A non-Linear MIMO-OFDM Preprocessor for non-Gaussian Channels

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Presenter

- Danilo S. Pena received his B.Sc. degree in 2012 and his M.Sc. degree in 2014, where he worked on signal processing and embedded systems projects. He obtained his Ph.D. degree in signal processing in 2019, where his research involves statistical signal processing, optimization, and array signal processing. He developed a novelty method for source localization based on acoustic signals over severe conditions at the Federal University of Rio Grande do Norte (UFRN), Brazil. Currently, he works as an R&D engineer in the Protocol TG at Sidia in Brazil.

Sidia Research

- Topics where Sidia has published
  - MIMO detectors
  - MIMO antennas
  - Massive MU-MIMO systems
  - Beamforming
  - mmWave systems
  - UE power consumption
  - Machine Learning applied to LTE networks

Agenda

- Introduction
- MIMO-OFDM System
  - Noise Model
- Non-Linear Preprocessors
  - Blanking
  - Clipping
- Proposed Preprocessor
- Results and Discussions
  - Impulsiveness Analysis
  - Threshold Analysis
- Conclusions

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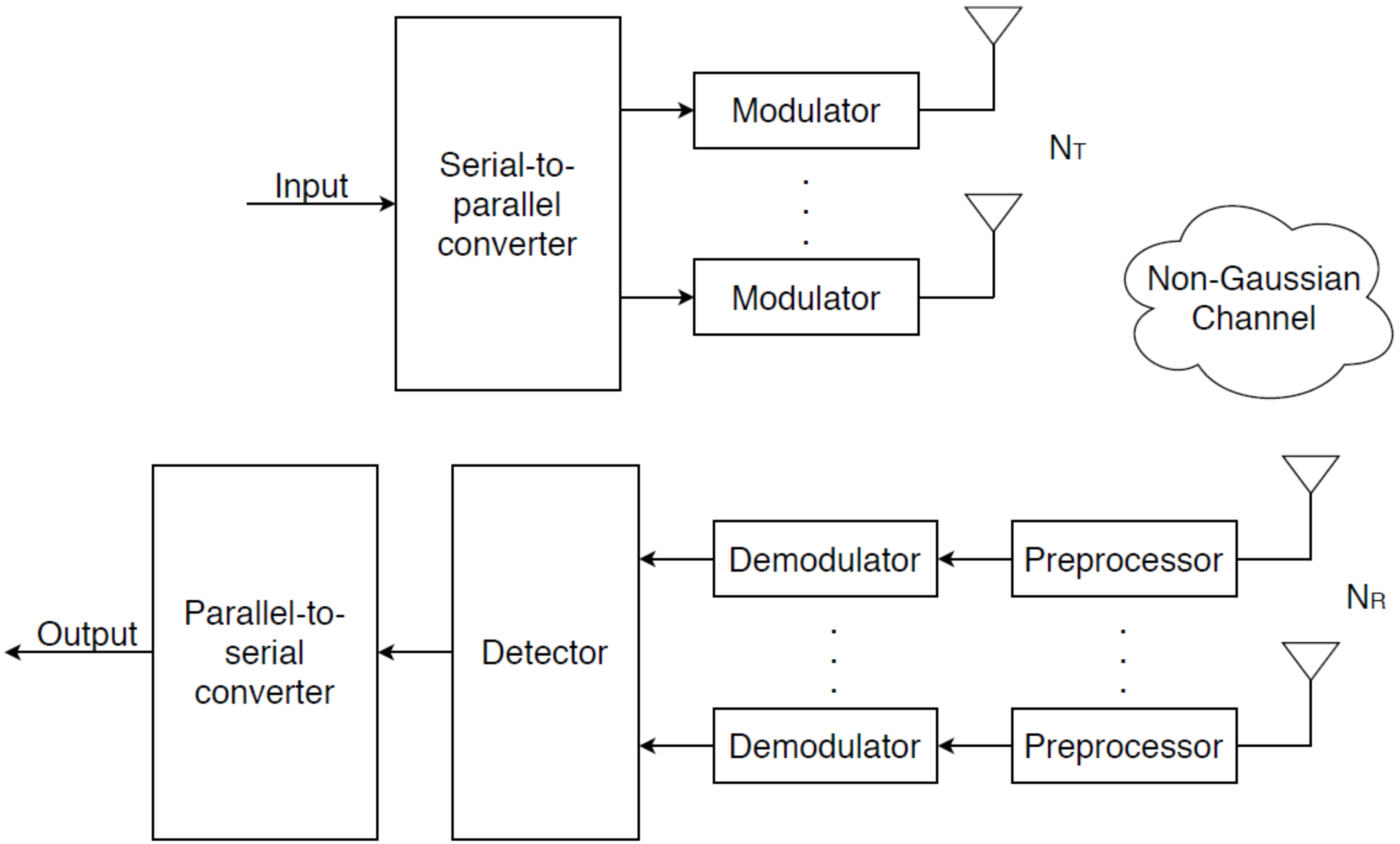
Introduction

