Gain Control Free Blind Phase and Frequency Offset Estimation for QAM Constellations

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Gain Control Free Blind Phase and Frequency Offset Acquisition

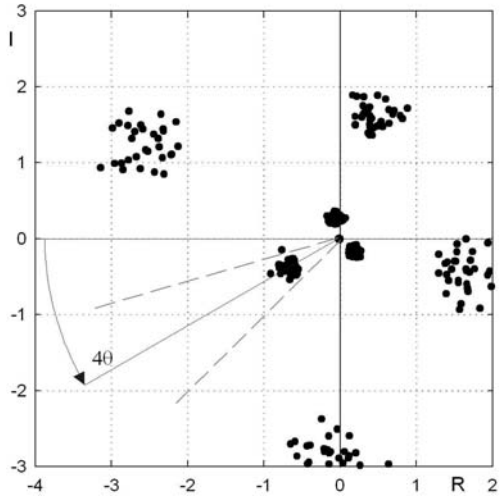
1. State of the art estimators assume perfect gain knowledge
   - Accuracy of gain estimation does affect estimation performance
   - Gain control require an increase of the overall computational complexity
2. Blind Phase offset estimator
   - **Gain control free**; only a coarse SNR estimation required
     - outperforms state of the art estimators
     - same slope of the Cramer Rao Bound
3. Blind Frequency offset estimator
   - Case of unknown constellation: **Gain control free**; doesnt need SNR estimation.
   - Case of known constellation: **Gain control free**; only a coarse SNR estimation required
     - outperforms state of the art estimators
     - same slope of the Cramer Rao Bound

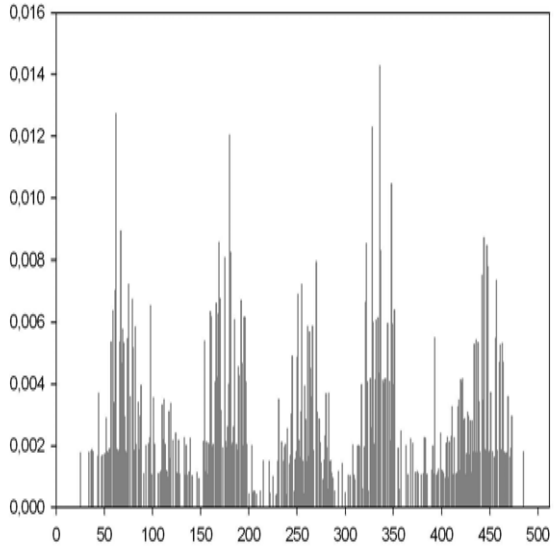
Phase Offset Estimation - Discrete time signal model

$$X[n] = G\, e^{j\theta + j2\pi f_e n}\, S[n] + W[n] \qquad f_e = 0$$

Nonlinear transformation of the received signal samples $X[n]$:

