World Journal of Innovative Research (WJIR)
ISSN: 2454-8236, Volume-3, Issue-1, July 2017 Pages 07-09

Implementation of Proposed PDF to Five Possible Receiver Structures

Ashok Kajla , Sheeba Khan

***Abstract*— As we know that closed form PDF (probability density function) does not present for noise which is normally detected at communication receiver. So, due to this reason implementation of optimum receiver is very difficult. And this noise(undesirable disturbance) is the sum of Guassian noise and impulsive interference . So, alternate PDF is proposed by many authors which makes implementation of optimum receiver easy.**

In this paper, we will examine five receiver structures; the linear AWGN receiver, the optimum ML receiver, the Cauchy receiver, soft-limiter receiver and the receiver based on proposed PDF suggested by authors.

***Index Terms*— interference, alpha stable, receiver performance, empirical characteristics function ,sub-optimal.**

I. INTRODUCTION

In practical conditions often noise and interference both are present at the same time in varying degrees. Noise is generally modeled as AWGN while interferenc is impulsive in nature so cannot be modeled as AWGN.

In this paper we consider α-stable distributed interference contaminated by AWGN.

The alternate PDF in the most general terms is proposed as

$$g(v) = \frac{1}{I}\left(c_1 g_0 e^{-\frac{v^2}{4\gamma_{sg}}} + \frac{\widehat{\alpha}\widehat{\gamma}_s C_{\widehat{\alpha}}}{|v|^{\widehat{\alpha}+1} + c_2}\right)$$

First of all, to modeling the noise PDF we have to estimate three noise parameters which is $\boldsymbol{\alpha}$, γ_s and γ_g . Standard estimators of α stable distribution such as Hill estimator, Pickands estimator, De Haan and Resnick estimator and some other estimaters performs poorly in this special case when the α-stable noise is further contaminated by Gaussian noise. So, here we will use the empirical characteristic function (ECF) to estimate these all three noise parameters.

Assuming, V is a vector containing M samples of noise ECF is defined as,

First Author name, His Department Name, University/ College/ Organization Name, City Name, Country Name, Phone/ Mobile No., (e-mail: fisrtauthor@gamil.com).
Second Author name, His Department Name, University/ College/ Organization Name, City Name, Country Name, Phone/ Mobile No., (e-mail: secondauthor@rediffmail.com).
Third Author name, His Department Name, University/ College/ Organization Name, City Name, Country Name, Phone/ Mobile No., (e-mail: thirdauthor@hotmail.com).

$$\hat{\phi}_V(\omega) = \frac{1}{M}\sum_{i=1}^{M} e^{j\omega V(i)}$$

The estimate improves as the number of available samples, M, increases.

II. RECEIVER STRUCTURES

The received signal $y[n]$ sampled at N times the symbol rate

$$y[n] = s_i[n] + v[n],$$

$$i \in \{0,1\},\ n \in \{1,2,\dots,N\}$$

Where, $si[n]$ is the antipodal symbol transmitted during a symbol period and $v[n]$ is a random variable from the noise model.

Here, Symbol $si[n]$ are also assumed to be equally probable. The symbol detection problem now can be formulated as a binary hypothesis testing problem:

$$\mathcal{H}_0 : y[n] = s_0[n] + v[n],\ n \in \{1,2,\dots,N\},$$
$$\mathcal{H}_1 : y[n] = s_1[n] + v[n],\ n \in \{1,2,\dots,N\},$$

Now, we will examine five receiver structures, the optimum ML receiver,the linear AWGN receiver, the Cauchy receiver, soft-limiter and the receiver based on proposed PDF

The test statistic for each receiver is enumerated as given below.

