Chapter 11

GBF Trained Neuro-Fuzzy Equalizer for Time Varying Channels

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ABSTRACT

This paper proposes a neuro-fuzzy filter for equalization of time-varying channels. Additionally, it proposes to tune the equalizer with a hybrid algorithm between Genetic Algorithms (GA) and Bacteria Foraging (BFO), termed as GBF. The major advantage of the method developed in this paper is that all parameters of the neuro-fuzzy network, including the rule base, are tuned simultaneously through the proposed hybrid algorithm of genetic Algorithm and bacteria foraging. The performance of the Neuro-Fuzzy equalizer designed using the proposed approach is compared with Genetic algorithm based equalizers. The results confirm that the methodology used in the paper is much better than existing approaches. The proposed hybrid algorithm also eliminates the limitations of GA based equalizer, i.e. the inherent characteristic of GA, i.e. GAs risk finding a sub-optimal solution.

1. INTRODUCTION

Communication channels medium are often modeled as band limited channel for which the channel impulse response is that of an ideal low pass filter. When a sequence of symbols is transmitted, the low pass filtering of the channel distorts the transmitted symbols over successive time intervals causing symbols spread and overlap with adjacent symbols. This resulting linear distortion is known as inter symbol interference (ISI). In addition nonlinear distortion is also caused by cross talk in the channel and use of amplifiers. Adaptive channel equalizers play an important role in recovering digital information from digital communication channels. Preparta (1989) had suggested a simple and attractive scheme for dispersal recovery of digital information based on the Discrete Fourier

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Transform. Subsequently Gibson et al. (1991) have reported an efficient nonlinear ANN structure for reconstructing digital signals, which have been passed through a dispersive channel and corrupted with additive noise. In a recent publication (Voulgaris & Hadjicostics, 2004) the authors have proposed optimal preprocessing strategies for perfect reconstruction of binary signals from a dispersive communication channels. Touri et al. (2006) have developed deterministic worst-case framework for perfect reconstruction of discrete data information from digital communication channels. Preparta (1989) had suggested a simple and attractive scheme for dispersal recovery of digital information based on the Discrete Fourier Transform. Subsequently Gibson et al. (1991) have reported an efficient nonlinear ANN structure for reconstructing digital signals, which have been passed through a dispersive channel and corrupted with additive noise.

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In recent days Bacterial Foraging Optimization (BFO) has been proposed (Passino, 2002) and has been applied for signal recovery (Acharya, Panda, & Lakshmi, 2009; Majhi & Panda, 2010; Guzmán, Delgado, & De Carvalho, 2009; Shoorehdeli, Teshnehlab, & Sedigh, 2009). The BFO is a useful alternative to GA and requires less number of computations. In addition BFO is also derivative free optimization technique. The number of parameters that are used for searching the total solution space are much higher in BFO compared to those in GA. Hence the possibility of avoiding the local minimum is higher in BFO. In this scheme, the foraging (methods for locating, handling and ingesting food) behavior of E. Coli bacteria present in our intestines is mimicked.

In this paper, a hybrid algorithm of GA and BFO (GBF) is used for updating the weights of the proposed neuro-fuzzy filter based adaptive equalizer. The same equalizer is also trained using GA to have a comparative study.

The organization of the paper is as follows: Section 2 discusses proposed system model. Activation functions for the proposed equalizer are discussed in Section3. In Section 4 the BFO and GA based hybrid algorithm is developed to update the equalizer. For performance evaluation, the simulation study is carried out which is dealt in Section 5. Finally conclusion of the paper is outlined in Section 6.

2. SYSTEM MODEL

The Neuro-fuzzy model used in this paper uses a multi-layer fuzzy neural network shown in Figure 1. The system has a total of 5 layers as proposed