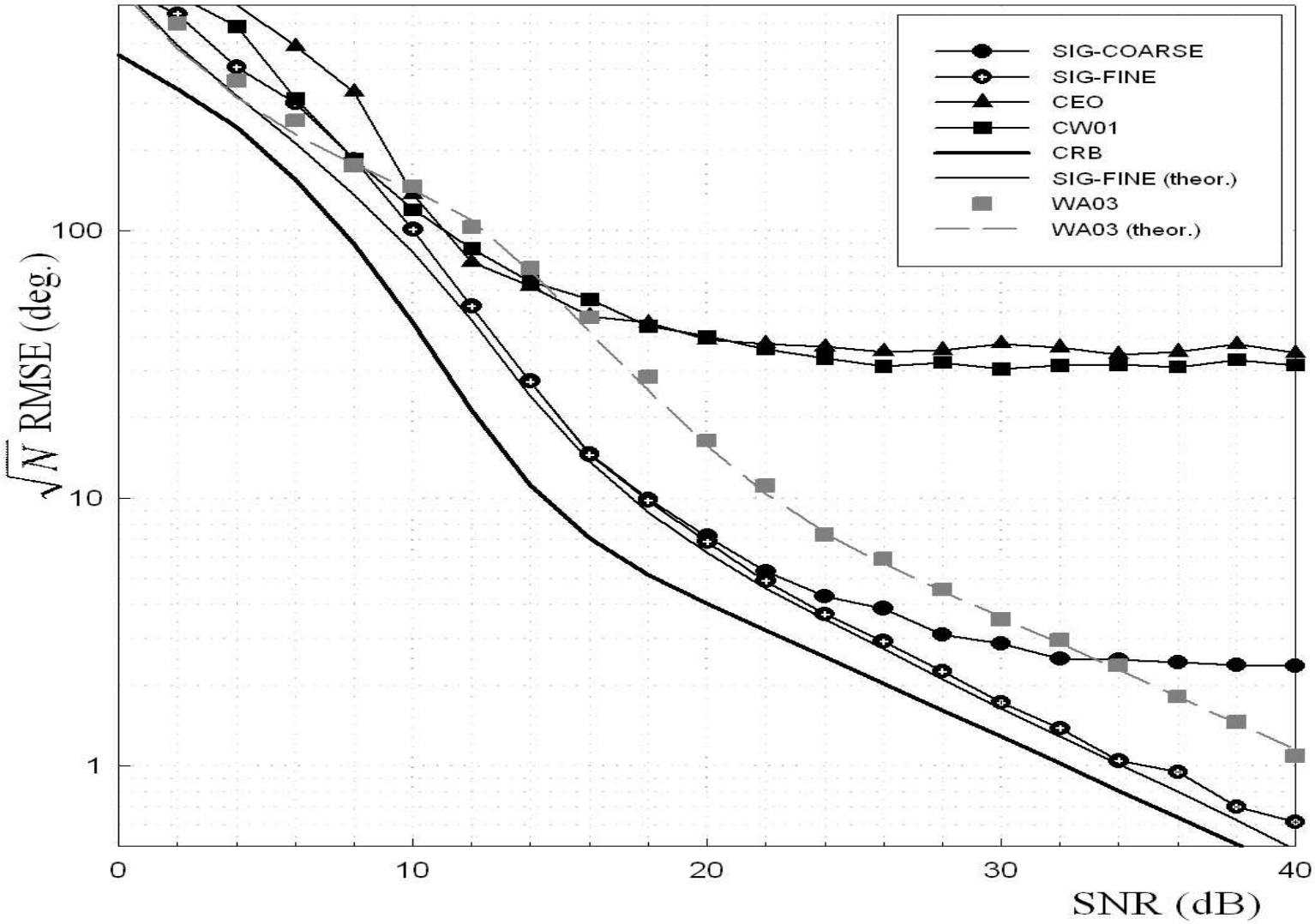
$$Y[n] = |X[n]|^P \cdot e^{j4 \cdot \arg X[n]}$$





