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14. ABSTRACT This Lecture Series presented the current state-of-the-art in navigation sensors and system integration technology through the improved use of advanced, low-cost navigation sensor technologies. The material presented provided an understanding of the issues faced by today's system designers. Through this Lecture Series, the technical community was updated on sensors and current integration techniques as practiced by leading experts in the field. The Lecture Series included information to bring the audience up-to-date with current practices, as well as, information on sensors, algorithms, and applications. Applications were described for navigating in difficult urban, indoor, and underground environments where typical GPS receivers do not function.					
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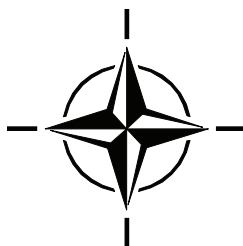
RTO EDUCATIONAL NOTES

EN-SET-116(2010)

Low-Cost Navigation Sensors and Integration Technology

(Capteurs de navigation à faible coût et technologie d'intégration)

The material in this publication was assembled to support a Lecture Series under the sponsorship of the Sensors and Electronics Technology Panel (SET) on 15-16 March 2010 in Ankara, Turkey; on 18-19 March 2010 in Prague, Czech Republic; 22-13 March 2010 in Toulouse, France and on 25-26 March 2010 in Porto, Portugal.



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- HFM Human Factors and Medicine Panel
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- NMSG NATO Modelling and Simulation Group
- SAS System Analysis and Studies Panel
- SCI Systems Concepts and Integration Panel
- SET Sensors and Electronics Technology Panel

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Low-Cost Navigation Sensors and Integration Technology

(RTO-EN-SET-116-2010)

Executive Summary

The objective of this two-day Lecture Series is to present the current state-of-the-art in navigation sensors and system integration technology through the improved use of advanced, low-cost navigation sensor technologies. Lecturers will present material that provides an understanding of the issues faced by today's system designers. Through this Lecture Series, the technical community will be updated on sensors and current integration techniques as practiced by leading experts in the field. The Lecture Series includes information to bring the audience up-to-date with current practices, as well as, information on sensors, algorithms, and applications. Technology trends are described for navigating in difficult urban, indoor, and underground environments where typical GPS receivers do not function.

The first day begins with an overview paper that focuses on accuracy and other technology trends for inertial sensors, Global Positioning Systems (GPS), and integrated strapdown Inertial Navigation System (INS/GPS) systems that will lead to better than 1-meter accuracy navigation systems of the future. The paper provides the rationale for the remaining papers. The second paper starts with a brief overview of inertial sensing and the technology trends underway. Discussions are presented on gyro and accelerometer technology development, with specific emphasis on designs and performance of Ring Laser Gyros, Fiber Optic Gyros, and MEMS sensors. The third paper discusses MEMS in depth. The specific advantage of MEMS in ruggedness and size is demonstrated with reference to specific applications, such as guided munitions. A precise kinematic relative positioning system using a stand-alone miniaturized L1 GPS data logger is described in the fourth paper. The fifth paper focuses on INS/GPS integration architectures including "loosely coupled", "tightly coupled", and "deeply integrated" configurations. The advantages and disadvantages of each level of integration are discussed. In the sixth and final paper of the first day, the three major INS/GPS systems architectures discussed in the previous paper will have their performance compared for various mission scenarios.

The second day of the Lecture Series focuses on applications involving limited GPS availability. The first paper discusses some of the ongoing activities in the technology development of small inertial navigation sensors and augmentation sensors that could be used to improve performance in applications with little or no GPS signal. The second paper focuses on the latest technology trends for navigating in difficult urban, indoor, and underground environments where typical GPS receivers do not function. Alternative navigation technologies based on electro-optical techniques will be described. These include optically aided and lidar-aided INS. The last paper focuses on multi-sensor fusion for navigation in difficult environments. A generic multi-sensor fusion approach is presented and simulation and experimental results are presented.

Les capteurs de navigation à bas coût et la technologie d'intégration

(RTO-EN-SET-116-2010)

Synthèse

L'objectif de cette Suite de Conférences de deux jours était de présenter l'état de l'art en matière de capteurs de navigation et de technologie d'intégration des systèmes avec une meilleure utilisation de technologies évoluées et à bas coût de capteurs de navigation. Les conférenciers ont présenté le matériel qui permettait de comprendre les problèmes auxquels sont confrontés les concepteurs actuels des systèmes. A travers cette suite de conférences, la communauté technique a reçu une mise à jour sur les capteurs et les techniques d'intégration actuelles telles qu'elles sont pratiquées par les meilleurs experts du domaine. La Suite de Conférences comprenait des travaux dirigés afin que les auditeurs soient informés sur les pratiques actuelles mais aussi sur les capteurs et leurs applications. Des orientations technologiques ont été décrites pour la navigation souterraine, pratiquée en intérieur ou en milieu urbain difficile, là où les récepteurs GPS classiques ne fonctionnent pas.

Le premier jour a commencé par une vue d'ensemble mettant l'accent sur la précision et les autres orientations technologiques pour les capteurs inertiels, le Global Positioning Systems (GPS) et les Systèmes de Navigation Inertiels intégrés (INS/GPS) qui porteront la précision des systèmes de navigation futurs à moins d'un mètre. Le document donnait son point de vue sur les documents suivants. Le second document commençait par une vue d'ensemble courte sur le sensing inertiel et les orientations technologiques en cours. Les débats sur le développement technologique des accéléromètres et des gyroscopes ont été présentés, l'accent étant particulièrement mis sur la conception et les performances des Gyroscopes à laser Périphériques, des gyroscopes à Fibres Optiques et des capteurs MEMS. Le troisième document fournit une vue d'ensemble des principaux éléments de calcul associés aux centrales inertielles liées. Un système de positionnement relatif précis, fonctionnant à l'aide d'un enregistreur de données L1 GPS miniaturisé et autonome, est détaillé dans le quatrième document. Le cinquième document s'intéresse aux architectures d'intégration INS/GPS comprenant les configurations « légèrement couplé », « fortement couplé » et « profondément intégré ». Les avantages et les désavantages de chaque niveau d'intégration sont examinés. Dans le sixième et dernier document du premier jour, les trois principales architectures des systèmes INS/GPS examinées dans le document précédent ont été comparées suivant leurs performances dans divers scénarios de missions.

Le deuxième exposé mettra l'accent sur les dernières tendances en matière de technologies destinées à naviguer dans des environnements difficiles, urbains, intérieurs, ou souterrains, là où les récepteurs GPS habituels ne fonctionnent pas. On décrira les technologies alternatives de navigation utilisant l'optronique, parmi lesquelles les INS hybridés avec optique et lidar. Le dernier exposé sera consacré à la fusion de multi-capteurs pour la navigation en milieux difficiles. La présentation sera faite d'une approche générique de fusion de multi-capteurs, ainsi que sa simulation et ses résultats expérimentaux.