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ANALYSIS AND COMPARISON OF LEADING AI OPTIMIZED INDUSTRIAL SINGLE BOARD COMPUTERS FOR USE ONBOARD NANOSATELLITES IN LEO AND EARTH OBSERVATION MISSIONS

Abstract

Industrial grade System on Chip (SoC) and Single Board Computers (SBC) are designed to withstand the harsh environments of industrial applications. This includes large temperature swings, various shock profiles, vibration, and in some cases, radiation. These systems are readily available as Commercial Off The Shelf (COTS) and are designed to provide high availability and low failure rates compared to consumer models of the same family of the SoCs and SBCs. There are several similarities between the operating environment of these industrial components and where most nanosatellites fly. Specifically, in most cases the minimum and maximum operating temperature is within the acceptable range of those nanosatellites flying in Low Earth Orbit (LEO). Also, the shock and vibration characteristics are within the acceptable range for most LEO launchers. In recent years, the industry has seen significant innovation in COTS SoC and SBC development, especially in the Edge Internet of Things (IoT), Machine Learning, and most recently with Neural Processing Unit (NPU) and Tensor Processing Unit (TPU). Rapid innovation in SoC and SBC architectures has revolutionized the consumer and industrial market. As a result, flying these systems onboard nanosatellites in LEO may drive and fast track the innovation in the nanosatellite sector. Although all SoCs and SBCs have been tested for industrial applications, little work has been done to understand their performance in nanosatellite LEO applications. This research aims to test and analyze three COTS leading edge SBC solutions with Edge-IoT and neural network computing capabilities. They include the NXP iMX8 Plus SoC, NVIDIA Jetson Nano, and Google Coral Edge TPU. The performance of each of these SBCs under simulated LEO like conditions will be analyzed. This includes software AI benchmarking under vacuum, thermal stress, excessive power loss, high G-Force, and high doses of radiation.