

Comparison of geomagnetic aided navigation algorithms for hypersonic vehicles

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Cite this as: Kai Chen, Wen-chao Liang, Ming-xin Liu, Han-yan Sun, 2020.
Comparison of geomagnetic aided navigation algorithms for hypersonic vehicles.
Journal of Zhejiang University-SCIENCE A (Applied Physics & Engineering),
21(8):673-683. <https://doi.org/10.1631/jzus.A1900648>

Hypersonic Vehicle and Geomagnetic Navigation

■ Owing to the high flight altitude, high speed and large space span of near space hypersonic vehicles, the navigation and positioning accuracies of different geomagnetic navigation algorithms can vary significantly different.



Fig. 1. The hypersonic vehicle flying in near space

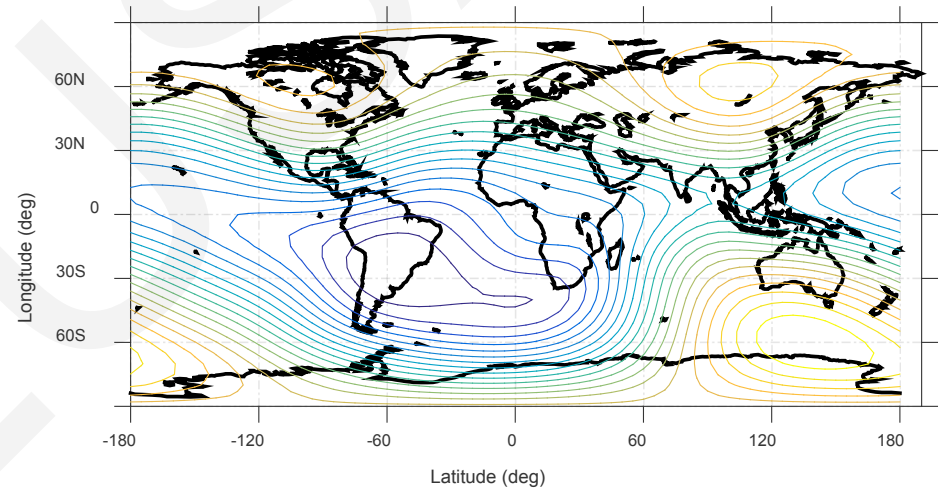


Fig. 2. Schematic diagram of total intensity (F) contour

Fig.1. originates from https://en.wikipedia.org/wiki/Hypersonic_Technology_Vehicle_2#/media/File:Speed_is_Life_HTV-2_Reentry_New.jpg

