Analysis of Quantum Computing and Trellis Coding based on PUM Codes

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ABSTRACT

In this paper, we describe the trellis coding where quantum computing (QC) is employed to analyze the coding gain and complexity. According to quantum information theory, quantum bits increase the storage capacity as well as speed. High complex trellis based on partial memory code (PUM) is designed and simulated in digital computers. In order to reduce simulation time for trellis decoding, QC is analyzed with PUM coding. From the theoretical analysis, QC in a quantum computer will be the best option because quantum bits can be stored simultaneously in a given moment of time. From this theory, trellis states, paths, metric calculations are stored in lesser time and space than conventional storing procedures. Therefore, QC certainly will improve the trellis coder performance.

General Terms

In this paper, QC is considered as my general term. Throughout this research, trellis coding analysis is considered with QC.

Keywords

Trellis coding, QC, complexity, PUM coding, information theory

1. INTRODUCTION

Bits are dominated in digital computers, and computations based on digital applications, but quantum bits are involved in quantum computers and computations. It will dominate future applications when digital processing is moving to quantum processing. Binary system provides 0, and 1 so, digital processing is based on 2 digits. In a quantum system, available quantum bits are more than 2 digits; therefore, quantum processing will take more than 2 digits.

In this research, trellis coding techniques are considered with QC approach. From the theoretical analysis, high-complex trellis designs are easily simulated because quantum bits, and their special properties are flexible to update storage capacities. Trellis designs are constructed using Shannon product theory [5][6], and they are applied in information theory, which deals with source and channel coding.

So far QC is used in both source and channel coding applications, but trellis coding hasn't been considered yet. Under these developments, encoder, decoder and other components have been updated. In order to analyze the trellis coding, PUM trellis coding designs are considered with QC. It is used as an error control coding in communication and digital magnetic recording (storage) channels. It is designed from a combination of block and convolutional coding. Necessary details of PUM coding are explained in section 3.

2. QUANTUM COMPUTING

Quantum computing is the science based on quantum bits calculations. In this computing, nanotechnology takes important roles, which limit according to the applications. It can be used in many complicated algorithms linked with long simulations and high complexities; therefore, QC is targeted in the potential research. It will help to improve the cost, time and energy which are basic factors of innovations. For instance, overall calculations are completed in a fraction of nano second. It means that speed is extremely higher than conventional calculations because properties of quantum bits are different from ordinary bits. However, speed of sound was targeted as a first breakthrough, currently, speed of light is being explored with a number of scientific approaches. Will QC provide any solution for speed of thought? That is the physical limit which should be specified between the speed of light and speed of thought. Whatever calculation in the future quantum computers, it wouldn't go beyond the physical limit. Potential digital computers are constructed with binary building blocks. Electronically, binary 1 is represented as fixed voltage and binary zero is another fixed voltage. These digits can be represented by positive and negative voltages (e.g., +/- 5v). According to the type of applications, values of these voltages are determined. Digital computers are based on these two binary digits. In quantum computers, all computations are based on quantum bits. So, architecture of classical computers is not compatible with quantum computers. This is one of the disadvantages during the quantum computations. Certainly, speed will grow until it reaches the physical limit [9][11][12].

Some of basic features such as adding, shifting etc. are used in quantum computers where executable QC is employed to do most of the processing. They may not be sufficient to implement quantum computers with specific features. Some selected features such as memory, input, output etc. are important.

3. TRELLIS CODING

3.1 Basic PUM coding

Here, basic PUM coding is illustrated for QC, but computing complexities during the simulations degrades the performance in digital computers. In order to make a simulation faster than conventional decoders, faster computing is necessary. QC is best option as far as time of processing is concerned during the