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A STUDY ON MEMS-BASED ON-BOARD BLACK BODY SYSTEM FOR SPACE APPLICATIONS

Abstract

Spaceborne image sensors such as an infrared (IR) detector have non-uniformity output characteristics owing to time elapses or detector on/off operation during the mission period in orbit. Therefore, these image sensors require periodic calibration to correct the non-uniformity characteristics using a black body system to maintain the estimation accuracy with respect to measurement objects and image quality of the observation satellite. The main objectives of a black body system are estimating a representative surface temperature for calibration of the image sensor and providing a uniform temperature distribution at various reference temperatures of a black body surface. For example, Oh et al. developed an on-board black body system that can provide temperature calibration from low to high temperature, while calibrating the non-uniformity characteristics to an IR detector. However, the function of the on-board black body system was mainly focused on calibrating the non-uniformity characteristics, such that the reference temperature range that can provide is very limited. In addition, the on-board black body system requires a complex thermal design to provide reliable, accurate temperature estimations. Because implementing low and high temperature information of the black body requires a thermal conduction path for cooling the black body through the radiator and additional heaters to heat-up the black body surface. These technical approaches might increase the complexity of the thermal design and lower its reliability. To overcome aforementioned drawbacks of the conventional black body system, a MEMS-based black body system was proposed in this paper. This system has advantages of lightweight, low power consumption, and high accuracy for estimating the representative surface temperature of the black body. In addition, the proposed system can provide high-temperature uniform information at various reference temperatures, from low to high temperature, compared with the conventional systems. In addition, this black body system can provide low temperature by cooling down the black body using a Peltier device. The feasibility of the proposed MEMS-based black body system using the Peltier device was validated through thermal analysis.