Speed Bag Hit Counter
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See also "breakdown2.xls"

The absolute values of the raw counts of each axis are added and fed to a high pass filter to remove the DC component and reduce low frequency noise. The absolute value of the filtered data represents full wave rectification, causing any oscillations to become a more continuous positive envelope. In the chart below, hpf_a is the low pass component of the high pass filter which is subtracted from the delayed sum of the x, y, and z values to produce the hpf value. Delaying the sum is necessary to compensate for the lag produced by the hpf_a filter algorithm.
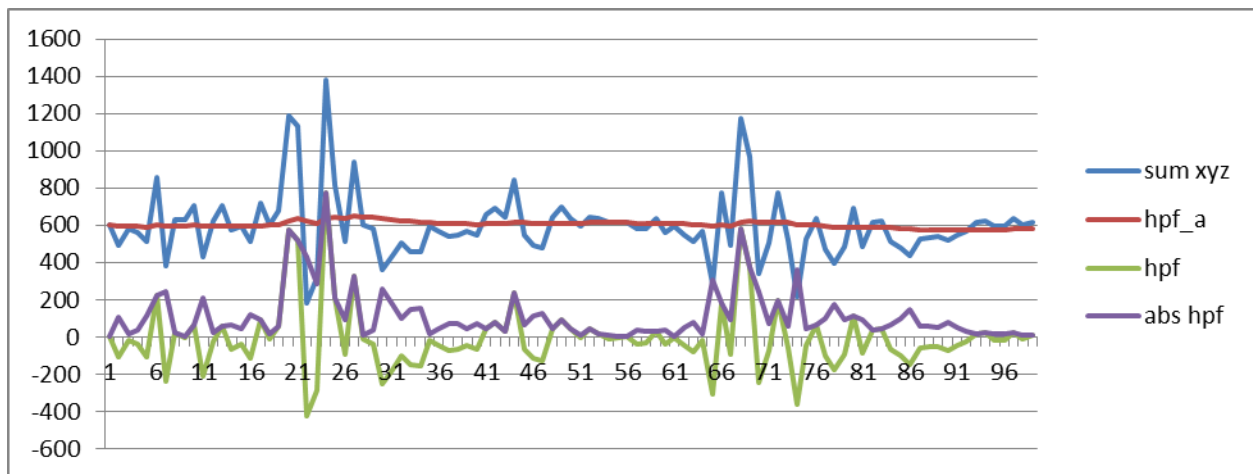
The absolute value of the high pass filtered data feeds an optional low pass filter to reduce high frequency noise, then to a fast attack / slow decay envelope detector. The fast attack ensures that impulses are captured, while the slow decay nearly eliminates trailing noise which falls below the amplitude of the impulse. The rate of decay should be chosen depending on the sample rate and the realistic time between actual impulse events. In this case, a decay tau of 256 yields satisfactory results.

The slope of the envelope is determined across 2 samples. If the slope is greater than a specified threshold then a hit has been detected. This is fed to a one shot timer to reduce the number of false reported hits. The slope may also be used to indicate the relative magnitude of the impact. A threshold of about 100 seems to work well, but could be higher to further reduce the false impulses seen between samples 1 and 16.
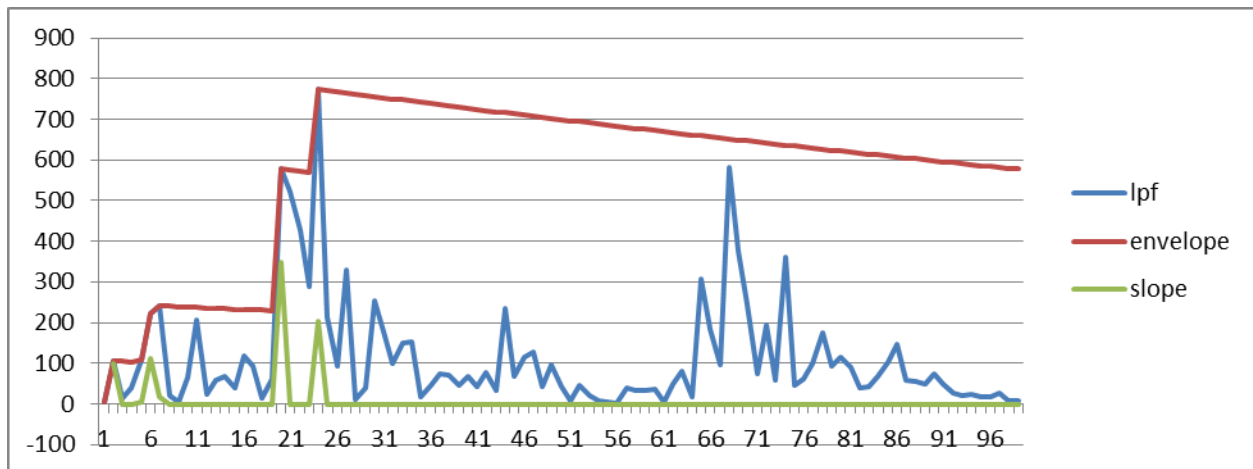
As shown above, the impulse at about sample 70 is not detected as the envelope has not decayed below the amplitude of the impulse.

