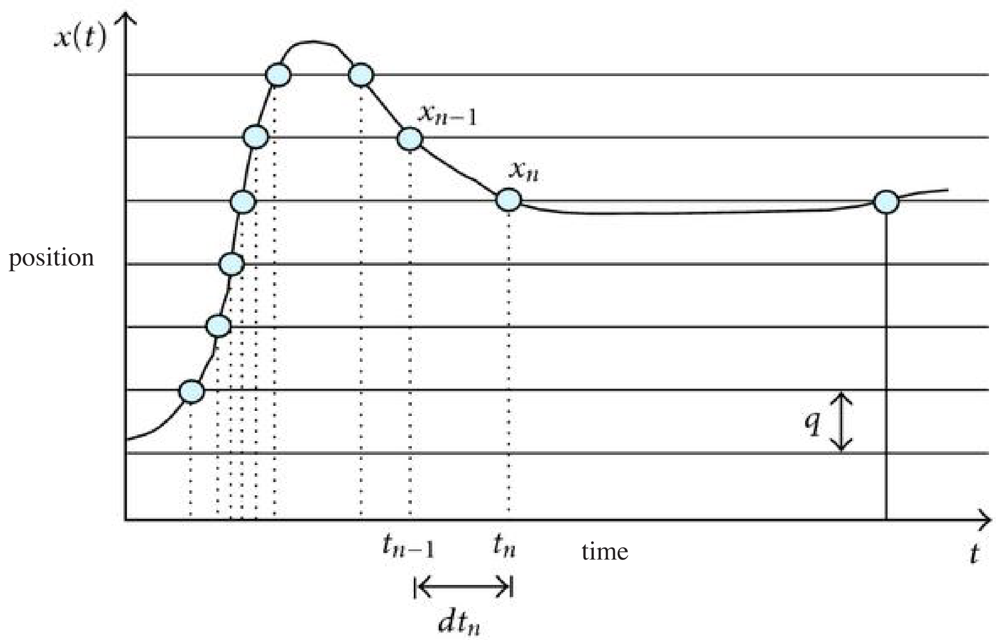
Sample Rate, Comparing Apples with Oranges.

There is a common misconception that GymAware only samples at 50Hz and so is less accurate than 200Hz systems. GymAware actually uses a far more sophisticated sampling technique than older analog displacement transducers.



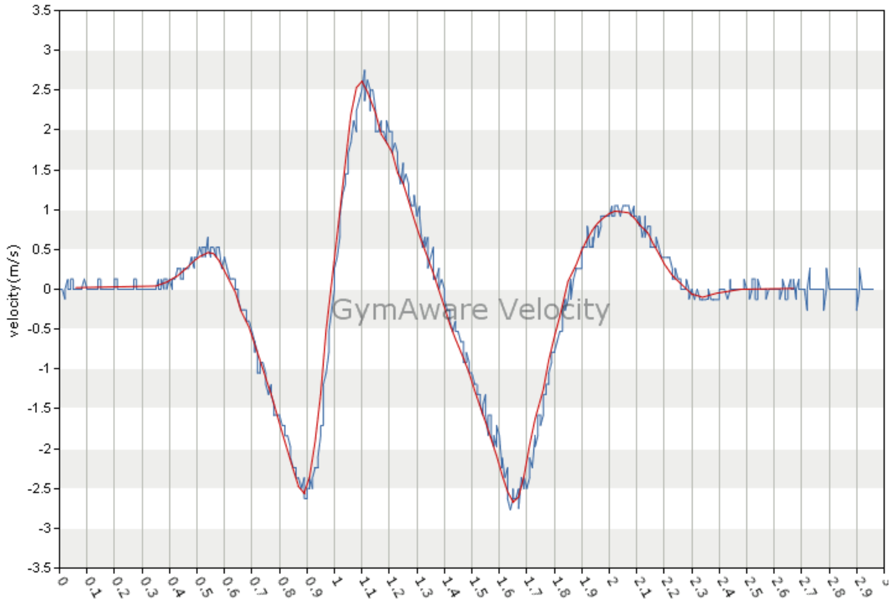
Referring to the figure above, GymAware data points are only recorded when displacement changes by q (600 microns), when this happens the position is recorded and timestamped (dtn in the figure) with a resolution of 35 microseconds - that's equivalent to a sampling rate of 29kHz!

We then down sample this signal to a maximum rate of 50 samples per second. We can do this without losing information because human movement tops out at under 10Hz and the Nyquist theorem states that we only need a sample rate of twice the frequency of interest to avoid information loss.

