 ICCES, vol.11, no.2, pp.33-34

Averaging TRIAD Algorithm for attitude determination

Dong-Hoon Kim[1], Sang-Wook Lee[1], Dong-Ik Cheon[1], Hwa-Suk Oh[1]

Summary

In general, accurate attitude information is essential to perform the mission. Two algorithms are well-known to determine the attitude through two or more vector observations. One is deterministic method such as TRIAD algorithm, the other is optimal method such as QUEST algorithm. This paper suggests the idea to improve performance of the TRIAD algorithm and to determine the attitude by combination of different sensors. First, we change the attitude matrix to Euler angle instead of using orthogonalization method and also use covariance in place of variance, then apply an unbiased minimum variance formula for more accurate solutions. We also suggest the methodology to determine the attitude when more than two measurements are given. The performance of the Averaging TRIAD algorithm upon the combination of different sensors is analyzed by numerical simulation in terms of standard deviation and probability.

keywords: Attitude, Determination, Accuracy, Covariance, Orthogonality, Standard Deviation, Probability

Introduction

Accurate attitude information is critical to perform the mission. It can be determined by allocated sensors of spacecraft such as star tracker, sun sensor, earth sensor etc.

In general, TRIAD which is deterministic and QUEST which is optimal method are well-known as attitude determination methods using vector observations. TRIAD is very simple algorithm and needs less computation but only can apply two observations and if we get the information using different sensors, it might be unreliable because of its accuracy difference. QUEST can find the optimal solution but algorithm is complicated and needs much computation relatively.

Attitude determination studies are now under way for the attitude information of Science and Technology Satellite 3(STSAT-3). We placed a great deal of weight on computation burden, so we selected TRIAD.

Optimized TRIAD algorithm has been researched to cover defects of TRIAD but still has problems. One is using variance instead of covariance for simplicity, other is ignoring orthogonal property during matrix calculation.

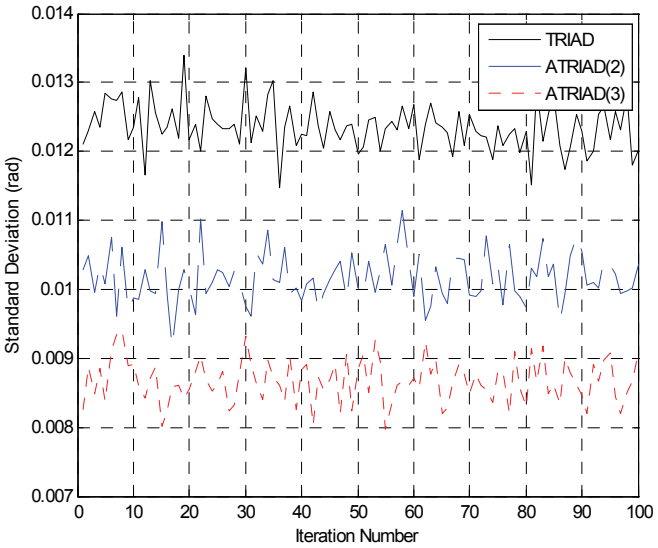
In this paper, we suggest Averaging TRIAD which is covered existing algorithms' defects and problems. We also verified the suggested algorithm by numerical simulation and hardware test.

[1]Korea Aerospace University, Goyang, 412-791, KOREA (Tel: +82-2-3159-0147; E-mail: aerospace38@kau.ac.kr)

Attitude Determimation

For more accurate attitude information, we use the covariance instead of variance applying minimum variance estimation method. We also consider orthogonality of direction cosine matrix during computation by transformation of other terms. Besides, we suggest the method to use all of observations when more than three observations are given.

Standard deviation upon the iteration numbers for algorithm performance analysis by numerical simulation are shown in a figure below.



Hardware verification of suggested algorithm is in progress by air-bearing simulator allocated different sensors.

Conclusions

We suggested the idea to improve the accuracy of attitude by combination of different sensors and using as many as observations and verified by numerical simulation.

References

1. M. D. Shuster and S. D. Oh, "Three-Axis Attitude Determination from Vector Observations," *Journal of Guidance, Control and Dynamics,* Vol.4, No.1, 1981, pp. 70-77
2. Itzhack Y. Bar-Itzhack and Richard R. Harman, "Optimized TRIAD Algorithm for Attitude Determination," *Journal of Guidance, Control and Dynamics,* Vol.20, No.1, 1996, pp. 208-211