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.

NASA's Jet Propulsion Laboratory, Pasadena, California

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-
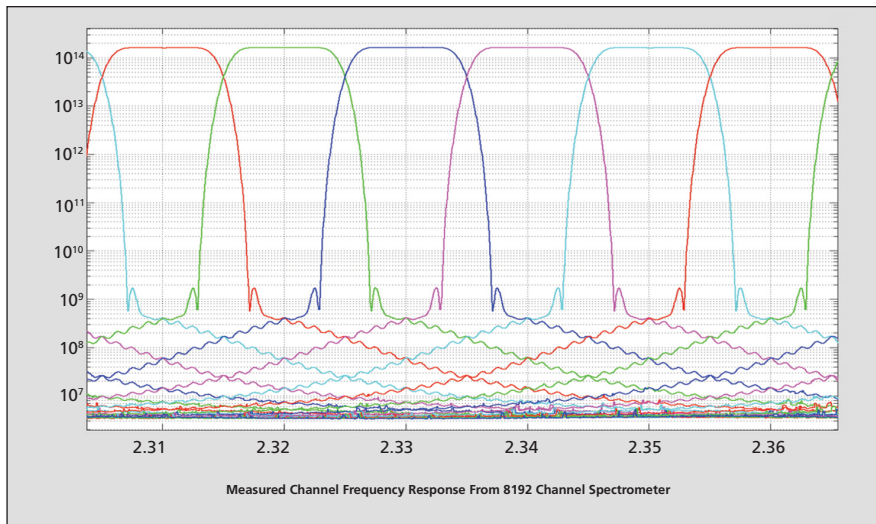
The measured channel frequency response from the 8192-channel **Spectrometer**.

In addition, a further improved spectrometer with double the frequency resolution, a polyphase-FIR filter front end, and substantially reduced noise has been successfully simulated and is presently in the final stages of development. When finished, it will offer a spectrometer developed on Virtex-5 hardware with bandwidth and spectral resolution an order of magnitude greater than the analog spectrometers presently in use.

Plans to make an 8-GHz spectrometer taking advantage of the same technology used for this device are already being made. Finally, efforts are presently being made to interface this design to a compact Nallatech board, which consumes less power and can be more readily used in remote locations and demanding environments.

This work was done by Robert F. Jarnot of Caltech and Ryan M. Monroe of Georgia Tech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-48352

quency resolution, dynamic range, and accumulation length when compared to previous versions. An alternate, dual-polarization, 1.5-GHz, 4096-channel spectrometer is available as well. Both designs are capable of accumulating for hours, several orders of magnitude over what is required.

Small Aircraft Data Distribution System

NASA's Jet Propulsion Laboratory, Pasadena, California

The CARVE Small Aircraft Data Distribution System acquires the aircraft location and attitude data that is required by the various programs running on a distributed network. This system distributes the data it acquires to the data acquisition programs for inclusion in their data files.

It uses UDP (User Datagram Protocol) to broadcast data over a LAN (Local Area Network) to any programs that might have a use for the data. The program is easily adaptable to acquire additional data and log that data to disk.

The current version also drives displays using precision pitch and roll information to aid the pilot in maintaining a level-level attitude for radar/radiometer mapping beyond the degree available by flying visually or using a standard gyro-driven attitude indicator.

The software is designed to acquire an array of data to help the mission manager make real-time decisions as to the effectiveness of the flight. This data is displayed for the mission manager and broadcast to the other experiments on the aircraft for inclusion in their data

files. The program also drives real-time precision pitch and roll displays for the pilot and copilot to aid them in maintaining the desired attitude, when required, during data acquisition on mapping lines.

This work was done by Seth L. Chazanoff and Steven J. Dinardo of Caltech for NASA's Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov.

This software is available for commercial licensing. Please contact Daniel Broderick of the California Institute of Technology at danielb@caltech.edu. Refer to NPO-48384.

Earth Science Datacasting v2.0

NASA's Jet Propulsion Laboratory, Pasadena, California

The Datacasting software, which consists of a server and a client, has been developed as part of the Earth Science (ES) Datacasting project. The goal of ES Datacasting is to provide scientists the ability to automatically and continuously download Earth science data that meets a precise, predefined need, and then to instantaneously visualize it on a local computer. This is achieved by applying

the concept of podcasting to deliver science data over the Internet using RSS (Really Simple Syndication) XML feeds. By extending the RSS specification, scientists can filter a feed and only download the files that are required for a particular application (for example, only files that contain information about a particular event, such as a hurricane or flood). The extension also provides the

ability for the client to understand the format of the data and visualize the information locally.

The server part enables a data provider to create and serve basic Datacasting (RSS-based) feeds. The user can subscribe to any number of feeds, view the information related to each item contained within a feed (including browse pre-made images),