

“TWOSTEP, a Fast Robust Algorithm for Attitude-Independent Magnetometer Bias Determination,” R. Alonso and M. D. Shuster, *The Journal of the Astronautical Sciences*, Vol. 50, No. 4, October–December 2002, pp. 433–451.

The core of the algorithm is the use of the centering operation, in which the measurement equation for each scalar measurement is averaged, as in the RESIDG algorithm, to obtain a center measurement equation, which is subtracted from the individual measurements to create effective measurements (the centered measurements) which are linear in the magnetometer bias. Unlike the RESIDG algorithm, however, the statistics are handled correctly. (For example, the centered measurements are correlated.) In addition, a statistical model is developed for the center measurement. Thus, rather than simply discarding data, the TWOSTEP algorithm, beginning with N independent scalar measurements, creates one center measurement and $N - 1$ centered measurements, which are an equivalent representation of the data. The centered estimate can be calculated in a single step, after which the center measurement, which is independent of the $N - 1$ centered measurements but quartic in the magnetometer-bias vector, can be treated as providing a correction to the centered estimate. Generally, the center correction converges very quickly, often in a single step. The centered estimation and the center correction are the two steps of the TWOSTEP algorithm.

The TWOSTEP Algorithm is extremely robust. The authors, in fact, were unable, despite numerous attempts, to create a case where the magnetometer bias was determinable and the TWOSTEP algorithm did not converge in a few steps, which could not be said for any of the other algorithms.

In 1983, the second author produced a set of notes on attitude-independent magnetometer bias determination which treated the statistics more correctly than did the RESIDG algorithm of Brij Gambhir or the RESIDT algorithm of Richard Thompson et al. 1984a. The work was not brought to a publishable state at the time, and received no dissemination other than a copy of the notes given to F. Landis Markley. In 1992 Roberto Alonso of the Argentine Space Agency (CONAE) was visiting NASA Goddard Space Flight Center and was interested in studying magnetometer-bias determination more closely. Markley gave him the ten-year-old notes. Beto Alonso and I collaborated on this problem for two years during which the earlier work was greatly extended. The present article, 2002b, 2002c, 2003e, which follow, were written and typeset in 1993 (2002a and 2003e were originally one article), submitted to the JAS and favorably reviewed for publication in 1996. Unfortunately, owing to a very long bout of depression by the second author, the final manuscript was not returned to the journal until 2002 and appeared in print near the end of 2003. Although I have always believed that papers are better after they simmer for a while, twenty years may be excessive. This article, 13 others which follow, and two errata were submitted to the JAS during a six-week period in the fall of 2002, largely out of fear that my poor health might prevent their ever being published.

Superseded 1984a, 1994d.