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Multi-geomagnetic-component assisted localization algorithm for hypersonic vehicles

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Hypersonic Vehicle and Geomagnetic Navigation

■Owing to the lack of information about geomagnetic anomaly fields, conventional geomagnetic matching algorithms in near space are prone to divergence. Therefore, geomagnetic matching navigation algorithms for hypersonic vehicles are also prone to divergence or mismatch.



Fig. 1. The hypersonic vehicle flying in near space

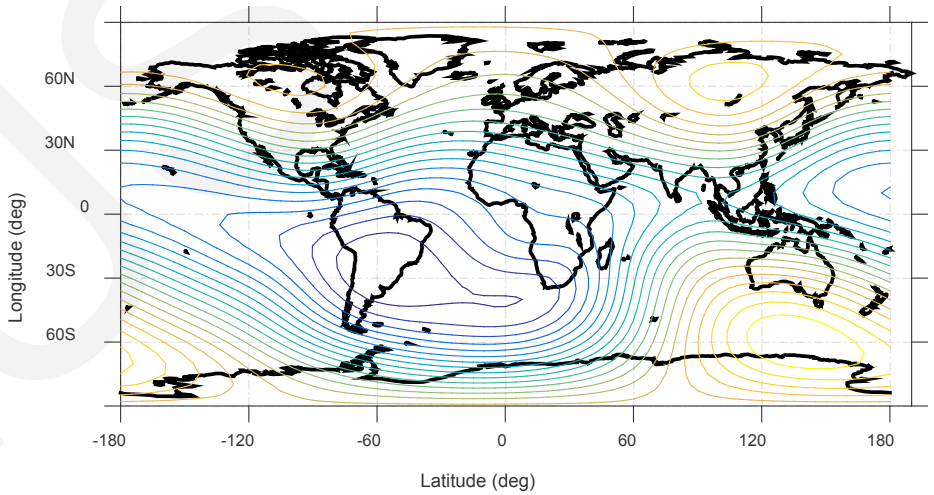


Fig. 2. Schematic diagram of total intensity (F) isopleth

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

Geomagnetic field and geomagnetic matching error

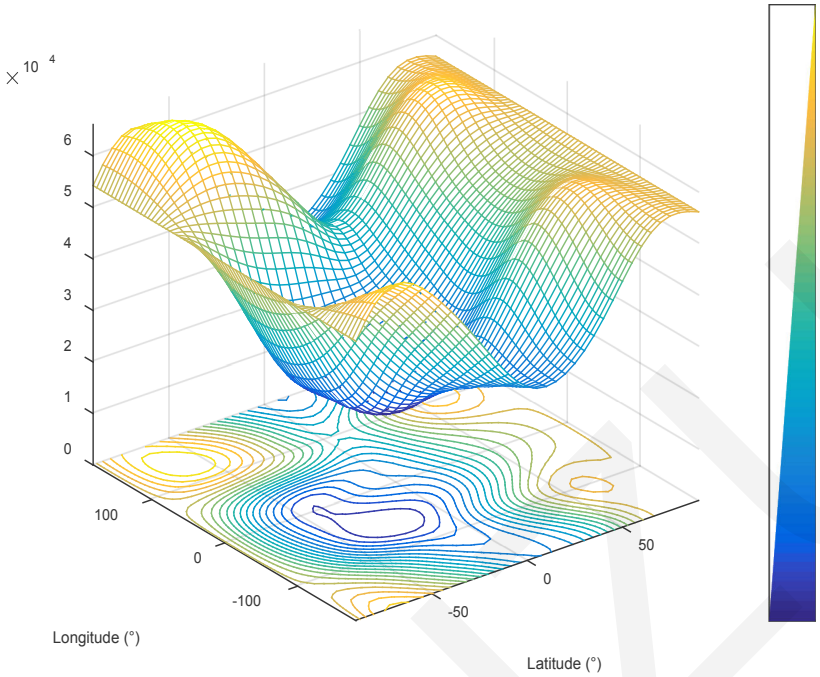


Fig. 3. Geomagnetic field and its isopleth

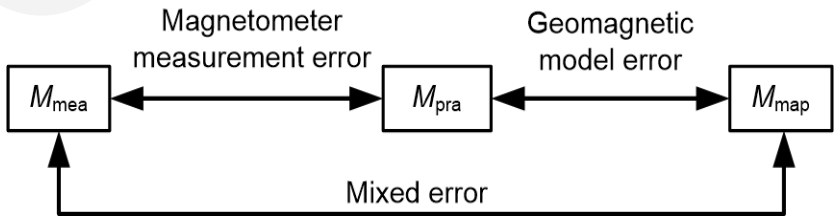


Fig. 4 Diagram illustrating the sources o geomagnetic matching error

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Multi Geomagnetic Component Assisted Localization (MCAL) Algorithm

