RADAR ANALYSIS AND VISUALIZATION ENVIRONMENT (RAVEN): SOFTWARE FOR POLARIMETRIC RADAR ANALYSIS

K. S. Kierein-Young [1,2], A. B. Lefkoff [1], and F. A. Kruse [1,2]

[1] Center for the Study of Earth from Space (CSES)
Cooperative Institute for Research in Environmental Sciences (CIRES)
University of Colorado, Boulder, Colorado 80309-0449

[2] Department of Geological Sciences
University of Colorado, Boulder, Colorado 80309

1. INTRODUCTION

Imaging radar data provides information about the geometric and dielectric properties of the Earth's surface (Ulaby et al, 1982). The Jet Propulsion Laboratory (JPL) polarimetric Airborne Synthetic Aperture Radar (AIRSAR) is currently obtaining imaging radar data for use in geologic, vegetation, snow and ice, and oceanic studies (Held et al., 1988; Zebker et al, 1987). In the near future, the Shuttle Imaging Radar C (SIR-C/X-SAR) and the Earth Observing System Synthetic Aperture Radar (EOS SAR) will also collect polarimetric radar data (JPL, 1986, 1991).

A need exists for a user-friendly, interactive software package for analysis of these polarimetric radar data sets. Previous software packages, such as JPL's Multiview (Burnette, 1988), while providing some analysis capabilities for these data, did not allow interactive viewing and were tied to specific image display hardware with operating system dependencies.

A prototype software system, the "Radar Analysis and Visualization Environment" (RAVEN) under development at the Center for the Study of Earth from Space (CSES) at the University of Colorado, is designed to deal with data from the JPL AIRSAR instrument and other proposed polarimetric radar instruments. RAVEN is being developed using the Interactive Data Language (IDL) (Research Systems, 1991). It takes advantage of high speed disk access and fast processors running under the UNIX operating system in a X-windows environment to allow for rapid, interactive visualization of AIRSAR data in both image and graphical ways. It provides a user-friendly interface through the use of menus, sliders, buttons, and display windows (Figure 1).

2. DISPLAY FEATURES

Analysis of polarimetric radar data requires innovative display of both images and quantitative information. The images provide spatial information and the graphics provide frequency and polarimetric information. It is necessary to view an entire scene and at the same time be able to see subscenes at full resolution, and enlarged to observe details. RAVEN is designed to create and manage multiple data windows. An entire AIRSAR scene subsampled to fit in a scroller window allows selection of an area to be displayed at full resolution in a image window. A zoom window allows for a subset of the image to be panned and zoomed from 1 to 16 times. RAVEN also provides the capability to interactively select and display synthesized polarimetric images for three frequencies as gray scale images, density-sliced images, or as color composites. These images are displayed as sigma-zero backscatter or total power values. Images of any polarization combination can be synthesized in RAVEN using the Stokes matrices for the calculations. This synthesis, however, takes approximately 2 minutes and is not considered real-time. Therefore, RAVEN also uses a band sequential format data set that contains various pre-synthesized polarization images. This makes possible rapid display of gray scale and color images.

Rapid viewing of frequency and polarization information for individual pixels allows users to get an idea of the variation in a data set. It also allows definition of areas for detailed analysis. RAVEN uses co-polarized and cross-polarized signature windows that provide real-time viewing of cross sections of polarization signatures. A window is also provided to view frequency plots. Frequency plots and full polarization signatures from multiple pixels are saved in another window and allow the user to compare different units.

3. ANALYSIS FEATURES

The analysis capabilities of RAVEN presently include creating and viewing polarization and frequency signatures for the three AIRSAR frequencies using a pull-down menu in the main RAVEN window. Calculation of polarization signatures and frequency plots for both individual pixels and polygon regions is provided. Polarization signatures are 3-dimensional plots that represent the radar backscatter as a function of all ellipticity and orientation polarizations (van Zyl et al, 1987). The polarization signatures generated in RAVEN are displayed as both 3-dimensional plots and 2-dimensional images. These plots and images are displayed as either gray scale or density-sliced color. Polarization signatures extracted from the data can be compared to each other or to theoretical polarization signatures created for specified input scattering matrix values. A signature viewer window also allows both subtraction and division operations to be performed on polarization signatures.

Images of RMS surface roughness, fractal dimension, and dielectric constants are imported from an inversion program and displayed in RAVEN (Kierein-Young and Kruse, 1992). The images allow the user to view the spatial variance of these parameters and help in creating maps of different units.

