Darin Tsui

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Education

Georgia Institute of Technology *Atlanta, GA*

Ph.D. in Electrical and Computer Engineering *Aug. 2023 - Jun. 2028 (Expected)*

- Advisor: Amirali Aghazadeh

University of California San Diego *San Diego, CA*

Bachelor of Science in Bioengineering, GPA 3.919 *Sep. 2019 - Jun. 2023*

- Advisors: Gert Cauwenberghs and Frank E. Talke

Research Experience

AI ML and Information Research Group at the Georgia Institute of Technology *Atlanta, GA*

Advisor: Amirali Aghazadeh *Jun. 2023 - Present*

- Improved supervised and generative model performance on biological datasets trained on minimal data by 60%. This was achieved through the L1 regularization of the Fourier Transform.
- Applied fast Walsh-Hadamard transforms on the evidence lower bound (ELBO) in variational autoencoders to extract explainable features.

Integrated Systems Neuroengineering Lab at UC San Diego *San Diego, CA*

Advisor: Gert Cauwenberghs *Jun. 2022 - Jun. 2023*

- Worked on the design and development of a COVID-19 diagnostic test using a graphene field-effect-transistor (GFET).
- Developed feature extraction and machine learning pipeline of current-voltage signals using scikit-learn.
- Achieved accuracies of 98.5% when detecting COVID-19 proteins, improving classification by 30.1%.

Talke Biomedical Device Lab at UC San Diego *San Diego, CA*

Advisor: Frank E. Talke *Dec. 2021 - Aug. 2023*

- Designed low-cost vision system for minimally invasive surgery using OpenCV with fiducial markers.
- Used ArUco markers to enable tracking of instruments in real-time in Python. Position tracking coordinates were exported and post-processed in MATLAB. Applied 3D homography to positional coordinates.
- Developed live platform for filtering and thresholding images for use in stereoscopic vision.
- Implemented Kalman filtering to achieve sub-millimeter error in design-validation testing.

Swartz Center for Computational Neuroscience at UC San Diego *San Diego, CA*

Advisor: Tzyy-Ping Jung *Mar. 2021 - Mar. 2023*

- Worked with Ph.D. candidate Chiyuan Chang in electroencephalography-based (EEG) classification experiments. Conducted machine learning analysis in Python of subjects' respective stress levels in resting and stressful classroom settings.
- Performed support vector machine (SVM) and linear discriminant analysis (LDA) and Mann Whitney U statistical analysis using MATLAB and Python.
- Improved classification of stress vs. non-stress groups by 42.1% in correlation with physiological features.

Paesani Research Group at UC San Diego *San Diego, CA*

Advisor: Francesco Paesani *Jan. 2020 - Sep. 2021*

- Worked with postdoctoral scholar Vinícius Cruzeiro to run AMBER molecular dynamics simulations in Bash and Python to model amino acid and water molecule behaviors.
- Validated interactions using radial distribution function (RDF) fits.

Teaching Experience

Teaching Assistant *Atlanta, GA*

Advisor: Jeffery Hurley *Aug. 2023 - Dec. 2023*

- Graduate teaching assistant for ECE 4122/6122—Advanced Programming Techniques for Engineering Applications—with an enrollment of 300 graduate and undergraduate students. The course teaches undergraduate and graduate students techniques for distributed and parallel computing to run computational heavy tasks.
- Taught and assisted students in developing C++ code for lab assignments. Held office hours for 10 hours a week.

Instructional Assistant *San Diego, CA*

Advisor: Robert Sah *Dec. 2020 - Mar. 2021*

- Oversaw two lab sections of 30 students each for BENG 1, an introductory Bioengineering lab course.
- Trained students in the fundamentals of Bioengineering. Topics taught included biomechanics, noninvasive cardiovascular sensing, and spine segmentation. Held office hours and lab sections for 10 hours a week.

Professional Experience

Surgalign *San Diego, CA*

Data Engineering Intern *Jan. 2023 - Aug. 2023*

- Interned at Surgalign, a small medical device company focused on developing AI solutions in spinal surgery (now acquired by Xtant Medical and Augmetics).
- Designed an internal MRI image processing application using Python that reduced preprocessing time per sample.
- Assisted in developing ground truth dataset of imaging data to assess the effectiveness of deep learning models.
- Validated deep learning models against surgeon-generated data using Sørensen-Dice coefficient statistical testing.

