Iterative per-Frame Gain and SNR Estimation for DVB-S2 receivers

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Abstract

In future 2nd-generation digital video broadcasting (DVB-S2) receivers working in ACM (Adaptive Coded Modulation) mode, an unknown residual gain must be estimated before the low-density parity-check (LDPC) decoding stage. Moreover, the signal-to-noise ratio (SNR) has to be estimated also, since the iterative decoding algorithms, such as those employed to decode LDPC codes, require its knowledge. Due to the presence of a time-varying phase, classical coherent algorithms for gain and SNR estimation cannot be carried out. We propose a novel gain and SNR estimator which works in conjunction with a recently proposed detection algorithm for channels with phase noise, known as CBC algorithm. In this way, implicit phase estimates by the CBC algorithm are employed to perform a partially coherent estimation of gain and SNR, which is iteratively refined.

I. Introduction

In future 2nd-generation digital video broadcasting (DVB-S2) receivers working in ACM (Adaptive Coded Modulation) mode, an unknown residual gain has to be estimated before the decoding stage of the low-density parity-check (LDPC) code. In addition, the signal-to-noise ratio (SNR) must be also estimated for decoding. This unknowns can be considered constant over a frame and independent frame by frame, due to the fact that the employed error correcting code as well as the modulation format can change frame by frame in the ACM mode.

While the low order modulations, such as quaternary phase shift keying (QPSK), tend to be quite robust to gain and SNR mismatches, the accuracy must increase for amplitude and phase modulations such as the amplitude-phase shift keying (APSK) modulations, whose performance loss in terms of Bit Error Rate (BER) could become considerable even for SNR and, especially, gain mismatches of a few tenths of dB. Thus, proper estimation algorithms have to be designed.

The problem of gain and SNR estimation has been widely studied in the past. However the application of those classical techniques to the DVB-S2 scenario poses an important issue: the presence of a time-varying phase. This phase noise, which is quite strong following the guidelines of DVB-S2 standard for consumer-grade equipments, prevents the use of all the classical techniques which consider a constant phase over a bunch of N consecutive symbols, for N larger than few units. A couple of solutions can thus be analyzed: the first one, based on a noncoherent approach (namely, irrespective to the value of the channel phase) and another, denoted as phase-aided, working jointly with the algorithm for detection in the presence of phase noise.

In [1], a low-complexity detection algorithm for channels with an unknown time-varying phase has been proposed. Thanks to its soft-input soft-output (SISO) structure, it is suitable to be used in iteratively decoded schemes, such as in the LDPC coded modulations employed in the DVB-S2 standard. It was derived by means of the Factor Graphs and the Sum-Product algorithm (FG/SPA) framework and, as it is shown in the cited paper, despite its low complexity, it is extremely robust to phase noise. We will denote this algorithm as "CBC".

In this paper, we propose a data aided[1] (DA) gain and SNR estimation algorithm embedded in the CBC algorithm, working in an iterative fashion with the LDPC decoder, taking advantage of the phase estimates implicitly produced by the CBC at every iteration. It is based on known symbols, namely the preamble or the distributed pilot symbols (if they are present) inserted in the DVB-S2 frames. The proposed algorithm is derived in this way: an overall FG, including the code symbols, the phases, the gain and the SNR is built. All the messages along the edges encompassing the gain and SNR nodes are forced to be Dirac deltas, whose position is updated following the equations of the SPA. Some approximations are introduced in order to obtain low complexity equations.

A key point of this kind of algorithms is the schedule. We propose this one: first, consider an initial guess of the gain and SNR (e.g., gain equal to 1 and SNR equal to the lowest SNR ensuring convergence for the employed code

[1] A straightforward extension to decision directed (DD) processing will be proposed also.

and modulation format). An instance of the CBC algorithm with these guess values is executed and the resulting phase estimations are used to update the gain and SNR guesses. Then, the LDPC SISO decoder is launched using the extrinsic informations generated by CBC algorithm and its extrinsic information is used as a priori information for another execution of the CBC. Then this procedure continues iteratively, allowing, for large enough SNR values, the convergence of the decoder as well as the gain and SNR estimated values to the true values.

