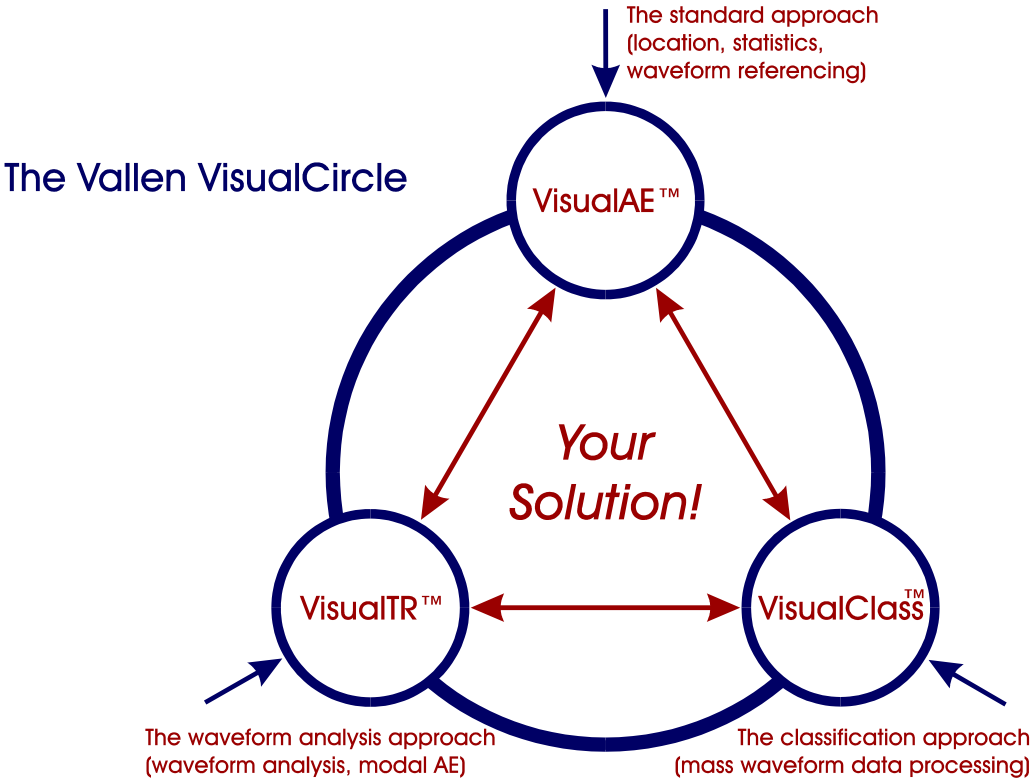
Vallen VisualAE™ - Structure

1 General Remarks

VisualAE represents newest generation 32-bit Windows software for the analysis of AE data. It offers unique functionality and outstanding user-friendliness. Never before has the analysis of AE data been such powerful, transparent and flexible.
Because AE analysis is a complex topic, the new dimension in AE analysis achieved with VisualAE will quickly become an important factor. The many features available with VisualAE require some learning efforts. The scope of this document is to reduce these efforts to a minimum. An introduction to the internal data processing structure will be given that enables the user to draw optimum benefit from the use of VisualAE.

2 VisualCircle

VisualAE™, **VisualTR™** and **VisualClass™** establish a powerful set of AE-analysis software:



VisualAE supports an unlimited number of 2D and 3D graphs on multiple pages, any combination of results, in-line filtering, many location algorithms, clustering, and more.
VisualTR is the ideal tool for a closer look at waveform data, with digital filtering, mode-selection using Gaussian cross-correlations, digital filtering, and includes a set of tools to manage learning data for signal classification.

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VisualClass is a powerful tool for the development of a waveform classifier. The classification process assigns a class number and class-distance to each hit which are then stored on a so-called feature file.
VisualAE can read that feature file and correlate the classification results with AE-parameters, external parameters, location results etc.. This closes the "VisualCircle": **VisualAE ➡ VisualTR ➡ VisualClass ➡ VisualAE**.
In addition, ActiveX-routines are now available through which a user-written program can read waveform data and write feature data that can be processed by VisualAE. This helps the user to concentrate on the feature extraction development using the programming language he likes, because ActiveX-routines can be used with any modern 32-bit Windows programming environment (supporting COM -objects).

