Mohammed Elmir

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Portfolio: elmirportfolio.netlify.app

Education

- **Ashesi University, Accra-Ghana** — Berekuso, Eastern Region
  Bachelor of Science - Electrical and Electronics Engineering; GPA: 3.56/4.0 — *Sep 2020- Aug 2024*

Research Interests

Advancing digital VLSI and embedded machine learning by leveraging FPGA-based hardware acceleration and low-power design to enable smarter, energy-efficient systems at the edge.

Honors and Awards

- **Most Innovative Final Year Project**: Awarded for "Precision Livestock Farming with Embedded CV/ML," Ashesi Quasar Night 2024. **[Link]**
- **iGEM 2023 Gold Medalist (West Africa's First Gold Medal)**: International Genetically Engineered Machine Competition, Paris. Project: Lithium biosensor with computer vision integration.
  [Official Results] **[News]** **[University Highlight]**
- **USD 10,000 R&D Grant**: Selected Under the Ashesi Venture Incubator and awarded USD 10,000 sponsorship to start RD in Ghana focused on innovating agriculture and healthcare
- **Dean's List**: Recognized for academic excellence (5/8 semesters, GPA 3.5/4.0).
- **Cum Laude Award (Top 10%)**: Graduated with distinction (cGPA 3.50–3.69).
- **Best Agricultural Project**: Awarded at Ashesi D:Lab Innovation Expo, 2022. **[Link]**

Research Conferences

- **iGEM 2023 Giant Jamboree** — Paris, France
  Presenter — *Nov 2023*
  - **Lithium Biosensor Project**: Developed a genetically modified bacteria biosensor for lithium detection.
  - **Systems Integration**: Designed a biosensor delivery device and computer vision system for monitoring bacterial changes.
- **IEEE ICAST Conference – Computer Vision & Embedded Systems** — Accra, Ghana
  Presenter — *Oct 2024*
  - **Research Presentation**: Published and presented work on tracking animal movement behavior using computer vision and embedded systems.

Research Experience

- **Research & Teaching Assistant** — Sept 2023 – Present
  Ashesi University – Embedded Systems ML Research — *Accra,Ghana*
  - **Cross-Domain Research Projects**: Contributed to research on FPGA acceleration, low-power Embedded Machine Learning, and IoT systems.
  - **Project Verification for Publication**: Verified and extended prior embedded ML/IoT work for publication
  - **Teaching and Academic Support**: Assisted in teaching Embedded Systems IoT courses; mentored junior students
- **Ashesi SEED Journal of Science & Engineering** — Ashesi University
  Editor-in-Chief — *Dec 2023 – Jan 2025*
  - **Editorial leadership**: Led the editorial process of Ashesi's peer-reviewed research journal, managing a student editorial team with faculty guidance. Journal: **SEED Journal**
  - **Manuscript review & publication**: Reviewed, edited, and published 15+ papers in electrical engineering, computer science, and applied research.
  - **Quality assurance**: Ensured rigor through plagiarism checks, technical accuracy, and mentoring of student authors.
  - **Impact**: Released the Journal's 4th edition, boosting Ashesi's research visibility and platform for emerging scholars.
- **iGEM — Ashesi Ghana (2023) — Gold Medalist** **Project Link** — Paris, France
  iGEM 2023 Giant Jamboree Conference, Paris, France — *May 2023 – Dec 2023*
  - **Synthetic biology innovation**: Engineered a bacterial biosensor for lithium detection, enabling sustainable and eco-friendly mining solutions.
  - **Computer vision integration**: Developed an image-analysis model to quantify hydrogel reactions via colorimetric change detection.
  - **Leadership & documentation**: Co-led a 10-member interdisciplinary team; authored a detailed technical wiki on design, results, and impact.

- **Conference presentation**: Presented outcomes at the iGEM 2023 Giant Jamboree in Paris, alongside 400+ global teams.
- **Recognition**: Won West Africa's first Gold Medal for excellence in innovation and impact. **LinkedIn**

