Chapter 10
Applications of Hybrid Intelligent Systems in Adaptive Communication

Atta ur Rahman
University of Dammam, Saudi Arabia

ABSTRACT

Dynamic allocation of the resources for optimum utilization and throughput maximization is one of the most important fields of research nowadays. In this process the available resources are allocated in such a way that they are maximally utilized to enhance the overall system throughput. In this chapter a similar problem is approached which is found in Orthogonal Frequency Division Multiplexing (OFDM) environment, in which the transmission parameters namely the code rate, modulation scheme and power are adapted in such a way that overall system's data rate is maximized with a constrained bit error rate and transmit power. A Fuzzy Rule Base System (FRBS) is proposed for adapting the code rate and modulation scheme while Genetic Algorithm (GA) and Differential Evolution (DE) algorithm are used for adaptive power allocation. The proposed scheme is compared with other schemes in the literature including the famous Water-filling technique which is considered as a benchmark in the adaptive loading paradigm. Supremacy of the proposed technique is shown through computer simulations.

INTRODUCTION

Demand of high data rates, mobility and enhanced quality of service (QoS) in wireless communication systems is increasing day by day due to the advent of various applications like cloud computing with thin client architecture, services like online conferencing, video streaming and many more. To meet these requirements, conventional fixed and static communication techniques are far from satisfaction.

This situation demands adaptive and dynamic communication systems to meet the day to day communication requirements and integrity of data. In adaptive communication, different transmission parameters like transmit power, modulation scheme, number of subcarriers and forward error correcting (FEC) code rate are adjusted according to the varying channel state information (CSI) and QoS demand

DOI: 10.4018/978-1-5225-2857-9.ch010

by the user during that transmission interval. Though, adaptive communication is not a new idea as it was started about two decades ago, however, its necessity in current communication systems is much more than ever because of the shift from wired communication links to wireless communication, need of mobility and numerous services demanding high data rates with quality. Moreover, initially the adaptive communication systems were based on conventional optimization techniques because number of transmission parameters being adapted were limited to one or two like adaptive modulation and/or adaptive code rate; even if both code rate and modulation schemes were to adapt, one of the two aspects was kept fixed while other was adapted; that is adaptive modulation with fixed code rate and vice versa.

Adaptive communication is a highly non-linear and dynamic phenomenon due to three major aspects. First, number of parameters being optimized increased; second, most of the modern communication systems shift from single carrier (SC) to multicarrier (MC) systems like orthogonal frequency division multiplexing (OFDM) systems where each subcarrier experiences a different channel behavior and third, flexible data rate demands on different subcarrier or group of subcarriers to satisfy user or application demand while satisfying several constraints. So, optimum selection of these parameters in presence of certain constraints like transmit power and target bit error rates (BER), is a hottest area of research. Also, it is proven to be a non-convex optimization problem that cannot be optimized by conventional optimization techniques unless it is made convex first (Bockelmann et al, 2000).

On the other hand, applications of evolutionary algorithms and soft-computing techniques like Genetic algorithms (GAs), Differential Evolution, Fuzzy Systems (FS and their combinations (hybrid intelligent systems) has been increasing tremendously over the past decade for the solution to highly non-linear and non-convex optimization problems, identical to the one mentioned above.

In this chapter, applications of soft and evolutionary computing techniques with their hybrid versions to solve the above cited optimization problem is presented. Majorly, this chapter summarizes the work done by Atta-ur-Rahman et al. (2012-2017). This chapter is organized as follows.

- Basic concept of adaptive communication is presented in first section
- Section two contains related work and problem definition
- Section three contains the system model and coded modulations and their performance
- Section four contains the design of Fuzzy Rule Based System
- Section five contains the simulation results
- Section six contains adaptive power background and techniques
- Section seven contain applications of GA and DE in combination to FRBS
- Section eight contain simulation results and conclusions

BACKGROUND

Adaptive Communication

Adaptive communication has gained attention of most of the current and future communication systems. Many 3rd generation (3G) and 4th generation (4G) systems have employed it as the main feature of communication while 5th generation (5G) is in research phase. These systems are mainly Orthogonal Frequency Division Multiplexing (OFDM) based systems. In OFDM systems, one large data stream is