- Scope: MIMO-OFDM receivers using preprocessor in their detectors over *non-Gaussian noise*. Traditional preprocessors depend on threshold parameters based on a priori information from the non-Gaussian noise. The proposed non-linear preprocessor does not have any parameter.

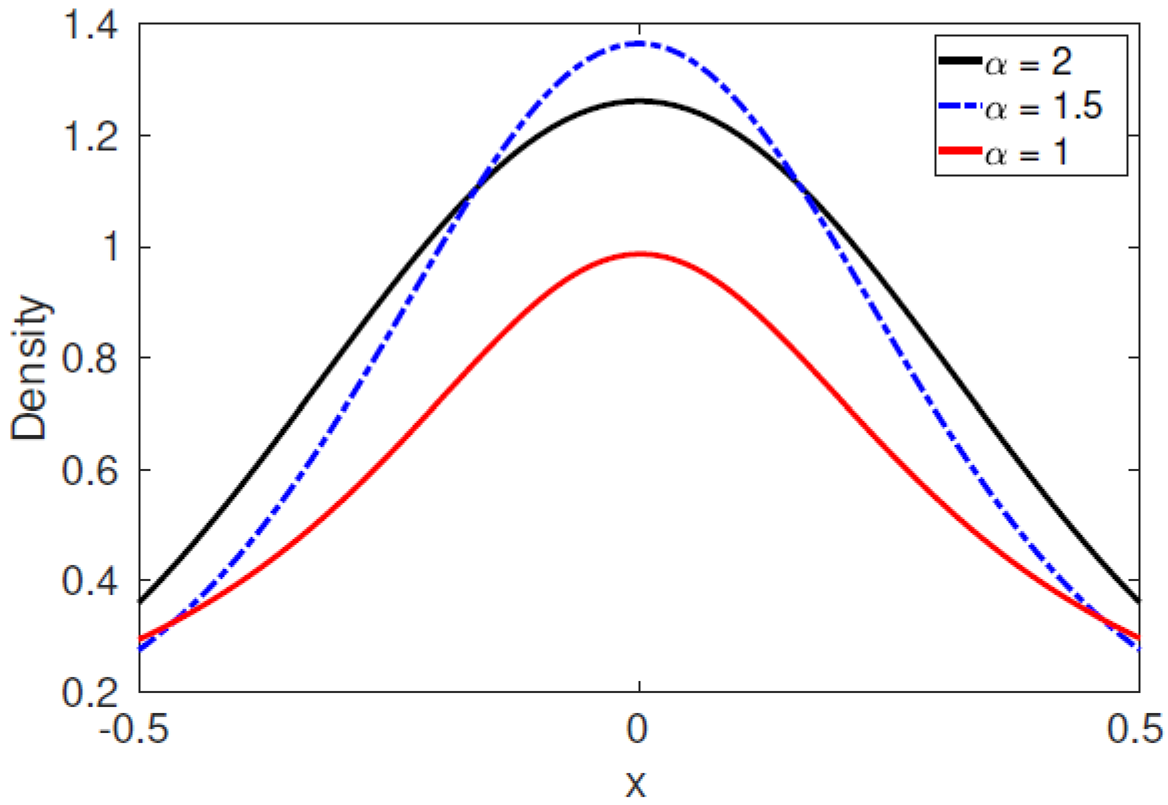
- Goal
  - Mitigate non-Gaussian noise in MIMO-OFDM receivers using preprocessor without any parameter.

MIMO-OFDM System



MIMO-OFDM System

- Non-Gaussian noise model: symmetric alpha-stable distribution (SαS).



