Applied Mathematics in Integrated Navigation Systems, Third Edition (AIAA Education)

Robert M. Rogers

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"The subject of integrated navigation systems covered in this book is designed for those directly involved with the design, integration, and test and evaluation of navigation systems. It is assumed that the reader has a background in mathematics, including calculus. Integrated navigation systems are the combination of an onboard navigation solution (position, velocity, and attitude) and independent navigation data (aids to navigation) to update or correct navigation solutions. In this book, this combination is accomplished with Kalman filter algorithms.

This presentation is segmented into two parts. In the first part, elements of basic mathematics, kinematics, equations describing navigation systems/sensors and their error models, aids to navigation, and Kalman filtering are developed. Detailed derivations are presented and examples are given to aid in the understanding of these elements of integrated navigation systems. Problems are included to expand the application of the materials presented.

The third edition includes additional background material, exercises and software. The added material includes: development of general form for Earth's gravitational potential with simplification to an ellipsoid model; development of satellite orbital equations for position and velocity and the impact of non-spherical earth gravitation on satellite orbital parameters; and illustrations in the development of derivative free Kalman filters including the Unscented and Divided Difference filter forms. Additional exercises are included that expand and supplement the material in the text and demonstrate properties of the Kalman filter. Additional software is included in this edition for simulating random processes and derivative free filter implementations.

This edition provides a more complete foundation for addressing the different aspects of integrated navigation systems."

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