Geomagnetic Contour Matching Algorithm

■ MAGCOM algorithm with rotating step

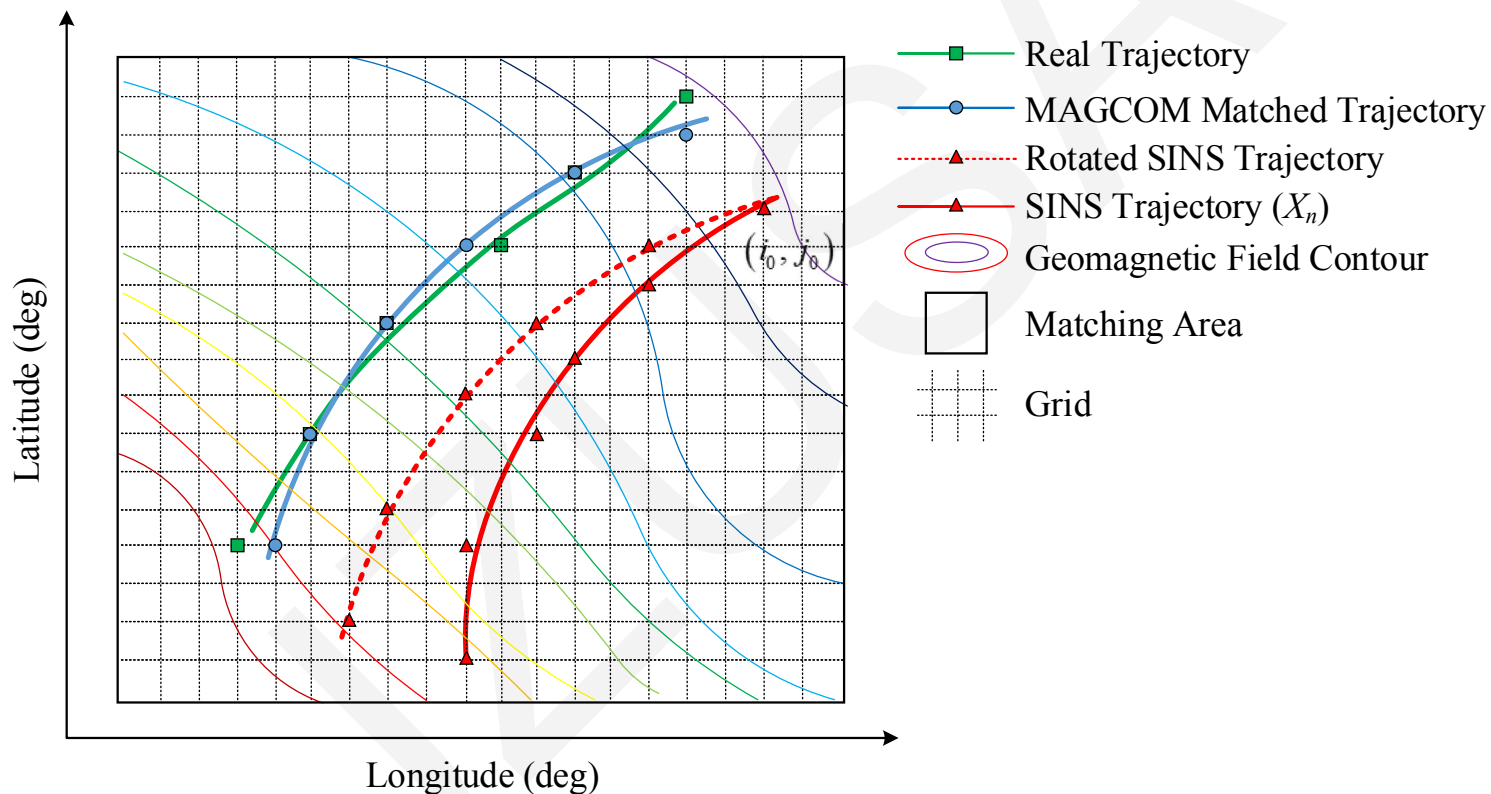


Fig. 3. Schematic of the MAGCOM algorithm.