- Linear AWGN receiver

$$\Lambda_L = \sum_{n=1}^{N} y[n]s_0[n] \underset{\mathcal{H}_1}{\overset{\mathcal{H}_0}{\gtrless}} 0$$

- Optimum ML receiver

$$\Lambda_O = \sum_{n=1}^{N} \log\frac{f_V(y[n]-s_0[n])}{f_V(y[n]-s_1[n])} \underset{\mathcal{H}_1}{\overset{\mathcal{H}_0}{\gtrless}} 0$$

- Cauchy receiver:
  Cauchy distribution is a well known SαS distribution with a closed-form PDF,

$$f_{\text{Cauchy}}(v) = \frac{\gamma_s}{\pi\left(\gamma_s^2 + |v|^2\right)}$$

The test statistic in this case is,

$$\Lambda_C = \sum_{n=1}^{N} \log\frac{f_{\text{Cauchy}}(y[n]-s_0[n])}{f_{\text{Cauchy}}(y[n]-s_1[n])} \underset{\mathcal{H}_1}{\overset{\mathcal{H}_0}{\gtrless}} 0$$

-
- Soft limiter:

The soft-limiter is a non-linear operation applied to the received signal to limit its maximum absolute value.

$$\Lambda_{\mathrm{SL}} = \sum_{n=1}^{N} h(y[n])s_0[n] \underset{\mathcal{H}_1}{\overset{\mathcal{H}_0}{\gtrless}} 0$$

- Receiver based on proposed PDF whose equation is given above.
  Now, the test statistic for such type of receiver will be

$$\Lambda_{\mathrm{P}} = \sum_{n=1}^{N} \log \frac{g(y[n]-s_0[n])}{g(y[n]-s_1[n])} \underset{\mathcal{H}_1}{\overset{\mathcal{H}_0}{\gtrless}} 0$$

III. SIMULATION

- **GSNR**

A generalized signal-to-noise ratio (generalized SNR) is defined for the situation where there are r, p-dimensional, real, or complex valued signals and a transmitted message is to be classified as either one of them or as pure white noise. The generalized signal-to-noise ratio (GSNR) is a measure of performance often used in evaluating binary hypothesis testing procedures.

Here, we can define the generalized signal-to-noise ratio as

$$GSNR = 10log_{10}\frac{\sum_{n=1}^{N} s_i^2[n]}{N(\gamma_s+\gamma_g)}$$

- **BER(bit error rate**)

The **bit error rate** (**BER**) is the number of bit errors per unit time. The **bit error ratio** (also **BER**) is the number of bit errors divided by the total number of transferred bits during a studied time interval. Bit error ratio is a unitless performance measure, often expressed as a percentage. The BER may be evaluated using stochastic (Monte Carlo) computer simulations. If a simple transmission channel and data source model is assumed, the BER may also be calculated analytically. Here, the BER simulations are performed via the Monte Carlo technique.

Each symbol is assumed to be represented by a rectangular pulse and sampled with N = 10. An SαS (symmetric alpha stable) random variable with dispersion γ_s and a zero-mean Gaussian random variable with dispersion γ_g is added to each sample of the randomly generated symbol.

To make easy for reference, the linear receiver , optimum receiver , Cauchy receiver, soft-limiting receiver and the alternate receiver are referred to in the simulation plots as 'LiRX', 'OpRX', 'CaRX', 'SLRX' and 'AlRX', respectively.

Performance of the proposed receiver for both the following given cases are simulated

(1) For the known noise parameters

(2)And for the estimated noise parameters

And these two cases are referred to as 'AlRX no est.'and 'AlRX est.' respectively in the simulation plots.

The following three figures shows BER plots for values of α, γ_s and γ_g with respect to GSNR.