Johnson & Johnson *Redwood City, CA*

Instruments R&D Intern *Jun. 2022 - Aug. 2022*

- Interned at Auris Health, Johnson & Johnson's flexible robotics division for minimally invasive surgery of urology. Supported design validation clinical trials through preparation and sterilization of instruments.
- Performed root cause analysis on the failure of instrument devices. Designed near-infrared camera system for calibration in endoscopes.
- Supported systems investigations towards optical calibration stations and instrumentation platforms.

Publications

D. Tsui, C. Melentyev, A. Rajan, R. Kumar, F. E. Talke. "An optical tracking approach to computer-assisted surgical navigation via stereoscopic vision," in *ASME 2023 32nd Conference on Information Storage and Processing Systems (ISPS)*, Milpitas, CA, 2023.

D. Tsui, F. Downey, S. Navaneethan, A. Paul, T. Bodily, M. Lee, Y. Xu, R. Lal, G. Cauwenberghs. "A machine learning approach to COVID-19 detection via graphene field-effect-transistor (GFET)," in *2023 45th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC).*, Sydney, Australia, 2023.

D. Tsui, M. Jo, B. Nguyen, F. Ahadian, F. E. Talke. "Optical surgical navigation: a promising low-cost alternative," in *2023 45th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC).*, Sydney, Australia, 2023.

Presentations

D. Tsui, "Surgical site localization with non-invasive skin markers for pain management," presented at the Center for Memory and Recording Research (CMRR) Research Review, San Diego, CA, 2023.

D. Tsui, "Bioelectronic COVID-19 detection via graphene-field-effect-transistor (GFET)," presented at Bioengineering Day at UC San Diego, San Diego, CA, 2023.

D. Tsui, "Machine learning: a gentle introduction to image classification," presented at IEEE @ UC San Diego, San Diego, CA, 2023.

D. Tsui, "Cracking the code - machine learning and medical diagnosis," presented at Biomedical Engineering Society (BMES) at UC San Diego, San Diego, CA, 2023.

D. Tsui, "Hacking the brain: machine learning and human behavior," presented at IEEE @ UC San Diego, San Diego, CA, 2023.

D. Tsui, "Design of a surgical navigation system via positional tracking of fiducial markers," presented at the 2022 Conference on Micromechatronics for Information and Precision Equipment, San Diego, CA, 2022.

Awards, Fellowships, and Grants

Graduate Student Conference Scholarship Award at ISPS 2023 *Aug. 2023*

- Award received at ISPS 2023 for outstanding research and paper submission.

President's Fellowship at Georgia Tech *Aug. 2023*

- Award received for exemplary levels of scholarship and research innovation.

Bioengineering Travel Award *Jun. 2023*

- Award received from the UC San Diego Bioengineering Department for presentation of research at ISPS 2023.

Anushka Michailova Memorial Best Undergraduate Poster Award at Bioengineering Day at UC San Diego *May 2023*

- Award received for best capstone project out of 100 teams. Submissions were evaluated on technical depth, innovation, and research dissemination.

Galvanizing Engineering in Medicine (GEM) Grant at UC San Diego *May 2022*

- Grant to perform research for the 2022-2023 school year in the Talke Biomedical Device Lab. Wrote the introduction, methods, and specific aims sections. Funded my research towards designing a low-cost stereoscopic vision system.

Academic Senate Grant at UC San Diego *Jan. 2022*

- Grant to perform research for the 2021-2022 school year in the Talke Biomedical Device Lab. Wrote the methods section. Funded research towards the real-time tracking of fiducial markers using a smartphone.

Projects

Supervised ML Approaches for Predicting Cancer Survival Rate, UC San Diego *Apr. 2023 - Jun. 2023*

- Performed binary classification on The Cancer Genome Atlas (TCGA) lung adenocarcinoma (LUAD) data to predict cancer survival.
- Performed feature selection on gene expression data using DESeq2 and XGBoost.
- Used Support Vector Machines (SVM) on feature set to achieve 69.05% accuracy.

