Department of Electrical and Computer Engineering
North South University

Senior Design Project

FAULT TOLERANT QUANTUM ERROR DETECTION CODE

MEZBAH UDDIN SAAD 1921703042

NUZHATH TABASSUM ORPAA 1931052042

Faculty Advisor:

Dr. Mahdy Rahman Chowdhury

Assistant Professor

ECE Department

Spring, 2023

LETTER OF TRANSMITTAL

December, 2023

To

Dr. Rajesh Palit
Chairman,
Department of Electrical and Computer Engineering
North South University, Dhaka

Subject: Submission of Capstone Project Report on "Fault Tolerant Quantum Error Detection Code"

Dear Sir,

With due respect, we would like to submit our Capstone Project Report on **"Fault Tolerant Quantum Error Detection Code"** as a part of our BSc program. The report deals with a fault tolerant code that can effectively detect errors for higher number of qubits. Through this project, we have tried to contribute to the ever growing field of quantum computing by merging the concepts of fault tolerance and quantum computing.

We will be highly obliged if you kindly receive this report and provide your valuable judgment. It would be our immense pleasure if you find this report useful and informative to have an apparent perspective on the issue.

Sincerely Yours,

.....

Mezbah Uddin Saad
ECE Department
North South University, Bangladesh

.....

Nuzhath Tabassum Orpaa
ECE Department
North South University, Bangladesh

APPROVAL

Mezbah Uddin Saad (1921703042) and Nuzhath Tabassum Orpaa (1931052042) from Electrical and Computer Engineering Department of North South University, have worked on the Senior Design Project titled **"Fault Tolerant Quantum Error Detection Code"** under the supervision of Dr. Mahdy Rahman Chowdhury in partial fulfillment of the requirement for the degree of Bachelors of Science in Engineering and has been accepted as satisfactory.

Supervisor's Signature

…….

Dr. Mahdy Rahman Chowdhury

Assistant Professor

Department of Electrical and Computer Engineering

North South University

Dhaka, Bangladesh.

Chairman's Signature

…….

Dr. Rajesh Palit

Professor

Department of Electrical and Computer Engineering

North South University

Dhaka, Bangladesh.

DECLARATION

This is to declare that this project is our original work. No part of this work has been submitted elsewhere partially or fully for the award of any other degree or diploma. All project related information will remain confidential and shall not be disclosed without the formal consent of the project supervisor. Relevant previous works presented in this report have been properly acknowledged and cited. The plagiarism policy, as stated by the supervisor, has been maintained.

Students' names & Signatures

_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

1. Mezbah Uddin Saad

_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

2. Nuzhath Tabassum Orpaa

ACKNOWLEDGEMENTS

The authors would like to express their heartfelt gratitude towards their project and research supervisor, Dr. Mahdy Rahman Chowdhury, Assistant Professor, Department of Electrical and Computer Engineering, North South University, Bangladesh, for his invaluable support, precise guidance and advice pertaining to the experiments, research and theoretical studies carried out during the course of the current project and also in the preparation of the current report.

Furthermore, the authors would like to thank the Department of Electrical and Computer Engineering, North South University, Bangladesh for facilitating the research. The authors would also like to thank their loved ones for their countless sacrifices and continual support.

ABSTRACT

“Fault Tolerant Quantum Error Detection Code”

The potential of quantum computing is extraordinary. Nevertheless, it faces challenges due to the susceptibility of quantum bits (qubits) to errors caused by factors such as decoherence, noise, coupling errors, etc. This project focuses on overcoming this challenge by introducing a fault error correction code designed for a state where 2n+1 qubits are entangled. Although there are codes for lower qubit error detection, our solution aims to detect both bit-flip and phase-flip errors for the last qubit and arbitrary faults for the first 2n-qubits. The main goal is to strengthen quantum computations against errors, making quantum processors more reliable and scalable. We plan to achieve this by developing and evaluating the foundations of the proposed code, conducting simulations to analyze its performance in different error scenarios, and exploring its practical application in real-world quantum processors. By addressing scalability issues and aiming for implementation, we aim to contribute towards advancing quantum technologies. This project represents a step in bridging the gap between upgrades and experimental implementations, fostering innovation in the ever-evolving field of quantum error correction.