Using one second of data (500 samples per second:)
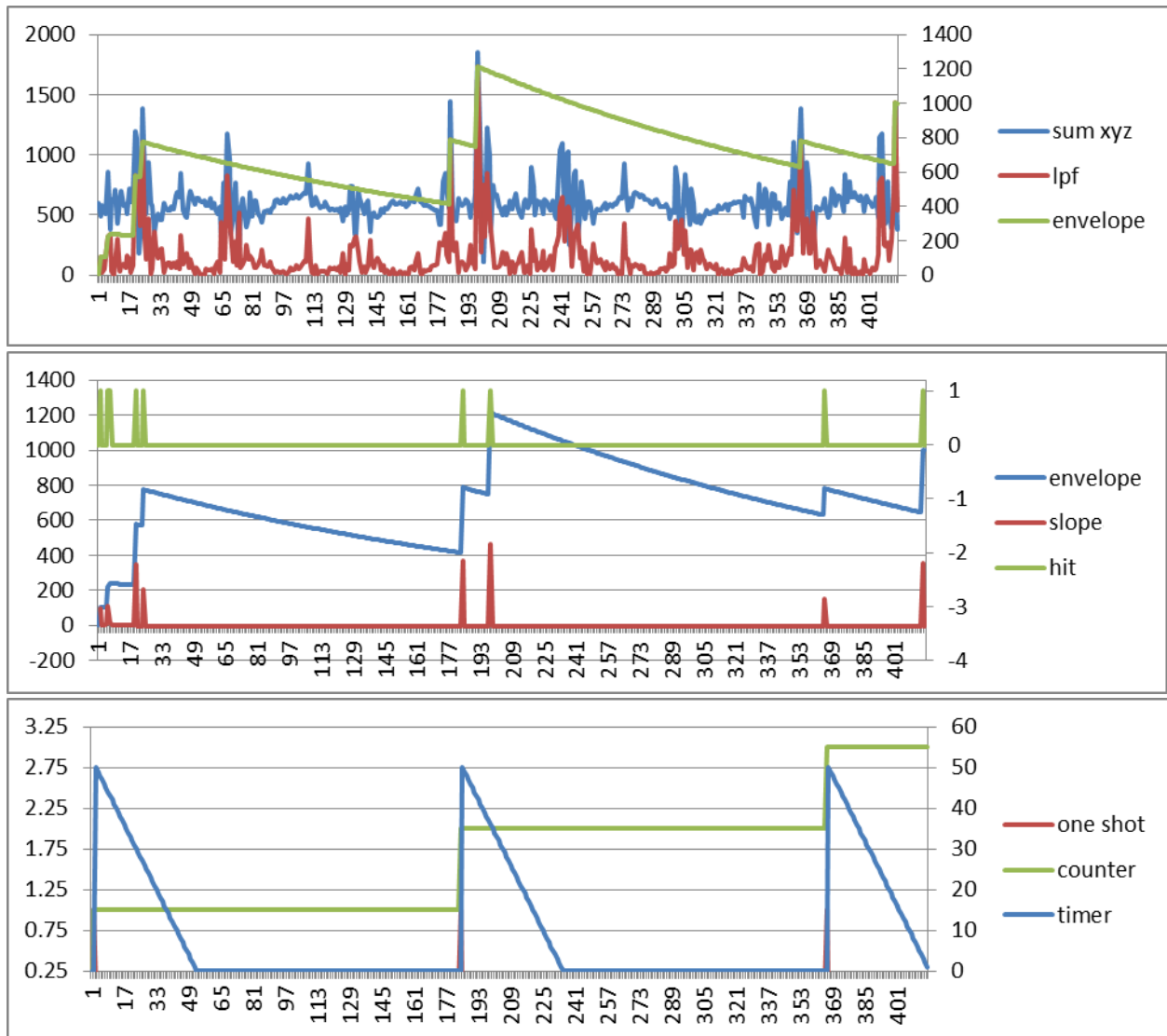
The envelope only rises when the lpf value is greater than the envelope. All other lpf values do not affect the envelope as they are less than the decaying envelope.

The slope of the envelope is only positive when an impact occurs and is a reliable source for hit detection. When a hit is detected and the one shot timer is zero, the hit counter is incremented and the one shot timer is started. If a hit is detected while the one shot timer is not zero, it is discarded.