Numerical Experiment

Root Mean Square Error for 32 QAM constellation

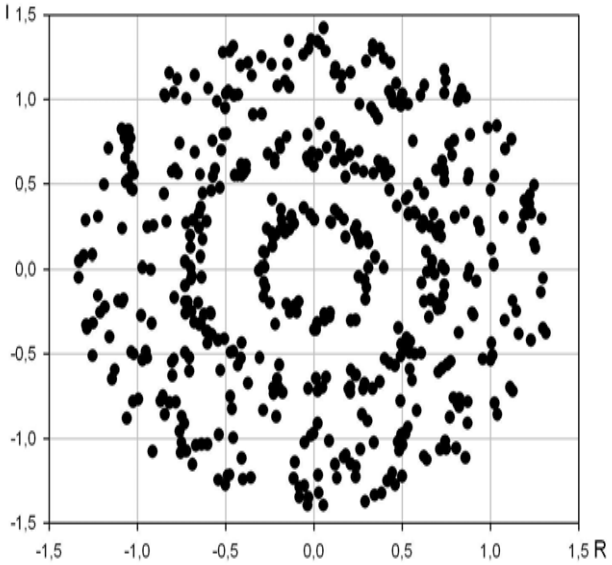


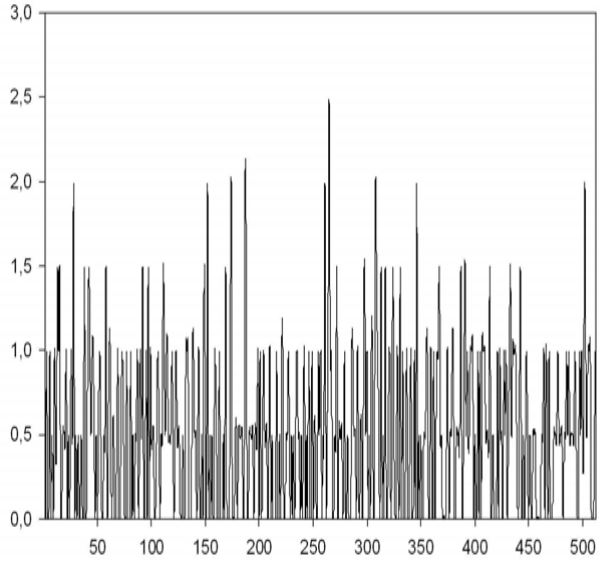
Frequency Offset Estimation - Discrete time signal model

$$X[n] = G\, e^{j\theta + j2\pi f_e n}\, S[n] + W[n] \qquad f_e \neq 0$$

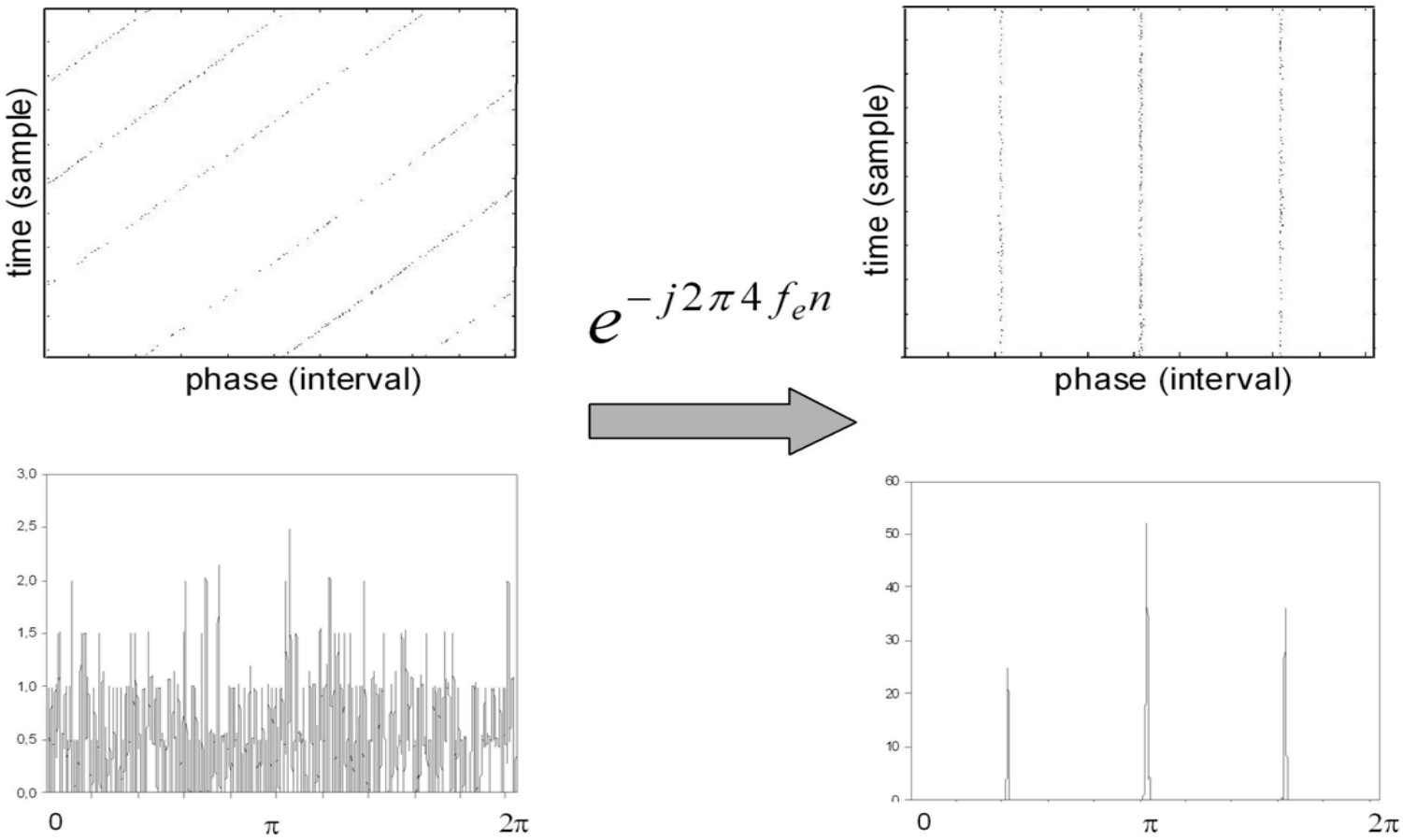
Nonlinear transformation of the received signal samples $X[n]$:

