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## #AS121 - Waveform Data Reduction

AcqKnowledge has features which permit the user to reduce waveform data in a variety of ways. If one collects many minutes or hours of data, one may wish to reduce the data to a more easily reportable form for evaluation or comparison.

A classic example of this requirement occurs when processing hemodynamic data (e.g. recording blood pressure parameters for long periods of time). In this case, one may wish to section the data into ten second block averages. For example, it may be advantageous to reduce the blood pressure waveform data into a series of rows and columns of TEXT. Each column of data may represent a different blood pressure parameter, like mean systolic, mean diastolic and mean BPM. Each row of TEXT data may indicate ten seconds of averaged (mean) data. The data might look like:

10 sec	125 mmHg	80 mmHg	62 BPM
20 sec	127 mmHg	83 mmHg	67 BPM
30 sec	120 mmHg	75 mmHg	65 BPM
•	•	•	•
•	•	•	•
•	•	•	•

In this case, the first ten seconds average (mean) systolic pressure was 125mmHg. This number was calculated by taking the average of all the beat to beat systolic values over the first one minute of data collection.

Another example of where this type of data reduction would be useful is with signal activity level determination over long time periods. Signal sources in this case might be the EMG (Electromyogram) or EOG (Electrooculogram). The EMG indicates levels of muscle electrical activity and the EOG indicates eye movement activity. In these cases, it may be reasonable to reduce long waveform data streams into two columns of data. One column would indicate the standard deviation of the data and the other would indicate the peak to peak value of the data. Both calculations would be updated every time interval. The time interval could be any length. You could divide the long waveform file into 1 second intervals, 2 seconds intervals or even 5 minute

intervals. In the middle case, the reduced data might look like:

2 sec	0.245 mV	1.345 mV
4 sec	0.210 mV	1.107 mV
6 sec	0.178 mV	0.923 mV
•	•	•
•	•	•
•	•	•

The method to reduce all these types of waveform data is very similar. All methods require the development of a gating or synchronizing waveform which is used to control the time location of the AcqKnowledge I-beam measurement tool via the peak detector function.

To begin, the synchronization waveform must be created. AcqKnowledge provides a variety of methods to create waveforms, but the easiest way to create long periodic waveforms is as follows:

- 1) Open the waveform file you wish to process
- 2) From the Display menu, use Statistics to determine the number of samples in the file
- 3) Select the Expression Evaluator function under the Transform menu
- 4) Create the expression:  $\text{COS}(2 \times 3.1416 \times \text{TIME}/[\text{Gating Interval Desired}])$

Place the result in a NEW channel

Answer the prompt for number of samples (same as measured in Step 2)

For a long data file, the calculation may take awhile. When finished, you should see a cosine wave in your waveform data file. The gating interval you require is the period of this cosine waveform. The first peak in the cosine waveform occurs exactly one gating interval into the record.

The following example illustrates a data reduction procedure from start to finish. Some hemodynamic data will be sectioned into 10 second blocks and the mean Systolic, Diastolic and Rate (BPM) will be automatically calculated for each of these consecutive 10 second blocks.

Start with the Expression Evaluator after opening the waveform data file. In this case, the synchronizing waveform is set up for a gating interval of 10 seconds:

