PV-WAVE

Visual data analysis

- *Software developers import, manipulate, analyze, and visualize data,*
- *PV-WAVE is an array oriented fourth-generation programming language used to build and deploy VDA applications*

RogueWave SOFTWARE *http://www.roguewave.com/products-services/pv-wave*

Development tools, components, and libraries

- *CodeDynamics*. CodeDynamics looks at your complex C and C++ applications at execution time to help you identify and correct bugs, memory issues, and crashes.
- *TotalView for HPC*. Prevent execution, memory, and data issues by using this highly-scalable, graphical debugger built specifically for troubleshooting massively parallel, multi-threaded, multi-process applications for high performance computing (HPC) environments.
- *Klocwork*. Detect security, safety, and reliability issues in real-time by using this static code analysis toolkit that works alongside developers, finding issues as early as possible, and integrates with teams, supporting continuous integration and actionable reporting.
- *OpenLogic*. Know, inventory, use, and resolve all aspects of open source software within your organization with this enterprise-class set of management, scanning, and support tools designed to simplify development and minimize risk.

… Development tools, components, and libraries

- *IMSL Numerical Libraries*. Deliver sophisticated analysis solutions by embedding these proven, reliable, and scalable mathematics, data mining, forecasting, and statistics algorithms into your applications.
- *Visualization*. Simplify the display and analysis of complex business information by using these cross-platform C++, Java, and Adobe and Apache Flex tools to create interactive, highly-graphical user interfaces, maps, graphs, schematics, and much more.
- *HostAccess*. Protect access to legacy systems by using this secure terminal emulation toolkit that supports over 30 different protocols, multiple concurrent sessions, and modernization of existing terminal-based applications through its AutoGUI feature.
- *HydraExpress*. Move your business logic easily from platform to platform by using this web services toolkit to create service-oriented architecture (SOA) applications with minimal effort.

- *MemoryScape*. Prevent hard-to-find memory problems in your high-performance computing applications by using this graphical, real-time analysis tool that exposes heap memory, memory usage, allocations, and violations with advanced displays, reporting, and customizable scripting.
- *PV-WAVE*. Simplify the visualization of complex datasets by using this robust visual data analysis (*VDA*) toolkit to rapidly import, manipulate, analyze, and visualize data.
- *SourcePro*. Create the apps you want without spending time on the basics by using these enterprise-class, cross-platform C++ tools to build portable infrastructure code that you write once, and deploy to any platform.
- *Stingray*. Simplify Windows user interface development by embedding these advanced controls and components to improve the look and feel of your application.

PV-WAVE can do

- *Manipulate and visualize simple to complex datasets*
- *Detect and display patterns, trends, anomalies, and other vital information*
- *Deliver powerful image and signal processing, data import and export, 3-D surface, plot, histogram, contour, animation, color editor, and a database table display*
- *Share data and collaborate enterprise-wide using JWAVE™, the Java™ based thin-client visual data analysis application*
- *Incorporate sophisticated analysis routines based on the industry-standard IMSL Numerical Libraries for reliable and precise numerical analysis*

PV-WAVE ~ Visual data analysis

Toolkits for image and signal processing.

- *The PV-WAVE Image Processing Toolkit includes an extensive set of filters, transforms, and image processing operators designed to meet the needs of even the most demanding image processing application.*
- *The PV-WAVE Signal Processing Toolkit provides a broad selection of pre-defined and readily customized digital signal processing (DSP) functions, designed to improve data analysis and simulations. Filters are transfer-function-based for easy design, analysis, and realization of custom filters. The toolkit includes functions and procedures for the Fourier and wavelet analysis of a signal, as well as utilities and source code to facilitate custom function development.*

TS-WAVE ~ Visual data analysis

Using PV-WAVE as the underlying language and technology, TS-WAVE is a robust time series analysis application.

In addition to being an excellent example of the complexity possible when building PV-WAVE applications, it is highly focused on:

- *Performing plot creation and batch processing of time series data*
- *Use of any of the four general functional areas provided: time history, tabular data, x-y plotting, and batch processing*
- *Customization for proprietary data formats*

Turn ideas and data into meaningful graphics

Reveal valuable insights you might otherwise overlook. PV-WAVE is an array-oriented fourth-generation programming language (4GL) used by engineers, scientists, researchers, business analysts, and software developers to build and deploy visual data analysis (VDA) applications. These applications let users manipulate and visualize complex or extremely large technical datasets to detect and display patterns, trends, anomalies, and other vital information.