Iterative Closest Contour Point Algorithm

■ ICCP algorithm originate from image matching algorithms

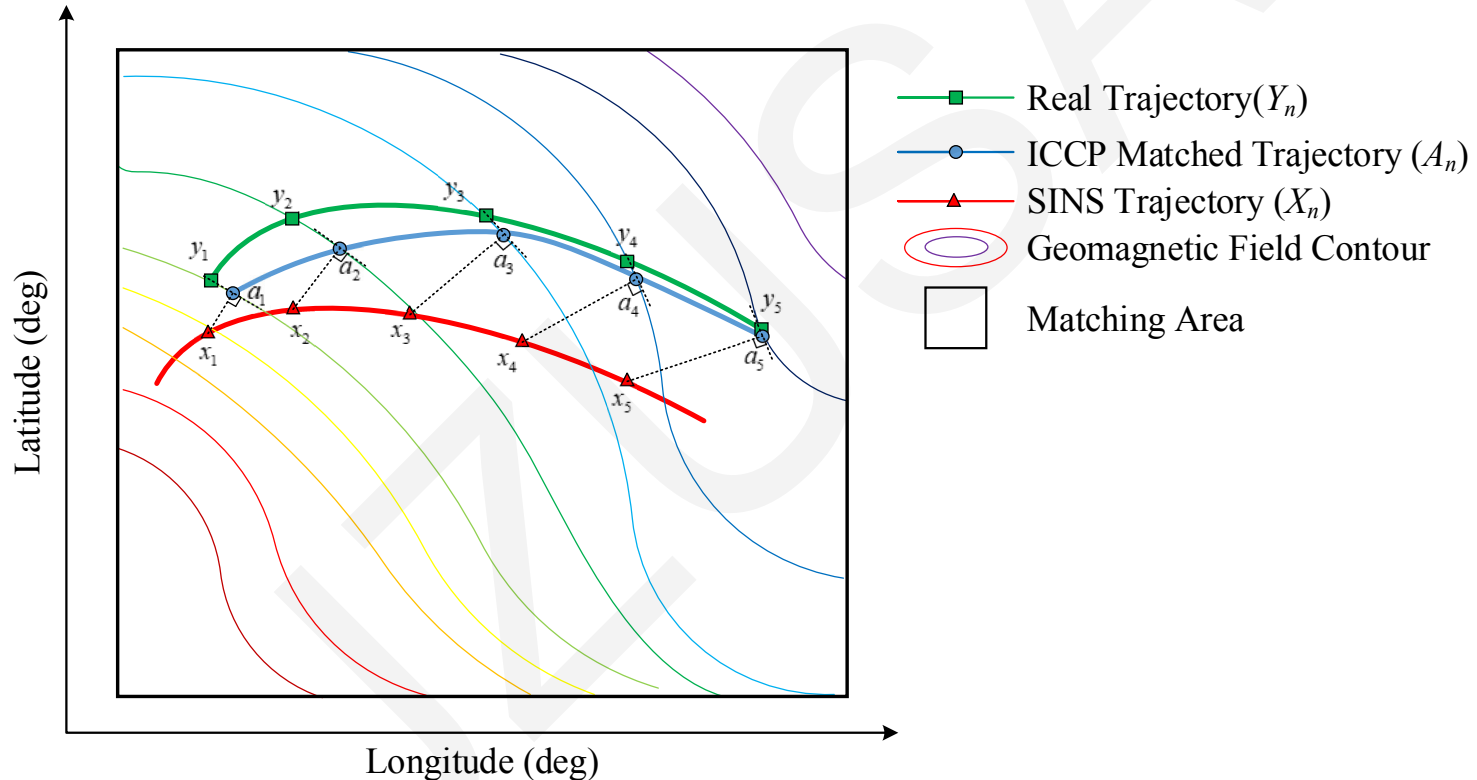


Fig. 4. Schematic of the ICCP algorithm.

Sandia Inertial Magnetic Aided Navigation Algorithm

- SIMAN algorithm is a single point matching algorithm

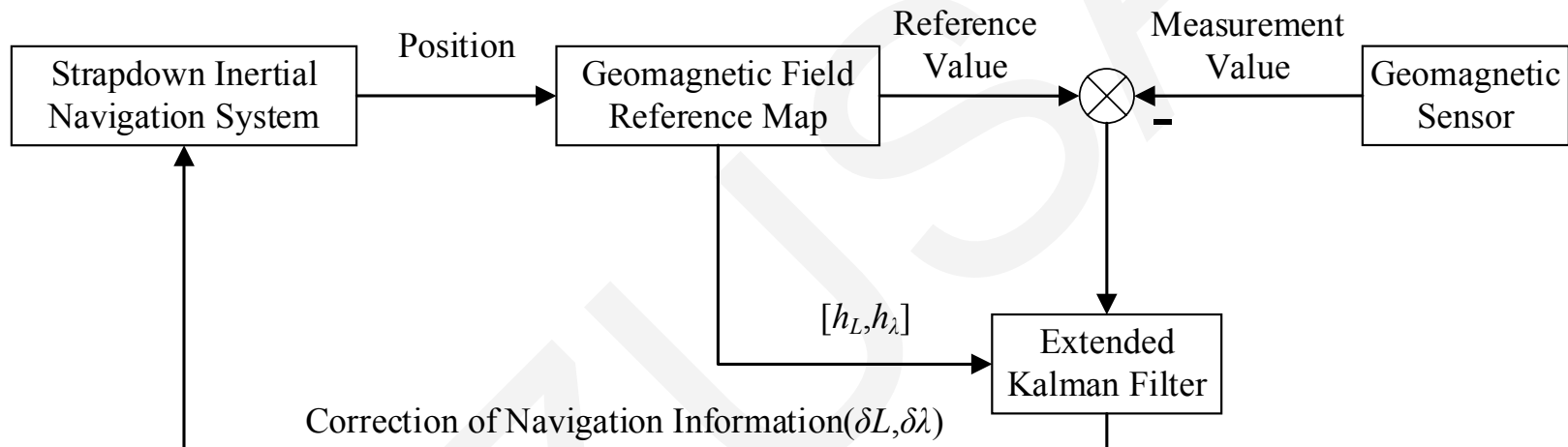


Fig. 5. Schematic of the SIMAN algorithm.

