

ADAPTIVE IIR SYSTEM IDENTIFICATION FOR THE DESIGN OF AN ADAPTIVE KALMAN FILTER

A Master's Thesis Presentation

By

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ABSTRACT

In theory, the optimality of the Kalman filter is assured by a few assumptions. One of these assumptions is that the system it is working with is exactly known. In order to perform its most common function as a state estimator, the Kalman filter requires knowledge of the dynamics of the system. However, in practice, the system model is usually not known precisely. The dynamics of the system may be riddled with unknowns or uncertainties. The system may even be time-varying. Under these circumstances, the function and performance of the Kalman filter can be greatly affected.

This is one of the reasons that motivate the development of an adaptive Kalman filter. In this thesis, the adaptive Kalman filter consists of a Kalman filter and an adaptive system identifier. This setup enables the Kalman filter to acquire the required knowledge on the dynamics of the system through online, recursive system identification procedures, as well as keep up with any changes in the system dynamics. This will then facilitate the Kalman filter in performing state estimation. Consequently, more accurate and effective control can be provided to the overall system.

Much of the focus of this thesis is on the adaptive system identification process. Two well known and commonly used adaptive filter algorithms are used for this purpose, namely, the RLS and LMS. Since Kalman filter most often works with system whose transfer function involve zeros and poles, the IIR model of these two algorithms are utilized. The adaptive filters are first tested on prototypical second-order systems, as well as a third-order and fourth-order system. Next, the adaptive filters are used in simple target tracking, to assess their performance in an environment most commonly encountered in Kalman filtering. The performance of the adaptive filters in each situation is observed in terms of stability of adaptation, robustness to noise, rate of convergence and accuracy of identification.