Quickly import and manipulate your data and interpret it visually in an easy-to-use application framework. At its core, PV-WAVE is a powerful array-based programming language with a rich set of analysis routines based on the renowned IMSL Numerical Libraries. Gain competitive advantage, see opportunities and unlock innovation by reducing your time to initial results, accelerating your development, and illustrating key knowledge contained in your data.

… Ideas & Data → Graphics

PV-WAVE features:

- *Array-based language*
- *Numerics*
- *Graphics*
- *Data import / export*
- *Open architecture*
- *Graphical user interface (GUI) development*
- *Visual data analysis tools*
- *Signal processing toolkit*
- *Advanced image processing toolkit*
- *Database connection toolkit*

… PV-WAVE features

Array-based language:

- Loosely-typed and extensible 4GL with an interactive command line interface to an event-driven interpreter
- Commands can be interactively interpreted or compiled into programs
- Sessions can be saved and restored
- Support for functions, subroutines, global, and local variables
- Complete set of data types for constants and variables (byte, integer, long integer, floating point, complex, double precision, double precision complex, string, date/time) in a variety of structures (scalar, array, table, structure, list, associative array)
- Arrays of up to eight dimensions
- Operators work on both scalars and arrays
- Looping and branching constructs
- Arrays can be subscripted conventionally or subscripted with other arrays
- Execute commands contained in strings
- Debugging utilities
- Powerful and convenient array creation/manipulation functions
- Complete set of utilities for processing string and date/time variables
- Trap and handle errors
- SQL-like query functions for tables
- Context-sensitive online help
- Full online documentation set

Numerics: … *PV-WAVE features*

- *Operators (array-enabled): numeric, relational, Boolean*
- *Common functions (array-enabled): abs, min, max, trigonometric, hyperbolic, and more*
- *Special functions (array-enabled): Bessel, error, gamma, and more*
- *Tensor functions: generalized tensor products, traces, transpositions*
- *Filters: multidimensional, convolution, parametric, polynomial, relational, Boolean*
- *Linear systems: inversion, determinants, decomposition, roots, least-squares, full and sparse matrix support, generalized eigensystems*
- *Nonlinear equations: systems, roots of polynomials, and functions*
- *Transforms: Laplace, multidimensional FFT*
- *Quadrature: multivariate differentiation and integration*
- *Differential equations: systems, ODEs, PDEs*
- *Optimization: multivariate, linear and nonlinear, constrained and unconstrained*
- *Interpolation and approximation: multidimensional gridding, n-linear interpolation, multivariate polynomials, multivariate splines*
- *Regression: multivariate, linear, polynomial, nonlinear*
- *Basic statistics: simple summary statistics, histograms, nonparametric statistics, goodness-of-fit tests, tabulation, sorting, ranking*
- *Correlation and covariance*
- *Analysis of variance*
- *Categorical and discrete data analysis*
- *Time series and forecasting: autocorrelation, autoregression, lack-of-fit, GARCH*
- *Multivariate cluster and factor analysis*
- *Survival analysis*
- *Probability distribution functions and random number generation*

… PV-WAVE features

Graphics:

- *Plotting: 2D and 3D line, 2D and 3D scatter, 2D and 3D vector, 2D and 3D bar, 2D and 3D contours, meshed and shaded surfaces*
- *Basic image processing: equalize, scale, shrink, expand, warp, zoom, pan, copy, rotate, threshold, profile, smooth, convolve, erode, and dilate images; filters (predefined and user-defined); define and analyze irregular regions of interest; algebraic operations; 3D projection*
- *Animation*
- *Polygonal rendering: 3D mesh generation, iso-surfaces, light source control*
- *Volume rendering: isosurfaces, opacity, diffusivity, shading, slicing, light source control*
- *Mapping: comprehensive geopolitical world database; wide variety of projections; overlay lines, images, contours, and vectors; support for user-supplied databases and projections*
- *Annotation: flexible axis, line and symbol styles; scalable/rotatable software/hardware fonts*
- *Comprehensive colortable control*
- *3D view control*
- *VRML support*

… PV-WAVE features

Data import / export:

- Formatted and unformatted read/write, XDR read/write, HDF read/write, HDF5 read/write, powerful ASCII read/write, XML, 8- and 24-bit image import/export (support for wide variety of image formats)

Open architecture:

- Spawn sub-tasks, transfer data via bi-directional pipes
- Call PV-WAVE from a C or Fortran program
- Call C or Fortran code from PV-WAVE
- Communicate between PV-WAVE and another application via remote procedure calls
- Create an optional PV-WAVE module using the options programming interface

Graphical user interface development:

- Comprehensive set of high-level and low-level widgets
- Resource file support and string services

… PV-WAVE features

Visual data analysis tools:

