RESEARCH ARTICLE OPEN ACCESS

Wave Frequency Invariance by Mathematically Based - Model Technology

Kharatti Lal
Dept. of Applied Science – Mathematics Govt. Millennium polytechnic College Chamba Himachal Pradesh – 176310 (INDIA)

ABSTRACT
Frequency Invariance is an interesting complexity saving property that is shared by all the digital active suppression method described in this paper .It follows from their same basic construction with silent measurement tones and is possible due to the properties of the DFT. Frequency invariance applies both to the model based. It means that if the RF signal and to the non –model based cancellers. It means that if the RF signal changes its frequency location, the RFI estimate coefficient represented by the matrix K which are dived do not read to be re-computed This is possible to achieve provided that a few criteria, which are described below, are met. Technical details showing that the frequency invariance for the deterministic and stochastic RFI cancellers can be found in respectively. Author complexity advantage with frequency invariance is that RFI from several RF signal can be cancelled independently of each other and by using the same estimator coefficients, k. Thats why this can be used in a scenario whose several amateur radio signal s in different HAM band, or with two sufficiently separated AM radio station,
Key Words: RFI signal, Matrix frequency, Digital frequency, Transmission, estimator coefficient,

I. INTRODUCTION

The minimum required frequency distance the number of subcarriers in the DMT DSL system, and the level of the background noise. The theortical requirements for obtaining the frequency invariance property are the RFI signals, frequency shift is an integer number of subcarriers

$$f_{c1} = f_{c0} + \frac{k_1}{N} fs , k_1 \varepsilon Z,$$

Where f_{c1} and f_{co} are represent the new and old RFI center of frequencies, respectively.

$$f_{c2} = f_{c1} + \frac{k_2}{N} fs , k_2 \varepsilon Z, \quad 1.2$$

Where f_{c2} and f_{c1} are represent the new and old RFI center frequencies, are shifted

The measurement tones are circularly shifted to the around new frequency possible

$$f_{c1} = w_1 = (k + k_1) \text{mod } N / k \varepsilon w_o \quad 1.3$$

Where f_{c1} and f_{co} are represent the new and old RFI center frequencies, respectively. The measurement tone placement should be always the same relative to the RFI center frequency. Sufficient non-reactangular receiver windowing is applied to the RF spectral leakage from the negative frequency. Component to the RF signal can be neglected. Only measurement tones from one DMT symbol at a time are used. The estimator coefficient in k can remain unchanged common Only a simple circular shift to the RFI estimator is required in order to get them into the right position before they are cancelled from the subcarriers as in show that

$$S^1 = S^0 (_{K + K1) \text{ mod } N}, \quad 0 < k < N-1 \quad 1.4$$

To summarize if the frequency is shifted to the RF signal is suddenly detected the measurement tones should only be shifted to around the new RFI peak location as they were at the previous frequency location, and the estimated interference rotated into position as in equation 1.4 before the cancellation The same procedure can be used in the case of several simultaneous RFIs no other changes need to be performed in the cancellation procedure.

Digital Suppression Methods:

This section be solved the performance of different passive and active RFI suppression methods The performance metrics are the PSD level of the RFI signals, and bit rates and symbol error rates of DMT DSL systems with and without TFI suppression. Canceller complexity are also compared by examining the number of operation needed to derive the estimator coefficient, the initial complexity and the runtime operation needed to derive RFI estimator

Time Frequency Plotted With Different Parameters:

The performance of the digital notch filter described its impulse response is described analytically, and then the time and frequency responces plotted with different parameters. Also investigated are the effects in the case when the infinite impulse response IIR of the filter is truncated to a finite impulse response (FIR) each adaptive notch filter, $G_k(z)$ with in the multiple notch filter

$G_Z = \Pi^{Q}_{k=1} G_K Z$ to expanded the equation

$$G_k(z) = \frac{1 + C_K Z{-}1}{1 - \alpha_k e^{-jwk} z^{-1}} + \frac{C_K{}^* Z^{-}}{1 - \alpha_k e^{-jwk} z^{-1}} \quad 1.6$$