Non-Linear Preprocessors

- Blanking

$$y_k = \begin{cases} r_k, & |r_k| \leq T \\ 0, & |r_k| > T \end{cases}, \quad k = 0, 1, \ldots M-1$$

- Clipping

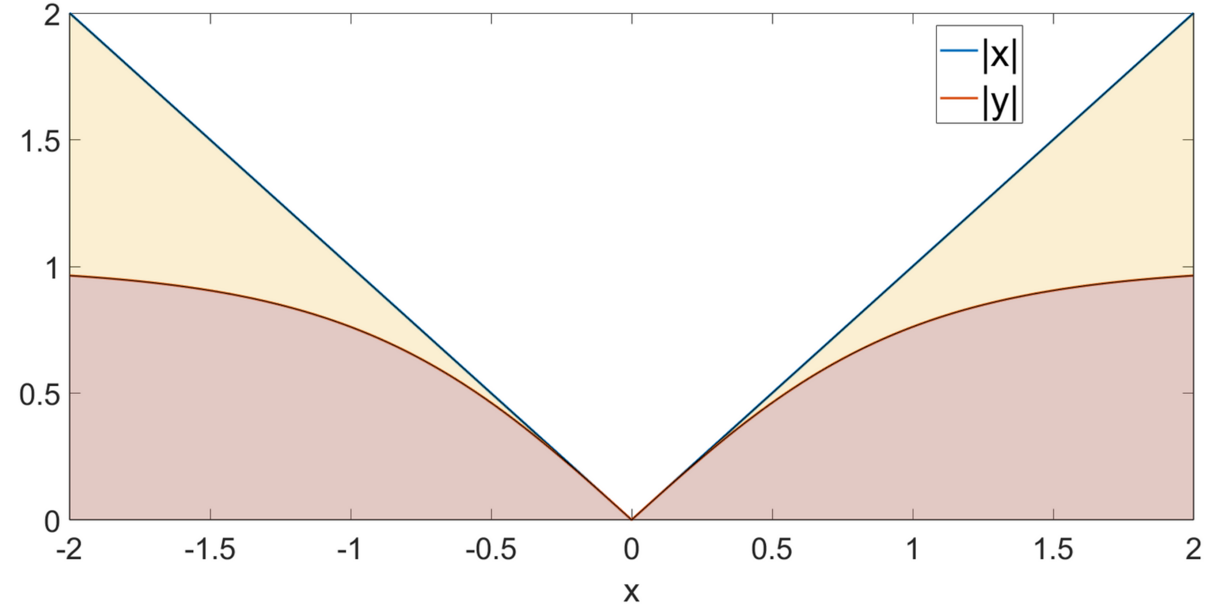
$$y_k = \begin{cases} r_k, & |r_k| \leq T \\ Te^{j\arg(r_k)}, & |r_k| > T \end{cases}, \quad k = 0, 1, \ldots M-1$$

Proposed Preprocessor

- Based on Sigmoid function

$$y_k = \tanh(r_k) = \frac{e^{r_k} - e^{-r_k}}{e^{r_k} + e^{-r_k}}$$

- Comparison with signal function (x : signal function, y : sigmoid function)



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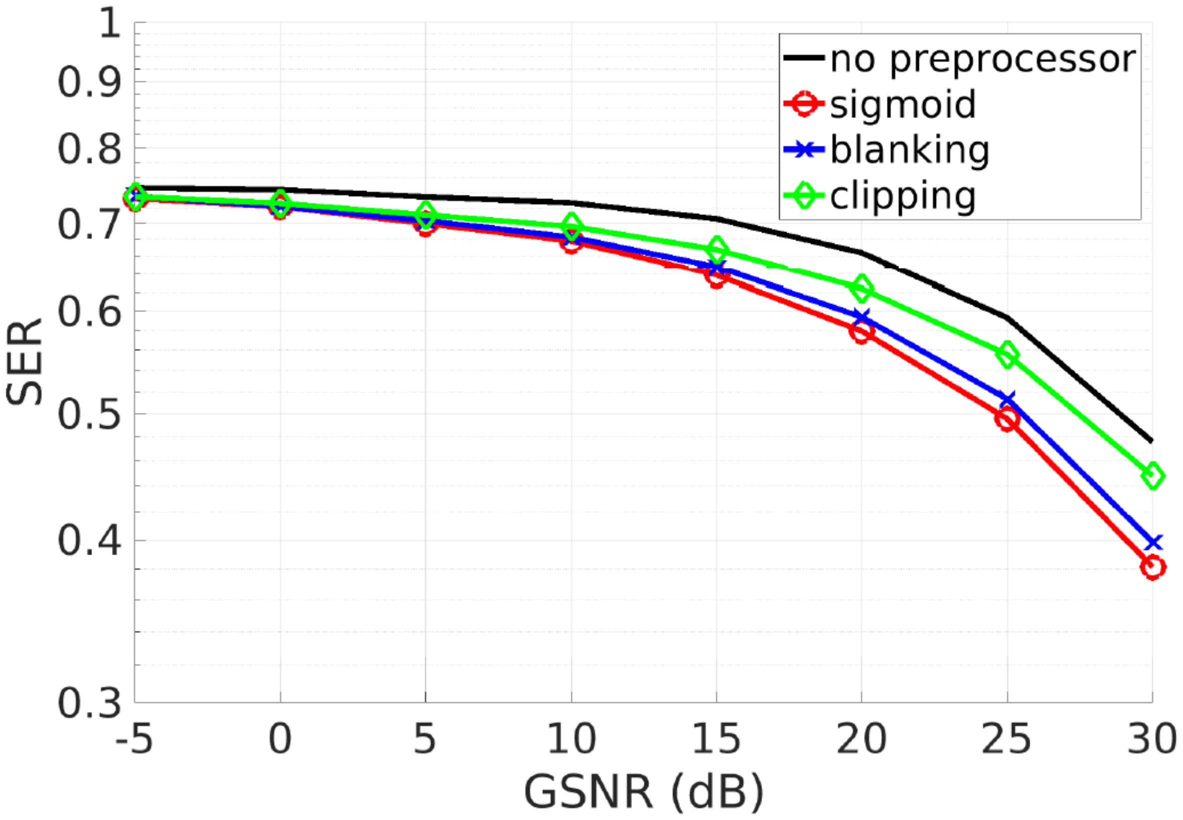
Results and Discussions