3 Relation of VisualAE to Acquisition32

The program "Acquisition32" performs high-speed data acquisition at very high reliability. Data is stored to hard disk in a very efficient format. Any single data set which is written to disk can be read by the analysis software VisualAE or VisualTR immediately. As data is time sorted before it is stored to disk, location calculation is possible online and without any restrictions. A special communication module, the Scheduler, takes care that each analysis program is aware of data sets which have just been acquired. Of course offline analysis can be performed as well, even during the acquisition of another data file.

4 Analysis using VisualAE

During analysis data is read by VisualAE from the HDD (hard disk drive) and then processed in a processing tree. Analysis with VisualAE may contain 3 types of elements:

a) Data Source (the file from where the program reads the data)
b) Data Processing (more or less intense)
c) Data Presentation (in graphical or numerical form)

The "**Data Source**" is usually a primary file that contains the binary AE-data with references into the waveform data file, plus the waveform data file, if one or more transient data diagrams are activated.
The "**Data Processing**" performs operations on data, such as location calculation, filtering, clustering and the evaluation of user-defined results. The user can define which of these processes shall take place and in which sequence. So the user has influence on the number and kind of results that are available for visualisation. (E.g. if there is no location specified by the user, the results X, Y, LUCY etc., will not be available for visualisation.). Multiple parallel processing paths can be linked to a previous processing element and form a more or less complex data processing tree.
Data Presentation is done by so-called "AE-Visuals". Each "AE-Visual" visualises selected results in graphical or numerical form. The term AE-Visual includes AE-diagrams, AE-Listings and waveform diagrams, also called TR-diagrams (TR: transient recorder).

4.1 Data Processing

The data-flow can be directed through several stages for calculations and/or decisions, in VisualAE called "processors". The data read from the HDD are directed through the first processor. Its output can be used as input for the next, subsequent processor stage(s) and so on.
A tree-structure can be created, starting from the data source (the "root" on top) and splitting up into several branches if required. At the end of each branch one or several "Visuals" present the data processing results in graphical or numerical form. (see section 4.2). The user can define the sequence of processors and Visuals by "drag & drop". This is similar to arranging files into the desired structure of sub-directories. There are no program limits in number of branches, processors, and Visuals. See the structure representation in Fig. 1 on the next page.

4.1.1 Location Processor

The location processor assembles hits into events (hits determined to be generated by a single source), calculates the location of the source, and adds results, such as X, Y, LUCY (location uncertainty), time-differences, number of hits of the event, and more, to the event's data for further processing by subsequent processors or visuals. Behind a location processor, AE parameters, such as amplitude, counts, etc., are taken from the first-hit of the event. The calculated kind of location results depend on the kind of location algorithm and can be x-, x-y-, x-y-z-coordinates, or latitude-longitude, for example.

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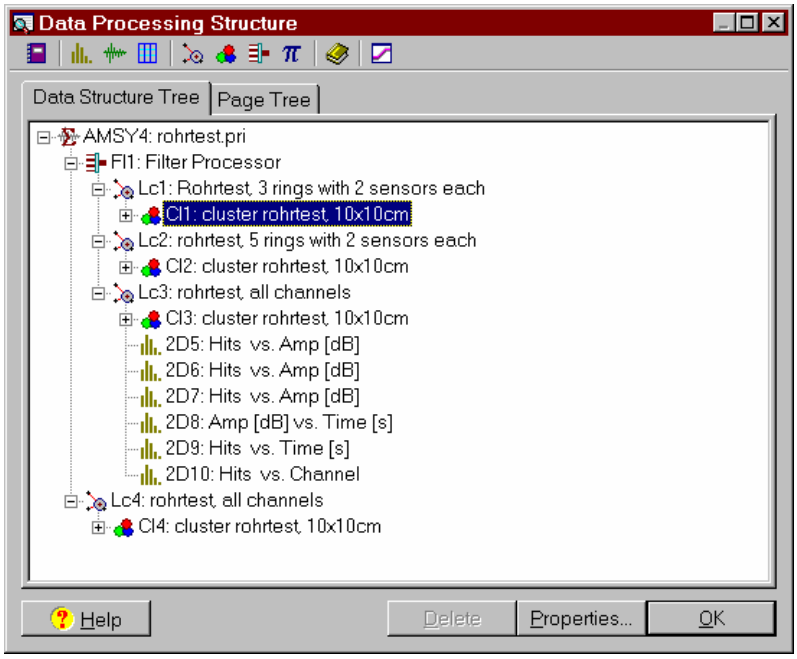