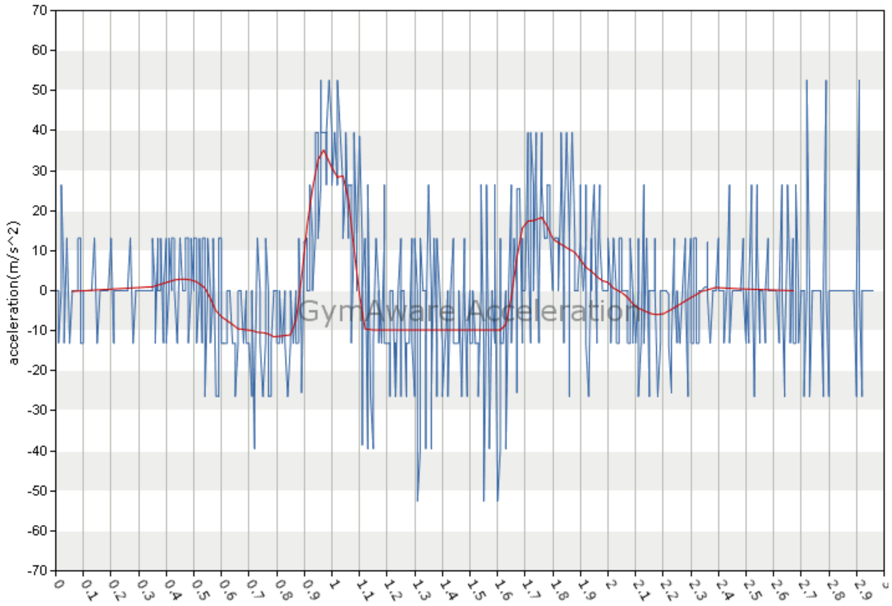
This is a far superior technique to the traditional sample and filter technique as it produces a clean signal that requires no additional filtering even when differentiating once for velocity and twice for acceleration. The images on the next page show a direct comparison of the two techniques.

For more detail see this article:

Adaptive Rate Sampling and Filtering Based on Level Crossing Sampling
Saeed Mian Qaisar, Laurent Fesquet (EURASIP Member) and Marc Renaudin
EURASIP Journal on Advances in Signal Processing
Volume 2009 (2009)



Above is an overlay of raw velocity from a jump recorded simultaneously with GymAware (Red) and the BMS system that uses the traditional 200Hz approach (Blue). Note the amplification of noise due to differentiation. Now lets look at the same signal differentiated again for acceleration:



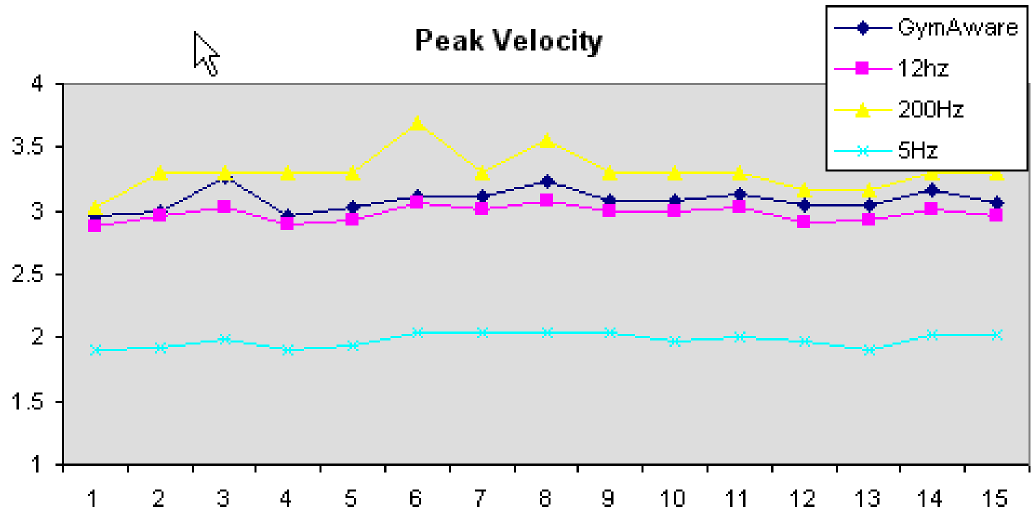
Notice how the blue trace now has a resolution of about 13m/sec-2. This is a combination of the poor positional resolution (bound by analog to digital resolution) - about 1.3mm and the 5millisecond (200Hz) timing resolution. This can be calculated from first principles using the known positional error and the timing resolution, but it is good to prove it empirically as we have done here. The user would not normally see this as further processing to the signal would smooth out this noise.

The GymAware trace above in red is the raw acceleration signal and no further processing is required.

Interestingly the blue BMS trace in this comparison is often referred to as the “gold standard” in research papers. Though looking at these signals, it would seem that may not be the case. Clearly more independent work needs to be done in transducer validation.

The figures on the previous page show unfiltered results, and normally users would filter this data - the trouble is research done with these systems is carried out at different sample rates, and filter frequencies. In many cases these settings are not reported in the findings. The fact that these settings are customisable (and have a significant effect on readings) makes it virtually impossible to confidently compare results recorded by different users, as the results lack consistency.

The figure below shows peak velocity for 15 reps recorded simultaneously with BMS and GymAware. The filter setting for BMS was then set to the 3 values shown. Note how the peak velocity changes dramatically, particularly between 12Hz and 5Hz. So, from a practitioners point, which peak velocity do they use and why?



GymAware solves this and greatly simplifies these measurements by standardising all power, velocity force acceleration and displacement measurements no matter where they are taken.

GymAware is designed by engineers with a 20 year track record in sports science technology development. It is simple to use, reliable, and accurate.