FPGA signal processing for real-time dust detection

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The NASA Lunar Science Institute's Colorado Center for Lunar Dust and Atmospheric Studies (CCLDAS) has completed the construction of a 3MV lunar dust accelerator facility to investigate the effects of micrometeoroid impacts on the surface of the Moon. Such impacts are believed to contribute to the lunar exosphere, and might be primarily responsible for the mixing and redistribution of the lunar soil. Beyond physical understanding of lunar and other airless bodies, the accelerator will also offer experimental services for the calibration of future instruments. This system consists of calibrated image-charge detectors sensitive from 10^4 - 4×10^6 electrons per particle. A cross-correlation algorithm, implemented on a field programmable gate array (FPGA), is used to detect signals lost within noise. The parallelism and easy implementation of FPGA algorithms offer a good solution for real-time, fast filtration schemes. The implementation of this system, as well as the usefulness of FPGAs to the broader context of digital filtration, is presented. The technique is of general interest for any signal processing problems in a low signal-to-noise environment and can be easily realizable using National Instruments' LabVIEW development tools.