Frame Synchronization : Global Summation of SOF/PLSC Detectors

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***Abstract*—This manual provides a brief description about the design and implementation of digital synchronization techniques for reliable communication.**

1. Frame Synchronization : Global Summation of SOF/PLSC Detectors

Let the frequency offset be Δf and phase offset be $\Delta\phi$.Then,

$$Y_k = X_k e^{j(2\pi\Delta f k M+\phi_k)} + V_k, \quad k = 1,\ldots,N \tag{1.1}$$

assuming that no pilot symbols are trasmitted. Let the phase information be θ_k, and defined as

$$e^{\theta(k)} = \frac{Y_k}{|Y_k|} \tag{1.2}$$

At the receiver, the header information is available in the form of

$$g_i(l) = x_s(l)x_s(l-i), l = 0,\ldots,SOF-1 \tag{1.3}$$

$$h_i(l) = x_p(l)x_p(l-i), l = 0,\ldots,PLSC-1 \tag{1.4}$$

where x_s are the mapped SOF symbols, x_p are the scrambled PLSC symbols, both modulated using 8-PSK for $i = 1, 2, 4, 8, 16, 32$. The SOM is choosen as a 64-bit length such that SOF and PLS each are of 32-bit length.

A special kind of correlation is performed to obtain

$$m_i(k) = \sum_{l=0}^{PLSC-1} e^{j(\theta(k-l)-\theta(k-l-i))} h_i(l), \tag{1.5}$$

$$n_i(k) = \sum_{l=0}^{SOF-1} e^{j(\theta(k-l)-\theta(k-l-i))} g_i(l), \tag{1.6}$$

$$k = 1,\ldots,N \tag{1.7}$$

Compute

$$p_i(k) = \begin{cases} \max\left(|n_i(k-PLSC)+m_i(k)|,\right. \\ \left.|n_i(k-PLSC)-m_i(k)|\right) & k > PLSC \end{cases} \tag{1.8}$$

GLOBAL variable $G_{R,T}(k)$ [1] defined as,

$$G_{R,T}(k) = \sum_{i\geq 1} p_i(k), \quad i = 1, 2, 4, 8, 16, 32 \tag{1.9}$$

At the receiver, let us consider we have sent two types of transmission. One is PLHEADER+DATA (Y_{k1}) and another is only DATA (Y_{k2}) and the GLOBAL variables for (Y_{k1}) and (Y_{k2}) from (1.9) are $G1_{R,T}(k)$, $G2_{R,T}(k)$ respectively.

A. Global Threshold Calculation

The Global Threshold variable is defined as

$$T = \max\left(\max\left(G1_{R,T}(k)\right), \max\left(G2_{R,T}(k)\right)\right) \tag{1.10}$$

The probability of false detection of plheader when only DATA frame (Y_{k2}) has been sent is defined as

$$P_{FA} = \frac{\sum \frac{sign(|Y_{k2}-T|)+1}{2}}{N} \tag{1.11}$$

The probability of missed detection of plheader when PLHEADER+DATA (Y_{k1}) has been sent is defined as

$$P_{MD} = \frac{\sum \frac{sign(T-|Y_{k1}|)+1}{2}}{N+PLSC+SOF} \tag{1.12}$$

B. Plots

Fig.1 shows the ROC curve ($P_{FA}vsP_{MD}$) at the receiver for frame synchronization at $\frac{E_b}{N_0} = -2$ dB and with a frequency offset of 250 KHz.

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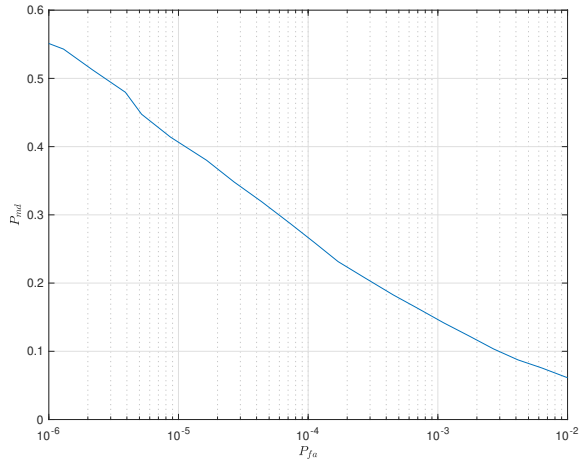

Fig. 1: Frame Synchronization Receiver Operating Characteristcs (ROC)

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