P1.3 RADAR OPERATIONS CENTER (ROC) PROGRESS IN RVP8 TIME SERIES PLAYBACK FOR SIGNAL PROCESSING EVALUATION

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INTRODUCTION

The WSR-88D Radar Operations Center (ROC) is responsible for implementing new signal processing algorithms planned for deployment in the Open Radar Data Acquisition (ORDA) System. The capture and playback of time series data allows for selection of relevant weather data and repetitive testing of an algorithm under development. It provides the ability to play recorded data through the processor, then to compare results with the output of "Legacy" processing. This paper will provide a historical perspective of time series data utilization, the status of the current record and playback capabilities, and a discussion of the application and benefits to the research community.

LEGACY WSR-88D

The Legacy WSR-88D Radar provided two means to record time series data: an analog In-phase (I) and Quadrature (Q) video output, and a digital I and Q output from the Hardwired Signal Processor (HSP). The National Center for Atmospheric Research (NCAR) developed the Archive 1 Data Analyzer (A1DA) to provide recording capability for Legacy time series data via the HSP digital data output (Gagnon, 1995). Time series data is captured by a dedicated real-time computer and stored on a large (for its time) disk array. The capture and storage of this data was controlled by software running on a dedicated Sun workstation. In addition to the time series recording capability, base moment data from the WSR-88D could be viewed and collected. This provided the user with a real-time view of the weather as seen by the radar, and allowed meteorologically significant areas to be defined for time series recording.

While the A1DA provided a flexible engineering analysis tool for the WSR-88D, there was no way to play back recorded time series data into the WSR-88D system. Also, processor speed, network speed, and disk storage capacity constraints limited the collection of I/Q data to relatively small areas of radar data. Recent technological advances in processor and network speed, as well as disk drive storage capacity have brought powerful new capabilities for I/Q data collection.

ORDA UPGRADED WSR-88D

The design of the ORDA system also allows the possibility of real-time playback using recorded I/Q data. The SIGMET RVP8 Time Series Application Programming Interface (TS API) provides the infrastructure to do this. The TS API is organized into time series readers and writers, with an exclusive writer application providing the source time series data. Multiple time series reader applications are allowed to attach and request time series data.

One of the major goals of the WSR-88D ORDA upgrade is to provide the ability to easily insert updated signal processing algorithms. The SZ-2 algorithm (Saxion, 2005) is one of the first new algorithms scheduled for deployment on the WSR-88D. This algorithm requires phase-encoded I/Q data to perform properly. The VCPs defined for the initial ORDA deployment do not transmit phase-encoded data. This meant that other means were needed to transmit phase-encoded pulses and record the required time series data. SIGMET's TS API provided the infrastructure for accessing the time series data, and future plans called for a record and playback capability. In the interim, ROC engineers developed the Level 1 Record and Playback (L1RP) utility.

L1RP recorded I/Q data from SIGMET's TS API to files on a remote machine over a network socket interface. As an interim measure before SIGMET's native playback feature was developed, ROC engineers inserted I/Q data using a modified function in the standard RVP8 software. Data conversion utilities allowed playback of phase-encoded data collected from various research radars. Figure 1 shows moment data processed after conversion from the A1DA file format. L1RP provided the initial capability to repeatedly analyze algorithm performance on actual weather data.

SIGMET TS ARCHIVE

After L1RP was developed, SIGMET's Time Series Archive (TS Archive) utility became available (SIGMET, 2004). TS Archive is layered on the previously mentioned TS API, with enhancements. Initially, the RVP8 was the only writer allowed by the TS API. Time series data can now be written into the TS API by

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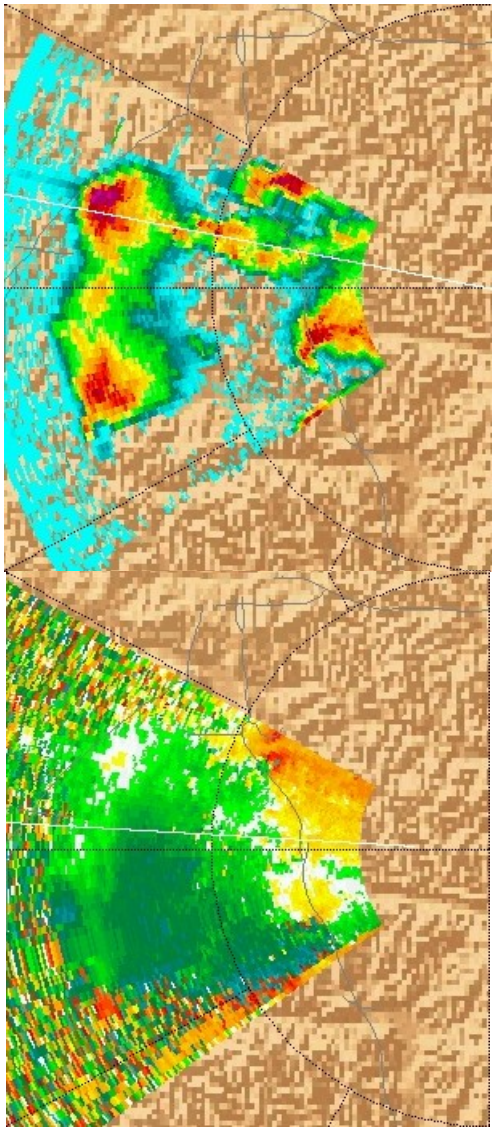

Figure 1 - Legacy Archive 1 Data Examples

processes other than the RVP8. The TS Switch utility program allows selection of the desired time series data source. Two network utilities, Tsexport and Tsimport, allow the user to distribute time series data over a network between the RVP8 and other Linux based computers. This has the advantage of reducing processor utilization on the RVP8, and enables the user to record and play back data from a separate computer with an enhanced storage capacity.