Brain-Computer Interface (BCI) Signal Classification, UC San Diego *Jan. 2023 - Apr. 2023*

- Performed multiclass classification analysis on motor imagery using a BCI competition dataset. Identified subjects' motor visualization using electroencephalography (EEG).
- Designed a novel feature extraction algorithm for electroencephalogram (EEG) data by ensembling time-based data.
- Improved state-of-the-art accuracy from 61.04% to 63.16% using PyTorch neural network architecture.

Convolutional Neural Networks (CNN) for Plankton Classification, UC San Diego *Jan. 2023 - Apr. 2023*

- Implemented AlexNet for plankton image classification using PyTorch.
- Increased model robustness by synthetically manipulating imaging data, improving the classification accuracy by 27%.

Leadership and Service

UC San Diego Bioengineering Senior Design *San Diego, CA*

Capstone Project Advisor *Jul. 2023 - Present*

- Capstone project advisor for a bioengineering capstone project with Dr. Frank E. Talke.
- Mentoring two undergraduates toward the design and development of a surgical navigation system with 3D tracking and augmented reality.

IEEE Engineering in Medicine and Biology Society (EMBS) at UC San Diego *San Diego, CA*

Founder *Apr. 2023 - Jul. 2023*

- Co-founded IEEE EMBS at UC San Diego with Dr. Gert Cauwenberghs and other Ph.D. students to increase awareness of bioengineering topics and research.
- Recruited 5 graduate students to mentor undergraduate students interested in getting involved in research.

IEEE at UC San Diego *San Diego, CA*

President *May 2022 - May 2023*

- Oversaw operations for a 300+ student body. Partnered with the San Diego Supercomputing Center (SDSC) to co-found IEEE's Supercomputing Team.
- Hosted lab recruiting talks and technical seminars targeted towards first and second-years looking to get into research. Topics included research in artificial intelligence, robotics, and wearable sensors.
- Awarded the Outstanding IEEE Large Student Branch award for maintaining strong project activities and company relations during tenure.

Outreach Chair *May 2021 - May 2022*

- Taught 60 elementary and middle school female-identifying students the basics of programming at Girls STEM Fair.
- Hosted a robotics workshop in collaboration with Robolink, a San Diego robotics company, where we invited 50 high school students from low-income communities to work with Robolink representatives on coding and designing their own aerial drones.

Biomedical Engineering Society (BMES) at UC San Diego *San Diego, CA*

Project Team Lead *Oct. 2021 - Jun. 2022*

- Led team of 20 undergraduates in designing a telesurgical prosthetic hand. Hand designs were formulated and constructed based on biomechanics principles.
- Held workshops in CAD, Arduino, and circuit design. Implemented robotic motion in Arduino and interfaced linear actuators.

Committee Member *Sept. 2019 - Jun. 2023*

- Committee member for UC San Diego's Biomedical Engineering Society's (BMES) Bioengineering Day committee, a day-long event celebrating all facets of bioengineering research and development, and Lab Expo committee, an undergraduate research symposium aiming to get students involved in research and academia.
- Recruited graduate students and professors to present research. Organized logistics and advertised events across campus.

Mentoring

2023	**Matthew Tam**, Bioengineering Undergraduate, University of California San Diego
2023	**Eric Lee**, Bioengineering Undergraduate, University of California San Diego
2023	**Kirsten Ramos**, Bioengineering Undergraduate, University of California San Diego
2022-2023	**Capalina Melentyev**, Bioengineering Undergraduate, University of California San Diego
2022-2023	**Ananya Rajan**, Bioengineering Master's, University of California San Diego
2022-2023	**Rohan Kumar**, Nanoengineering Undergraduate, University of California San Diego

Skills

Programming	Python, MATLAB, Bash (Linux Shell Scripting), C++
Libraries	PyTorch, TensorFlow, Scikit-learn, OpenCV, Scipy, Matplotlib, Numpy, Pandas
Relevant Coursework	Statistical Learning, Neural Networks and Deep Learning, Bioinformatics Statistical Analysis