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P1.24: High-speed Readout System of X-ray CMOS Image Sensor for the Time Domain Astronomy

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We have developed an FPGA-based high-speed readout system for a CMOS image sensor to observe X-ray transients in future satellite missions such as HiZ-GUNDAM. The results of our previous research suggested that the CMOS image sensor has a low-energy X-ray detection capability (0.4–4 keV) and strong radiation tolerance, which satisfy the requirements of the HiZ-GUNDAM mission. However, CMOS sensors typically have small pixel sizes, resulting in large volumes of image data. The GSENSE400BSI we used has 2048 × 2048 pixels, producing 6-Mbyte per frame. These large volumes of the observed raw image data cannot be stored in the satellite bus system. Therefore, only X-ray events are extracted. Furthermore, the readout time of CMOS image sensors is approximately ten times faster than that of X-ray CCDs, thereby requiring faster event extraction. To address this problem, we developed an FPGA-based image signal processing system capable of high-speed X-ray event extraction on-board. The compact design of this system enables it to be mounted on a CubeSat mission, facilitating an early in-orbit operation demonstration. In this paper, we present the results of the performance evaluation tests of the proposed FPGA-based readout system using X-ray irradiation experiments. The results of on-board X-ray event extraction and off-line processing are consistent, validating the functionality of the proposed system.

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