The paper is organized as follows. In Section II we describe the signal model and the problem formulation. In Section III we firstly review the CBC algorithm and in Section IV we develop the proposed novel iterative gain and SNR estimation algorithm. Performance evaluation for the DVB-S2 scenario is analyzed in Section V by means of computer simulations. Finally, Section VI concludes the paper.

II. System Model

We consider the transmission of a sequence of complex modulation symbols $\mathbf{c} = (c_0, c_1, \ldots, c_{K-1})$ over an additive white Gaussian noise (AWGN) channel affected by phase noise. Symbols c_k are linearly modulated. Assuming Nyquist transmitted pulses, matched filtering, and phase variations slow enough so as no intersymbol interference arises, the discrete-time baseband complex equivalent channel model at the receiver is given by

$$r_k = A c_k e^{j\theta_k} + n_k, \quad k = 0, \ldots, K-1\,. \tag{1}$$

We assume that the sequence $\mathbf{c}$ is a codeword of a channel code $\mathcal{C}$ constructed over an M-ary modulation constellation $\mathcal{X} \subset \mathbb{C}$. We include possible pilot symbols (known to the receiver) as a part of the code $\mathcal{C}$. The vector of noise samples $\mathbf{n} = (n_0, n_1, \ldots, n_{K-1})$ has i.i.d., complex circularly symmetric components, with $n_k \sim \mathcal{N}_{\mathbb{C}}(0, 2\sigma^2)$.[2] The vector of channel phases $\boldsymbol{\theta} = (\theta_0, \theta_1, \ldots, \theta_{K-1})$ is random, unknown to both transmitter and receiver, and statistically independent of $\mathbf{c}$ and $\mathbf{n}$. We assume that the real positive gain A is constant over a frame and independent frame by frame.

A common model for the phase noise process $\{\theta_k\}$ is the random-walk (Wiener) model described by

$$\theta_k = \theta_{k-1} + \Delta_k \tag{2}$$

where $\{\Delta_k\}$ is a white real Gaussian process with $\Delta_k \sim \mathcal{N}(0, \sigma_\Delta^2)$. Under this assumption and assuming $\theta_0 \sim$ Uniform$[0, 2\pi)$, it follows that

$$p(\theta_k|\theta_{k-1}, \theta_{k-2}, \ldots, \theta_0) = p(\theta_k|\theta_{k-1}) = p_\Delta(\theta_k - \theta_{k-1}) \tag{3}$$

where we define $p_\Delta(\phi)$ as the pdf of the increment $\Delta_k \bmod [0, 2\pi)$, i.e.,

$$p_\Delta(\phi) \triangleq \begin{cases} \displaystyle\sum_{\ell=-\infty}^{\infty} g\left(0, \sigma_\Delta^2, \phi - \ell 2\pi\right) & \phi \in [0, 2\pi) \\ 0 & \text{elsewhere.} \end{cases} \tag{4}$$

The Wiener phase noise model will be considered in the following as a working assumption in order to derive efficient iterative detection and decoding algorithms. This assumption will be relaxed in Section V, where we apply our algorithms to the DVB-S2-compliant European Space Agency (ESA) model described in [2], [3] (see Section V).

