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3. Title page
4. Table of content
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6. Summary of the thesis work in English and in a second language
7. Introduction: explanation of the task, design objectives, motivations behind the task, short description of the organization of the thesis
8. Detailed explanation and analysis of the task description
9. Preliminaries (results available in the literature, similar designs and constructions), comparisons and conclusions
10. Detailed description of the design process, evaluation of available options, motivations and justifications of design decisions
11. critical assessment of the engineering product designed, further development options
12. Acknowledgements (if applicable)
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Budapest University of Technology and Economics

Faculty of Electrical Engineering and Informatics

Department of Control Engineering and Information Technology

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MAXIMIZING POWER CONSUMPTION OF MIMO NETWORK USING A NOVEL QUANTUM GENETIC ALGORITHM

SUPERVISOR

Dr. El Gaily Sara

BUDAPEST, 2023

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Full text of thesis works classified upon the decision of the Dean will be published after a period of three years.

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...…………………………………………….

Areeba Tabassum Shoaib

Summary

Quantum computing is one of the most promising approaches to addressing the problems of computational complexity, data storage, and power consumption because of its extremely fast performance. Applying the principles of quantum computing to the development of optimization algorithms is a rapidly growing field of study.

With its ability to provide game-changing improvements in area throughput and energy efficiency, the massive multiple-input multiple-output (MIMO) system offers significant potential for 5th generation (5G) wireless communication systems. The number of antennas used by the base station is increased in massive MIMO. This has several advantages, including an array gain that may be utilized to expand coverage, favorable propagation that makes user separation easier, and channel hardening that makes the system more robust and stable. Yet, the computational complexity of the embedded optimization techniques in MIMO systems remains a problem. Several techniques, such as the Nash equilibrium-based effective water-filling algorithm (WFA), have been developed in an effort to enhance the power allocation system for MIMO.

This thesis focuses on the question of how the power consumption of MIMO systems can be maximized by using a novel Quantum Genetic Algorithm.

In this research , we implemented a quantum optimization technique known as the Quantum Extreme Value Searching Algorithm (QEVSA) to Develop a new Unconstrained Quantum Genetic Algorithm (UQGA).

Sommaire

The text of a ½-1 page long summary goes here in a second language, different of English (German, French, Portuguese, Russian, Finnish, Korean, Chinese, Japanese, Hungarian, etc,). This summary is the translation of the summary in English and has to be also uploaded to the Thesis Portal separately.

# Introduction

This chapter presents a couple of examples of the usual formatting requirements of different items you may need to include into your thesis.

## Quantum Computing Overview

In classical computing, the smallest unit of information is referred to as a "bit" and can be represented by one of two states, "0" or "1"; these states are also known as classical states. The classical processor carries out a variety of transformations on classical states, i.e., information processing using classical gates. Comparable to classical computing, Quantum computing employs specific quantum elements that do not exist in traditional computation. It is important to note that there are four primary postulates that describe quantum computer, and they are as follows:

### Postulates of Quantum Computing

**First postulate (State-space)**

A qubit is the fundamental quantum systems unit in the quantum universe that can simultaneously contemplate both classical states, referred as superposition. Below is an illustration of a qubit:

(

where a and b are complex coefficients, and |0 > and |1 > are the so-called computational basis states , such that,

Two classical states can coexist in one qubit. The outcome of a coin flip can be thought of as an example of a qubit. If we toss a coin (and assume it's fair), we've got an equal chance of getting a head or a tail with a probability of 0.5 for either outcome.

It is important to stress that is a superposition of two states, and the precise formula of (1.1) can be stated as follows:

**Second postulate (Evolution)**

How a quantum state changes over time is described by the second postulate. For those unfamiliar, the quantum gate is just a unitary operator used in quantum computing.

A unitary operator satisfies the following formula:

Moreover, the unit norm of the quantum state is conserved by a unitary transformation. The relation between and is shown as in Figure 1.1, where between is an input quantum state and is the output quantum state after performing the unitary transform U.

