Accurate variational Quantum Eigensolvers

Malay Singh

Supervisors : Msc Ramiro Sagastizabal and Dr. Leonardo Di Carlo
Department of Applied Physics

Delft University of technology

Three Month Report

Abstract

Put your abstract or summary here, if your university requires it.

Contents

List of Figures

LIST OF FIGURES

List of Tables

LIST OF TABLES

1

Project Proposal

One of the proposed powerful applications for near-term quantum computers is to address problems in quantum simulation of molecular structures and condensed matter physics problems, which currently stretch the limits of existing high-performance computing infrastructure[1].

1. PROJECT PROPOSAL

2

Superconducting Qubits

2.1 Quantum Information

Figure 2.1: Bloch Sphere visualisation of a single qubit state.

2.2 Superconducting Qubits

0.5

Figure 2.2: Effective Circuit for the transmon qubit

0.5

Figure 2.3: Energy levels for the transmon qubit for

$$\frac{E_J}{E_C} =?$$

found by simulation.

2.2.1 Circuit Quantum Electrodynamics

2.2.2 Single and Two qubit gates

2.2.3 Readout

2.2.4 Noise

Figure 2.4: The transmission profile of the resonator is shifted to one of two peaks conditioned on the states of the qubit.

3

Quantum Simulations with Superconducting Qubits

3.1 Introduction

3.2 Hydrogen Hamiltonian

Figure 3.1: A Flowchart depicting the steps used in mapping Real Space Molecular Hamiltonian on to Qubit Hilbert space.

Figure 3.2: The dissociation curve for Hydrogen molecule.

3.3 Variational Quantum Eigensolvers

Figure 3.3: Hardware and software schematic of the variational quantum eigensolver.

4

State preparation Ansatze

4.1 Six parameter circuit

4.2 Particle number conserving circuit

5

Error Signalling Circuit

6

Active Error minimization

6.1 Limitations of Simulations

7

Outlook

7.1 Experience Gained

7.1.1 Oscilloscope Driver

7.1.2 Quantum State Tomography

7.1.3 Miscellaneous

7.2 Experience Necessary

8

Materials & methods