Without loss of generality, we assume that the code $\mathcal{C}$ admits an encoding function $\mu_{\mathcal{C}} : \mathbb{F}_2^B \to \mathcal{X}^K$, mapping binary information messages $\mathbf{b} \in \mathbb{F}_2^B$ into the codewords. The optimal decision rule that minimizes the average bit-error probability is given by

$$\widehat{b}_i = \arg\max_{b_i \in \mathbb{F}_2} P(b_i|\mathbf{r}) \tag{5}$$

where $P(b_i|\mathbf{r})$ denotes the a posteriori probability mass function (pmf) for the i-th information bit b_i given the received signal vector $\mathbf{r} = (r_0, \ldots, r_{K-1})$. Let $P(\mathbf{b}, \boldsymbol{\theta}|\mathbf{r})$ denote the joint posterior probability distribution function[3] of the information bits and of the phase noise vector $\boldsymbol{\theta}$ given $\mathbf{r}$. Clearly, the desired $P(b_i|\mathbf{r})$ can be obtained by marginalizing $P(\mathbf{b}, \boldsymbol{\theta}|\mathbf{r})$ with respect to $\boldsymbol{\theta}$ and to all b_j for $j \neq i$. This can be accomplished in an approximated low-complexity way by the SPA applied on the FG of $P(\mathbf{b}, \boldsymbol{\theta}, A, \sigma^2|\mathbf{r})$, as illustrated in the following.

[2]A complex circularly symmetric (resp., real) Gaussian random vector $\mathbf{v}$ with mean $\mathbf{m}$ and covariance matrix $\boldsymbol{\Sigma}$ is denoted by $\mathbf{v} \sim \mathcal{N}_{\mathbb{C}}(\mathbf{m}, \boldsymbol{\Sigma})$ (resp., by $\mathbf{v} \sim \mathcal{N}(\mathbf{m}, \boldsymbol{\Sigma})$). We denote the multivariate complex circularly symmetric (resp. real) Gaussian probability density function (pdf) with mean $\mathbf{m}$, covariance matrix $\boldsymbol{\Sigma}$ and argument $\mathbf{x}$ by $g_{\mathbb{C}}(\mathbf{m}, \boldsymbol{\Sigma}, \mathbf{x})$ (resp., by $g(\mathbf{m}, \boldsymbol{\Sigma}, \mathbf{x})$).

[3]We use the term probability distribution function to denote a continuous pdf with some discrete probability masses. For a probability distribution function we still use the symbol $P(.)$.

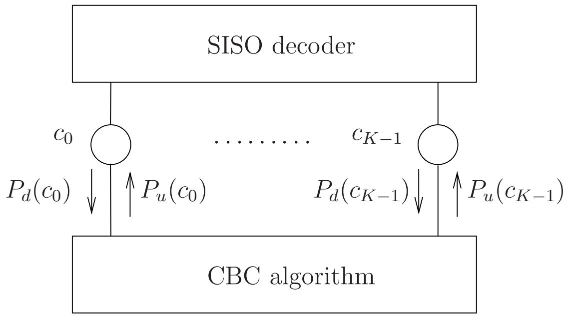

Fig. 1. Pictorial representation of the iterative receiver.

III. The CBC algorithm

The FG representation and the SPA [4] provide a general and powerful framework to reinterpret a number of well-known algorithms in digital communications, such as the Viterbi algorithm [5], the BCJR algorithm [6], the iterative "turbo" decoding algorithm [7], and the belief propagation algorithm for LDPC codes [8].

In [1], [9], the FG/SPA framework has been used to derive a new efficient algorithm for iterative detection and decoding of channel codes transmitted over channels affected by phase noise. The approach is Bayesian, i.e., the unknown channel parameter is modeled as a stochastic process with known statistics. The FG corresponding to the joint a posteriori probability distribution of the information message bits given the received signal is built and the SPA is used to compute the posterior marginal distributions. Bit-by-bit decisions are then made, based on the resulting posterior marginals. The FG includes the knowledge of the unknown parameter statistics. Expectation over the unknown parameters is implicitly performed by the SPA as part of the marginalization.