- **Non-intrusive water flow metering research** Sept 2024 – Present
  Ashesi University *Accra, Ghana*
  - **Non-intrusive flow metering research**: Developed a low-cost pipeline flow rate estimation system using **embedded machine learning (TinyML)**. Designed a data collection pipeline with accelerometers, explored both traditional ML and deep learning algorithms, for predicting water flow rates based of vibrations in pipes **Portfolio Link**
  - **Results**: Achieved $R^2 = 0.998$ (Decision Tree), $R^2 = 0.762$ (DNN), $R^2 = 0.9309$ (CNN); demonstrated feasibility of MCU-based real-time inference.
- **Precision Livestock Farming with Embedded CV/ML** **Github Link** Sept 2023 – Jul 2024
  Ashesi University *Accra, Ghana*
  - **Embedded Computer Vision Deployment**: Deployed lightweight CV models (YOLOv8n, EfficientNet-B0) on Raspberry Pi for real-time livestock feeding and movement behavior monitoring (97% accuracy). **Link 1** **Link2**
  - **IoT Integration & IEE Xplore Paper**: Integrated IoT-based feed monitoring into farmer dashboard; co-authored IEEE ICAST 2024 paper. **[IEEE Paper]**
  - **Electrical Department Award**: Project recognized as Most Innovative Applied Research at Ashesi Quasar Night 2024.
- **Comparative Power & Acceleration Study for Embedded ML** **Github Link** Dec 2024 – Present
  Ashesi University *Accra, Ghana*
  - **Research**: Investigating latency–power trade-offs for SVM/ANN inference on Cortex-M MCUs vs FPGA.
  - **Measurements & Findings**: Benchmarked KL25Z (Cortex-M0+) and K64F (Cortex-M4): reduced MCU power from 8.0 mW to 3.59 mW via custom kernels **[Portfolio Link]**
  - **FPGA Accelerator Work (ongoing)**: Extending study to FPGA acceleration (MCU-only vs MCU+FPGA vs FPGA-only) to quantify energy-per-inference and throughput.
  - **Impact**: provide design guidelines for when to optimize MCU software vs offload to FPGA for edge ML

Publications

- S. N. Adu Tagoe, M. Elmir and N. Amanquah, "Monitoring of Animal Movement using Computer Vision," 2024 IEEE 9th International Conference on Adaptive Science and Technology (ICAST), Accra, Ghana, 2024, pp. 1-6, doi: 10.1109/ICAST61769.2024.10856474.," *Proc. IEEE ICAST*, Accra, Ghana, 2024. **[Published]**
- M. Elmir and S. Tagoe, "Design of a Rectifier and DC-DC Buck Converter," *SEED Journal*, vol. 2, no. 2, Nov. 2024. **[Published]**
- M. Elmir, S. Tagoe and N. Amanquah, "Real Time Animal Behaviour Monitoring Using Computer Vision Techniques," 2025 13th International Conference on Intelligent Embedded, MicroElectronics, Communication and Optical Networks (IEMECON), Jaipur, India, 2025, doi: N/A.," (ACCEPTED), 2025.
- D. Debre, M. Elmir, and N. Amanquah, "A Non-Intrusive Approach To Measuring Flow Rate In A Pipe Using Machine Learning," 2025 13th International Conference on Intelligent Embedded, MicroElectronics, Communication and Optical Networks (IEMECON), Jaipur, India, 2025, doi: N/A.," (Submitted for Publication), 2025.
- J. Baraka, M. Elmir and N. Amanquah, "Comparative Evaluation of Power Consumption Between Custom Machine Learning Kernels and CMSIS-DSP Libraries on ARM Cortex-M Boards,"" (In preparation for Publication), 2026.

Selected Technical Projects

- **Implementation of Deep Neural Network on Basys3 (May '25)**:
  - **Hardware Acceleration**: Implemented a simple deep neural network (DNN) on the Basys3 FPGA board using fixed-point units and MAC operations.
  - **Fixed Point Arithmetic**: Focused on optimizing performance with hardware acceleration for fixed-point arithmetic operations.
  - **Key Technologies**: DNN, Fixed-Point Arithmetic, FPGA, VHDL, TensorFlow
- **Communication Between Basys3 and STM32 (Embedded Systems) (February '25)**:
  - **FPGA-MCU Communication via AXI**: Worked on communication between a Basys3 FPGA board and STM32 microcontroller through USART using IP and AXI protocols.
  - **Basys3 soft-core processor**: Utilized the MicroBlaze soft-core processor for effective communication and data handling
  - **Key Technologies**: VHDL, MicroBlaze, AXI, USART, Embedded Systems,HLS

Skills Summary

- **Programming**: Python, C/C++, MATLAB
- **Machine Learning Frameworks**: Scikit-learn, TensorFlow, Keras, PyTorch
- **HDL & EDA Tools**: VHDL, Verilog, Vivado, ModelSim, MATLAB/Simulink
- **Embedded Platforms**: Raspberry Pi, STM32, ARM Cortex-M, FPGA (Basys3, Xilinx)
- **Tools**: Git, Keil uVision, MCUXpresso, EasyEDA, Firebase
- **Soft Skills**: Leadership, Academic Writing, Research Communication, Time Management