

Use of Kalman Filters in Time and Frequency Analysis

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Kalman filters have many applications both in time and frequency and in related topics, for example GNSS analysis.

In this tutorial an overview will be given of the Kalman filter and its relationship to other filters and smoothing algorithms. A detailed description will be given of each element of the Kalman filter, with emphasis on the underlying physical meanings and limited use of mathematics. A step by step description of the filtering process will then be provided.

There are several key applications of Kalman filters within time and frequency analysis. These include clock ensemble algorithms, clock predictors and steering algorithms. The use within the Kalman filter of each of the well-known power law noise processes will be examined. Models of clock and time transfer noise will be discussed in detail, along with the treatment of periodic instabilities and linear frequency drift. Methods of testing Kalman filters using simulated data sets will be demonstrated. Finally the concept of observability, which is of particular importance to clock ensemble algorithms, will be examined.