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Donghyeon Joo

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Research Interests

Domain-specific architectures, Deep learning acceleration, Sparse problem acceleration, HW/SW co-design, Reconfigurable computing

Education

University of Maryland, College Park **Aug. 2023 — Present**
Ph.D. in Computer Science

Korea University **Mar. 2017 — Feb. 2023**
Bachelor of Science in Electrical Engineering (GPA: 3.96 / 4.5)

Publication

Donghyeon Joo, Seok Young Kim, and Seon Wook Kim. 2022. Implementation of Block Matrix Multiplication and its Performance Analysis on CPU. Poster in *the 2022 Summer Annual Conference of IEIE*. [pdf] [post]

Research Experience

Research Assistant **Aug. 2023 — Present**
Computer Architecture and Systems Lab(CASL) (Advisor: Prof. Bahar Asgari) *University of Maryland, College Park*

- Currently working on exploiting sparsity to accelerate transformers and LLMs at both hardware and software levels.

Undergraduate Research Intern **Dec. 2021 — Present**
Compiler and Computer Architecture Lab (Advisor: Prof. Seon Wook Kim) *Korea University*

- Implemented NVIDIA Deep Learning Accelerator(NVDLA) integrated system on Xilinx FPGA and analyzed performance with CNN workloads.
- Profiled transformer ELECTRA's operators on CPU platform with PyTorch source-build and Intel Vtune Profiler.
- (Undergraduate Thesis) Analyzed performance of multi-threaded block matrix multiplication in relation to block matrix size and cache size.

Engineering Experience

Text-to-Illustration Synthesis for Children's Book **Jul. 2022 — Jan. 2023**
OAZ Text-to-Image (Advisor: Prof. Jong-Ok Kim) *Korea University*

- Applied text-to-image synthesis neural network to create an interactive reading experience for children.
- Implemented and profiled both encoder-decoder-based and diffusion-based text-to-image models.

BEAVAR: Bird's Eye Assistance View for Autonomous dRiving **Jul. 2022 — Aug. 2022**
Qualcomm IT Tour *Qualcomm San Diego*

- Idea proposal of assisting autonomous emergency vehicle with drone-collected bird's eye view data.
- Vehicle-paired, position-hovering drone collects and extracts data of the vehicle's blind spots.
- Presented for the CEO of Qualcomm Christiano Amon and awarded best proposal. [video]

Optimizing DCT JPEG Compression Circuit **Mar. 2022 — Jun. 2022**
KECE463 VLSI Design and Laboratory *Korea University*

- Circuit area optimization using discrete cosine transform's sensitivity difference.
- Initial simulation with MatLAB, RTL circuit design in Verilog.
- Circuit synthesis with Synopsis Design Compiler.
- Circuit area, power, and critical path analysis.

IMAD Instruction Extension on RISC-V Core and GCC-LLVM Toolchain **Mar. 2021 — Dec. 2021**
KECE343 Computer Architecture, KECE456 Code Generation and System Optimization *Korea University*

- Increased cache block size and analyzed resulting increased cache hit ratio.
- Designed hardware performance counter which counts number of each instruction type.
- Used designed HPC to profile graph algorithm and analyze stall by each instruction type.
- Modified LLVM compiler and GCC assembler source code to compile integer multiply addition as IMAD instruction.
- Extended RISC-V core to support IMAD instruction.

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Singing the Poem: Text-based Song Synthesis AI **Jul. 2021 — Feb. 2022**
OAZ Deepvoice (Advisor: Prof. Jong-Ok Kim) *Korea University*

- Aimed at singing a poem in arbitrary voice, to make poem more enjoyable.
- Implemented an LSTM-GAN to create MIDI data(melody) from text data(poem).
- With MIDI and text, a mel-spectrogram-based voice synthesis system sings the poem in a pretrained voice.

A Diverse Style Transform Solution with Neural Network **Jul. 2017 — Sep. 2018**
OAZ Computer Deep Art *Korea University*

- Application to perform real-time style transform on an image with a server-based neural network.
- Designed and trained an image transform network to perform real-time image transform with a CNN-based loss.
- Experimented with different filter shapes and sizes for optimal result.
- Awarded Qualcomm Innovation Award 2017.

Honors and Awards

Dean's Fellowship, University of Maryland, College Park 2023
Semester High Honors, Korea University 2021, 2022
Certificate of Achievement, United States Department of Defense 2020
Creative Challenger Program Scholarship, Korea University 2018, 2021, 2022
KU Undergraduate Research Grant, Korea University 2018
Qualcomm Innovation Award, Korea University and Qualcomm 2017

Skills

Programming Languages Python(PyTorch), C(OpenMP), Verilog
Tools Intel Vtune Profiler, FPGA (Xilinx Vivado, PetaLinux), Synopsys Design Compiler
Languages Korean (Native), English (TOEIC 990, TOEFL 112, GRE (V 161, Q 167, W 4.0)), Chinese (HSK Level 4)

Teaching Experience

Introduction to Computer Systems (CMSC216) Fall 2023

Personal Experience

President, Korea University Programming Club OneandZero (OAZ) 2021 — 2022
Vice President, Korea University Basketball Club Hwaku 2022
Mentor for International Students, Korea University Global Service Center 2021 — 2022
Leadership Translater, Military Service at ROK Army 1998th Unit 2019 — 2020