`yacoub`: a Python package for Simulating Generalized Fading Channels

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***Abstract*—We present a well tested Python-based library for simulating and computing generalized fading channels, named `yacoub`. We describe the applicability of `yacoub` using examples in recent communications systems challenges, namely: cooperative spectrum sensing, bit error rate computation in generalized fading channel, and parameter estimation in free space optics. The development of `yacoub` open source and its code is avaliable at `http://github.com/mirca/yacoub`.**

I. Introduction

A. Note on notation

Scalars and random variables are denoted as *italic* small-case letters *e.g.* x; vectors and random vectors are denoted as *italic*, boldface, small-case letters *e.g.* $\boldsymbol{x}$. A complex vector of length n is defined as $\boldsymbol{x} \in \mathbb{C}^{1\times n}$. All vectors are column vectors. Matrices are denoted as *italic*, boldface, capital letters as in $\boldsymbol{X}$; the identity matrix of order n is denoted as $\boldsymbol{I}_n$. We define a discrete-time circularly symmetric Gaussian process $\boldsymbol{z}$ as any (finite or infinite) collection of random varibles $\boldsymbol{z} = \boldsymbol{x} + j\boldsymbol{y}$, $j \triangleq \sqrt{-1}$, such that $\boldsymbol{x}$ and $\boldsymbol{y}$ are iid jointly Gaussian with zero mean vector and covariance matrix given by $\mathbb{E}\left[\boldsymbol{z}\boldsymbol{z}^{\dagger}\right]$, in which $\boldsymbol{z}^{\dagger}$ means the conjugate transpose of $\boldsymbol{z}$.

II. The Acceptance-Rejection sampler in log-space

III. Examples

A. Spectrum Sensing in Complex Generalized Fading Channels

The spectrum sensing problem consists in deciding whether or not a given channel frequency band is being occupied by a licensed (primary) user and, in case that such frequency band is available, how to opportuniscally allocate secondary users such that...

From a probabilistic point of view, the spectrum sensing problem may be framed as a decision theory problem, as follows

$$\mathcal{H}_0 : \ \boldsymbol{y} = \boldsymbol{w}, \tag{1}$$

$$\mathcal{H}_1 : \ \boldsymbol{y} = h\boldsymbol{s} + \boldsymbol{w}, \tag{2}$$

in which $\boldsymbol{y} \in \mathbb{C}^{1\times n}$ is the decoded received vector, $\boldsymbol{w} \in \mathbb{C}^{1\times n}$ is complex Gaussian noise process with zero mean vector and covariance matrix given as $\sigma^2 \boldsymbol{I}_n$

B. Parameter Estimation in Free Space Optics

C. BER in Complex $\alpha - \mu$ Fading

IV. Conclusions

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