4. FUTURE DEVELOPMENT

RAVEN is a prototype software tool under development for analysis of polarimetric radar data. Features are being added to deal specifically with analysis requirements for geologic targets. Classifications, library functions, polarimetric matching techniques, and inversion models are some of the future enhancements planned for the RAVEN package.

5. ACKNOWLEDGEMENTS

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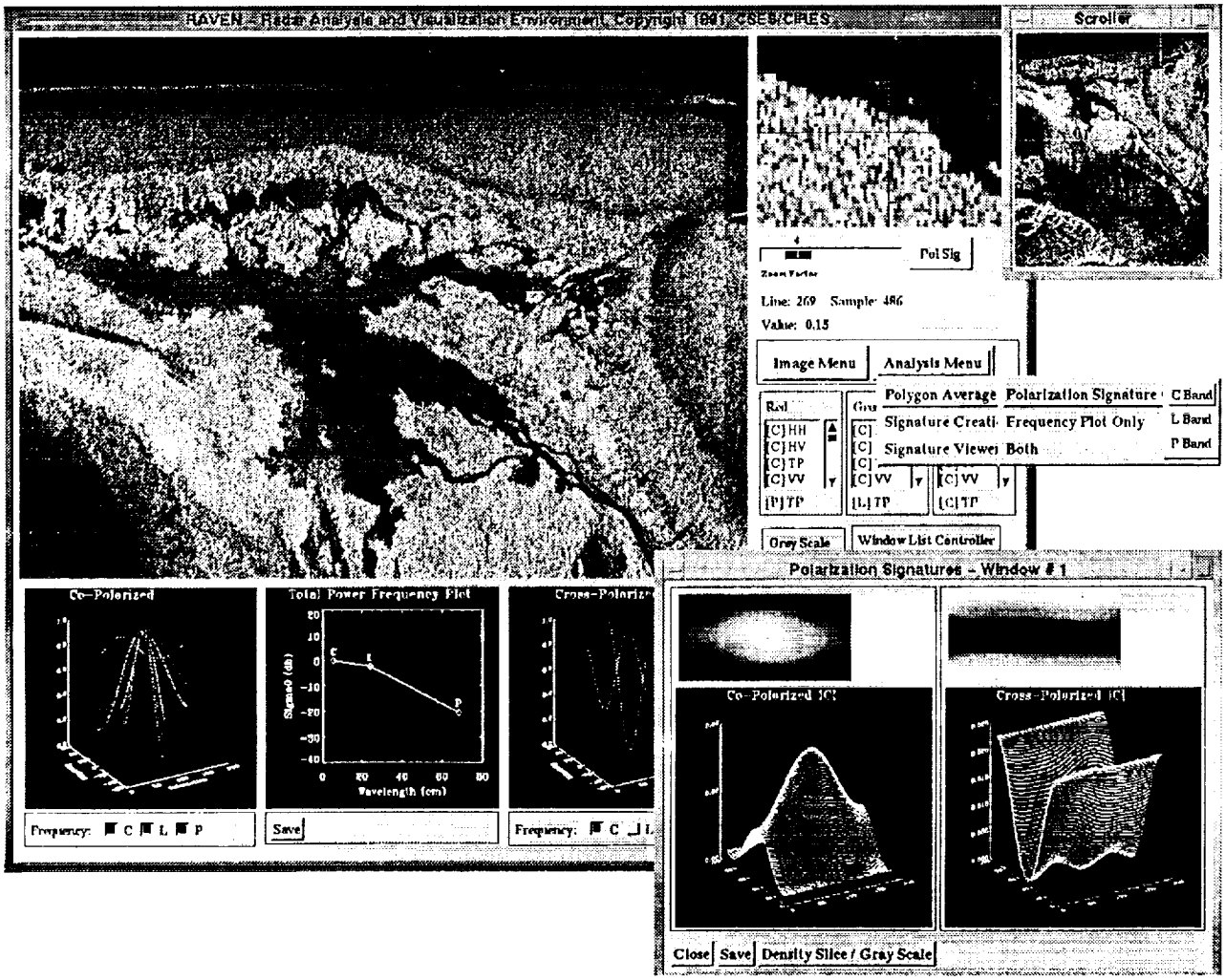

Figure 1. An example of the RAVEN software display screen.