MEMS IMU Based INS/GNSS Integration: Design Strategies and System Performance Evaluation

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Abstract

This study focuses on the integration design of INS with GNSS based on MEMS IMU sensors. The sophisticated MEMS IMU error models are employed to evaluate the MEMS error impacts on INS performance. Through the use of the MEMS IMU error model, the MEMS IMU raw measurements can be simulated conveniently. Moreover, it provides the fundamental model for the inertial sensor error compensation before INS calculation. The Kalman filter based integration configuration is also designed by combining GNSS solutions in this paper. Different experimental scenarios are designed to evaluate the performance of the proposed integration configuration by various simulation tests. The experimental results indicated that the performance of the MEMS based INS is greatly enhanced by integration of GNSS compared with its stand-alone usage and by employing the MEMS IMU error model to compensate the deterministic sensor errors.

Research Outlines

• MEMS IMU Based INS/GNSS Integration Structure (Simulation)
• INS Digital Integration Algorithm Design
• Integrated Kalman Filter Design
• System Validation and Experimental Results

Design Methods

Error Model Parameters

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<th>Error Model Parameter</th>
<th>Mean</th>
<th>Std Dev</th>
<th>Min</th>
<th>Max</th>
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<td>MEMS Bias - X</td>
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System Validation and Experimental Results

Conclusion

• MEMS IMU error models are introduced to simulate the various noises in the raw MEMS IMU measurements.
• Proposed models provide the fundamental structure for the compensation of raw IMU deterministic noises.
• Integrated INS/GNSS Kalman filter is designed to deliver the optimally integrated solutions meanwhile compensating the random noises in the raw MEMS measurements.

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