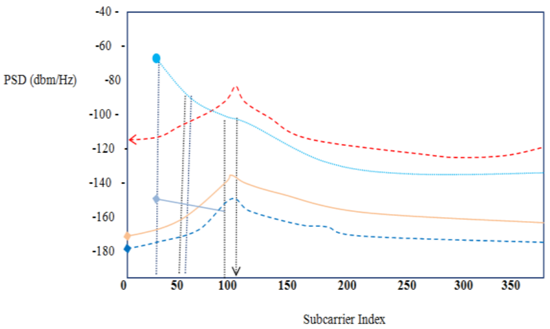
$$C_K = \frac{1 - \alpha_k + (\alpha_{2k} - \alpha_k) e{-}j^{2wk}}{A_k (e^{-jwk} - e^{jwk})} \quad 1.7$$

where C_K is a complex constant in terms of Z Therefore the impulse response obtained by the inverse transformation of equation 1.6 then becomes

$$g_k[n] = g[n]\, 2\alpha_k{}^{n-1} \operatorname{Re} \; c_{k\,e}{}^{-jwk\,(n-1)}\, u[n-1] \quad 1.8$$

Where u[n] is the unit step sequence and Re (.) denote the real part. and g[n]is the discrete impulse sequence

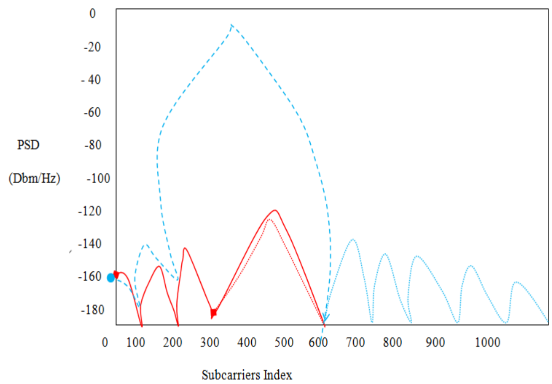
Figure 2.1: DSL signal, RFI Signal, Deterministic D p = 4,Dn = 4,Stochastic WLE full rank,



It is no model mismatch and the widely linear estimator (WLE) structure uses in total 14 measurement tones. Half of the measurement tones, Y_k, are placed around the RFIs positive center frequency, $f = f_c$ with in the second HAM band. The other half is selected as their complex conjugate $Y_k{}^* = Y_{N-K}$ which corresponds to the negative frequency around $f = -f\ c$ for the deterministic canceller, $L\ p = L\ n = 4$, and the reduced rank stochastic canceller has rank 4. For this scenario the use of rank = 4 is slightly low. Estimator depends on the spectral leakage from the negative frequencies with non – reactangular receiver windowing, however, the rank = 4, estimator would suffice to suppress the RFI.

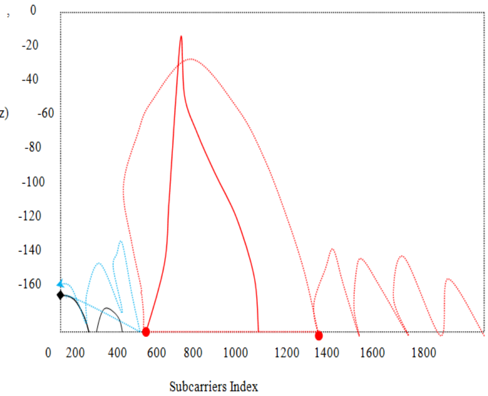
In this section to show that the active digital RFI cancellation method s for DMT based DSL are evaluated. Specifically, characteristics of the RFI PSD before and after cancellation with the different method are shown and then corresponding effects on the bit rate and symbol error rate is considered. The cancellation performance in terms of RFI PSDs before and after cancellation for the deterministic and stochastic based– model cancellers.The sampling frequency is F s = 232 MHz and the numbers of subcarriers is N = 256 and N = 1024,from figure 2.1 and 2.2The RFI bandwidth is 0.5 subcarriers wide corresponding to 21.5khz and 5.4 KHz respectively. The RFI frequency is located at fc = 3.6 MHz and adjusted precisely in between two subcarriers that is it is worst case position. The average RFI powers is equal to the average received DSL signal power after the DFT with a single to interference ratio SIR of ‘0’ d band the background AWGN floor was set to -140 dbm / Hz The model parameters for the cancellers in these two figures are carefully selected to illustrate some on the edge characteristics of the cancellation.

