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Airborne laser sensors and integrated systems

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ABSTRACT

The underlying principles and technologies enabling the design and operation of airborne laser sensors are introduced and a detailed review of state-of-the-art avionic systems for civil and military applications is presented. Airborne lasers including Light Detection and Ranging (LIDAR), Laser Range Finders (LRF), and Laser Weapon Systems (LWS) are extensively used today and new promising technologies are being explored. Most laser systems are active devices that operate in a manner very similar to microwave radars but at much higher frequencies (e.g., LIDAR and LRF). Other devices (e.g., laser target designators and beam-riders) are used to precisely direct Laser Guided Weapons (LGW) against ground targets. The integration of both functions is often encountered in modern military avionics navigation-attack systems. The beneficial effects of airborne lasers including the use of smaller components and remarkable angular resolution have resulted in a host of manned and unmanned aircraft applications. On the other hand, laser sensors performance are much more sensitive to the vagaries of the atmosphere and are thus generally restricted to shorter ranges than microwave systems. Hence it is of paramount importance to analyse the performance of laser sensors and systems in various weather and environmental conditions. Additionally, it is important to define airborne laser safety criteria, since several systems currently in service operate in the near infrared with considerable risk for the naked human eye. Therefore, appropriate methods for predicting and evaluating the performance of infrared laser sensors/systems are presented, taking into account laser safety issues. For aircraft experimental activities with laser systems, it is essential to define test requirements taking into account the specific conditions for operational employment of the systems in the intended scenarios and to verify the performance in realistic environments at the test ranges. To support the development of such requirements, useful guidelines are provided for test and evaluation of airborne laser systems including laboratory, ground and flight test activities.

Contents

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1. Airborne laser technology

Throughout the 1950s, significant research efforts were devoted to laser technology and some practical applications started to emerge. Since then, a large number of R&D programmes have been carried out on lasers, which have led to a rich diversity of systems, ranging from laboratory devices used for studying nonlinear optical emissions and propagation, to eye-safe, compact and inexpensive laser-ranging binoculars. Over the years, military interests in airborne laser systems have concentrated in four general areas: Laser Rangefinders (LRF) and Target Designators (LTD), laser radars (Light Detection and Ranging – LIDAR), Laser Communication Systems (LCS) and Directed Energy Weapons (DEW). Although military lasers are significantly different from those in the public domain, the transfer of military technologies (i.e. powerful laser sources and other electro-optical devices) has resulted in numerous civil applications, including 3D mapping, turbulence detection, wireless power transmission and ground