Fig. 1: Example for the data processing structure of VisualAE. It is a to-down tree-like structure (similar to the windows explorer).
From the root on top (here: file rohrtest.pri) data is read and processed via several processing paths. Different processors, e.g. a filter processor (FI1), location processors Lc1 to Lc4, and cluster processors Cl1 to CL4 form the processing paths as shown.
At the end of each branch of the processing tree, there are Visuals (diagrams and listings) which present the processing results. (Here the Visuals 2D5 to 2D10 behind Cl3 are visible, the others are hidden for clarity).

4.1.1.1 Event builder

The event builder groups hits into events. The corresponding set-up parameter are found in the Event Builder Tab of the location setup. The "channels" portion of the dialog identifies which channels belong to the location set and whether it has a "normal", "guard" or "combined" function. The event assembly time criteria define how long the time differences can be for one event within a location set. If there are more hits than required to calculate the location, a location uncertainty result (LUCY) is available with most of the algorithms. Finally, general location setting, such as speed of sound, velocity units, maximum distance between sensors, etc. are also to be specified. These general settings are independent of the selected location algorithm.

4.1.1.2 Channel Group

There may be one or more channel groups defined for a location set. With multiple channel groups more complex structures can be covered. Different location algorithms and co-ordinate systems may be assigned to each channel group. For instance, with a cylindrical vessel with bottom and top caps, the channels on the cylindrical part can be assigned to the first channel group, the top cap channel(s) plus the channels of the top ring can be assigned to the second channel group, and the bottom cap channel plus channels of the bottom ring to a third channel group. The event building process (assigning hits to an event data set) is common for all channel groups. Each channel group that includes the first-hit of the event can deliver a location result for this event. The user can look at all results, e.g. separated by color, or select only one result per event, based on various selection criteria. This new channel grouping feature in VisualAE includes but is not limited to the Multi-Triplet location algorithm as known from the Vallen MultiPlot program.

4.1.1.3 Location and Location Set (Options VAELx)

To calculate the source location a location algorithm must be assigned to each individual channel group. The kind of algorithm is based on a structure's geometry and how sensors are arranged on the structure. There are many different location options offered with VisualAE. The basic package already includes the event builder which is sufficient for zone location. The algorithms usually place some restrictions on number and position of sensors. For instance the algorithm “Solid 3D” requires hits from at least 4 sensors which must not be positioned on one geometric plane. The restrictions are explained in detail in the online help.
Sensors and source locations are relative to the user-defined co-ordinate system for the channel group. If the sensors are not exactly at the position as entered in the software, this will influence the location accuracy.

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4.1.2 Cluster Processor (Option VAECP)

While the cluster processor passes through all data, it adds density levels as defined by thresholds and provide additional statistics about these regions. In the past, clustering has been performed on location results (indicating the location density). In VisualAE the process has been generalized and clustering can be performed on any number and kind of results, such as location results, AE parameters, time, external parameters, and user-defined results.
The user specifies the results to be used for clustering (any number), size, shape (circle/rectangle) and minimum number of elements that shall establish a valid cluster. Graphs linked to the cluster processor and showing the cluster results will display color coded clusters along with a cluster-legend explaining the color's meaning. As many cluster processors as desired can be used. For instance, one can see the influence of the parameter "cluster size" by simply having two cluster processors of different "cluster size" linked to the same location processor output.

4.1.3 Filter Processor (Option VAEFP)

A filter processor passes or rejects AE-data sets based on user specified criteria. The filter processor considers AE-data and external parameters, if it is linked directly to the data file. Behind a location processor, it also considers location results. Behind a user-processor, it also considers the user-defined results. Between location processor and clustering it may influence the cluster results. If the filter processor is placed behind a location set, it considers only hit-data of the first-hit per event. As many filter processors as desired can be used. Visuals that receive data through a filter processor indicate this in the windows ID string (option).

