximations to the system has been presented in the literature. This new TD stability analysis method, called the Matrix Lambert W (MLW) Function Method, involves using a matrix version of the Lambert W function to obtain analytic solutions for a set of delay differential equations. The research presented in this dissertation discusses the MLW Method in five parts: (1) fundamentals of the Lambert W function and MLW Method are presented, (2) a state-of-the-art review of the most current research is presented, (3) a comparison of the MLW Method versus simulation is presented for three different time-delayed systems, (4) experimental results for one of these systems are presented, and (5) enhanced MLW Method results are shown for this real world system.