Simulation

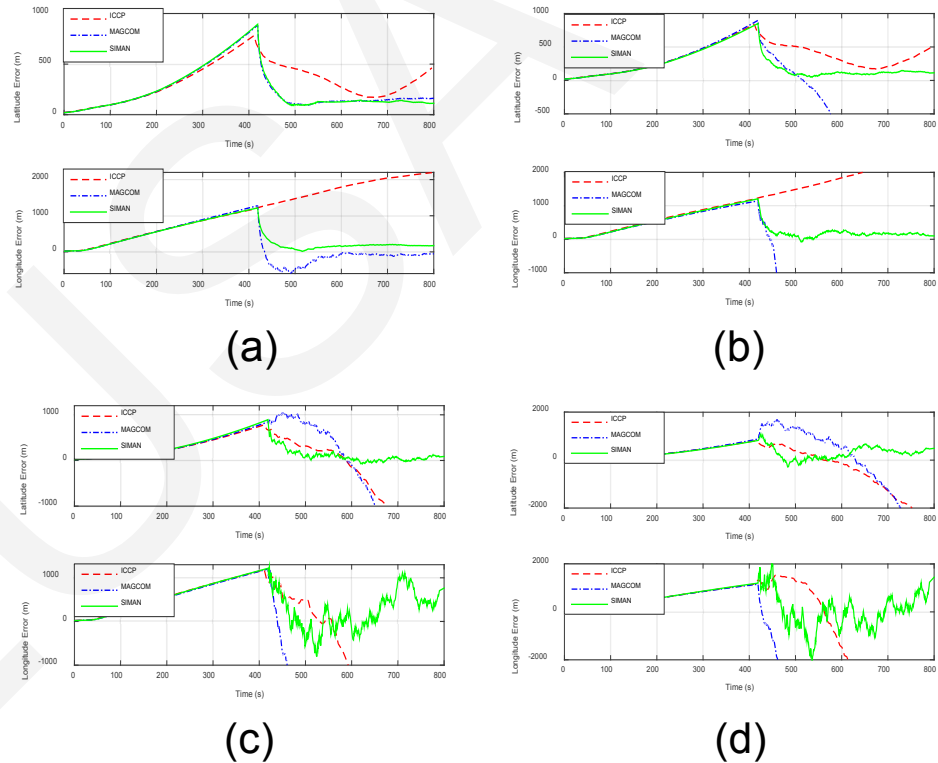
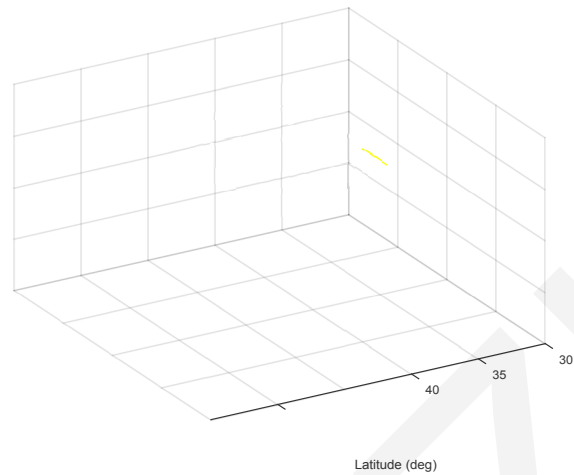


Fig. 6. Trajectory and geomagnetic navigation area of near space hypersonic vehicle.

Fig. 7. (a), (b), (c) and (d) are the results when the mag error level (MEL) is ± 0.1 nT, ± 1 nT, ± 5 nT and ± 10 nT respectively

Conclusions

- we have presented a summary of the procedures of three classical geomagnetic navigation algorithms for the navigation of near space hypersonic vehicles, and simulations of integrated navigations. The simulation results of the different integrated navigation systems were analyzed and their applications to the navigation of hypersonic vehicles compared. According to the simulation results, the SIMAN algorithm was superior to the other two algorithms in terms of its real-time nature, positioning accuracy, reliability and stability.