Logic gates in digital circuits function similarly to quantum gates in quantum circuits. The manipulation and alteration of qubits is their primary goal. Contrary to logic gates, quantum gates support the idea of reversibility, which allows us to easily convert an input quantum state into an output quantum state and vice versa.

We list some well-known quantum gates here that work with just one qubit,

**Hadamard-gate**

All quantum algorithms rely heavily on this operator during their startup phase. It is well known that when the Hadamard gate is dominated by classical states, uniform probability distributions of all computational basis states are generated.

**Third postulate (Measurement)**

It is important to note that a quantum state cannot be observed; the only way to ascertain its state is to carryout a measurement. Notice that the measurement of a quantum system can be characterized by measurement operators , where m represents a potential measurement outcome. If the system is in state , then the probability of measuring the potential state m may very well be expressed as:

where the adjoint of is denoted by and the adjoint of is denoted by . The measurement apparatus is viewed as a connection between the classical and quantum worlds; hence, in order to validate the precision of the constructed measurement apparatus, the following completeness relationship needs to be satisfied.

**Fourth postulate (Composite systems)**

The postulate describes a quantum register. The term "quantum register" refers to the component that is created when numerous quantum states are grouped together using a mathematical technique called the "tensor product." Take, for instance, the case where there are three qubits available. In order to combine these three qubits into a single quantum register, we will make use of the tensor product.

The first qubit can be represented in the following manner:

While the second and third qubits are respectively described as,

It is possible to achieve the composite of these three qubits in the following manner:

### Quantum Entanglement

Quantum entanglement was first discovered in the 1960s and was named after John von Neumann, who discovered quantum mechanics. Quantum entanglement is a logical connection between quantum states in such a way that they are spatially separated but communicating with each other; in other words, there is a certain hidden relationship between the quantum states.. For instance, if two quantum states are separated by a significant distance, the measurement of one quantum state enables instantaneous estimations of the other quantum state. The capacity of quantum entanglement to communicate at speeds greater than the speed of light is perhaps its most crucial function, as it will greatly accelerate the rate at which human society expands.

The most well-known piece of mathematical equipment that can generate entangled states is called a CNOT-gate. One of the inputs of the CNOT gate is used for controlling the device, and the other input is used for feeding it data. One will be used for the output control, while the other will be used for the output data. When we input 0 into the control terminal, the value at the data terminal does not change, which is a crucial point to keep in mind. If we enter 1 into the control terminal, then the value at the data terminal will be averted. For example, if our control terminal is set to 1, and the data terminal is receiving input 1, then the output of the data terminal will be 0.

It is worth noting that the most well-known entangled states are termed Bell states, and they are stated as follows:

.

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1.1. figure: Caption example

### Program codes

Use the **Prg code** syle to insert programming code as bellow.

using System;

namespace MyApp

{

class Program

{

static void Main( string[] args )

{

Console.WriteLine( "Hello world! Kachi Kapsida" );

}

}

}

### References

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You may place citations of references in the text using the *Insert / Cross-reference* command (an example looks like this: [1]). These citations are updated automatically if a new reference is added or their order is changed.

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* Update cross-references: select all the text first (Ctrl+A) and then press F9 to let the Word to update all cross-references. A check for “Error!..” at the places of references should be carried out.
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* Check the PDF: the best test of the document is to go through the PDF file generated from the Word version attentively.

References

1. Levendovszky, J., Jereb, L., Elek, Zs., Vesztergombi, Gy.: Adaptive statistical algorithms in network reliability analysis, Performance Evaluation - Elsevier, Vol. 48, 2002, pp. 225-236
2. National Istruments: LabVIEW grafikus fejlesztői környezet leírása, <http://www.ni.com/> (2010. nov.)
3. Fowler, M.: UML Distilled, 3rd edition, ISBN 0-321-19368-7, Addison-Wesley, 2004
4. Wikipedia: Evaluation strategy, <http://en.wikipedia.org/wiki/Evaluation_strategy> (revision 18:11, 31 July 2012)

Annex