Match Filtering for Digital Communication

EE340: Prelab Reading Material for Experiment 6

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In general,in digital communication the transmitted signal through the channel gets corrupted with noise along the way to the receiver. At receiver these pulses are contaminated with the noise and if we sample directly the noise will increase the probability of error in decoding.Maximising Signal-to-Noise Ratio will decrease the probability of decoding error.
SNR can be increased by either increasing Signal energy but that limits the distance between the transmitter and receiver and is also energy expensive. Decreasing the noise energy which can be done by filter , a band pass filter removes out of band noise but still noise is present in the pulses.

Match Filters: Match filtering is a process of detecting a known signal which is embedded in noise.It increases SNR with respect to noise. Match filter is a linear time-invariant filter.
The input to the filter is x(t) a known signal and n(t)(noise) ,the response of the filter is h(t). If h(t) is time reversal of the x(t) then

$$y(t) = (x(t) + n(t)) * x(T - t)$$

then the convolution results in correlation of the input signal. This can be better visualised by the following figures:
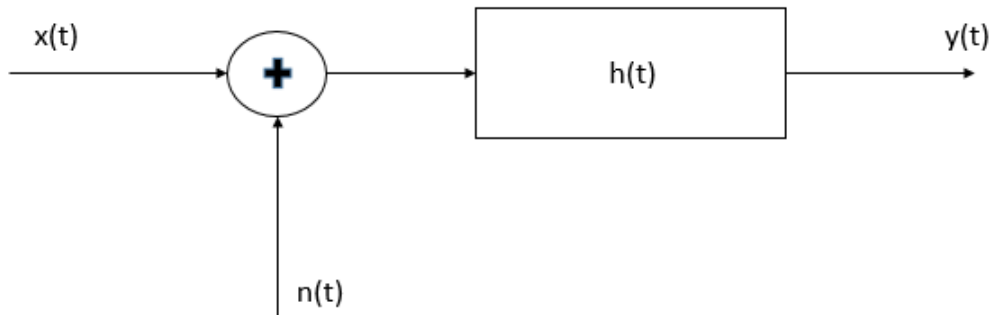

Figure 1: Match filter

Figure 1 represents the transmitted pulse and figure 2 represents the received waveform which is input to the match filter.The Y-axis represents the different various values of SNR.
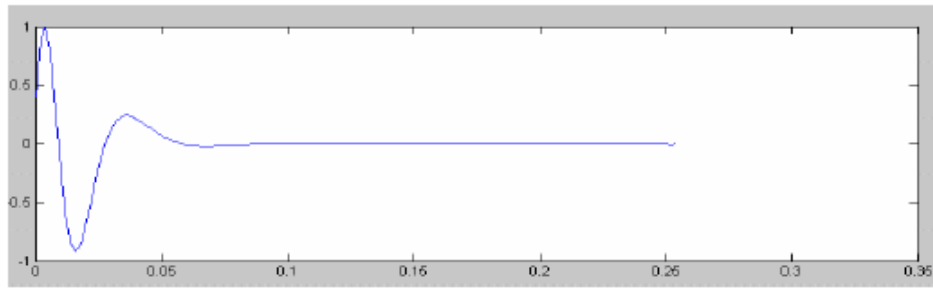Figure 3 represents the output of the matched filter.
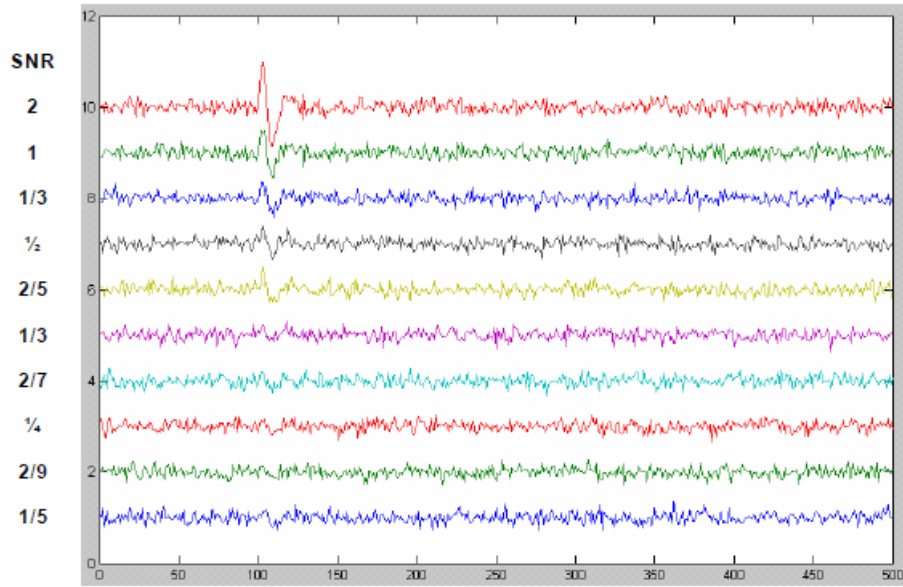
Figure 2: A transmitted pulse.[1]
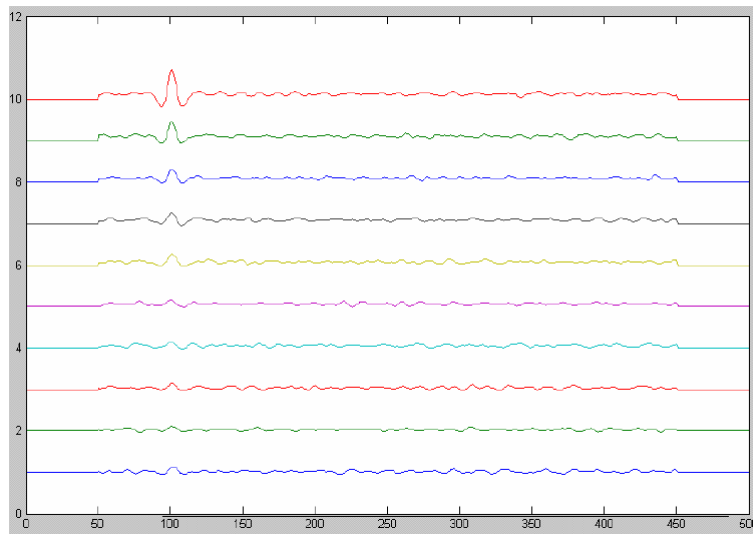

Figure 3: The noise contaminated pulses.[1]

Figure 4: Output of matched filter.[1]

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Raised cosine filter: The Pulse shaping filter needs to satisfy the zero ISI criteria .If the channel response is flat and channel noise is white then we can split the pulse shaping filter into two filters one at transmitter and other at receiver. So the overall response of raised cosine is split into square root raised cosine which is implemented by root raised cosine filter in gnu radio.
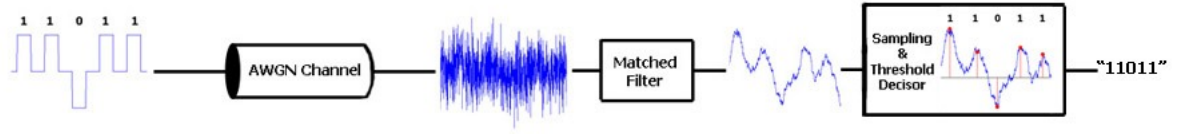

Figure 5: End to end communication

References

[1] J. C. Bancroft, "Introduction to matched filters," *CREWES Research*, vol. 297, 2002.