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LINK BETWEEN LYAPUNOV EQUATION AND LACK OF OPTIMALITY IN ENERGY FOR UNDERACTUATED DYNAMIC SYSTEMS VALIDATED WITH PARSEVAL'S CONDITION

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Abstract. An under actuated ship model is analyzed under the influence of integrated time delays into system definitions. It was observed small variations in the delay defined would drastically impact the performance of the ship. The stability was analyzed by Lyapunovs equation and it was observed the system failed to stabilize when the delay increases above 0.02 seconds. The time delay was integrated by row and column generation and the analysis was performed by Lyapunov. The analysis has proved the application of Lyapunov analysis is successful for integrated time delay model plants and can be used for studies on various cascaded complex dynamic systems where time delay becomes critical. The Lyapunov solution for energy analysis was compared with parsevals condition for casual systems and was found that it lack optimal energy usage.

Keywords. Delay, Lyapunov, Stability, Marine vessels, Parsevals condition

1 Introduction

Ship tracking, maneuvering have been studied in the literature for decades out of passion to explore the seas. The influence of different control parameters has been well established by researchers. The studies are useful in navigation, design of war ship with better tactics, development of sophisticated vessels. Also, exploration of deep seas and unmanned underwater vehicle designs are possible with better studies of vessels and ships. Lefeber et al [1] addressed the tracking problem for an under actuated ship using two controls, namely surge force and yaw moment. A simple state-feedback control law was developed and proved to render the tracking error dynamics exponentially stable. Experimental results were presented where the controller