1993f

"The Quaternion in the Kalman Filter," M. D. Shuster, Paper No. AAS 93-553, *AAS/AIAA Astrodynamics Specialists Conference*, Victoria, British Columbia, Canada, August 16–19, 1993; Proceedings: *Advances in the Astronautical Sciences*, Vol. 85, 1993, pp. 25–37.

This work demonstrated in three dimensions that the additive and the multiplicative Kalman filters are, in fact, both additive and differ only in the frame chosen for the update step. Problems associated with the relaxation of the norm constraint for the quaternion were discussed, and the demonstration that correct restoration of the norm constraint to the quaternion obtained from the unconstrained quaternion Kalman filter of Bar-Itzhack and Oshman resulted in the usual multiplicative EFK was repeated in three dimensions.

Given these results, it was clear that the unconstrained quaternion Kalman filter of Bar-Itzhack and Oshman was of very limited value, since the most efficient way to restore the norm constraint to the Bar-Itzhack-Oshman result correctly was to discard it entirely and start all over again using a properly constrained quaternion Kalman filter.

Bar-Itzhack and Oshman called their unconstrained Kalman filter the AEKF (additive extended Kalman filter) and contrasts it with the MEKF (multiplicative EKF) of 1982c. That nomenclature is misleading since 1982c describes an implementation of the AEKF for the quaternion which is properly constrained. Thus, it would be more correct to call the Bar-Itzhack filter the "unconstrained AEKF" so as to better distinguish it from correctly constrained AEKFÐs.

Superseded by 2003a and 2003b.