Figure 2.2: DSL Signal, RFI Signal, Deterministic LE, D p = 5,D n = 0 Stochastic LE, MMSE full Rank,

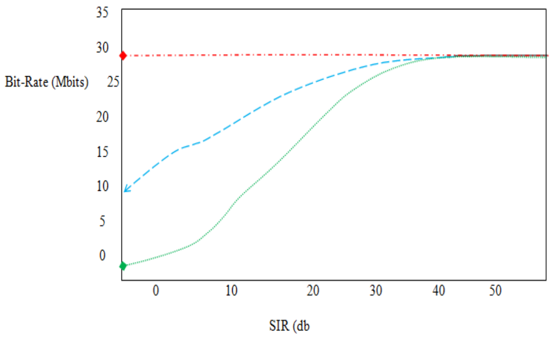


There is a model mismatch of the RFI PSD a frequency offset fc – fc = 2.7KHz.For the stochastic canceller, the modeled RFI bandwidth is 1.0 subcarriers wide. For example LE is used with eight measurement tones only on the positive side of the spectrum .The deterministic canceller has Lp = 5, Ln = 0 ie no negative frequencies of the RF signal are included in the model. Windowing is used with $\mu = 20$.corresponding to 1 percent of the DMT symbol length. Note that the modelled bandwidth for the stochastic canceller is at the limit to completely span the true RFI PSD. Although spectral leakage from the negative frequency components is ignored in this example, The RFI suppression still performs quite well. This is due to the windowing which largely suppresses the leakage from the negative frequency components $B^*(t)\,(e^{-j2\Pi\ ft})$ or s $b^*(t)\, e^{-j2\Pi fct}$ from equation 1.7 and 1.8 respectively. Without windowing however, all the LEs would more produce much worse result. Here, however the stochastic rank = 5 canceller perform as well as the full rank canceller. Reducing the rank to four would case the canceller to perform slightly worse, which was able to the case for the deterministic canceller. It is possible to achieve excellent suppression result also with very few measurements tones if a narrow residual RFI peak can be accepted. For example, by using only two measuring tones that are placed at a careful distance on each side of the peak, a residual peak, remains between the measurements tones. For a system with many subcarriers, such as VDSL.This can be tolerated with in the silent HAM band.

Figure 2.3
DSL Signal, RFI Signal
Deterministic L, E, D p = 2, D n = 0
Stochastic LE – MMSE, full rank,
Stochastic, L E - MMSE, rank = 2

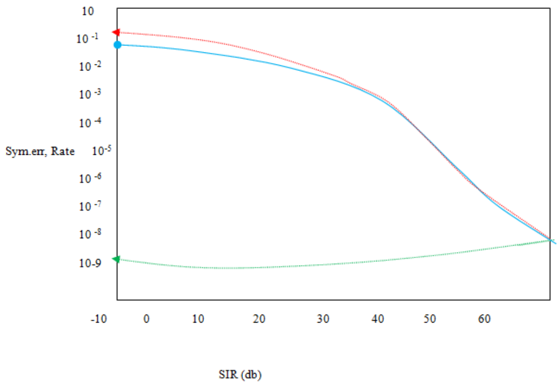


Shows that the performance for N = 2048 subcarriers, with only two measurement tones and using a linear estimator combined with windowing. The windowing uses μ = 20 extra cyclic extension samples, which corresponds to less than 0.5% of DMT symbol length. In practice, such a small windowing size would not require any increased cyclic extension. As seen the figure 2.3 the suppression using each method a virtually identical there is no SNR degradation on any useful subcarrier. Each method require only two complex multiplication per subcarrier. Here the rank = 2 is the same as the full rank canceller because only two measurement tones are used for this case. Average SNR47.4db Average SIR = 0db, 1000 m TPI cable Figure 2.4



In this section the cancellation was successful in suppressing the RFI to below the background noise. In this evaluation, the bit allocation results in the system maintaining a symbol error rate of less than 10^{-7}. With cancellation, the bit rates are practically identically to the case when no RFI are present. The stochastic canceller is marginally better then the deterministic canceller, but in practice they are equivalent. Furthermore, due to the windowing, fewer than half of the subcarriers would need to the RFI cancellation, and it is also enables the use of LE instead of using the more complex WLE equivalents. This subsection consider the complexity of RFI suppression for the passive and active method described in earlier sections. An important general difference between the methods described for single carrier system in that RFI suppression methods for single carriers system need to be performed at the sampling rate, fs typically using time domain processing, whereas methods for multi – carrier systems often can be performed at the symbol rate , fs / (N + N_{CE})

, Figure: 2.5
No Windowing, Only Windowing,
Canceller RFI
No RFI



From this figure shows that the corresponding SERs for the case when the bit allocation is performed without any RFI present In this mismatched bit allocation scenario which can be occur when an RFI suddenly becomes active or changes characteristics ,the effect of windowing is small if no RFI cancellation is performed. Symbol error are frequent also for quite high for SIR, and they are most common on subcarriers close to the RFI center frequency, where windowing has little effect .With cancellation, however, the increased SER can be avoided.

