MITIGATION OF INTERFERENCE INTO UWB SIGNALS USING WAVELETS

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• Possible high power signals in the frequency range 3-10 GHz (IEEE 802.11a and 802.15.3a) can cause significant degradation of UWB communication signals.

• In the IEEE 802.11a system 8 channels are available in the range 5.15-5.35 GHz.

• The OFDM channel at the lowest centre frequency of 5.18 GHz, with 52 subcarriers at 312.5 KHz spacings, interferes with UWB.

• Can use wavelet-based pulses to reject interference.

• To reduce this interference into the UWB system, the interfering subcarriers are adaptively identified using received power levels.

• Then, as a template for a matched filter receiver a modified wavelet-based UWB pulse is used, a pulse obtained by eliminating the interfering subcarriers.
Wavelets are used to perform a multiresolution analysis of a transmitted UWB pulse into multiple subband pulses whose frequency responses are centred on distinct subcarriers.
\[ s_0(t) = \exp\left(-\frac{A t^2}{\tau^2}\right) \sin(2\pi f_0 t) \]

- **Original Pulse**

- **Wavelet Pulse**
  - Wavelet transform 
    \[ W_{\psi} f(a) = \int_{t=\infty}^{t=-\infty} \psi\left(\frac{t}{a}\right)s_0(t)dt \]
  - Subcarriers
    \[ \psi(t/a) = \exp\left(-\frac{A t^2}{\tau_1^2}\right) \sin(2\pi at) \]
  - Wavelet pulse
    \[ s_0'(t) = \sum_a W_{\psi} f(a) \psi\left(\frac{t}{a}\right) \]

**ILLUSTRATIONS OF WAVELET-BASED UWB PULSES**

- Example of wavelet-based UWB transmitted pulse: \( A = \log_e 10, \tau = 0.5 \text{ ns}, f_0 = 4.2 \text{ GHz}, \tau_1 = 2 \text{ ns}, a = nf_s\), with \( n \) being an integer and \( f_s = 200 \text{ MHz} \).
With these parameters the energy of pulses is concentrated between 3.2 and 5.2 GHz.

Subplots 1-11, respectively, show subcarrier waveforms 1-11, and subplot 12 shows the combined UWB pulse.
The UWB original pulse (dashed-curve) and wavelet-based UWB pulse (solid-curve).

Frequency spectrum of the wavelet-based UWB pulse and the original UWB pulse.
• Eliminate the UWB subcarriers at 3.2, 4.8, 5.0 and 5.2 GHz to mitigate the interference into UWB at these frequencies.

• At the UWB transmitter the modified wavelet-based pulse with 7 subcarriers is used to mitigate interference into the UWB communication system.

Percentage of energy in each of the 11 subcarriers.
Frequency spectrum of the wavelet-based UWB pulses generated using $\tau_1=1, 2$ and $4$ ns.
Bi-Phase Modulated (BPM) UWB pulses representing 0 1 0 1: 1ns pulses trans. every 5 ns.

Frequency spectrum of biphas modulated UWB pulses.
Acknowledgement: Dr. Mathini Sellathurai, formerly at CRC, and now at Cardiff University in Wales, provided much appreciated computational and simulation results.