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**Application of Reconfigurable Computing Technology to Multi-KiloHertz Micro-Laser Altimeter (MMLA) Data Processing**

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*Abstract*

The Multi-KiloHertz Micro-Laser Altimeter (MMLA) is an aircraft based instrument developed by NASA Goddard Space Flight Center with several potential spaceflight applications. This presentation describes how reconfigurable computing technology was employed to perform MMLA signal extraction in real-time under realistic operating constraints.

The MMLA is a “single-photon-counting” airborne laser altimeter that is used to measure land surface features such as topography and vegetation canopy height. This instrument has to date flown a number of times aboard the NASA P3 aircraft acquiring data at a number of sites in the Mid-Atlantic region.

This instrument pulses a relatively low-powered laser at a very high rate (10kHz) and then measures the time-of-flight of discrete returns from the target surface. The instrument then bins these measurements into a two-dimensional array (vertical height vs. horizontal ground track) and selects the most likely signal path through the array. Return data that does not correspond to the selected signal path (noise returns) are then discarded.

The MMLA signal extraction algorithm is very compute intensive in that a score must be computed for every possible path through the two dimensional array in order to select the most likely signal path. For realistic array sizes (i.e. 100 x 5), roughly 1,000 to 10,000 individual paths must be scored. Furthermore, the number of paths increases exponentially with the horizontal size of the array, and linearly with the vertical size. Yet, increasing the horizontal and vertical sizes of the array offer advantages such as improved range, resolution, and noise rejection.

Due to the volume of return data and the compute intensive signal extraction algorithm, the existing PC-based MMLA data system has been unable to perform signal extraction

in real-time unless the array is limited in size to one column. This limits the ability of the MMLA to operate in environments with a high number of noise returns. However, an FPGA-based, reconfigurable computing data system has been developed that has been demonstrated to perform real-time signal extraction under realistic operating constraints. This reconfigurable data system is based on the commercially available Firebird Board from Annapolis Microsystems. This PCI board consists of a Xilinx Virtex 2000E FPGA along with 36 MB of SRAM arranged in five separately addressable banks. This board is housed in a rackmount PC with dual 850MHz Pentium processors running the Windows 2000 operating system. This data system performs all signal extraction in hardware on the Firebird, but also runs the existing "software based" signal extraction in tandem for comparison purposes.

Using a relatively small amount of the Virtex 2000E resources, the reconfigurable data system has demonstrated to improve performance improvement over the existing software based data system by an order of magnitude. Performance could be further improved by employing parallelism. An engineering test flight aboard the NASA P3 has also been performed, during which the reconfigurable data system was demonstrated to match the results of the existing data system.