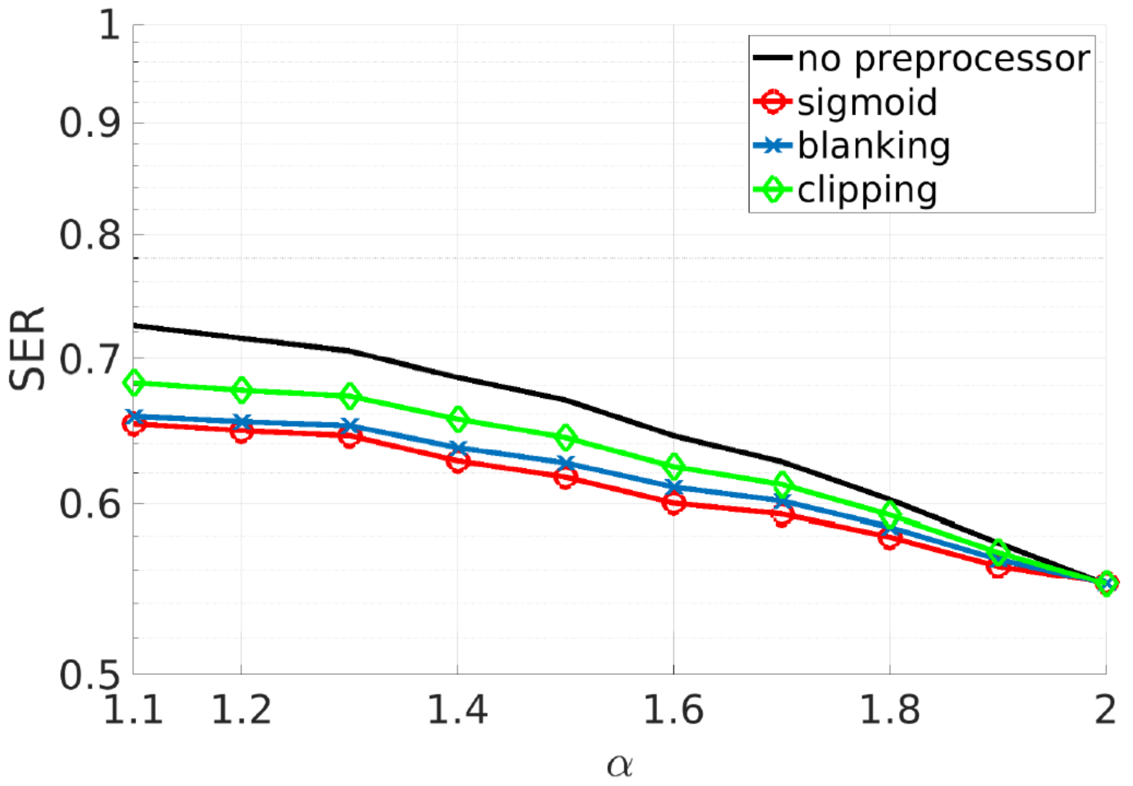
- Performance comparison among the preprocessor techniques over SαS noise with $\alpha = 1.3$ and $T = 2$.