**Evaluate expression:**

**COS(2\*3.1416\*TIME/10)**

Sources: **TIME**      Functions: **ABS()**

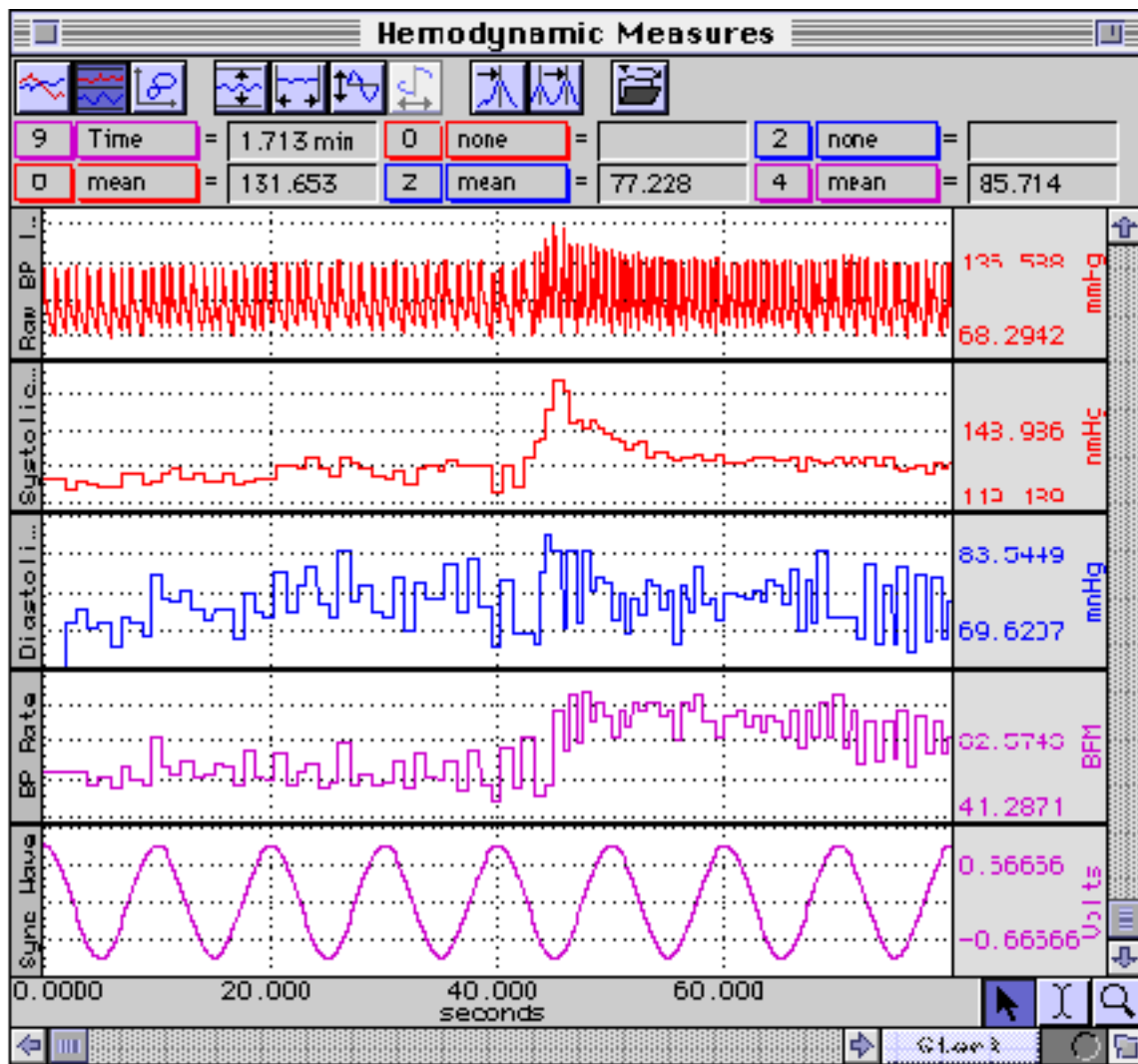
Destination: **New**      Operators: **+**

**Transform entire wave**

**Ok**      **Cancel**

Following is a graph showing a blood pressure waveform and some calculated beat by beat hemodynamic data. The bottom waveform was calculated using the Expression Evaluator as described. Notice that each cosine peak is 10 seconds apart. The pop-up measurements have been set to measure on the calculated Systolic, Diastolic and BPM waveform data. The pop-up measurements have been set to determine the mean of each, at 10 second intervals defined by the synchronizing waveform.

