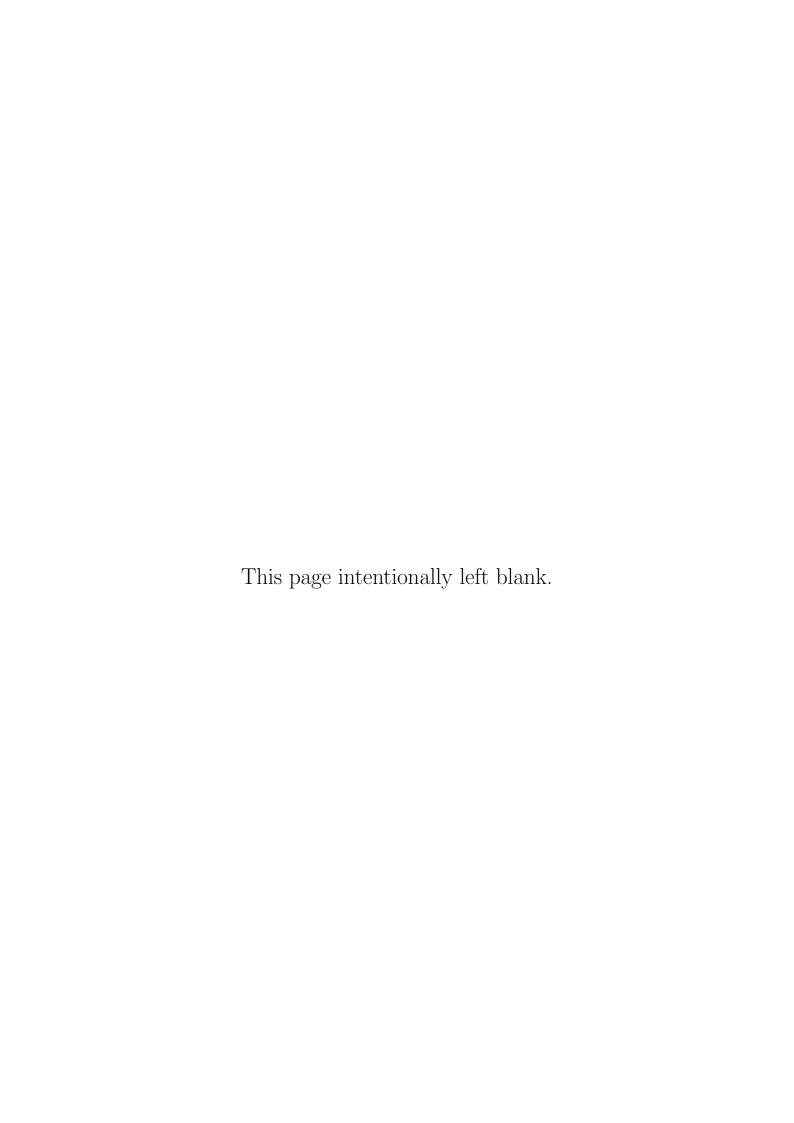
Vision Transformer Accelerator ASIC for In-Ear Sleep Staging

by Tristan Robitaille

Supervisor: Professor Xilin Liu April 2024

B.A.Sc. Thesis





ESC499 Engineering Science Thesis

Vision Transformer Accelerator ASIC for In-Ear Sleep Staging

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April 12th, 2024

Abstract

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Keywords: Sleep staging, ASIC accelerator, vision transformer, computer architecture

Acknowledgements

I would like to express my gratitude to...

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List of Abbreviations

 ${\bf ASIC}\,$ Application-Specific Integrated Circuit

CMOS Complimentary Metal Oxide Semiconductor

 \mathbf{HDL} Hardware Description Language

See [1]. I am making an Application-Specific Integrated Circuit (ASIC). It's small, low-power and fast. It's better than Google's.

1 Introduction

2 Background

3 How to Design an AI Accelerator

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3.1 Model Prototyping

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3.2 Accelerator Functional Simulation

3.3 Accelerator Hardware Implementation

4 Design Overview

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4.1 Vision Transformer

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4.2 Accelerator Architecture

- 4.2.1 Centralized vs. Distributed Architecture
- 4.2.2 Master Architecture
- 4.2.3 Data and Control Bus
- 4.2.4 Compute-in-Memory: Fixed-Point Accuracy
- 4.2.5 Compute-in-Memory: Memory
- 4.2.6 Compute-in-Memory: Compute Modules

4.3 A Note About Software-Hardware Co-Design

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5 Evaluation of Performance Metrics

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5.1 Vision Transformer

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5.2 Accelerator

6 Future Work

7 Conclusion

References

[1] Xilin Liu and Andrew G Richardson. "Edge deep learning for neural implants: a case study of seizure detection and prediction". In: *Journal of Neural Engineering* 18.4 (2021), p. 046034.

A Codebase Statistics

It may be interesting to the reader to appreciate the size of the codebase needed to develop a project of similar scale. The code for this project is available in my GitHub repository. The following table provides a breakdown of the number of lines of code in the project.

Table I: Line and file count per file type in the codebase.

File type	File count	Line count	Percent of total
Python	12	3000	33.7%
SystemVerilog	12	2500	30.4%
C++	12	1250	18.9%
TeX	12	670	8.2%
Shell	12	300	4.3%
Other	12	20	4.5%
Total	60	13,000	100%

In addition, there have been 200 commits to the repository.

B Reflection on Learnings and Experience Gained