The TS Archive utility provides a graphical interface allowing the user to control time series playback and recording, as well as the selection and organization of the time series data files.

APPLICATION

The character of time series data played back using the TS Archive utility is necessarily different than time series data from live radar. It does not respond to requested parameter changes that are otherwise changeable on a live radar (e.g. PRF, pulse width, antenna position/rate, etc.). Because of this, at present only SIGMET's Ascope utility fully supports TS Archive playback for radar moment calculations. Ascope is quite useful for analyzing moment data at a detailed level for any particular range bin, but it lacks a PPI radar data display capability. For algorithm development and testing, this type of output is helpful. Also, the SZ-2 algorithm requires that the control software delineate between Surveillance and Doppler scans. While SIGMET IRIS software can be used on a limited basis with properly defined tasks, it cannot provide for the proper control of the SZ-2 algorithm without modification. This led the ROC engineers to develop a utility called Process Driver (PD) to meet these needs.

PD is a program that uses SIGMET DSP library calls to control the way the RVP8 processes moment data. It monitors the incoming time series data, watching for mismatches between the commanded processing parameters and those inherent in the data itself. When a mismatch is detected, it issues a new processing command that matches the current data.

PD provides moment data output in two ways: (1) writing directly to a file, and (2) using SIGMET's real-time display transmitters. The benefit derived from using the real-time display transmitters is twofold: (1) SIGMET's standard real-time display utility can be used to view reflectivity, velocity and spectrum width (albeit at reduced resolution), and (2) NCAR's UDP radar data collection tool can be used to capture and store full resolution data to disk for subsequent analysis with NCAR's CIDD tool. Figure 2 shows an example of SZ-2 processed velocity using this method.

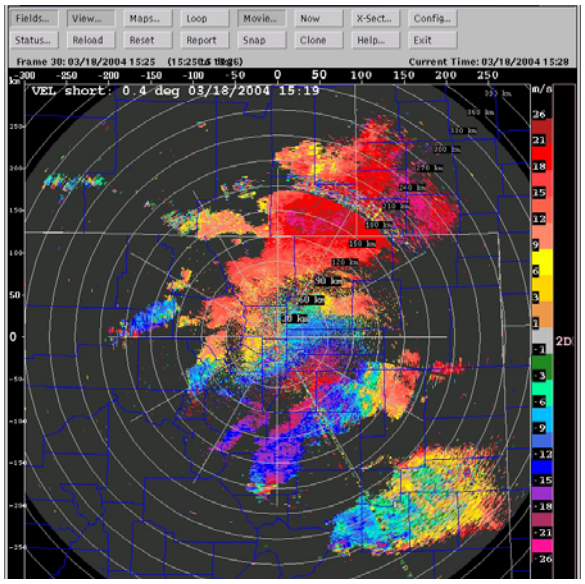

Figure 2 – CIDD Display of SZ-2 Velocity

BENEFITS

One of the key constraints in testing new radar signal processing algorithms is the limited availability of radar time for research and testing. Further impacting this problem is the fact that the meteorological phenomena necessary to fully test the performance of these new algorithms cannot be scheduled. Also, when they do occur, their occurrence location will likely be far from the site where the test algorithm is set up to run. The time series recording and playback capability provided by the ORDA mitigates the impact of these issues on the researchers and developers of these algorithms in several ways. (1) It maximizes the use of limited radar time by allowing the recording of meaningful test cases for later playback. This recording can occur at a location far removed from the research and development sites. In many cases, the data can be collected without requiring exclusive control of the radar. (2) Time series recording and playback allows the recovery of moment data for a meteorological event, even if the real-time processing was flawed or unavailable for review. (3) It enables the testing and development of new radar signal processing techniques over a wide range of trial conditions.

FUTURE WORK

While the ORDA RVP8 time series data record and playback infrastructure is currently providing an important aid to algorithm development, there are areas planned for further enhancement in the future. At present, playback capabilities using standard ORDA software are limited. Future time series playback plans call for full compatibility with ORDA software. This playback should work without requiring attachment to an actual radar. Also planned is the collection of a coordinated data set consisting of (1) time series data, RVP8 moment data (2) prior to ORDA processing, and (3) subsequent to ORDA processing. This data set will allow the analysis and comparison of the output from new signal processing algorithms with the output of current signal processing algorithms, permitting inspection and validation at each step of the ORDA processing chain.

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