Natnael Masresha Zerihun

MEMS & Microsystems Engineer
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Profile

MEMS engineer with hands-on cleanroom microfabrication experience and a strong background in sensor characterization and calibration. M.Sc. thesis in industry : thermal characterization and shutterless calibration of an uncooled LWIR microbolometer camera. Experienced across the full chain from fabrication and multiphysics simulation to electrical/optical metrology, digital design (VHDL/FPGA), and data-analysis software. Fascinated by electromagnetic waves and light–matter interaction, from visible light to thermal infrared.

Education

Aalto University | USN | BME — Finland | Norway | Hungary
Erasmus Mundus Joint M.Sc. in Smart Systems Integrated Solutions (SSIs) — *Aug. 2024 – Aug. 2026*

- Joint master's across three universities with extensive cleanroom, CAD, and materials-lab access.
- Focus: microfabrication, MEMS design, heterogeneous integration, measurement & characterization, and system-level integration of smart sensor systems.
- Three-semester design project taken from concept to functional prototype (wildlife acoustic sensor node).

Addis Ababa University — Ethiopia
B.Sc. in Electrical and Computer Engineering | Computer Engineering major — *Sept. 2015 – Dec. 2020*

Experience

Thermal Sensor Characterization & Shutterless Calibration (M.Sc. Thesis) — Jan. 2026 – June 2026
IDEAS – Integrated Detector Electronics AS — *Oslo, Norway*

- Characterized an uncooled LWIR microbolometer FPA (Lynred ATTO640D, 640×480, 12 µm pitch, 8–14 µm band) against an HGH DCN 1000 blackbody source over a 0–110 °C sweep.
- Derived per-pixel signal transfer function (SiTF), responsivity, and NETD; achieved a minimum median NETD of ≈99 mK (IQR 93–106 mK) with saturation-aware pixel screening.
- Quantified fixed-pattern noise and thermal drift from cold-start warm-up recordings (thermal-chamber conditioning), showed drift is offset-dominated while pixel gain remains stable after the initial transient.
- Developed and compared shutterless non-uniformity correction (NUC) methods: one-point and two-point correction, a lookup-table calibration matrices, temperature-indexed calibration with linear interpolation, and scene-based correction.
- Defined image-quality metrics (high-pass roughness, column-FPN, spatial σ) for automatic selection of the best correction matrix during live operation.
- Built the supporting real-time acquisition, streaming, and remote-control platform (Python/FastAPI backend, React web client) used for all measurements and demonstrations.

ML Engineer & Fullstack Developer — Jan. 2023 – Sept. 2024
Adludio Ltd — *London, UK (remote)*

- Developed a web-based creative design studio and data/ML pipelines for interactive advertising; reduced creative delivery time by ≈85% through reusable design abstractions.

Fullstack Developer | R&D — March 2021 – Sept. 2022
CNET Software Technologies — *Addis Ababa, Ethiopia*

- Developed APIs, dashboards, and ERP/LMS web applications using .NET Core, Blazor, and Python.

MEMS & Microsystems Projects

Cleanroom Microfabrication of Silicon Microstructures | *Photolithography, Etching, PVD* — SSIs M.Sc.

- Executed a full microfabrication flow on Si wafers in the USN cleanroom: substrate cleaning, thermal oxidation, spin-coated photoresist, UV photolithography and TMAH development, ICP dry etching of SiO_2, O_2 plasma ashing, anisotropic KOH wet etching, and thermal evaporation of Al/Cu bilayers.
- Verified each process step with stylus profilometry and ellipsometry (film thickness, etch depth, step height).
- Complementary studies: photoresist processing techniques (coating, exposure, development, post-bakes) and green/advanced dry-etching technologies for MEMS (IBE, laser-based, ICP-RIE, AI-assisted etch control).

Piezoelectric MEMS Microphone – Design & FEM Simulation | *COMSOL Multiphysics* — SSIs M.Sc.

- Redesigned and simulated a circular-membrane AlN piezoelectric MEMS microphone (solid mechanics + electrostatics with piezoelectric coupling, 2D axisymmetric model) reproducing a published reference design.

- Improved sensitivity from 1.1 to 3.21 mV/Pa by changing piezoelectric material (AlN → ZnO) and passivation (SiO_2 → polyimide); tuned membrane resonance to ≈4.87 kHz as design strategy to escape the target acoustic band (elk vocalizations, 100–3500 Hz).
- Evaluated CMOS-compatible fabrication routes and material trade-offs (AlN, ScAlN, ZnO, PZT).