4.1.4 User Processor (Options VAEUP, VAEUPE, VAEAC)

User processors can extend the range of results by performing mathematical operations on all kind of incoming data. The user can choose from a list of predefined mathematical operations, supply one or more parameters or constants (depending on the operation) and give the new parameter both, name and units. User-defined results are available to any process and visual behind the user processor. For example to produce a plot "Cumulative Hits vs. Load", one can define a user-processor which gives the sum of hits (the value of "Hits" is always one for a hit) give it the name CumHITS, and then create a X/Y-history showing CumHits at the vertical axis and the parametric input for the load at the horizontal axis. In addition, combination of AE-parameters can easily be defined with user-processors, e.g. Risetime/Amplitude or Counts/Duration. Two levels of user processors can be purchased: The option VAEUP includes the statistical functions: sum, min, max, variance, standard deviation, average change. The option VAEUPE includes the functions: divide, multiply, power, linear scale. The option VAEAC provides the correction of the amplitude as a function of distance between calculated source and first-hit channel, considering different attenuation in the near- and far-field. More functions will be implemented according to the feedback we receive from you.

4.1.5 Summary

An overview about the current data processing structure is provided by a dialog window which shows the complete data processing tree including data source, processors and visuals. From this window the properties of all processors and visuals can be accessed and modified. The elements can be rearranged by drag-and-drop. The user has complete and very convenient control of the whole data processing structure.

4.2 AE Visuals

For data presentation, VisualAE offers so-called AE-Visuals, which can be diagrams (AE and TR) and listings. Any number of visuals can be arranged to any point in the data tree. Of course, the results to be visualised must be available at the linked point. For instance, the AE-Visual can present a user-defined result only, if it is linked to a point behind the user-processor that evaluates this user-defined result.

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4.2.1 Diagrams

Several different types of diagrams are available: 2D-, 3D-graphs, TR-diagrams. TR-diagrams show waveforms (transient data) in time and/or frequency domain. Many properties of those graphs can be adjusted by the operator: the results (attributes) to be shown (e.g. Amplitude vs. time, or Duration vs. Energy,...), left + right axis legend, caption (top) and comment text (bottom). Legends can be edited or made invisible and/or not printable. Diagrams can show distributions, correlations (point plots), histories, etc., depending on the selected kind of results. Each diagram can show several planes. Data represented on a plane can be filtered, the colour and shape of symbols can be selected and more.

4.2.2 Listing

A listing presents data in columns of numbers. The results to be listed and their ordering can be selected in the property menu where you also can define which kind of listing lines you want, such as first-hits only, subsequent hits, time driven external parameters and/or time driven status sets.

4.2.3 Calibration Table

The calibration table presents the results of an auto-calibration run and is a powerful tool for checking sensor coupling and determining the speed of sound. If there are multiple auto-calibration runs on a file, each run can be selected and differences between the runs can be shown.

5 Reporting

At the end of each data analysis task a report has to be created usually. This part of your work, the representation of your results, is very important, can be quite time consuming and puzzling. VisualAE accelerates these important tasks tremendously. VisualAE offers numerous features for the generation of perfectly looking reports in a minimum of time.

5.1 Exporting Diagrams

Complete VisualAE-pages can be exported to clipboard (if the corresponding option is enabled) and transferred to your word processor or saved to file. Optional packages are available that include tools to copy only an individual AE-Visual. Powerful tools for adjusting the appearance of the graphs, such as the resolution, the inclusion of certain legends, and more, are included.

5.2 Printing

Creating hardcopies directly from VisualAE is simple and convenient. Any Windows-supported printer can be used. A dialog window offers a printer-preview and many possibilities for adjusting the appearance of the printed page (landscape or portrait, size, position on page,...).

The above mentioned details do not completely describe all features of VisualAE. The target of this description is to enable you to find your way through VisualAE, learn its use and get confident in a minimum of time. VisualAE is supported by extensive, context sensitive help texts. You can also quickly find information of interest over the help text's list of contents and index.

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