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HIGH RESOLUTION DEEP SPACE IMAGING AND EARTH OBSERVATION MISSIONS WITH ARTIFICIAL INTELLIGENCE BASED ASIC ACCELERATORS

Abstract

Due to the inherent limitations posed by current generation communications and solid state recording technologies; it is not viable to operate imaging payloads at their highest resolution for long durations. In case of imaging missions, the payload is either duty cycled to operate for only small amounts of time, or is operated at a lower resolution between two access times to prevent memory overflow. This leads to severe under-utilization of payload capacity. This becomes exceedingly troublesome in case of interplanetary and surveillance missions. This technology gap can be overcome by a technology upgrade to improve the throughput of potential data usage using AI/ML in-situ operations using computer-vision and deep-learning for future missions where imagers are expected to be far more powerful and data intensive. High profile missions like hyper-spectralimaging, radar imaging, deep-space imaging, extra-terrestrial imaging and even landing and rover missions are prime candidates which can be revolutionized by the impact of artificial intelligence. AI assisted on-board data indexing can help in better utilization of data bandwidth for extended imaging durations even failure condition/high load condition. Technology demonstrations involving dedicated AI ASICs on-board cubesats are in the pipeline for several leading space agencies. Real time analysis of high resolution images requires massive computational resources. Standard microprocessor based SoC (Systems-On-Chip) cannot meet the specifications demanded by inherently parallel deep-network architectures and fall short of the required computation power by at-least 3 orders of magnitude. A custom designs implemented on FPGAs offer a near perfect solution for advanced AI algorithms. But space grade FPGAs with required density of logic cells might be cost prohibitive. FPGAs can be used for design validation and as a test platform. In this paper, cost effective solution in the form of an ASIC is developed compared with FPGA. The design is validated for performance in terms of computation load and accuracy of AI algorithm in view of earth observation application. The performance details are discussed in detail in this paper