Muhammad Nabeel Tahir

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EDUCATION

RUTGERS The State University of New Jersey, New Brunswick, NJ	2022-Present
Ph.D. Candidate in Electrical and Computer Engineering (Solid State Electronics)	CGPA: 3.83

Completed NSF I-Corps Program as Entrepreneurial Lead with an award of $50,000.

Lahore University of Management Sciences, Lahore, Pakistan	2018-2021
M.Sc. in Electrical Engineering (Signal Processing)	CGPA: 3.65

Amongst the top 1% of Graduate Students.

University of Engineering and Technology, Lahore, Pakistan	2013-2017
B.Sc. in Electrical Engineering	CGPA: 3.32

SKILLS AND TECHNIQUES

Programming Languages: C/C++, Python, TypeScript, MATLAB, Java, Assembly Language, Verilog, MySQL, HTML.
Embedded Systems Design: Schematics and PCB design, Digital/Analog circuit design, ARM, Raspberry Pi, FPGA.
Analysis and Design Tools: Mixed Signal Design, Electric Waves and Radiations, Microelectronics Processing, Cadence, Eagle, Altium Designer, PSpice, LtSpice, LabView, AutoCad, Multisim, Signal Processing, Visual Studio Code.
Peripherals: I2C, SPI, UART, RS-485/232, BLE, USB, CAN.
Machine Learning: Clustering, Classification, Regression, ANN, CNN, RNN, LSTM, Autoencoders, and GANs implementation in Tensorflow and Pytorch, scikit-learn, matrix-vector operations, linear algebra.
Other Expertise: React Native, Rest API, Git/GitHub, PyQt UI Designer, Android Development, Computer Architecture, CAD, 3D Printing, Microfabrication, Lithography, Thin film deposition, Profilometers.

RELEVANT RESEARCH AND DEVELOPMENT EXPERIENCES

Rutgers, The State University of New Jersey, Piscataway, NJ **Jan 2022-Present**
Graduate Assistant, ECE

- Developed and published an automated fluorescent microscope image processing tool for quantification of human leukocytes and bioparticles in a biosample using fast feature detection and statistical filtering. Applied imaged enhancement methods of Gaussian and Averaging filters and improved the signal difference to noise ratio (SDNR) from 10dB to 25dB and contrast to noise ratio (CNR) from 0.5 to 5.
- Developed and trained deep learning models (CNN, VGG, ResNet) for classifying metal oxide-coated particles, achieving a classification accuracy of 95% in the impedance flow cytometry data by applying time-frequency transformations.
- Designed and developed microfluidic devices with serpentine geometry using Fusion360 and improved bioparticle conjugation by 25%.
- Revised, updated, and added new features to the ThemisNJ Android application developed to provide information regarding the free voluntary services available for low-income families. Published the application on the Android store.

Rutgers, The State University of New Jersey, Piscataway, NJ **June 2023-July 2023**
Summer Instructor: Taught the programming methodology I course in C++. Covered basic to advanced topics of inheritance, polymorphism, and standard template libraries. Organized the labs, designed the homework assignments, and evaluated students' projects developed in C++.

Rutgers, The State University of New Jersey, Piscataway, NJ **Jan 2023-May 2023**
Teaching Assistant: Designed and conducted the lab session for the computer architecture and assembly language course. Delivered lectures covering the topics to be used in the lab experiments on RISC-V architecture. Lab topics covered: RISC-V datapath and control code writing. Writing RISC-V assembly code for caching, memory handling, and developing recursive and functional algorithms.

Lahore University of Management Sciences, Lahore, Pakistan **Mar 2018-Nov 2021**
Project Team Lead: Led a team of 5 individuals, conducted research, and developed two industrial projects using the classical and deep learning-based feature detection techniques to identify objects in live video streams.

TECHNICAL AND RESEARCH PROJECTS

Multimodal Bioparticle Sensing Platform

- Developing an impedance and fluorescence flow cytometry-based bioparticle quantification and analysis platform with applications in early diagnosis of infectious diseases. The system involves laser/optical detection and impedance data recording from lock-in and current amplifier circuits.
- Fabricating microfluidic devices with laser cutting, laminate manufacturing, and microfabricating the electrodes using soft-lithography and screen printing. Fabricated 70um channels with laser cutting and 100nm electrodes with photolithography and thin film deposition.

Differential Lockin Amplifier Noise Analysis

- Modeled the microfluidic channels as resistive electrical components and estimated the channel impedance.

