

Research Statement

Introduction

My research interests lie at the intersection of embedded systems, artificial intelligence (AI), and hardware design, focusing particularly on the development of FPGA-based computing systems. I am fascinated by the potential of AI-driven hardware acceleration to enhance computational efficiency and meet the increasing demands of advanced AI models. My previous academic work has laid a strong foundation in FPGA design and AI, and I am eager to further explore how these technologies can be synergized to create more efficient and powerful computing platforms.

Research Interests

My primary research interest is in FPGA-based computing system design, with a focus on the following areas:

Hardware Acceleration for AI: I am passionate about optimizing AI computing platforms through innovative hardware acceleration strategies. My goal is to explore and develop FPGA and ASIC-based systems that can significantly enhance the execution speed of AI models, thereby alleviating computational bottlenecks and improving overall system performance. I am particularly interested in designing customized hardware solutions that cater specifically to the needs of deep learning and other complex AI algorithms.

Embedded Systems and Hardware/Software Co-design: I aim to investigate the integration of AI algorithms with specialized hardware to create embedded AI systems that perform efficiently even in resource-constrained environments. My focus is on developing systems that can handle real-time data processing and parallel computation with high efficiency, which is crucial for a wide range of applications, from mobile computing to edge AI devices.

FPGA and ASIC-Based Computing Systems: I am keen on exploring the design of computing systems using programmable hardware like FPGAs and ASICs. The flexibility and reconfigurability of these technologies make them ideal for creating scalable and high-performance computing platforms. My interest lies in how these systems can be customized to meet the demands of next-generation AI applications, particularly in terms of speed, latency, and energy efficiency.

Previous Research Projects

FPGA Design and Implementation: During my undergraduate studies, I developed a strong foundation in FPGA design through a series of projects that included the design of a pipelined CPU and the implementation of a Snake game using Quartus II software. These projects involved extensive work with Verilog, a hardware description language, and provided me with practical experience in the entire FPGA design process, from schematic design to physical implementation.

Digital Logic Circuits and Computer Architecture: I explored the principles of digital logic circuits and computer architecture, culminating in the successful design of key components such as multiplexers, ALUs, and register files. These projects not only enhanced my understanding of hardware design but also equipped me with the skills to use tools like Logisim and ISE for simulation and verification.

EDA Understanding and Practice: I completed several projects that deepened my knowledge of electronic design automation (EDA) tools and FPGA applications. One of the most significant

projects was the design and implementation of a 12-bit binary counter and an 8-bit running light control system, which helped me understand the practical aspects of FPGA development.

AI and Deep Learning: In my master's program, I expanded my research focus to include AI, particularly deep learning. I conducted a series of experiments that built a comprehensive knowledge base in AI, including work on linear regression, logistic regression, binary classification, multi-classification, and convolutional neural networks (CNNs). These experiments were crucial in developing my understanding of how AI models can be applied to real-world problems.

Tumor Segmentation and Classification: My final project focused on the development of a deep learning model for tumor segmentation and classification in ultrasound scan data. The model achieved an F1 score of 0.89, demonstrating its effectiveness in identifying and localizing tumors. This project solidified my interest in applying AI techniques to complex problems and showcased my ability to design and implement AI models with practical applications.

Master's Thesis - Enhancing On-Chip Network Predictions With Advanced AI Techniques: My master's thesis represents the culmination of my research into the integration of AI and hardware design. The project aimed to improve the prediction accuracy of key parameters in Network-on-Chip (NoC) systems using advanced AI techniques. I explored the potential of linear regression models to optimize the design and performance of complex hardware systems, providing insights into how AI can be used to enhance traditional hardware design methodologies.

Future Research Directions

Looking forward, I am eager to delve deeper into the challenges and opportunities presented by the integration of AI and FPGA-based systems. I am particularly interested in:

Developing FPGA-accelerated AI models that can handle large-scale computations with low latency, which is critical for applications in autonomous systems, real-time processing, and high-frequency trading.

Exploring the use of hardware/software co-design approaches to create more efficient embedded AI systems that can operate effectively in environments with limited computational resources, such as IoT devices and edge computing platforms.

Investigating the potential of novel FPGA architectures and design methodologies to support the next generation of AI applications, particularly in areas where traditional computing paradigms fall short.

Conclusion

I am confident that my background in FPGA design and AI, combined with my research interests, aligns well with the objectives of the PhD programme in FPGA-Based Computing System Design at the University of Groningen. I am excited about the opportunity to contribute to and benefit from the cutting-edge research being conducted at your institution, and I am eager to explore new frontiers in the integration of AI and hardware design.

Thank you for considering my application. I look forward to the opportunity to discuss my research interests further.