Error Propagation Compensation Technique for Coded Decision Feedback Equalizer

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***Abstract*— In this paper, we review decision feedback equalizer (DFE). From the DFE structure, error propagation is inevitable phenomenon. We start with a comprehensive signal model including error propagation. Based on this signal modeling, we derive new equations for the DFE filter which support the enhanced bit error rate (BER) performance. Newly derived filter equation considers the decision error propagation and computes the optimal soft bit Log-Likelihood Ratio (LLR) metric for soft input Viterbi decoder. In the simulation section, we compare the performance of two systems and show the performance improvement when adopting the proposed technique.**

I. Introduction

Channel equalization techniques have been widely used by communication engineers to mitigate the effects of the intersymbol interference (ISI) of a channel in many communication systems. Among them, a decision feedback equalizer (DFE) is one popular equalization structure as a practical detection scheme [1], [2].

The DFE decodes channel inputs on a symbol-by-symbol basis and uses past decisions to remove trailing ISI. The feedforward filter in the DFE tries to concentrate the channel energy into the first sample, and then the feedback filter cancels the trailing ISI using previous decisions. The minimum-mean-square-error decision feedback equalizer (MMSE-DFE) optimizes the feedforward and feedback filter to minimize the mean square error (MSE)[3].

Channel coding gives better performance than uncoded system because it gives immunity to channel by inserting the redundancy [4]. The DFE can also be used in the coded systems as part of a separate equalization and decoding scheme [5]. Hence we connect the convolutional coding to the MMSE-DFE. Compared with the uncoded MMSE-DFE system, this scheme performs better but is more complex and incur larger overall decoding delay. In the coded MMSE-DFE system, we need a soft output demapper which produces a log-likelihood ratio (LLR) values for soft input Viterbi decoder. For obtaining the LLR, we employ the soft output demapper at the receiver [6]. In soft output demapper, the noise variance has a great important role to obtain the performance.

The DFE is inherently a nonlinear receiver. However, it can be analyzed using linear techniques, if one assumes all previous decisions are correct. But in practice, this may not be true, and can be a significant weakness of decision feedback that cannot be overlooked. Actually there are some papers to handle the mitigating of the error propagation effects in the DFE system [7], [8].

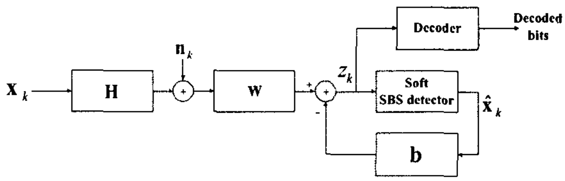

Fig. 1. Coded decision feedback equalizer

Therefore, in this paper, we focus an error propagation of the coded MMSE-DFE receiver. First, we analyze the DFE algorithm which takes the error propagation effect into account. By including the decision errors into the equalizer formulation, an improved detection performance is attained. Based on the analysis of the equalization process with error propagation, we newly derive mean-square error and their variance. With this compensated variance, we propose the coded MMSE-DFE system whose the demapper can works with more accuracy.

The paper is organized as follows: In section II, the system model for the conventional DFE is presented. The enhanced DFE structure and derived filter tap are proposed in section III. Also error compensated variance for soft output demapper is described in section III. Finally, the simulation results and a conclusion are presented in sections IV and V, respectively.

II. Conventional DFE Model

Before presenting the proposed scheme, we review the conventional DFE system. The structure of the conventional DFE is shown in Fig. 1. We assume that the pulse response $h(t)$ extends over a finite interval $0 \le t \le \nu T$, where T denotes the symbol period. The channel model is given by

$$y(t) = \sum_m x_m h(t - mT) + n(t) \tag{1}$$