- *Super-widgets allow non-programmers to do animation, image analysis, line plots, scatter plots, surface plots, contour plots, histogram plots, color table manipulation, variable manipulation, and data import/export*

Signal processing toolkit:

- *Filter analysis: complex frequency response, analog and digital transfer functions*
- *Classical filter design: bilinear transform, windowed FIR and IIR*
- *Advanced filter design: least squares and optimal FIR and IIR*
- *Multirate filter functions: decimation, interpolation, quadrature*
- *Filter realization: FIR/IIR causal and anticausal, multi-rate*
- *Statistical signal processing: filter design, Toeplitz matrix factorization, autocorrelation*
- *Transforms and spectral analysis: spectogram, power spectrum analysis, wavelet transforms*
- *Polynomial manipulation: spectral factorization, stabilization, algebraic operations*
- *Specialized plotting routines: zero-pole plot of filter, comb plot of digital signal*

… PV-WAVE features

Advanced image processing toolkit:

- Graphical user interface (GUI)
- Image file formats: import/export, most common formats
- Support for multi-layered images, volumes, signals, animation, and regions of interest
- Point operations: algebraic, Boolean, trigonometric, logarithmic, thresholding, slicing
- General filtering: edge, noise removal/generation, linear (convolutions, user-defined)
- Advanced filtering: spatial (nonlinear, adaptive), frequency (butterworth, ideal, and more)
- Morphological image processing: erode/dilate, open/close, outline, skeletonize
- Mensuration: shape (moments, major axis, perimeter), statistical, distance mapping
- Representation and description: histograms, spatial/spectral textural analysis
- Image transforms: FFT, DCT, PCT, Hough, Slant, Radon, Wavelet
- Geometric transforms: scale, rotate, translate, interactive warp
- Color: linear and nonlinear conversions between grayscale and 8-bit/24-bit color
- Classification and segmentation

… PV-WAVE features

Database connection toolkit:

- *Direct link between Oracle, Sybase, or ODBC database*
- *Use standard SQL syntax to interactively open, query, subset, sort, and filter null values*
- *Support for multi-row fetches with adjustable row counts for Oracle and Sybase connections*
- *User control over commits and rollbacks for ODBC connection*

Image Processing Toolkit

- *Point Operations* (-_-)
- *Algebraic and Logical Operations*
- *Thresholding*
- *Histogram Operations*
- *Filtering*
- *Spatial Domain Linear Filters*
- *Frequency Domain Linear Filters*
- *Nonlinear and Adaptive Filters*
- *Windowing*
- *Morphological Image Processing*
- *Mensuration*
- *Representation and Description*
- *Texture*
- *Correlation*
- *Image Transforms*
- *Geometric Transforms*
- *Color Image Processing*
- *Color Quantization*
- *Classification and Segmentation*
- *Utilities*

… Image Processing Toolkit

- *Point Operations*
  - *Algebraic and Logical Operations*
    - *BLEND, Blends two images together*
    - *IPALOG, Computes the natural logarithm of an image, excluding zero values*
    - *IPMATH, Performs mathematical and logical operations on a single image or between two images*
  - *Thresholding*
    - *DENSITY_SLICE, Performs color density slicing on individual 2D images*
    - *THRESH_ADAP, Performs adaptive thresholding on an image*
    - *THRESHOLD, Performs either binary or grayscale global thresholding on an image*
  - *Histogram Operations* **(-_-)**
    - *HIST_STATS, Computes six different statistical operations on image histograms*
    - *IPHISTOGRAM, Computes the density function or the cumulative density function for an image*

❖ Point Operations …

- ❑ …
- ❑ Histogram Operations (-_-)
  - ❑ HIST_STATS, Computes six different statistical operations on image histograms
  - ❑ …

- ✓ Usage: result = HIST_STATS(hist_data)
- ✓ Input Parameters: hist_data—A 1D or 2D long array containing one or more histograms.
- ✓ Returned Value: result—A double array with six statistical results (mean, variance, skewness, kurtosis, energy, and entropy, respectively) for each histogram in the hist_data array.
- ✓ Keywords:
  - Binsize—The bin size used to compute the histogram. (Default: 1.0)
  - Maxgray—Specifies the maximum graylevel that was considered in computing the histogram values (hist_data).
  - Mingray—Specifies the minimum graylevel that was considered in computing the histogram values (hist_data).
- ✓ Example:

```
; Read an image.
image = IMAGE_READ(!IP_Data + ’airplane.tif’)
image_hist = IPHISTOGRAM(image(’pixels’)
stats = HIST_STATS(image_hist)
; Compute the histogram statistics and print them to the screen.
PRINT, stats
```