Homework #1b – Signal Acquisition

Description: Implementation of conventional, parallel code phase acquisition method and signal simulator

The result of all tasks should be described in a proper way.

Deliverable: HW#1b Report (including the answers to Task-3 to 6, and the relevant descriptions by yourself)

Deadline: not later than 18.12.2015

Attachment: IncomingIF.mat - Matlab MAT-file

Task-3: Conventional acquisition method (Time-Frequency space search)

1) Read the data from "IncomingIF.mat" and save the first 1ms samples into "incoming_1msIF".
2) Generate a carrier waveform $\sin/\cos(2\pi(f_{IF}+f_d)t_k)$ for 1 msec. f_{IF} = 4.3 MHz, f_d=Doppler frequency (+/-10 KHz, 250 Hz or smaller Doppler bin), t_k = 0 … 1msec with the increment of T_s.
3) Generate sampled C/A code sequence (Use Task-1) for 0 to 1023 with 0.5 chip (or smaller) code delay.
4) Correlate 1) with 2) and 3), and after then sum Inphase (I) and Quadrature (Q) after squared (=I^2+Q^2) for all PRNs (cold start).

   Hint: three "for-loop" states

```
for sv=1:32
    for code_delay=0:d:1023
        for Doppler=-10K:DopBin:10K
            test .....
        end
    end
end
```

5) Plot the 2-dimensional acquisition function (i.e., code delay and Doppler) for a searched PRN.
6) Make a selection logic with a threshold value K. You should assume a value of K with a proper knowledge on the basis of detection and false alarm probabilities.

Task-4: FFT-IFFT acquisition method (Parallel code phase search)

1) Read the data from “IncomingIF.mat” and save the first 1ms samples into “incoming_1msIF”.
2) Apply FFT to the data to generate X(N).
3) Generate a carrier waveform $\sin/\cos(2\pi(f_{IF}+f_d)t_k)$ for 1 msec and for Doppler frequencies.
4) Generate sampled C/A code sequence (Use Task-1).
5) Apply FFT to 3)x4) to generate H(N)
6) Apply IFFT to X(N)xH*(N).

   Hint: Use Matlab functions “fft.m” and “ifft.m”.

   * represents complex conjugate.

Task-5: Implement a signal simulator

1) Generate a carrier waveform $\cos(2\pi(f_{IF}+f_d)t_k)$ for 1 msec with a given Doppler frequency.

   e.g., Doppler frequency setting = +3 KHz.
2) Generate sampled C/A code sequence (Use Task-1) with a given code delay.

   e.g., code delay setting = 201.3 chip
3) Write a Matlab function noise=AWGN(mean,std,num) to generate Additive White Gaussian Noise (AWGN) sequence.

In/Out	Argument name	Description	Unit/Dimension
[input]	mean	Mean	[unitless] 1-by-1
	std	Standard deviation	[unitless] 1-by-1
[output]	noise	Noise output	[unitless] 1-by-num

Here, use a Matlab m-function “rand.m” to generate a uniformly distributed random numbers, and consider Central Limit Theorem (CLT). Or you can directly use a Matlab m-function “randn.m” to generate a normally distributed random numbers.

4) Write a Matlab function “received_signal=RcvSigGen(code_delay, init_carrier_phase, Doppler,CN0)” to generate received signals.

Hint: $r(t_k) = \text{sqrt}(2*P)*D(t-\tau)*CA(t-\tau)*\cos(2\pi(f_{IF}+f_d)t_k + \varphi_0)$

Hint: Use the appropriate values for t_k, f_{IF}, P. (D = 1)

In/Out	Argument name	Description	Unit/Dimension
[input]	code_delay	code delay	[chips] 1-by-1
	Init_carrier_phase	Initial carrier phase	[cycles]
	Doppler	Doppler	[Hz]
	CN0	Carrier-to-noise ratio	[dB-Hz]
[output]	received_sigal	Received signal Duration is 1 msec	[unitless] 1-by-5714

5) Save the generated received signals in 4) into a one-dimensional array variable “GeneratedIncomingIF”, and repeat Task-4.

Task-6: Acquisition time analysis on Galileo signals

1) Fill-out the following table of the cold start acquisition time for a cell for GPS L1CA and Galileo OS signals. Describe the impact of BOC-like signals on the acquisition time with a special attention on the size of code bin. More specifically, describe the impact of sidelobe peak in case of BOC signals, and the methods to mitigate this impact. You need to do the literature survey.

	Option	Code rate [Mcps]	Code length [chips]	Code duration [ms]	Data rate [sps]	Required CNo [dB-Hz]	Size of search space (ΔTxΔf)	Size of search grid (δTxδf)	T_{acq} for one SV [s]
GPS	L1-C/A	1.023	1023	1	50				
Galileo	OS-E1			4		**(To be defined later)**			