Invention Title
Using Ripples in a Full-Band Capture to Accurately Discover Echo Tunnels

Invention Summary
An Inverse Fast Fourier Transform is performed on the magnitude spectral data of a signal to reveal the presence of an echo tunnel.

Invention Description
See attached. Magnitudes of averaged noise-like signals are analyzed with an Inverse Fast Fourier Transform to reveal echoes. Imaginary values are set to 0, and real values are set the the averaged signal.

Invention Commercial Value/Customers
Large. Having exceedingly accurate echo location data is valuable.

Invention Differences compare to DOCSIS 3.1 with 192MHz band for analysis

Using Ripples in a Full-Band Capture to Discover Echo Tunnels

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Problem:

Modern cable modems currently have a capability to measure the spectrum of a downstream signal using a high-speed (e.g. 2.5Gsamples/sec) A-D converter. Because the devices don't have high-speed memory, they re-tune the narrow band demodulator to obtain a full spectrum by gluing together many narrower bands (e.g. Broadcom uses 7.5MHz). This means that signals from different parts of the spectrum were captured at different times. This renders the phase information inaccurate, but if the signals are noise-like, the magnitude information is valuable, particularly if it is averaged. If we had phase information of the channel response it would be possible to take a IFFT and determine the impulse response of an echo.

Solution:

1. Assume the digital 6MHz channels take the shape of the channel's response.
2. Assume the phase information is all 0's.
3. Perform an IFFT. Use a window, such as a Blackman-Harris window.
4. Ignore the comb in the time domain created by the spectral notch between carriers. This has an analogy of looking at animals at the zoo through bars. The teeth of the comb every 167ns, which is the reciprocal of 6MHz.
5. Analyze the time response to determine the length of the echo tunnel, accounting for the velocity of propagation of the cable.
6. Note that the accuracy of the distance measurement is exceedingly high due to the very wide band of the full-band capture.
7. Generally ripples at low frequencies are caused by damaged coaxial components, while ripples at high frequencies are caused by poor tap return loss.

What is novel about this approach is using the shape of a noise-like signal(s) to infer the channel's magnitude, and assuming the phase is flat. Not true, but it is a good enough approximation to yield valuable information about the location of damaged cable.