$$Y^{(f_0)}[n] = |X[n]|^P \cdot e^{j4\cdot\arg\{X[n]\}} e^{-j2\pi 4 f_0 n}$$



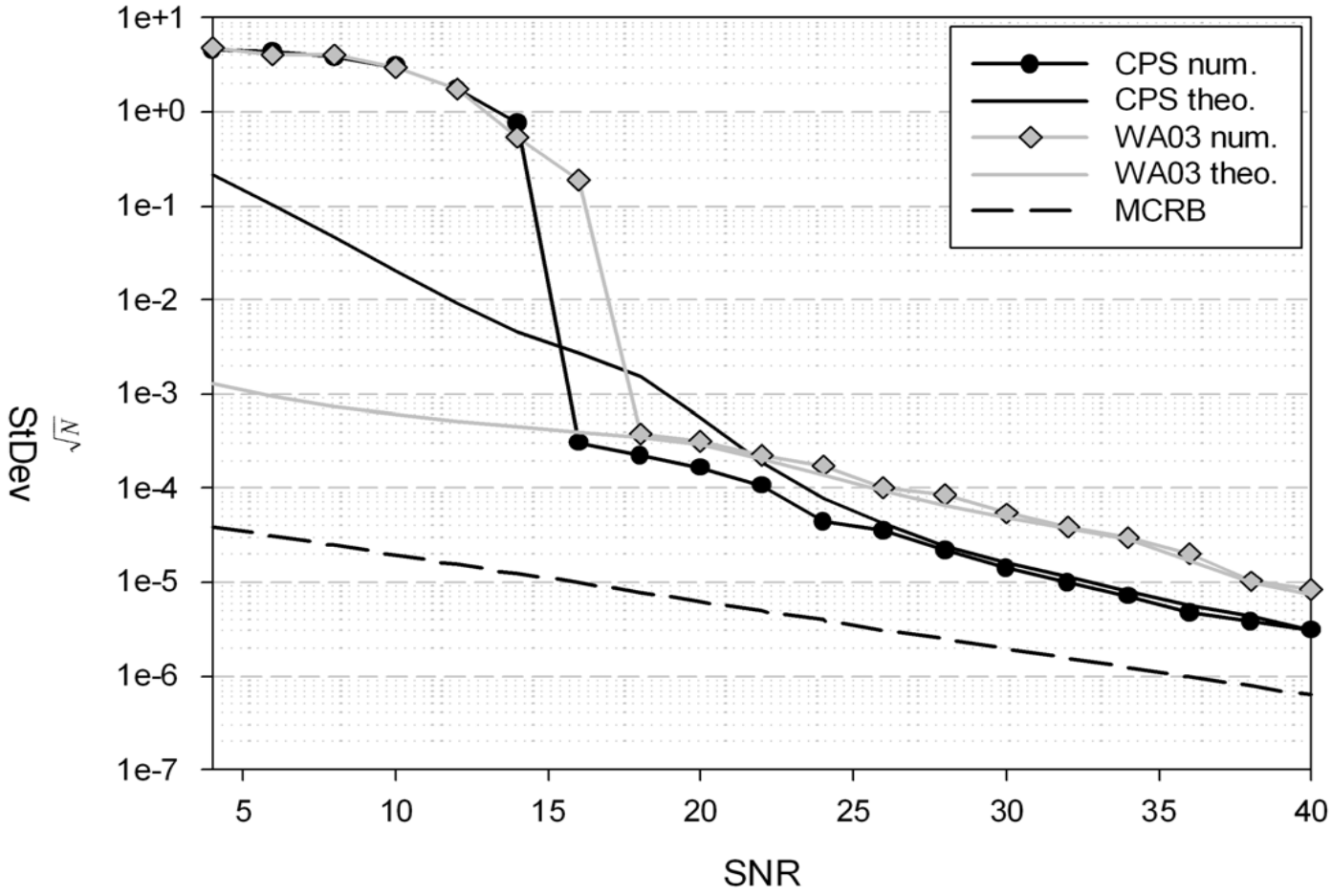


Frequency Offset Estimation: an Image Processing Approach



Numerical Experiment

Mean Square Error for 128 QAM constellation:



Conclusions and Future work

- Novel gain control free, not data aided, phase and frequency offset estimators for QAM signalling has been presented.
- A theoretical analysis concerning with asymptotic performance has been also carried out and assessed by numerical simulations.

- Future work
  - Joint phase and frequency estimation
  - CRB derivation for joint estimation

Elenco Pubblicazioni

[J1] S. Colonnese, G. Panci, S. Rinauro, G. Scarano, "Gain Control Free Near Efficient Phase Acquisition for QAM Constellations", *IEEE Transaction on Signal Processing*,Volume 56, Issue 7, Part 1, July 2008 Page(s):2849 - 2864.

[C1] S. Colonnese, G. Panci, S. Rinauro, G. Scarano, "Optimal Video Coding for Bitstream Switching Applications: a Game Theoretic Approach", WOWMOM 2007, Helsinky, Finland, June 18-21 2007.