SER: Symbol Error Rates;
T: threshold level;
α: noise parameter (SαS).

Results and Discussions

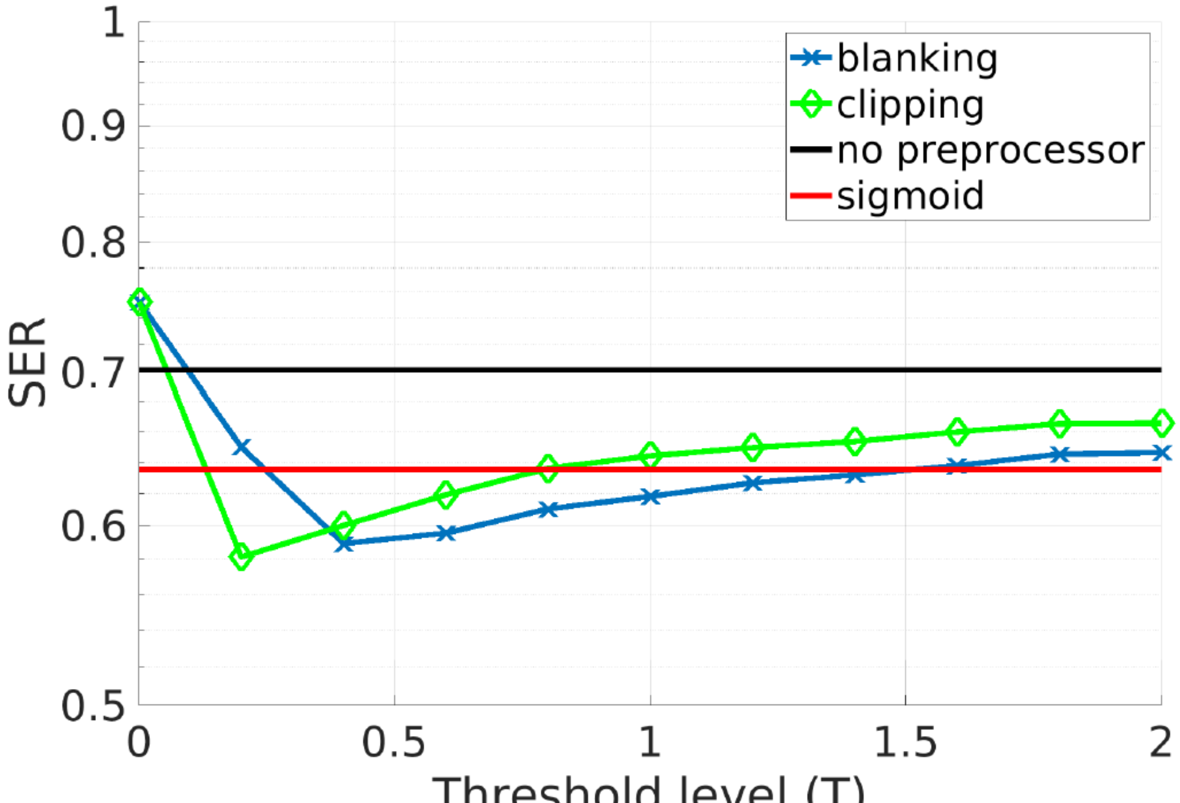
- Performance of preprocessors over SαS noise with many different values of α, GSNR $=$ 15 dB and $T\ =\ 2$.



SER: Symbol Error Rates;
T: threshold level;
GSNR: Geometric SNR.

Results and Discussions

- Performance varying threshold level of blanking and clipping preprocessors over SαS noise with $\alpha = 1.3$ and GSNR 15 dB.



SER: Symbol Error Rates;
GSNR: Geometric SNR;
α: noise parameter (SαS).

Conclusions

- We concluded that the traditional blanking and clipping preprocessors depend on the threshold level, which, in turn, also depends on the impulsiveness level in the environment. On the other hand, the sigmoid function does not have any parameters, being an alternative in the tradeoff of preprocessors in the MIMO-OFDM detection systems.
- Future works
  - Compare the solution with adaptive preprocessors and MIMO detectors;
  - Use MIMO detectors based on Machine Learning to solve the non-Gaussian scenario, and compare with the sigmoid preprocessor.

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