2003a

"Constraint in Attitude Estimation Part I: Constrained Estimation," M. D. Shuster, *The Journal of the Astronautical Sciences*, Vol. 51, No. 1, January–March 2003, pp. 51–74.

This work showed the problems inherent in trying to estimate a quaternion when one does not take account of the quaternion norm during the estimation process. Part I of this paper was concerned mostly with the calculation of the measurement sensitivity matrix for properly constrained and unconstrained quaternions. This measurement sensitivity matrix was shown to be highly ambiguous when the norm constraint was relaxed. A physically meaningful example was presented which led to a stupid result when the quaternion norm was not maintained in the estimation process. This demonstrated the very poor results that could be obtained by using the unconstrained quaternion Kalman filter of Bar-Itzhack and Oshman.

Bar-Itzhack calls his 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-Oshman filter the "unconstrained AEKF" so as to better distinguish it from correctly constrained AEKF's.

The major portion of Part I of this two-part work is devoted to developing very efficient Cartesian methods for batch three-axis attitude estimation, both for general measurement models and the QUEST measurement model. It might have been preferable to label Part I simply as "Batch Three-Axis Attitude Estimation" and to eliminate "Part II" from the title of the succeeding work, perhaps, shifting some material from Part I to Part II in the process.

Superseded 1993f.

Succeeded by 2003b.