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Real-time implementation of intelligent data processing applications: gamma/neutron discrimination and hot spot identification

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This contribution presents the methodology used for implementing two intelligent data processing applications using real-time heterogeneous platforms.
• The first application involves discriminating between gamma and neutron pulses acquired using a scintillator through the use of deep learning techniques implemented with 1-D convolutional neural networks (CNNs) and high-sampling rate analog to digital converters (ADCs). The selected architecture was implemented using the IntelFPGA OpenCL SDK environment and evaluated for performance and resource utilization.
• The second application uses the Connected Components Labeling algorithm to detect hot-spot in an image acquired with a high-speed camera. Heterogeneous computing techniques based on the OpenCL standard were applied to achieve real-time performance on a Micro Telecommunications Computer Architecture (MTCA) platform.
Both applications use the CPU, GPU, and FPGA computation capabilities to process the acquired data and have been integrated with the nominal device support (NDS) model developed by ITER. The results are comparable to the state-of-the-art solutions while employing a much-reduced development cycle with high-level programming languages such as C/C++, the specialized algorithms can be evaluated in a short development cycle. The proposed solutions balance the computational load between a field-programmable gate array (FPGA) and a graphical processing unit (GPU), and the algorithm is optimized to take advantage of the specific characteristics of each platform. The neutron discrimination algorithm achieved up to 79k Events of real-time discrimination, while the hot spot detection algorithm achieved up to 3000 frames processed per second. Using the OpenCL programming framework for these developments has been beneficial because the same algorithm can be evaluated in different hardware platforms; thus, the developer may select the platform that best fits the best performance.

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