CabinPlant:

Rapid estimation of final state for a damped oscillation

Contact: Henning Ingermann Hansen

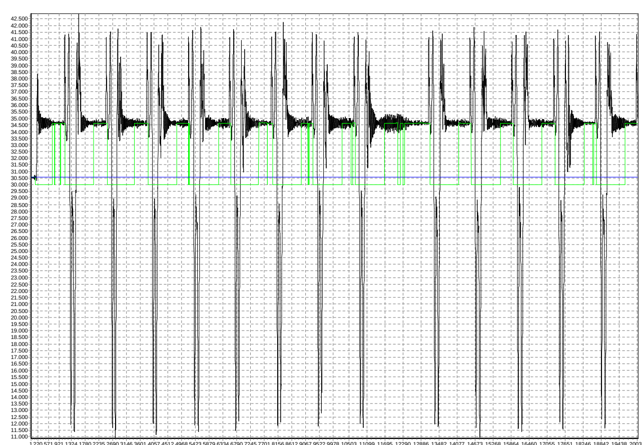
We need an algorithm for rapid estimation of a damped (and noisy) oscillation.

The problem arises for instance when a mass falls onto an electronic scale. The pan will oscillate for some time before coming to rest; during this time the mass measurement fluctuates. The mass being measured can consist of several items who fall differently and not at the same time; so the oscillation is not a pure harmonic.

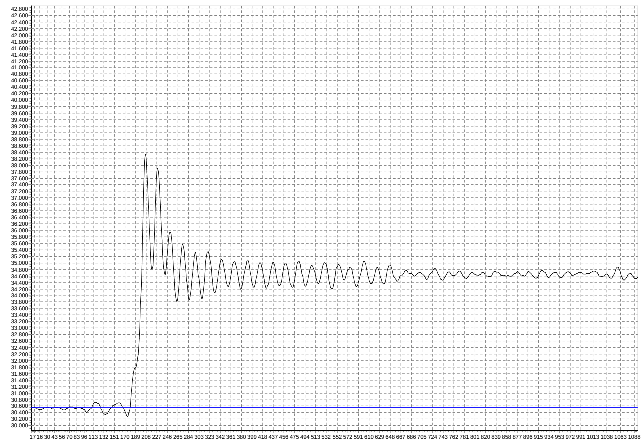
The mass or masses will nevertheless settle down very much faster than the time it takes for the entire scale to come to rest. We believe that by observing the precise short-time form of the oscillations it is possible to estimate the asymptotic form of the oscillation and consequently the mass.

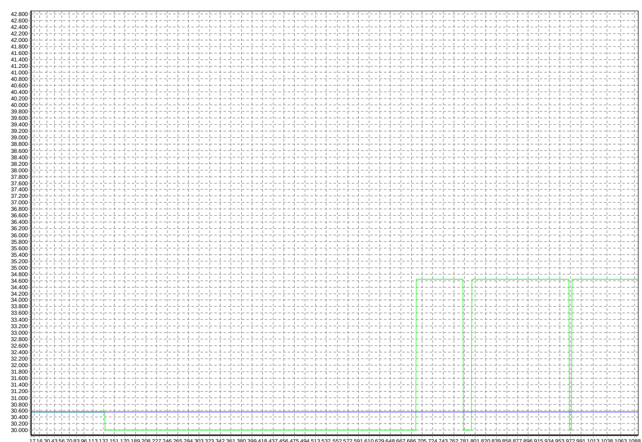
To acquire data from the oscillation we assume a digital processor which samples at a given frequency. A single-point cell is used in determining the mass.

As an illustration, the attached pdf documents show some examples of oscillations. The same mass is dropped onto the pan several times.



Further data files are available. See the file "`sample.zip`". This file contains raw data from test runs lasting 20 seconds, using the same mass. The mass





has been lifted up from the weight container while this was being opened, and the mass then lowered back down again. This procedure was intended to simulate a cycle where a known mass is weighed several times. One pdf file shows the evolution over the 20 second test run, and the other two are a segment from the first filling , both the raw signal and the signal output from the filters we currently employ. The black curve is is the raw data. The green curve is the filter output, and the dashed blue line is the a virtual 0 g line. The sample frequency is around 1 kHz.

To further quantify the problem are here some typical magnitudes:

- The time it takes the mass to fall onto the pan (from first sub item to last sub item): around 200 ms.

- The time it takes the pan to come to rest, counted from from first collision with last part of load: 800 ms.
- The sampling frequency: 100 Hz - 1 kHz
- The base frequency. Difficult to estimate as it depends on the scale model and the base on which the scale stands. Low, below 50 Hz.
- The sampling precision: 16 bit A/D converter.
- Background noise: On the order of 20 g on the raw data.
- Desired accuracy: Around .3 g, corresponding to 10 divisions of the A/D converter.
- Processor Speed: 2.7 MIPS