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Project Title: **"Information Sharing Java Interface for Storm Targeted Radar Wind Retrievals at Very High Resolution"**

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Proposal Theme: Theme 2: Technologies for Collaboration, Visualization, and Analysis; Theme 3: Disaster Monitoring or Response.

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Executive Summery:

The objective of this proposal is to develop an information sharing Java interface for storm targeted wind retrievals (STWR) at very high resolution (up to 250 m). The central piece of STWR is the two-dimensional simple adjoint (2dSA) package (Xu et al. 1995, 2001) to retrieve very-high-resolution storm winds from two or more consecutively radar scans. The existing radar wind retrieval (RWR) system (http://gaussian.gcn.ou.edu: 8080/rtime.shtm) does not have the required resolution but can provide much needed background information to improve the 2dSA. Incorporating the 2dSA into RWR yields an improved very-high-resolution capability for storm targeted wind analysis. An

information sharing interface is critically needed for this new capability, as strongly suggested by the experiences from the 2dSA operational demo project at the Oklahoma Norman Weather Forecast Office (WFO) during the 2003 spring storm season. This interface will allow the users not only to timely and interactively configure the retrieval domain on-screen following the concerned feature (such as tornadic storm or mesocyclone), which is necessary for the automated retrieval run, but also to share, especially between the forecasters and developers realtime on-line, the complete run information and products along with their comments and questions. Developing such an interface requires innovated applications of the powerful graphic and communication capabilities of Java 2D API and Perl script at their cutting-edge.

By minimizing the manual operations and associated human errors (or inaccuracy), this Java interface should improve the realtime efficiency and reliability of STWR. By monitoring the data flow and computer resource usage, this interface will allow the realtime efficiency and capabilities of STWR be further improve or maximized. For its future development, such an interface will be able to link to and display data from a variety of sources (in addition to radar) for verifications and synthetic analysis of storm winds and invoke other scientific algorithms. All these will make the proposed Java interface a paradigm applicable to other realtime interfaces.

This proposal targets the FY04 HPCC Theme 2: Technologies for Collaboration, Visualization, and Analysis. The application of proposed interface fits Theme 3: Disaster Planning, Mitigation, Response and Recovery.

Problem Statement:

The 2dSA is recently developed into a stand-alone package to retrieve storm winds from WSR-88D level-II wind data in a storm-following moving frame. With the retrieved storm winds overlaid with the radar reflectivity (or radial-wind) image on detailed county maps, this package is designed to provide a comprehensive view of realtime storm winds in critical areas threatened by the storm and help the forecasters to make warning decisions with an improved accuracy. Funded by ROC/MOU, this stand-alone package was tested during the 2003 spring storm season for operational demonstrations with the outputs shown to forecasters at the Norman WFO. It produced realtime high-resolution winds on 1 km grid within storms on the severe-weather active dates: April 15, 19, 23; May 6, 7-8 (overnight), 8-10, 15-16 (overnight), 16, 19; June 11-12 (overnight), during the demo period. The retrieved storm winds agreed closely with the radial velocities around 70% of the time.

Problems showed by the remaining 30% are being examined. Four types of errors are so far identified: (i) Velocity dealiasing errors in mesocyclones due to the lack of primary data quality controls, (ii) Retrieval errors in data void areas due to the absence of background information on the environmental winds; (iii) Retrieval errors in mesocyclones near the radar due to insufficient resolution (1 km during the demo) and its

trigged failures in refined iterative dealiasing (but the problem is corrected in reruns with the resolution increased to 250 m, (iv) Retrieval errors caused by hasty and inaccurate specifications and parameter inputs due to the non-automated and non-interactive nature of the current interface (which requires the run specifications and parameters be determined manually and typed into the run-script). In addition, it is necessary to archive the run specifications and products for after-fact studies. This was done manually by typing and thus was found to be time consuming and interrupting the primary tasks.

Upon the completion of the current FY03 HPCC project, the automated management system will provide primary data quality controls to reduce or avoid the above type-1 error, while the RWR will produce the much needed background field to reduce the type2 error. Increasing resolution to 250 m can reduce or eliminate the above type-3 error. This, however, is computationally feasible (on our dedicated workstation) only when the domain size is reduced to 20x20 km^2. Thus, there will be a trade-off between selections of resolution and domain size, which must be determined timely and interactively on-scene based on the signature that needs to be further identified and/or resolved within a storm and based on its range distance from the radar. These operations cannot be executed as required without a two-way interface, not even mention other interface capabilities needed for reducing the above type-4 error. Thus, an efficient and user-friendly interface is critically important for STWR, as this new capability is incorporated with the improved 2dSA into the RWR.

As experienced from the 2dSA demo at the WFO during the 2003 spring storm season, it is desirable and necessary to develop an interface with the following functions:

1) Automated listing and updating of available realtime radar data files; 2) On-screen interactive configuration of retrieval domain and estimation of moving speed and direction of concerned feature (such as tornadic storm or mesocyclone); 3) Mouse-click selection/change of retrieval run specifications and input parameters with button-press execution of retrieval run and histogram monitoring of computation and communication loads; 4) Zoom display of retrieved vector winds overlaid on radar image and county/city maps with mouse-click capability in on-screen wind speed and location reading and on-line information sharing.

In addition, the interface should have flexible platforms for both on-line realtime runs and off-line historical reruns.

