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Author: Prof. Mudambi Ananthasayanam
Indian Institute of Science, India

AN APPRECIATION OF THE PROGRESS IN NAVIGATION FROM THE PERSPECTIVE OF
KALMAN FILTER

Abstract

The history of navigation has an exciting role in the development of Astronautics. Based on the available information it could be broadly classified since antiquity into three phases called respectively mythological, medieval, and modern (i) from 5000 BC up to 900 AD, (ii) the centuries from 900 AD to 1900 AD, and (iii) the decades from 1900 AD to the present. Some important events in the above periods during the millenniums, centuries, and decades respectively provide a reference view of the progress. To briefly summarize in the first phase the ancients finding the sea route easier and more profitable than over land built ships and navigated near coastal regions, then sailed in the oceans for trade using winds, birds, ocean depths, charts and stars. In the second phase the sun, moon, stars, magnetic compass, astrolabes, cross staff, sextant, improved maps, and chronometer helped them to explore the planet more easily for commerce and conquest. In the third phase the inertial, and radio navigation systems have been developed to highly sophisticated and accurate levels. The approaches to navigate in the above three phases can be broadly classified respectively as correlational, calculational and computational with increasing speed and accuracy. The above progress in navigation when viewed from the perspective of the Kalman filter (which can be considered as expanding the knowledge front by absorbing newer information in the best possible way) provides newer insights. In a Kalman filter generally the state to be estimated namely the position and the measurement quantities such as angle, acceleration, and the time of arrival of a signal are of different nature. The qualitative structure and the quantitative parameters in both the state and measurements have to be improved and estimated by the filter based on the measurements. Also a successful filter operation requires controllability, observability, and identifiability conditions to be met. The progress in navigation through the ages is similar to a filter suppressing the effect of noise, fusion, and assimilation of data, improvement of model, and measurement. Many illustrative examples are provided in the paper to provide a new perspective of the history of navigation.