We now briefly review the derivation of the algorithm proposed in [1] (denoted as the "CBC" algorithm in the following). Let us focus on the random-walk phase noise model with Gaussian increments, as in [10]. While the SPA is well-suited to handle discrete random variables, characterized by a pmf, the channel parameters are typically continuous random variables, characterized by a pdf. The SPA for continuous random variables involves integration and computation of continuous pdfs, and it is not suited for direct implementation. A solution for this problem is suggested in [11] and consists of the use of *canonical distributions*, i.e., the pdfs computed by the SPA are constrained to be in a certain "canonical" family, characterized by some parameterization. Hence, the SPA has just to forward the parameters of the pdf rather than the pdf itself. Clearly, several different algorithms can be obtained depending of the choice of the canonical distribution.

In [1], an approach based on a Tikhonov parameterization has been proposed. It yields a one-dimensional forward-backward recursion that can be regarded (roughly speaking) as a non-linear version of the Kalman smoother. Remarkably, its performance is nearly as good as the discretized-phase approach (nearly optimal) with considerable less complexity [1].[4] Let consider Fig. 1, which represents a pictorial description of the iterative receiver. Two blocks, namely the SISO decoder (e.g., the LDPC decoder in the DVB-S2 scenario) and the CBC algorithm are iteratively activated and exchange themselves the extrinsic symbol probabilities. We denote with $P_d(c_k)$ the a priori probability of the modulation symbol c_k at time epoch k provided by the decoder and with $P_u(c_k)$ the extrinsic a posteriori probability evaluated by the CBC algorithm. These probabilities are iteratively updated, but the explicit reference on the iteration number is dropped for simplicity.

The CBC algorithm is based on the following steps:

1) Given the messages $P_d(c_k), k = 0, 1, \ldots, K-1, c_k \in \mathcal{X}$, provided by the decoder, for $k = 0, 1, \ldots, K-1$, compute

$$\alpha_k = A \sum_{c_k} P_d(c_k) c_k \tag{6}$$

and

$$\beta_k = A^2 \sum_{c_k} P_d(c_k) |c_k|^2 \,. \tag{7}$$

[4] In [1] it is found that a minimum number of pilot symbols is necessary for this algorithm to bootstrap the iterative decoder in the case of strong phase noise and long codewords.

The complex parameter α_k and the real one β_k are respectively the first and second order moments of the a priori pmf $P_d(c_k)$.

2) Forward recursion. It consists of the evaluation of a sequence of complex parameters, one for each time epoch, denoted as $a_{f,k}$ and implicitly representing an estimate of the phase at time k. Let $a_{f,0} = 0$. For all $k = 1, 2, \ldots, K-1$, compute
$$a'_{f,k} = a_{f,k-1} + 2\frac{r_{k-1}\alpha^*_{k-1}}{2\sigma^2 + \beta_{k-1} - |\alpha_{k-1}|^2} \tag{8}$$
and then
$$a_{f,k} = \frac{a'_{f,k}}{1 + \sigma^2_\Delta |a'_{f,k}|} \,. \tag{9}$$
In the previous recursive equation, σ_Δ is, as already mentioned, the standard deviation of the increment Δ_k of the Wiener process. In the numerical results, we will consider a phase noise that cannot be modeled as a Wiener process. In that case, σ_Δ must be considered as a design parameter to be optimized by computer simulation for the phase noise at hand.

3) Backward recursion. Similary to the forward recursion, a sequence of complex parameters $a_{b,k}$ is recursively updated during this stage. Let $a_{b,K-1} = 0$. For all $k = K-2, \ldots, 1, 0$, compute
$$a'_{b,k} = a_{b,k+1} + 2\frac{r_{k+1}\alpha^*_{k+1}}{2\sigma^2 + \beta_{k+1} - |\alpha_{k+1}|^2} \tag{10}$$
and then
$$a_{b,k} = \frac{a'_{b,k}}{1 + \sigma^2_\Delta |a'_{b,k}|} \,. \tag{11}$$

