Digital Communications and Laboratory
Second Homework

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Setup and presentation

Exercise 1

Exercise 2

A flat fading channel with only one top $h_0(nT_c)$ was studied, assuming a *Rice factor* of k=2 dB and normalized M_{h_0}. Moreover, a classical *Doppler Spectrum* with $f_d T_c = 40 \cdot 10^{-5}$ was considered. The schematical model to generate the coefficient h_0 of the channel is given in Fig. 1

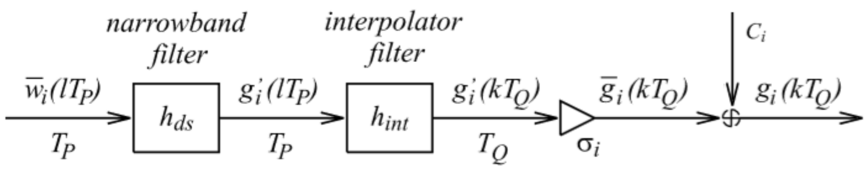

Figure 1. Model to generate the coefficient h_0 of the time-varying channel.

Problem 1

Problem 2

To generate the Doppler Spectrum, we used an IIR filter with the following parameters:

$H_{ds}(z) = B(z)/A(z)$	$f_d T_p = 0.1$		
$\{a_n\}$,	$n = 0, \cdots, 11$:		
1	-4.4153	8.6283	-9.4592
6.1051	-1.3542	-3.3622	7.2390
-7.9361	5.1221	-1.8401	2.8706e-1
$\{b_n\}$,	$n = 0, \cdots, 21$:		
1.3651e-4	8.1905e-4	2.0476e-3	2.7302e-3
2.0476e-3	9.0939e-4	6.7852e-4	1.3550e-3
1.8076e-3	1.3550e-3	5.3726e-4	6.1818e-5
-7.1294e-5	-9.5058e-5	-7.1294e-5	-2.5505e-5
1.3321e-5	4.5186e-5	6.0248e-5	4.5186e-5
1.8074e-5	3.0124e-6		

The grafical rapresentation of the impulse resonse of the IIR filter and the Doppler Spectrum is shown in Fig. 2. To obtain h_0, following the scheme of Fig. 1, the noise component $w \sim \mathcal{CN}(0, 1)$ was filtered with the IIR filter previously described. Note that the frequency response of this filter is $H_{ds}(f) = \sqrt{D(f)}$ while the PSD of the noise is constant and equal to

1. For this reason, the equivalent impulse response of this part is equal to $D(f) = 1 \cdot |H_{ds}|^2$ which is actually the Doppler spectrum.
The output of the filter was affected by a transient, which we have avoided by considering only values after $5N_{eq}T_p$, where $N_{eq} = \left\lceil -\frac{1}{\ln(|p|)} \right\rceil$ is the equivalent time constant, and p is the pole with the highest magnitude. Then, after having scaled the coefficient such that $M_{h_0}/\sqrt{E_{h_{ds}}} = 1$, the signal was filtered with an interpolation filter of factor $1/T_Q = T_p/T_c = 250$. The interpolator output signal was then multiplied by a constant $\sigma_0 = \sqrt{M_d}$ to impose the desired power delay profile, and finally added up with another constant, C, which included the deterministic component according to the statistical description of the fading channel.

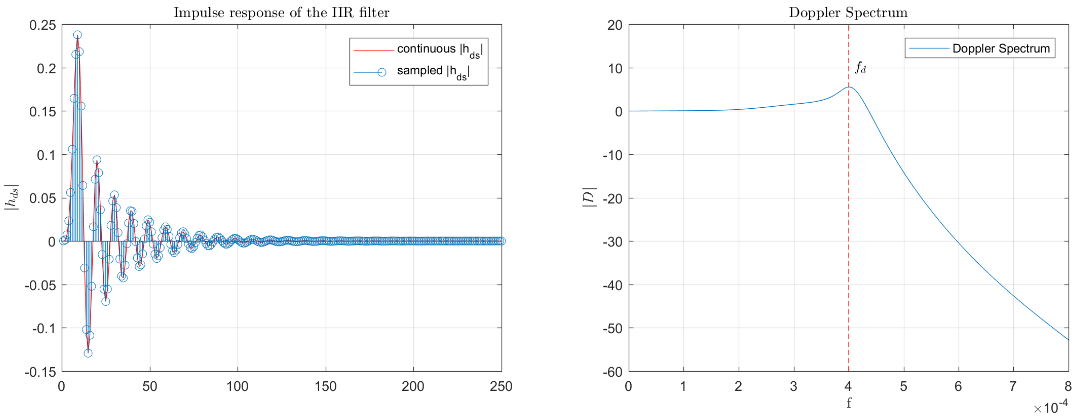

Figure 2. impulse resonse of the IIR filter and Doppler Spectrum.

Bibliography

[1] Nevio Benvenuto, Giovanni Cherubini, *Algorithms for Communication Systems and their Applications*. Wiley, 2002.