The next step requires the set-up of the peak detector so we can control how the measurements are performed. The peak detector controls the I-beam measurement tool and the I-beam measurement tool will determine the amount of waveform data evaluated by the pop-up measurements. As the I-beam cursor moves from peak to peak on the synchronizing waveform it covers the same time interval on the relevant hemodynamic data.



### Hemodynamic Data with Synchronizing Waveform

After the synchronizing waveform is created and the pop-up measurements are correctly selected, the peak detector can be setup to perform an automatic analysis of the waveform data. Place the I-beam cursor at the beginning of the waveform data. Use the Arrow tool to select the synchronizing wave and then select the Find Peak function under the Transform menu.

The synchronizing waveform is a periodic cosine wave with a peak to peak amplitude of 2 volts. The positive going wave has an amplitude of +1.00 volts and the negative going wave has an amplitude of -1.00 volts, so set the peak detector to a fixed threshold of 0.00 volts (halfway).

### Peak Detector Setup for Automatic Data Reduction

Be sure to click on the Paste Measurements Into Journal option. Close the window and you will find that the cursor has located the first peak of the synchronizing wave. You should also see that the first set of values have been written to the Journal. Now select the Find All Peaks function. As soon as this function is selected, the cursor will step through the waveform data at the intervals specified by the synchronizing waveform. You should see the cursor moving along and the pop-up measurement values should be recording in the Journal.

Because the pop-up measurements have been pre-set to the functions: Time, Mean (Systolic), Mean (Diastolic) and Mean (BPM), these values will be automatically written to the Journal as the cursor automatically steps through the data. After the I-beam cursor has worked its way completely through the waveform data, the Journal will show how many peaks have been found. This amount is the total number of synchronizing intervals processed.

The data written into the Journal appears as shown below. The left-most column is the time interval the mean calculations were performed over. For instance, for the time period 30.00 seconds to 40.00 seconds, the mean Systolic pressure was 132.769 mmHg, the mean Diastolic pressure was 76.238 mmHg and the mean Rate was 64.547 BPM.

New journal			
Time(9) = 10.00 sec	mean(0) = 128.202 mmHg	mean(2) = 62.293 mmHg	mean(4) = 63.897 BPM
Time(9) = 20.00 sec	mean(0) = 129.804 mmHg	mean(2) = 74.115 mmHg	mean(4) = 67.140 BPM
Time(9) = 30.00 sec	mean(0) = 133.775 mmHg	mean(2) = 77.113 mmHg	mean(4) = 64.761 BPM
Time(9) = 40.00 sec	mean(0) = 132.769 mmHg	mean(2) = 76.238 mmHg	mean(4) = 64.547 BPM
Time(9) = 50.00 sec	mean(0) = 146.459 mmHg	mean(2) = 77.286 mmHg	mean(4) = 82.564 BPM
Time(9) = 60.00 sec	mean(0) = 140.155 mmHg	mean(2) = 74.919 mmHg	mean(4) = 96.987 BPM
Time(9) = 70.00 sec	mean(0) = 136.336 mmHg	mean(2) = 76.608 mmHg	mean(4) = 94.285 BPM
Time(9) = 80.00 sec	mean(0) = 134.976 mmHg	mean(2) = 73.967 mmHg	mean(4) = 86.303 BPM
Time(9) = 90.00 sec	mean(0) = 133.860 mmHg	mean(2) = 75.320 mmHg	mean(4) = 82.387 BPM
Time(9) = 100.0 sec	mean(0) = 136.262 mmHg	mean(2) = 74.874 mmHg	mean(4) = 79.188 BPM
Time(9) = 1.833 min	mean(0) = 130.445 mmHg	mean(2) = 70.392 mmHg	mean(4) = 75.034 BPM
10 peaks found			

### Reduced Data Output in TEXT

In this case, ten (10) peaks were found because the data file was 100 seconds long. If the data file was 36,000 seconds (10 hours) long, then 3600 peaks (gating intervals) should have been found.

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