4) The messages sent to the decoder for a new iteration will be, for all $k = 0, 1, \ldots, K-1$
$$P_u(c_k) \;\propto\; \exp\left\{-A^2\frac{|c_k|^2}{2\sigma^2}\right\} \mathrm{I}_0\left(\left|a_{f,k} + a_{b,k} + A\frac{r_k c^*_k}{\sigma^2}\right|\right) \tag{12}$$
$$\simeq\; \exp\left\{-A^2\frac{|c_k|^2}{2\sigma^2} + \left|a_{f,k} + a_{b,k} + A\frac{r_k c^*_k}{\sigma^2}\right|\right\} \,. \tag{13}$$

where $\mathrm{I}_0(\cdot)$ is the modified Bessel function of the first kind of order zero. Eq. (13) stems from the fact that, for large enough argument, $\mathrm{I}_0(x) \simeq e^x$.

Hence, the algorithm is based on a forward-backward schedule performed over the whole codeword. Alternatively, a mixed serial-parallel schedule, performing separate and parallel forward-backward recursions between pilot fields, can be adopted with a negligible performance loss. In this way, the degree of parallelism of the implementation can be increased.

IV. Proposed estimation algorithm

It is important to remark that the CBC algorithm requires the exact knowledge of the gain and of the signal-to-noise ratio (since, in eqns. (6)-(12) the gain A and the noise variance σ^2 explicitly appear). Therefore, an extension is required, in order to estimate gain and SNR. We propose to embed a gain/SNR estimation algorithm in the CBC, in which a new estimation is carried out at every iteration, with the aim of iteratively improving the estimates. Since the problem of gain and SNR estimation is not critical, that is, it is not required to have very low estimation accuracies, we verified by computer simulations (as shown in Section V) that in the DVB-S2 scenario a DA estimation algorithm based on the known preamble only (or possibly on the distributed pilot symbols, if present) can reach the accuracy required to have only a minor loss with respect to the case of known gain and SNR.

However, to coherently estimate these unknown parameters, an estimate of the phase noise samples is required. We employ the implicit phase estimates produced by the CBC algorithm for this purpose. It is important to remark that the arguments of the complex parameters $a_{f,k}$ and $a_{b,k}$, evaluated during the forward and backward recursions represent an estimate of the channel phase at time epoch k, given the past and future observed samples, respectively[5]. Thus, the best estimate of the phase at time k at the end of the ℓ-th iteration turns out to be
$$\hat{\theta}^{(\ell)}_k = \arg\left(a^{(\ell)}_{f,k} + a^{(\ell)}_{b,k}\right) \tag{14}$$

[5]On the other hand, it can be shown that the magnitude of the complex parameters $a_{f,k}$ and $a_{b,k}$ is instead inversely proportional to the phase estimation variance. Hence, the larger the magnitude, the higher the reliability of the phase estimate.

TABLE I

COMPUTATIONAL LOAD PER ITERATION OF THE PROPOSED GAIN AND SNR ESTIMATION ALGORITHM.

	Real operations	ROM accesses
	$31\mathrm{card}(\mathcal{P})+2$	$\mathrm{card}(\mathcal{P})$
$\mathrm{card}(\mathcal{P})=90$	2792	90

where the superscript ℓ denotes the iteration. Let us therefore denote as $\mathcal{P}$ a set of time epochs, such that $\forall k \in \mathcal{P}, c_k$ is known. By assuming $\hat{\theta}_k^{(\ell)} = \theta_k$ (that is the true phase at time k coincides with its estimate evaluated by the CBC, which is a realistic hypothesis especially after some iterations) and applying the joint maximum likelihood (ML) estimation of the parameters (A, σ^2) (coherently with respect to the channel phase) it turns out that the estimates of gain and noise variance at the $(\ell+1)$-th iteration become

$$\hat{\sigma}^{2\,(\ell+1)} = \frac{1}{2\mathrm{card}(\mathcal{P})} \sum_{n\in\mathcal{P}} \left| r_n - \hat{A}^{(\ell)} c_n e^{j\hat{\theta}_n^{(\ell)}} \right|^2 \tag{15}$$

$$\hat{A}^{(\ell+1)} = \frac{1}{\mathrm{card}(\mathcal{P})} \sum_{n\in\mathcal{P}} \mathrm{Re}\left[r_n c_n^* e^{-j\hat{\theta}_n^{(\ell)}} \right] . \tag{16}$$