MEMS Accelerometer – Coupled Simulation & ROM Generation | *ANSYS, Twin Builder* SSIs M.Sc.

- Designed an electrostatic MEMS accelerometer and performed coupled electrostatic–structural FEM simulation in ANSYS (∼45k nodes), including electrostatic spring-softening and linear-perturbation modal analysis.
- Validated simulations against analytical hand calculations (stiffness, pull-in force, capacitance, natural frequency) with 1–10% deviation; generated a reduced-order model (ROM) and simulated acceleration loads in Ansys Twin Builder.

System-Level Design of a MEMS Acoustic Sensor Node (Design Lab) | *ANSYS, FPGA* SSIs M.Sc.

- Three-semester project integrating a piezoelectric MEMS microphone ROM, an analog front-end, and digital detection logic into one system-level digital twin in Ansys Twin Builder.
- Designed a two-stage amplifier at transistor level in Cadence (topology comparison, hand calculations, simulation) and a VCO behavioral model in VHDL-AMS.
- Implemented the digital back-end (frequency measurement and acoustic event classification) in VHDL; verified in ModelSim and synthesized with Intel Quartus Prime (TimeQuest static timing analysis) onto an FPGA.

Heterogeneous Integration & Advanced Packaging | *TSV, 3D-IC, FEM stress analysis* SSIs M.Sc.

- Simulated thermo-mechanical stress in Cu TSV arrays under thermal cycling (25–400 °C); analyzed CTE-mismatch-driven von Mises stress concentrations (≈700 MPa at Cu/SiO_2 boundaries), plastic deformation, and keep-out-zone implications for 3D-ICs.

Surface Metrology of RF MEMS Structures | *Optical interferometry, PSI/VSI* SSIs M.Sc.

- Characterized height, topography, and surface roughness of RF MEMS switch structures with a Wyko NT9100 white-light interferometer (PSI and VSI modes), resolving sub-nanometer roughness (e.g., 0.42 nm Ra on Au transmission lines).

Wildlife Acoustic Monitoring Sensor Node (Animal Watch) | *MEMS microphones, Raspberry Pi, ML*SSIs M.Sc.

- Designed a solar-powered elk-monitoring node integrating MEMS/USB microphone arrays and temperature sensors on Raspberry Pi; direction-of-arrival (TDOA) localization and ML sound classification (few-shot PyTorch / modified YAMNet).

Digital Design (VHDL/FPGA) Projects

Frequency-Measurement & Acoustic Event Classification System | *VHDL, ModelSim, Quartus* SSIs M.Sc.

- Designed a hierarchical RTL system in VHDL integrating a parameterized window-based frequency-measurement core, three band-specific frequency-range detectors with temporal activity filtering, and seven-segment display decoders for real-time classification of acoustic events.
- Implemented a two-stage input synchronizer with edge detection to safely sample the asynchronous input signal; used VHDL generics for measurement resolution and system clock frequency to keep the design reusable across configurations.
- Verified module- and system-level behavior with ModelSim testbenches and waveform analysis; synthesized with Intel Quartus Prime and analyzed timing with TimeQuest.

Synchronous RTL Design & Verification Coursework | *VHDL, ModelSim* SSIs M.Sc.

- Designed a parameterized multi-digit password-verification FSM (nine states, enumerated types) with generic-configurable output hold time implemented via counter-based output gating; simulated correct- and wrong-sequence paths in ModelSim.
- Implemented and simulated a set of synchronous building blocks event counters, shift registers, a Mealy sequence-detector FSM, and BCD counters with seven-segment decoding each with a dedicated testbench.

Technical Skills

Microfabrication: Photolithography, ICP/RIE dry etching, KOH wet etching, thermal oxidation, PVD (thermal evaporation), O_2 plasma ashing, cleanroom practice
Characterization: Blackbody radiometric calibration, NETD/SiTF/responsivity analysis, stylus profilometry, ellipsometry, white-light interferometry (PSI/VSI), optical microscopy, SEM
Simulation & CAD: COMSOL Multiphysics, ANSYS Workbench & Twin Builder (ROM), Cadence (analog IC), LTSpice, Proteus
FPGA & Digital Design: VHDL, synchronous RTL design, FSMs, input synchronization & edge detection, parameterized (generic) design, testbench development, ModelSim, Intel Quartus Prime, TimeQuest STA, Cyclone III
Embedded & Test: LabVIEW (NI DAQ, HIL testing), Raspberry Pi, Arduino
Programming: Python (NumPy, OpenCV, Matplotlib, FastAPI, Jupyter), C#, JavaScript/TypeScript, Git