Physiometry 101

Post Processing

Ok, so you have carefully connected electrodes and transducers to your subject, and have used some sort of data collection system to record your physiometry data. You may be able to process your recorded data again, after you have recorded it (hence post processing), in order to get access to even more data. The post-processed results are kind of like free data, although the post processing algorithm you wish to run may impact aspects of your data collection process.

An example may help here. If you record the ECG signal at 1000 Hz., and then peak detect (a post processing algorithm) to find the R waves, and then time the number of milliseconds between successive R waves, you can electronically analyze your ECG data to get the interval, in milliseconds, between each heart beat. This value is referred to as the Inter-beat Interval, or IBI. The significance and analysis of the IBI can add a whole new layer to your data! And, all it took for this new data is just running a processing algorithm on your already recorded ECG data!

Lets look at a few general post processing categories to give you an idea what additional measures your recorded data can also contain!

Counting

If your recorded data has some sort of repetitive feature; a peak, a positive bump, or a level crossing, then it is usually fairly easy to count these features over a known time interval, and generate an appropriate rate measurement from your recorded data. And this added measure may prove a valuable addition to your research.

For human and animal subjects, heart rate and respiration rate are the two most common post processing rate measures. Brief, small excursions in a subject's Skin Conductance can also be tallied as a measure of psychological responsiveness.

And these are just examples. There are other measures across all different types of subjects. If there is some way to describe a repetitive aspect of your data, then there is probably a way to put together an algorithm to count it.

Interval Timing

This algorithm is a refinement on the counting algorithm mentioned above. As we saw, we can use an algorithm to generate heart rate from ECG data by counting the R peaks over a given period. Research in this area has shown that the actual millisecond length of the interval between R waves can have a lot of significance too! An algorithm to time the actual interval makes use of the fact that the sample rate of the data gives you the ability to calculate the time interval between two features. If you already have the ability to identify some repetitive aspect in your data, then generating a series of time intervals can also add to your understanding of your data and your subject.

The mention of the sample rate of the data highlights something worth keeping in mind. The sample rate is the basis for the time keeping function of an interval timing algorithm. If you will be doing interval timing from your data, then the sample rate you choose will have a direct impact on the resolution of the interval you wish to time. Using the IBI as an example, if you record the ECG at a very fast 1000 Hz., then you will have approximately 1 millisecond resolution in your detected IBI interval, and this supplies easily enough resolution for IBI research. However, if you only record the ECG at 100 Hz., then the resolution of your timed intervals will only be approximately 10 milliseconds, and this is usually not sufficient for IBI research. The sample rate you choose needs to supply a small enough time interval to give you sufficient resolution for the intervals you are deriving from your recorded data.

Multiple Channels

Pulse Transit Time is roughly the time interval between the beating of the heart, and the point at which the fresh shot of blood from that heart beat shows up in, for example, the finger. So, if you have an ECG signal recorded, and the same data record also has a PPG signal recorded, you can configure an algorithm to look for the R wave, as well as the positive ascent of the PPG, and then time the interval between these two features. And this is only an example.

The point is that, sometimes you can look at multiple channels, and perform some sort of comparitive algorithm, in order to derive more data from your recorded signals.

Stacking Multiple Events

The Baer signal is a series of small waves that accompany the reception of an acoustic stimulus by the Ear, followed by the flow of that signal through the neurological details of the hearing process, ultimately to the brain. The problem is that the Baer signal is very small, and if you attempt to capture it by increasing the gain of the amplifier, you will usually see just a lot of noise. The Baer signal is normally measured by recording the Baer waveform repetitively, and stacking the results up (well, adding them together) so that the Baer signal is re-inforced and the noise cancels out. Most Baer testing equipment further optimizes the capability of this approach by carefully controlling the timing of a specific auditory stimulus, and then performing the successive segment recording from the more exact point of the stimulus. But the basic algorithm simply stacks up numerous records of some repetitive aspect of the data to generate the desired result.

You can also configure an algorithm that carefully times a certain point of the PPG signal, say the 50% point on the ascent perhaps. Your algorithm can then stack successive PPG pulse waveforms up, and then run some measurements on the results of that exercise; variability in height, width, etc. But again, we are dealing with an algorithm that stacks events up to allow another dimension of analysis.

On-line or Post Processing?

Maybe you want to run an IBI algorithm on your recorded data, but you want to record other data channels too, and 1000 Hz. sampling is way too fast for the other channels. Most physiometry recording equipment is managed by a fairly powerful controller. It is usually possible for the controller inside the data recorder to run an IBI detection algorithm as well. This allows you to sample the ECG data at 1000 Hz. and perform the IBI timing with the 1000 Hz. data, while also recording the ECG data at a slower speed, 100 Hz. perhaps.

There are a number of post processing algorithms that can be integrated into the physiometry recording equipment. This can save substantially on the size of the recorded data file, or else supply longer recording time for the same amount of memory.

Actually performing your post processing algorithm on a powerful computer, after you have recorded your data -- this approach still has its merits. For some post processing algorithms, such as for IBI, a powerful correction and artifact rejection capability can be added. Such algorithms can evaluate a stretch of data, and determine if it contains valid data, or even check for known IBI algorithm errors, and actually correct for that! Post processing algorithms that run on a desk top computer are usually far more powerful than a data recording controller.

Which is the best approach? That really depends on your research!

Conclusion

Sometimes you can apply a post processing algorithm to your already recorded physiometry data, and get even more meaningful data from it! Generally however, the details of the post processing algorithm will have a certain impact on the data collection process.