It is worth noting that, as the iterations proceed, better phase estimates are produced by the CBC, thus refining also the estimates of the gain and noise variance. This approach will be denoted as DA/PED (i.e., Data Aided, since it uses only the known symbols, and Phase Estimate Directed, since it perform coherent estimation by using the phase estimates coming from the CBC). Clearly, an initial guess of the parameters is required in order for the algorithm to bootstrap. A natural choice is $\hat{A}^{(0)} = E\{A\}$ (i.e., its expected value) and $\hat{\sigma}^{2\,(0)}$ corresponding to the lowest SNR value for which the considered communication system is below a given BER (the so-called SNR threshold value).

As a final remark, we point out that, if necessary, a modification of the proposed algorithm may be developed to take advantage also from the unknown (code) symbols during the estimation, by using the preliminary decision from the LDPC decoder, thus obtaining a DA-DD/PED version (where DD stands for Decision Directed). Anyway, we will not pursue this solution in the section devoted to performance evaluation since we verified that in the DVB-S2 scenario the estimates based only on the known preamble are always sufficiently accurate.

Complexity considerations

In addition to the computations carried out by the CBC algorithm (6)-(12), whose complexity has been assessed in [1], the proposed iterative gain and SNR estimator requires the evaluation of (14)-(16) for every iteration. Table I reports the computational complexity per iteration in terms of real operations and ROM accesses for the evaluation of (14)-(16). The second row in the table refers to the DVB-S2 scenario in which the estimate is based on the preamble only. Hence, in this case $\mathrm{card}(\mathcal{P}) = 90$.

V. NUMERICAL RESULTS

In this Section, the performance of the proposed algorithm is assessed by computer simulations in terms of bit error rate (BER) versus E_b/N_0, E_b being the received signal energy per information bit and N_0 the one-sided noise power spectral density. Unless otherwise stated, for the LDPC decoding a maximum of 50 iterations of the SPA on the overall graph is allowed. For each simulated point, a minimum of 50 frame errors were counted.

In all simulated cases, pilot symbols are inserted in the transmitted codeword in order to make the iterative decoding algorithms bootstrap. Pilot symbols involve a slight decrease of the effective information rate, resulting in an increase in the required signal-to-noise ratio. This increase has been introduced artificially in the curve labeled "known phase" for the sake of comparison. Hence, the gap between the "known phase" curve and the others is not related to the rate decrease due to pilot symbols.

Despite the CBC algorithm were developed with a Wiener phase noise model in mind [1], in the computer simulations we consider the DVB-S2 compliant ESA phase noise model described as follows: $\{\theta_k\}$ is the sum of the outputs of two infinite impulse response filters driven by the same white Gaussian noise process with unit variance, where the

