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OPTIMIZED FPGA-BASED REAL-TIME ONBOARD PROCESSING FOR ENHANCED MARITIME SURVEILLANCE

Abstract

The imperative for real-time ship detection in maritime surveillance cannot be overstated, with applications ranging from security and traffic management to environmental monitoring. The initiation of Deep Neural Networks (DNNs), particularly the You Only Look Once (YOLO) algorithm, has markedly advanced the accuracy of ship detection in remote sensing imagery. Nonetheless, the deployment of these sophisticated models on embedded systems for on-board processing encounters significant challenges. These include not only performance bottlenecks but also increased latency and elevated energy demands, largely due to the DNNs' computational complexity and substantial model sizes. Such constraints are particularly pronounced in embedded devices, where computational resources are inherently limited. This research explores the optimization of the YOLO model for real-time ship detection, emphasizing the balance between detection performance and energy efficiency. It evaluates the Xilinx Artix-7 FPGA as an optimized computing platform for YOLO-based ship detection, in comparison with a standard Commercial Off-The-Shelf (COTS) onboard processing unit. The research results reveal that, while both platforms offer comparable detection accuracy, the FPGA implementation achieves a significant reduction in processing time of 45% faster alongside a 9% improvement in power efficiency. These results underscore the FPGA's potential to enhance real-time maritime surveillance capabilities, offering a viable solution for deploying advanced DNN models in constrained on-board processing environments.