RWTH Aachen University
Department of Computer Science

Design and Performance Engineering of GPU-Accelerated Tensor Network Algorithms for Large-Scale Scientific Simulations

Master Thesis

submitted by

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Aachen, February 17, 2026

Abstract

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Acknowledgements

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Listings

List of Symbols

$\mathcal{T}$	Tensor
$\mathbf{A}, \mathbf{B}$	Matrices
$\mathbf{v}$	Vector
χ	Bond dimension
d	Local (physical) dimension
N	Matrix/problem size
$\mathcal{O}(\cdot)$	Asymptotic upper bound

List of Abbreviations

BLAS	Basic Linear Algebra Subprograms
DFT	Density Functional Theory
GEMM	General Matrix Multiply
GPU	Graphics Processing Unit
HBM	High Bandwidth Memory
HPC	High Performance Computing
MPI	Message Passing Interface
MPS	Matrix Product State
SM	Streaming Multiprocessor
TN	Tensor Network

1. Introduction

1.1. Motivation

1.2. Problem Statement

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The remainder of this thesis is structured as follows. Chapter 2 introduces …Chapter 3 presents …Chapter 4 details …Chapter 5 evaluates …Chapter 6 summarises …

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A. Supplementary Benchmarks

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Declaration of Authorship

I hereby declare that I have created this work completely on my own and used no other sources or tools than the ones listed, and that I have marked any quotes accordingly.

Aachen, February 17, 2026 Daniel Sinkin