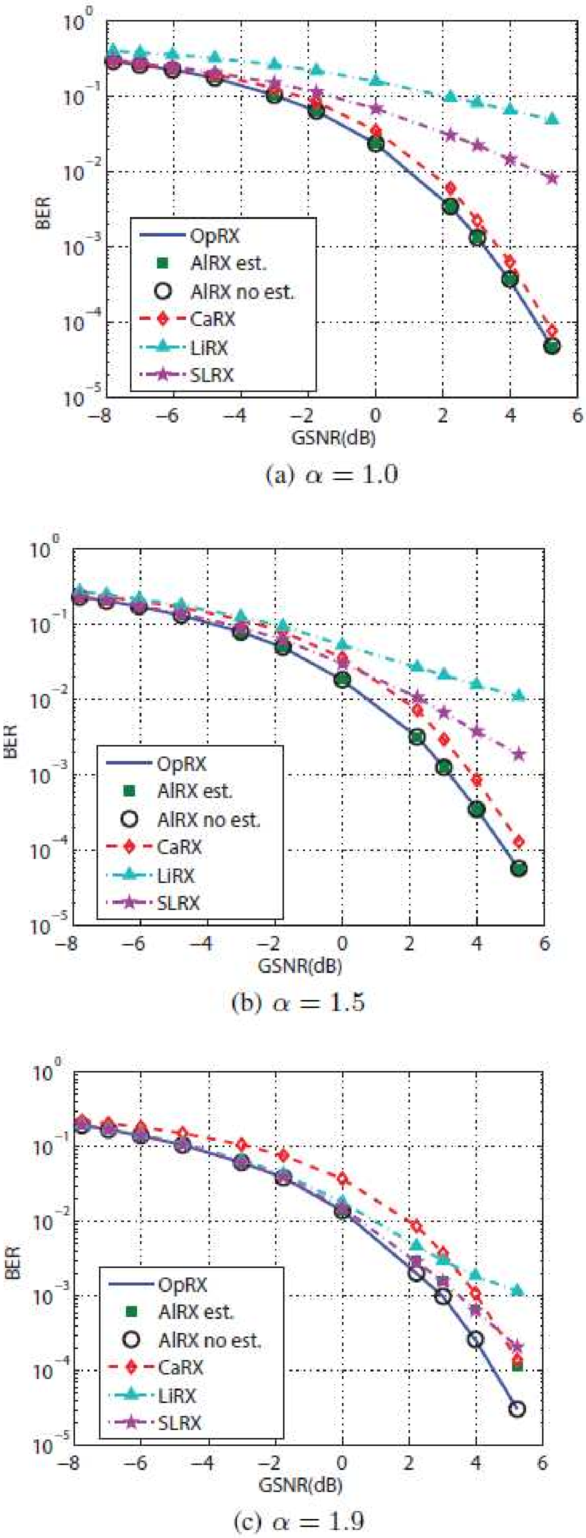

Fig.1. BER plots for $\gamma_s = \gamma_g$ and various values of of α

These three simulation plots are for $\gamma_s = \gamma_g$ and various values of of α. Here, $\gamma_s = \gamma_g$ represents the case when impulsive noise and AWGN have similar dispersion values.

IV. SIMULATION RESULT

All simulations were performed using Matlab running on a machine with dual core, 2.53GHz CPU with 4GB RAM.

It can be easily observed from the figures (a) (b) and (c) that the proposed receiver outperforms from all other sub optimum receivers. For the case of $\alpha = 1.9$, the noise is almost Gaussian, linear receiver and the soft limiting receiver approach the optimum performance as well.

REFERENCES

[1] C. Nikias and M. Shao, *Signal Processing with Alpha-Stable Distributions and Applications*. Wiley-Interscience, 1995.

[2] M. Win, P. Pinto, and L. Shepp, "A mathematical theory of network interference and its applications," *Proc. IEEE*, vol. 97, no. 2, pp. 205– 230, Feb. 2009.

[3]T. Saleh, I. Marsland, and M. El-Tanany, "Suboptimal detectors for alpha-stable noise: simplifying design and improving performance," *IEEE Trans. Commun.*, vol. 60, pp. 2982–2989, Oct. 2012.

[4]S. Ambike, J. Ilow, and D. Hatzinakos, "Detection for binary transmission in a mixture of Gaussian noise and impulsive noise modeled as an alpha-stable process," *IEEE Signal Process. Lett.*, vol. 1, no. 3, Mar.1994.

[5] H. El Ghannudi, L. Clavier, N. Azzaoui, F. Septier, and P.-A. Rolland, "Alpha-stable interference modeling and Cauchy receiver for an IRUWB ad hoc network," *IEEE Trans. Commun.*, vol. 58, pp. 1748–1757, June 2010.

[6] S. Niranjayan and N. Beaulieu, "The BER optimal linear rake receiver for signal detection in symmetric alpha-stable noise," *IEEE Trans. Commun.*, vol. 57, pp. 3585–3588, Dec. 2009.