Technology Focus: Data Acquisition

iGlobe Interactive Visualization and Analysis of Spatial Data

Ames Research Center, Moffett Field, California

iGlobe is open-source software built on NASA World Wind virtual globe technology. iGlobe provides a growing set of tools for weather science, climate research, and agricultural analysis. Up until now, these types of sophisticated tools have been developed in isolation by national agencies, academic institutions, and research organizations. By providing an open-source solution to analyze and visualize weather, climate, and agricultural data, the scientific and research communities can more readily advance solutions needed to understand better the dynamics of our home planet, Earth.

iGlobe provides a flexible interface for sophisticated analysis and highly interactive visualization of NetCDF (Network Common Data Format) data. NetCDF, the data format typically used for weather and climate data, is large and complex in nature. Even the simple act of accessing NetCDF data is a computation- and data-storage-intensive undertaking. iGlobe is there for the international community to advance collectively solutions that address issues of concern to all.

iGlobe is a 4D virtual globe application using NASA World Wind visualization technology (www.goworldwind.org). iGlobe integrates analysis of climate model outputs and remote sensing observations, combined with demographic and environmental data sets, to understand global and regional phenomena better, and provides impact analysis on a critical national resource, our agricultural industry. iGlobe allows seamless access to remote data repositories, allows users to run sophisticated data analysis algorithms on the server side, and provides accelerated statistical analysis on the client side via a thin client analytic engine able to incorporate server-side processing power.

iGlobe server-side analysis provides support for different data analysis algorithms purposed to identify patterns in spatial-temporal data, i.e., change detection, anomaly detection, clustering, and frequent-pattern analysis. The iGlobe client-side analysis also provides support for statistical operations on selected regions using any number of spatial-temporal data layers and parameters, i.e., spatial mean, median, variance, autocorrelation, etc.

This work was done by Patrick Hogan of Ames Research Center. Further information is contained in a TSP (see page 1). ARC-15166-1A

Broad-Bandwidth FPGA-Based Digital Polyphase Spectrometer

Applications include microwave radiometers, laser heterodyne systems, and radar.

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With present concern for ecological sustainability ever increasing, it is desirable to model the composition of Earth's upper atmosphere accurately with regards to certain helpful and harmful chemicals, such as greenhouse gases and ozone. The microwave limb sounder (MLS) is an instrument designed to map the global day-to-day concentrations of key atmospheric constituents continuously. One important component in MLS is the spectrometer, which processes the raw data provided by the receivers into frequency-domain information that cannot only be transmitted more efficiently, but also processed directly once received. The present-generation spectrometer is fully analog. The goal is to include a fully digital spectrometer in the next-generation sensor. In a digital spectrometer, incoming analog data must be converted into a digital format, processed through a Fourier transform, and finally accumulated to reduce the impact of input noise. While the final design will be placed on an application specific integrated circuit (ASIC), the building of these chips is prohibitively expensive. To that end, this design was constructed on a field-programmable gate array (FPGA).

A family of state-of-the-art digital Fourier transform spectrometers has been developed, with a combination of high bandwidth and fine resolution. Analog signals consisting of radiation emitted by constituents in planetary atmospheres or galactic sources are down-converted and subsequently digitized by a pair of interleaved analog-to-digital converters (ADCs). This 6-Gsps (gigasample per second) digital representation of the analog signal is then processed through an FPGA-based streaming fast Fourier transform (FFT). Digital spectrometers have many advantages over previously used analog spectrometers, especially in terms of accuracy and resolution, both of which are particularly important for the type of scientific questions to be addressed with next-generation radiometers.

The high-level building blocks (filter and FFT components) were optimized for the Xilinx Virtex 5 FPGA, and for interfacing with one another. The design, from building blocks to complete implementation, was floor-planned in order to make efficient use of the FPGA resources. As more aggressive spectrometer designs were created, designing the hardware to run at a sufficiently high clock rate became progressively more difficult. These issues were mitigated by duplicating hardware and adding (or removing) latency as necessary. The floor-planning of the design was changed dramatically from the original.

The final spectrometer design is an 8192-channel implementation. Designed with additional output capacity, the spectrometer has superior fre-