Passive Methods

Each notch in the filter of g[n], which has described two zeros and two poles, which was expressed in the general, therefore it can be denoted as

$$e_n = y_n + \delta_n y_{n-1} + y_{n-2} - \alpha_k \delta_n e_{n-1} - \alpha_k^2 e_{n-2} \quad 1.9$$

hence and each samples interval 1/f s, five real multiplication need to be computed for each notch In addition to steer each notch to be right RFI location, the adaptation of the ten real multiplication per sample interval.

Receiver Windowing for DMT a fixed receiver window for example, with raised cosine shaped tails, of length 2μ samples, requires only 2μ real multiplication per DMT symbol during a time interval of (N + Nce) / f_s seconds

II. CONCLUSION

In this section for suppressing radio frequency interference RFI radio frequency inference in DSL. Two major sources of RFI in DSL were identified and characterized amateur Ham radio and AM radio broadcasting. Both of them are relatively narrowband compared to the DSL signal. Compared to the more wideband crosstalk noise, the limited bandwidth of RFI allows effective suppression with low complexity methods. Suppressing method s for both analog and digital domain s were presented and categorized into two classes active suppression and passive suppression .Analog domain RFI suppression is important mainly to avoid saturation the analog to digital converter ADC caused by strong RF ingress. This is crusical because no effective countermeasures can be taken in the digital domain if the ADC has severely clipped the received analog signal. On the other hand , if the received signal , passes through the ADC without clipping ,powerful suppression techniques can be applied in the digital domain. There is possible to suppress the RFI to negligible levels, which results in practically, no SNR or bit rate degradation. Although the passive suppression method can be achieved good RFI suppression, they have limited performance, and the best result are obtained with active method s specially designed to cancel the RFI while leaving the information bearing signal intact. In the literature available publicly, single carrier transmission is limited to passive RFI suppression methods, like notch filters. Multi-carrier transmission, on the other hand, can use both passive and active RFI suppression methods and also combine them effectively, an example is passive receiver is windowing for DMT performed in the digital time domain and combined with frequency domain RFI cancellation. This combination offers the best RFI suppression performance and the lowest requirements on complexity.

REFERENCE

[1]. D.L. pazaitis, J. Maris, S, Vernalde, M. Engels, and I. Bolsens. Equation and radio frequency interference Cancellation in broadband twisted pair Receivers. In proc. of the IEEE global Telecommunication conferences, GLOBECOM, Volume 6, pages 3503 - 3508 Sydney Australia, nov.1998.

[2]. A.J.Redfern Receiver window design for multicarrier communication system IEEE Transaction on signals Processing, 43(8): 2030 – 2033, Aug.1995.

[3]. B.Picinbono, Second order complex random vectors and normal distribution. IEEE Transaction on signal Processing, 44(10): 2637 – 2640, Oct.1996.

[4]. L.W.CouchII. digital and Analog communication Systems.Prentice – Hall, Upper Saddle river, NJ, 6th edition, 2001.

[5]. M.Cioffi, M.Mallory, and J.Bingham. Analog RF Cancellation with SDMT Technical Report TIEI.4/96 – 084, ANSI, 1996.

[6]. A.D.Naofaland S.H. Diggavi. Maximum Throughput loss of noisy ISI channel due to narrowband interference. IEEE Communication Letters, 5(6): 233 – 235. June 2001.

[7]. D.Daecke. Frequence dependence of cable balance. Technical report TM6 TD37 003t37, ETSI Vienna sept. 2000.

[8]. D.Daecke. The electromagnetic fields environment in Europe. Technical report TM6 TD36 003t36, ETSI, Vienna, Sept. 2000.

[9]. P. Odling P.O. Borjesson, T. Magesacher, and T. Nordstrom. An approach to analog mitigation of RFI. IEEE journal on selected area in communication, 20(5):974 – 986, June 2002.