MCAL Algorithm

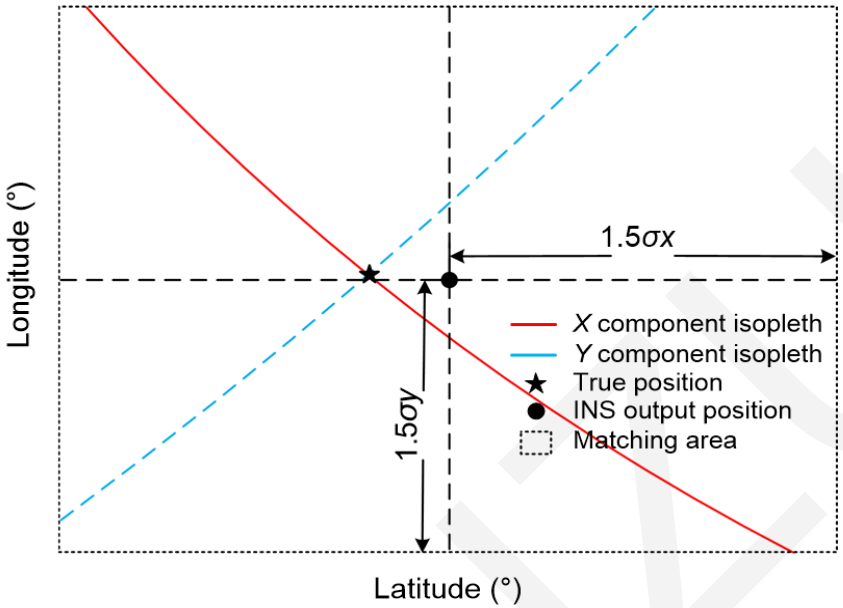


Fig. 5 Algorithm sketch with mixed error is 0 nT

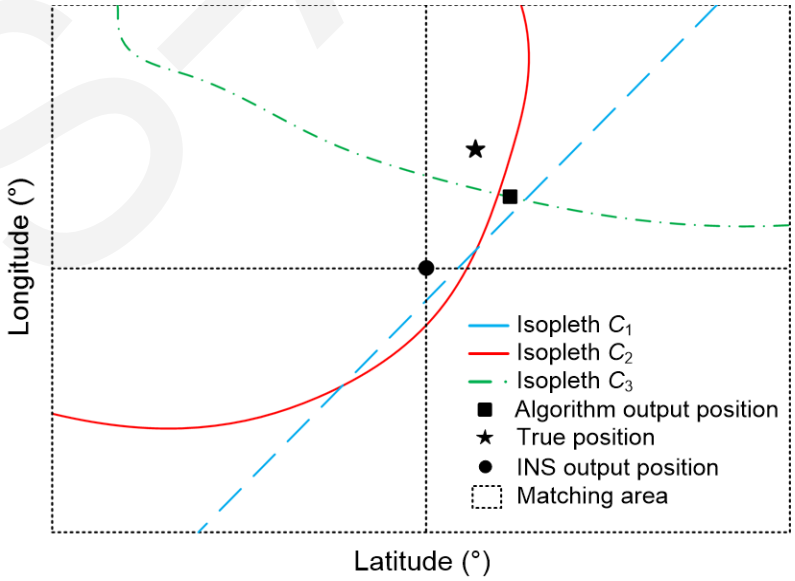


Fig. 6 Schematic of multiple intersections with mixed error

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Simulation

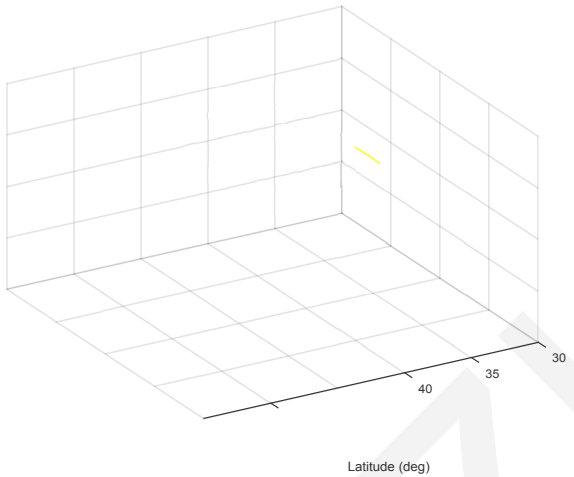


Fig. 7. Trajectory and geomagnetic navigation area of near space hypersonic vehicle.

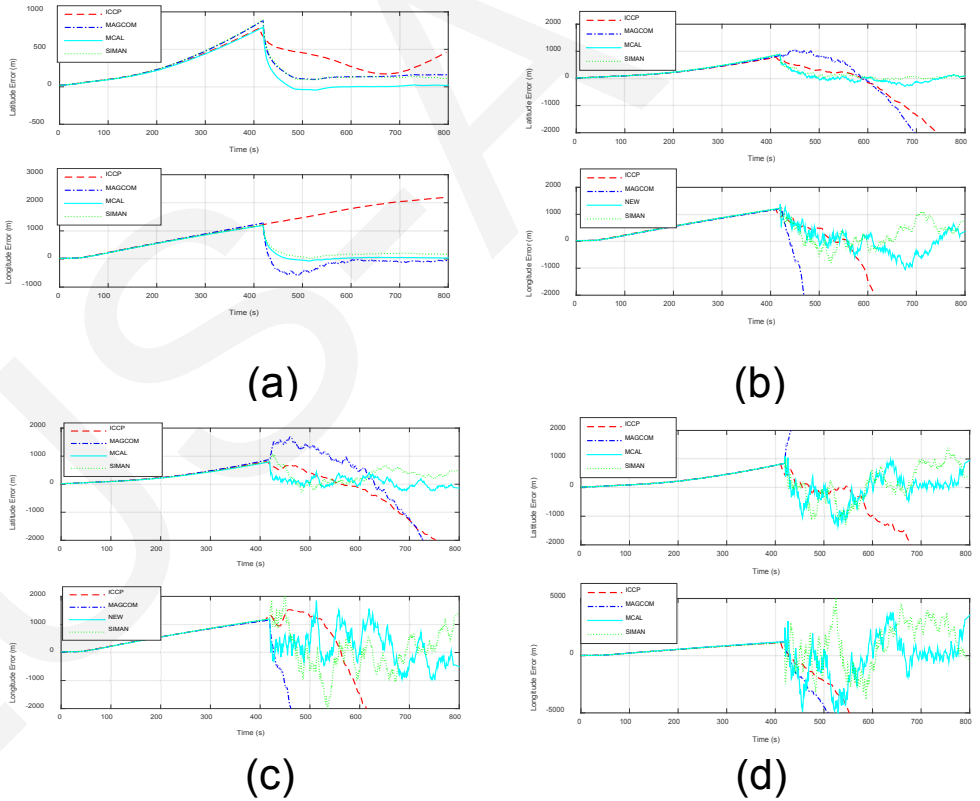


Fig. 7. (a), (b), (c) and (d) are the results when the mixed error (per axis) is ±0.1 nT, ±5 nT, ±10 nT and ±30 nT respectively

Conclusions

- To overcome the mismatch issue of near space hypersonic vehicles in geomagnetic navigation, where only the information of the main geomagnetic field can be used, we developed the MCAL algorithm. Through the analysis and calculation of the intersection of multiple geomagnetic component isopleths, the real time position of a carrier was estimated. Compared with conventional sequential matching algorithms, this method can provide higher positioning accuracy in the main geomagnetic field environment where near space hypersonic vehicles are flown.