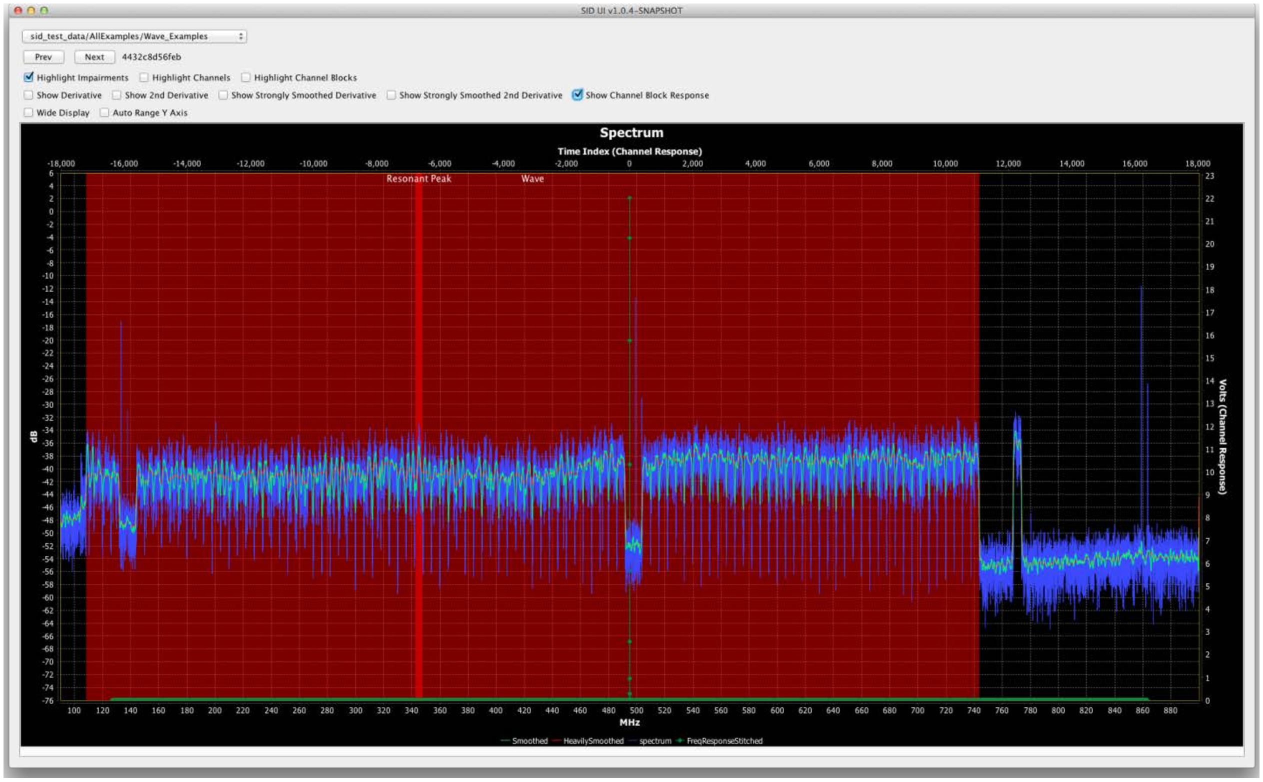

Figure 1 Screenshot of SID UI displaying a spectrum with 2 waves

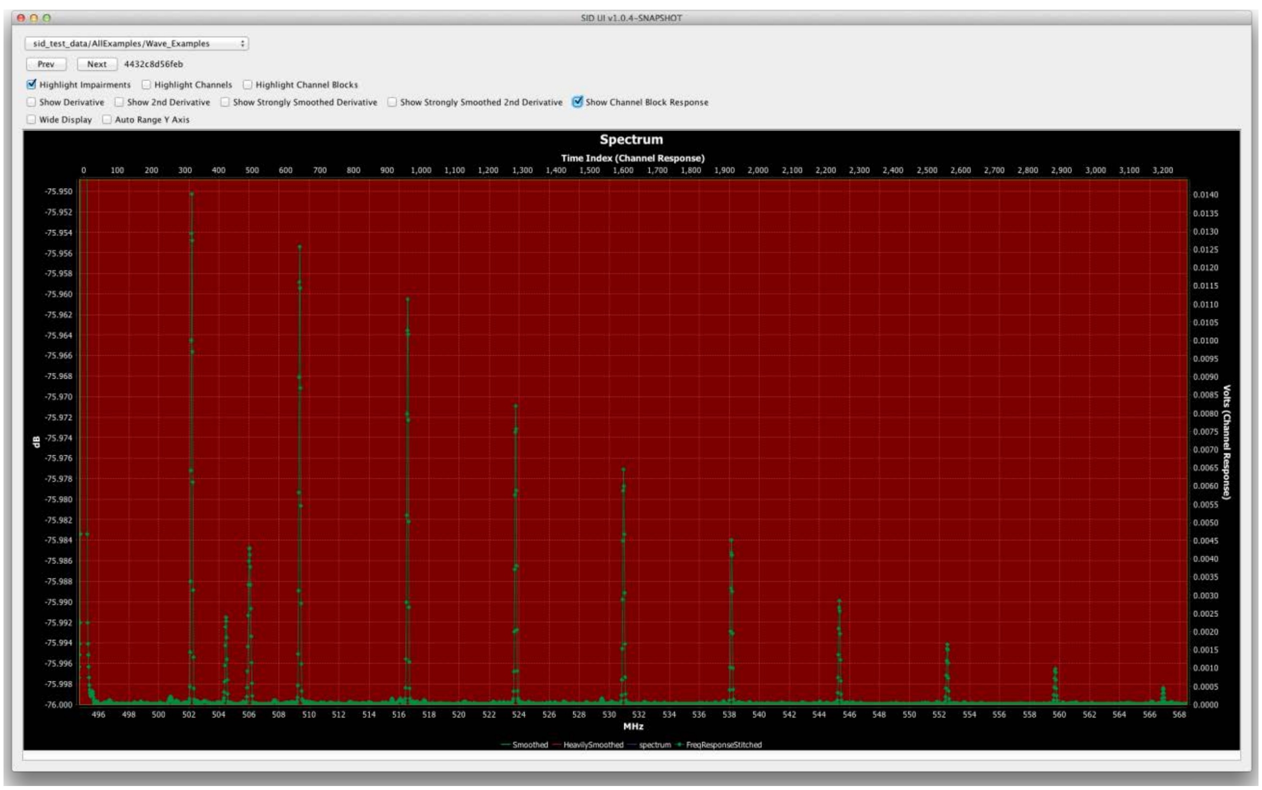

Figure 2 Screenshot of SID zoomed in on the time domain showing the channel comb and the 2 wave impulses