An Advanced FPGA-Based Processor and Controller for the Next-Generation Precipitation Radar*

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Abstract

With the success of the Precipitation Radar on the Tropical Rainfall Measuring Mission (TRMM), a new class of spaceborne precipitation radars are being developed for the TRMM follow-on missions, such as the Global Precipitation Mission. The Next-Generation Precipitation Radar (PR-2) prototyped by NASA/JPL will depend heavily on high-performance digital processing to collect meaningful rain echo data. Using field-programmable gate arrays (FPGAs), we have developed for the PR-2 a compact, radiation tolerant data processor and adaptive timing controller that will permit full on-board processing capabilities from a 14 and 36 GHz spaceborne radar.

Several enabling technologies are included in the PR-2 processor for sensitive rain rate detection (0.5 mm/hr), high range resolution (250 m) and wide swath coverage (500 km). To reduce sea surface clutter, a complex, 20×10^9 op/s pulse compression filter with a range sidelobe performance of -60 dB is designed into each data processor FPGA. Fading noise within each echo is also reduced by 4.5 dB, using wideband chirp radar and range averaging techniques. Alongside the processor core, a novel control and timing unit (CTU) FPGA allows the PR-2 to use its own "quick-scan" data to electronically steer the radar beam to only those areas which contain precipitation, and to ignore areas that are precipitation-free. The transmit/receive timing solution generated by the CTU is 90% efficient and yields an order-of-magnitude increase in the number of independent looks for each rain bin.

In the summer of 2001, the processor core was successfully tested in our airborne prototype of the PR-2 which was deployed during the 4th Convection and Moisture Experiment (CAMEX-4). The first 14 and 36 GHz rain echo data sets collected in CAMEX-4 demonstrate the PR-2's high spatial resolution and sensitivity over a range of rain rates. Presently, new versions of the data processor and CTU firmware are being developed to realize features of the spaceborne PR-2, like the adaptive scanning method and echo averaging.

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