

Decoding of Decode and Forward (DF) Relay Protocol using Min-Sum Based Low Density Parity Check (LDPC) System

Jamaah Suud, Hushairi Zen, Al-Khalid B Hj Othman, Khairuddin Ab. Hamid

Department of Electrical and Electronic Engineering, Faculty of Engineering, University Malaysia Sarawak, Kota Samarahan, Sarawak, Malaysia

Abstract: Decoding high complexity is a major issue to design a decode and forward (DF) relay protocol. Thus, the establishment of low complexity decoding system would be beneficial to assist decode and forward relay protocol. This paper reviews existing methods for the min-sum based LDPC decoding system as the low complexity decoding system. Reference lists of chosen articles were further reviewed for associated publications. This paper introduces comprehensive system model representing and describing the methods developed for LDPC based for DF relay protocol. It consists of a number of components: (1) encoder and modulation at the source node, (2) demodulation, decoding, encoding and modulation at relay node, and (3) demodulation and decoding at the destination node. This paper also proposes a new taxonomy for min-sum based LDPC decoding techniques, highlights some of the most important components such as data used, result performances and profiles the Variable and Check Node (VCN) operation methods that have the potential to be used in DF relay protocol. Min-sum based LDPC decoding methods have the potential to provide an objective measure the best tradeoff between low complexities decoding process and the decoding error performance, and emerge as a cost-effective solution for practical application.

Keywords: Decode and Forward, Min-sum, Cooperative communication, LDPC, Variable Node, Check Node

1. Introduction

Malaysian's mobile market has shown a remarkable growth over the years. The next generation services have since been rolled out and had started having a major impact on the market. Mobile phone usage keeps increasing over the years and people become more mobile [1]. According to World Bank, Malaysia leading Indonesia, Thailand and even United States with 140% mobile penetration which mean 47% Malaysians own more than one mobile phone. New data transfer applications such as download information from internet or sending a video has emerged in mobile phone technology, thus demand higher data rates, high speed data transfer capability and less error rate [2]. In a middle 2015, the total number of cellular subscription according to major mobile operator in Malaysia with Celcom had the largest mobile market about 12.3 million subscribers (31.3%), followed by Maxis with 31% and then Digi with 30%. By November 2015, the number internet users in Malaysia have reached 20.6 million [3].

The fifth generation technologies beyond the current wireless communication networks are required to cater a tremendous Internet of Thing (IOT) era demand. Such demand include the embed sensor into security system, automated door locks, health monitoring and mobile transportation. The immediate need of IOT devices for 5G technology is expected to double

to over 50 billion by year 2020 [4]. However, wireless channel fading issue on the transmitted signal usually severely degraded the performance of the overall system to gain high data rate. This channel fading effect can be combated effectively by employing a diversity technique called cooperative communication. The cooperative communication is achieved through formation of virtual antenna array created by cooperation of a number of distributed single antenna terminals. Cooperative communication system proposed by Van Der Meulen in 1971 [5], [6] based on relay channel concept was an efficient method for continuous improvement and mitigate all the above factors and at the same time maintaining the reliability of communications particularly for smaller and lighter devices like mobile phone. In the design, the relay was aided between the transmitter and the receiver working as a virtual antenna array.

Cooperative communications have emerged as considerable area of research and become a viable option for next generation communication systems requirement. Furthermore, various error control codes technique can be adapted to cooperative communication environment. Sendonaris et. al was a pioneer in area of cooperative communication introduce in 2003 [7], [8]. In 2006, Hunter et. al [9] introduced convolutional codes integrate to cooperative communication called coded cooperation. Further improvement on the existing works led to development of an embed Turbo codes [10] in the system in order to achieve higher coding gain. Number of the research in [11]–[14] were performed using Turbo code. Then, an advanced development in channel coding technique named LDPC code take place as an efficient solution by exploiting its superior in transferring data performance over noisy relay channel. Among all error control codes, LDPC code shown the great potential error correcting codes compare to other codes as it approaches Shannon channel capacity [15]–[17]. LDPC code was first adopted in relay channel by Khojastepour et. al [17].

The aim of this paper is to review the literature on the min-sum based LDPC decoding method for decode and forward (DF) relay protocol and describe the current methods available in the min-sum based LDPC decoding process. More specifically, the paper endeavors to (1) proposed LDPC based system model for decode and forward protocol consist of source, relay and destination components, (2) investigate the existing min-sum based LDPC decoding approaches, (3) compare the performances of the min-sum based LDPC decoding system, (4) identify the potential of