[C2] S. Colonnese, G. Panci, S. Rinauro, G. Scarano, "Semi-Blind Bussgang Equalization for Long Sparse Channel", DSP 2007, Cardiff, Wales (UK), July 1-4 2007.

[C3] S. Colonnese, G. Panci, S. Rinauro, G. Scarano, "Blind Carrier Frequency Offset Estimation for Cross QAM Constellation", ISWCS 2007, Trondheim, Norway, October 17-19, 2007.

[C4] S. Colonnese, G. Panci, S. Rinauro, G. Scarano, "Modeling of H.264 Video Sources Performing Bitstream Switching", PCS 2007, Lisbon, Portugal, November 7-9, 2007.

[C5] S. Colonnese, G. Panci, S. Rinauro, G. Scarano, "High SNR Performance Analysis of a Blind Frequency Offset Estimator for Cross QAM Communication", ICASSP 2008, Las Vegas, Nevada, US, March 30 - April 4, 2008.

[C6] S. Colonnese, G. Panci, S. Rinauro, G. Scarano, "Markov Model of H.264 Video Sources Performing Bit-Rate Switching", *to be presented at* ICIP 2008

[C7] S. Colonnese, G. Panci, S. Rinauro, G. Scarano, "Gain Control Free Blind Frequency Offset Estimator for General QAM Communication", *to be presented at*EUSIPCO 2008

[C8]S. Colonnese, S. Rinauro, L. Rossi, G. Scarano, "Markov Model of H.264 Video Traffic", *to be presented at* ISIVC 2008.