- Designed a Lock-in amplifier with OPA1612 operational amplifiers and AD835 voltage mixers. Performed the theoretical and simulation-based noise analysis of the differential amplifier using LTspice. The estimated output referred voltage noise was 640µV.
- Designed a two-stage active bandpass filter with a center frequency of 1 MHz and a quality factor greater than 1. Performed AC/DC analysis and obtained an open-loop gain of 63 dB with a phase margin of 52° and a gain-bandwidth product of 86 MHz.

Motorway to Safety: A Traffic Management and Law Enforcement System.
- Investigated and studied methods of heterogeneous sensor data fusion (radar, video, motion sensors) for multiple object detection and tracking.
- Developed deep learning-enabled real-time vehicle detection and tracking, type classification, number plate detection and identification, speed measurement, and lane identification system, deployed on Nvidia Nano Edge device. Trained the YoLo model on vehicle data collected on the roads of Pakistan. The deployed models exhibited a run-time classification accuracy of 95% for number plate extraction and digit identification, and over 96% for vehicle model and make identification.

OBC: On-Board Computer for a Micro LEO Satellite
- Designed the circuit and schematics for the onboard computer of the attitude control subsystem of the micro-Leo satellite. Implemented data read and write protocols from the magnetic and light sensors using CAN, I2C, and UART protocols. Implemented RTOS-based firmware for the STM32 control unit.
- Designed an 8-layer PCB using Altium Designer, with an electrical surge protection circuit, on board a 12V to 3.3V power converter. Implemented test beds using the STM32 evaluation board over the CAN interface to test different components on the PCB board.

FizyoGauge: A Wearable Solution for Heart Rate Estimation and Variability Tracking during Physical Activity
- Developed an embedded system and ML/signal processing-based wearable solution for heart-rate estimation and variability tracking. Applied extreme learning machines and Kalman filtering to optimize the estimates. Improved the heart rate estimation by removing the outliers from 85% to 91%.
- The developed embedded platform collects real-time data from MAX30101 PPG, EMG sensor, BMI160 IMU sensor, and MAX3025 body temperature sensor, and transfers it on an ultra-low BLE connection using the Nordic nRF51822 chip.

Generating Emojis Using Deep Convolutional Generative Adversarial Networks (DCGAN)
- Designed and implemented a new architecture of DCGAN for generating emoji images from a random noise sample. Implemented deep CNN-based discriminators and generators containing convolution and fully connected layers. Stabilized GANs by adding Adam optimizer, LeakyRelu, and Gaussian weight initialization.

Cross-View Image Retrieval (CVIR) with Custom Distance Metric Learner Architecture
- Implemented a CVIR system consisting of a VGG16-based image extraction component, followed by cosine and distance metric learning-based similarity matching, and retrieval of images with different views but similar semantic features.
- An accuracy of over 95% was achieved on the feature extraction model, and an accuracy of over 97% for the residual neural network-based distance metric learner model was achieved. The models were trained on Nvidia 2080Ti using TensorFlow and Keras libraries.

Sentiment Analysis on IMDB Movie Review Data
- Designed and implemented an LSTM-based sentiment analysis system for IMDB review data, classifying between positive and negative sentiments. Three different models (LSTM, Bi-directional LSTM, and reduced parameter LSTM(10,000)) were trained, and an accuracy of over 92% was achieved. Data cleaning techniques, i.e., HTML tags, white spaces, brackets, numbers, and single characters, were employed. The data was converted into tokens.

Vending Machine Controller Circuit
- Designed an industrial-grade vending machine controller with ESP32 as the microcontroller. Designed the power regulators and battery management circuit and DS3231-based RTC circuit. Designed a motor driver circuit for 28 motors using N-type power MOSFET. Extended the I/Os of the controller using MCO23017, an I2C-based IO expander. Designed schematics and 3-layer PCB using EasyEDA.

Implementation of 8-bit RISC using Xilinx
- Implemented data path and controller for execution of RISC instructions in Verilog on Xilinx Spartan. Implemented RTL design and simulation of ALU for R-type, LOAD, and STORE type, and BRANCH instructions.

SELECTED PUBLICATIONS

- **M N Tahir**, et.al, "FluoCount: An Efficient and Accurate Cells and Bioparticles Enumeration Mobile Application for Portable Fluorescence Microscopes".
- **M Kokabi, M N Tahir**, et.al, "Advancing healthcare: synergizing biosensors and machine learning for early cancer diagnosis".
- **M N Tahir**, et.al, "A Time-Frequency Deep Learning Classification Model for Metal Oxide Coated Particles".
- **MA Sami, M N Tahir**, et.al, "AQAFI: A Bioanalytical Method for Automated KPIs Quantification of Fluorescent Images of Human Leukocytes and Micro-Nano Particles".
- **M N Tahir**, et.al, "Online, Real-time and Robust Detection and Localization of Foreign Objects on Paper Surface using Machine Vision and Clustering".