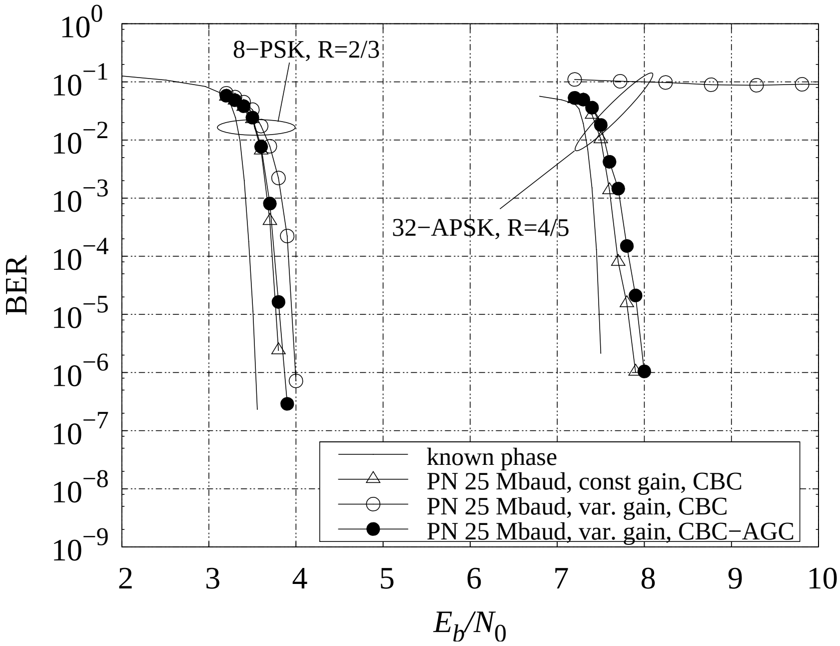

Fig. 2. Performance of the proposed algorithm. The ESA phase model for a baudrate of 25 Mbaud is considered along with 8-PSK and 32-APSK modulations.

filters are chosen to fit an experimental phase noise mask. The filter transfer functions are given by [2], [3]:

$$
\begin{aligned}
H_1(z) &= \frac{1}{\sqrt{2T}} \frac{-4.7 \cdot 10^{-11}}{(z-0.999975)^2} \\
H_2(z) &= \frac{1}{\sqrt{2T}} \frac{2.8 \cdot 10^{-6}(z-0.992015)(z-1.103181)}{(z-0.991725)(z-0.9999985)(z-0.563507)}
\end{aligned}
$$

where T is the symbol interval. For all the considered receivers, parameter σ_Δ, optimized via simulation, takes on the value $\sigma_\Delta = 0.2$ degrees. Finally, the curves labeled "var. gain" refers to simulations in which $A|_{\mathrm{dB}} \sim \mathrm{Uniform}(-2\mathrm{dB}, +2\mathrm{dB})$, which is a realistic model for the residual gain after the coarse AGC.

We consider three standardized LDPC codes with codewords of length 64800 [12], namely a rate-1/2 code mapped onto an QPSK modulation, a rate-2/3 mapped onto an 8-PSK modulation and a rate-4/5 mapped onto an 32-APSK modulation. The above mentioned phase noise ESA model is considered, for a baudrate of 25 Mbaud. Known symbols are organized into bursts of 36 symbols every 1476 transmitted symbols [12], that is the standard DVB-S2 pilot distribution, along with a preamble of 90 symbols (including both the preamble itself and the PLS code [12], which is supposed to be already successfully decoded). The performance for 8-PSK and 32-APSK is shown in Fig. 2. Along with the known-phase/known-gain curve, three other scenarios are considered:

- known gain and SNR, presence of phase noise and the plain CBC algorithm;
- unknown random gain, unknown SNR, presence of phase noise and the plain CBC algorithm;
- unknown random gain, unknown SNR, presence of phase noise and the CBC algorithm with embedded gain and SNR estimation (based only on the preamble of 90 symbols).

Some observations can be drawn from Fig. 2. First, the CBC algorithm performance is close to the known phase case, thus confirming the results in [1]. In the presence of a random unknown gain and an unknown SNR, the loss of the CBC algorithm increases due to the fact that no explicit estimation and compensation if performed. It is particularly worth the result for 32-APSK, for which the receiver without the explicit estimation cannot reach BER values less than 10^{-1}. This is well in line with the fact that APSK modulations are much more sensitive to gain and SNR mismatches. Finally, by considering the proposed gain and SNR estimators along with the CBC algorithm, the performance practically coincides with the case of known gain and SNR. Therefore the proposed algorithm is very effective in estimating and compensating for unknown gain and SNR.