Proposed Solution:

The proposed solution will build upon and leverage the recent successes derived from two previous projects, the CRAFT (funded by a grant from the Oklahoma State Regents for Higher Education and HPCC) and the ESDIM Program (Environmental Services Data and Information Management Program). In particular, the realtime WSR-88D radar level II data will be obtained through high speed internet, managed by LDM (Local Data Manager) system, and displayed using IRAS (Interactive Radar Analysis System) on realtime. Built upon these infrastructures, the above desired Java interface functions will be developed for STWR along with the integration of the 2dSA package into the existing realtime RWR system.

The proposed interface will inherit the framework of IRAS system coded in Java. It will be featured by button click (instead of manual file editing and calculation) to execute realtime runs of wind retrieval and display for operational applications.

Drawing and displaying radar images will be implemented by using Java 2D API. Java 2D API is a sophisticated, generic, and low-level API that covers a broad portion of computer 2D graphics, and is designed to serve all kinds of graphics needs. It provides the underlying support for the graphics in the Java platform, for example, other APIs such as the Abstract Window Toolkit (AWT) or Swing, rely on the Java 2D API for all drawing operations.

Java also provides facility to support user interaction and external program invoking, such as selecting the retrieval domain and run parameters and invoking 2dSA**.** It can be implemented by using runtime objects in Java. Runtime objects provide two services. First, they communicate with the components of the runtime environment-getting information and invoking functions. Second, runtime objects are also the interface to system-dependent capabilities.

The merit of Java interactivity will be utilized to develop the interface. Perl script will also be used to manage data ingests, wind retrieval and display processes. The following functions will be included in the interface:

Data ingest interface

One volume scan can be ingested through a subinterface and displayed using the existing IRAS system. But the 2dSA package requires at least two volume scans be ingested. A new subinterface will be developed with automated listing and updating of available real-time radar data files for fast selection of retrieval time window and input radar data files.

Graphic selection of retrieval domain

A subinterface will be developed for on-screen graphic selection of retrieval domain with digital labels on realtime radar data display and looping, so users can easily locate the center of retrieval domain and define the domain size by dragging a rectangular box that embraces the desired area.

Interactive estimation of moving speed and direction

The above subinterface will also facilitate another important function, that is, on-screen interactive estimation of moving speed and direction of a concerned feature (such as tornadic storm or mesocyclone) from real-time radar data display and looping. By clicking the mouse at the concerned feature on consecutive radar scans, its moving speed and direction will be automatically calculated and ingested into the retrieval package.

Parameter settings

A subinterface will be designed to set or reset the run specifications and input parameters (such as grid resolution, retrieval time window &, etc) if the default setting is not used.

Button-press execution of retrieval run and display

A button will be designed for executing the retrieval run with the selected domain (moving frame) and specified run parameters. A Perl script will be implanted behind the button to control the retrieval process. The computation and communication loads will also be monitored and displayed as needed.

Zoom display of retrieved winds

The ultimate task is to display the retrieved vector winds overlaid on radar image and county/city maps. This function is critical for the utilities of the proposed interface. It will allow users to simply click a button to view the retrieved wind field overlapped onto the relevant radar PPI type scan image. Zoom in/out and loop functions must be also available for users to view the detailed as well as overall wind structures. It is desirable and possible (depending on the effort allowed and urgency of need) to have mouse-click functions for on-screen reading wind speed and location information and on-line information delivering (to now forecasters and/or related users).

Information sharing

Drawing ability of the Java interface will allow users to mark the concerned feature or area onto the radar image overlaid with the retrieved winds and to record their comments and questions into an accompanying window as needed. A button will be designed to post the marked image and accompanying window along with the run specifications automatically onto a web site where developers and users can have a forum to share information and exchange ideas for improved designs and performances.

Historical rerun

The interface will have flexible platform for both on-line realtime runs and off-line historical reruns. Rerunning archived level II data for challenging cases with different run specifications and input parameters will facilitate further improvements.

The proposed interface can be customized in combination with other algorithms for a variety of users as well as developers to test their upgraded versions. Potentially, it can be also integrated into other systems, such as the AWIPS (Advanced Weather Interactive Processing System) system currently used by the National Weather Service.

Analysis:

Java-IRAS browser is a platform independent software application developed by NSSL/CIMMS. Inheriting IRAS's Java framework and enhancing its functions actually make the development of new interface efficient and the interface will preserve its portability to different platforms and interactivity for users.

As the Internet blooms continuously, Java and Perl script become increasingly popular and powerful. Java has been identified as an important emerging technology in both business and education/government environments. Widespread training has been provided to potential users throughout the nation. One of Java's powerful functions heavily utilized by the proposed work is its remarkable capability in graphics.

Most importantly, the interface will greatly improve the working efficiency and reliability in a nowcast environment. It also provides a very-high-resolution and yet comprehensive view of high winds around a concerned feature within a storm for nowcast applications. In addition, the interface also can be operated in archive mode. It allows the users and especially developers to rerun challenging cases for further improvements and developements.

Performance:

Milestones

• Receive award notification (estimated) and begin project	February 1, 2004
• Order hardware and software	March 1, 2004
• Complete detailed design	April 1, 2004
• Integrate RWR with IRAS	May 15, 2004
• Complete all the functions of the interface	September 1, 2004
• Complete interface test	October 1, 2004

Deliverable

• The whole package includes Java Interface and RWR. It will be ready to use on realtime for the tornado season of year 2005.

References

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