In Fig. 3 the performance for QPSK modulation is shown. Since in this scenario the working SNR is much lower

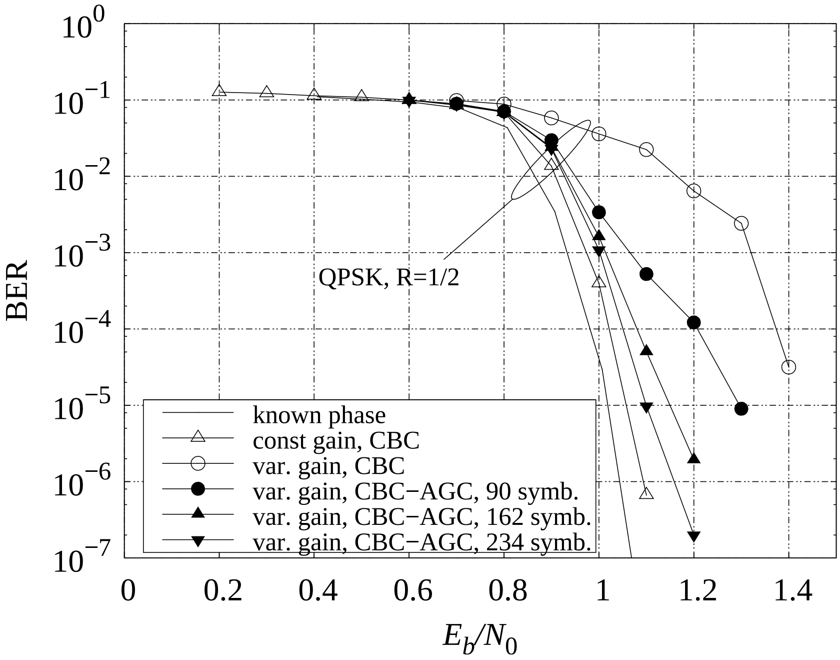

Fig. 3. Performance of the proposed algorithm for QPSK modulation, with gain and SNR estimation working on different block sizes.

($E_b/N_0 \approx 1$ dB, corresponding to $E_s/N_0 \approx 0.88$ dB), the gain and SNR estimation accuracy may be not sufficient to get performance similar to that of the case of known gain and SNR. Indeed, the curve labeled “CBC-AGC, 90 symb.”, obtained with the proposed algorithm carrying out estimation only over the preamble, exhibits a significant loss and a different slope with respect to the ideal case. Hence, a larger number of symbols is required for the estimation purposes: as it can be seen from the figure, by using two or four pilot fields beside the preamble (for a total number of pilot symbols of 162 and 234 respectively) the performance approaches that of the ideal case of known gain and SNR.

VI. Conclusions

The problem of gain and SNR estimation in the DVB-S2 scenario has been considered. Since the phase is rapidly time-varying, due to the phase noise introduced by the employed consumer-grade equipments, classical coherent gain and SNR estimation cannot be carried out.

In [1], a very effective detection algorithm for AWGN channels with phase noise, denoted as CBC, assuming known gain and SNR, was proposed. In this paper, the CBC algorithm has been extended to take into account the gain and SNR estimation. The proposed algorithm employs the phase estimates implicitly produced by the CBC to perform a partially coherent estimation of gain and SNR. Moreover, this estimated values are iteratively improved during the iterations, exploiting the fact that the phase estimates become more and more reliable.

In the numerical results section it has been shown that the proposed algorithm is very effective to combat the presence of unknown gain and SNR. Thanks also to its very low computational complexity, it is well suited for systems where powerful LDPC-coded modulations are transmitted in the presence of phase noise and unknown gain constant over a frame, such as in next-generation satellite Digital Video Broadcasting systems.

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