Varun Shijo

CONTACT INFORMATION

340 Davis Hall
Department of Computer Science & Engineering
University at Buffalo, SUNY
Buffalo, NY, 14260-2500 USA

Phone: (716) 936-4330
E-mail: varunshi@buffalo.edu
Page: https://varunshijo.com
ORCID: 0000-0001-8266-9047

RESEARCH INTERESTS

My research focus is **Neural Representations for Real-time Computational Biosensing**. Specifically, I investigate compact encodings across biosignal dimensionalities: 1D time-series (EEG, IMU, speech), 2D/3D imagery (ultrasound, photoacoustic); and their derivatives (pose, volume) to enable low-cost clinical sensing: reconstruction, detection, and real-time biofeedback. The unifying framework for my research, broadly, consists of biosignal acquisition and exploration, biomarker identification using learned features, and interpreting them to develop low-cost intervention methods with an emphasis on translational clinical outcomes and real-world impact.

My present research is comprised of:

Low-Cost Clinical Sensing: Adapting computer vision and edge computing to consumer-grade hardware for real-time biofeedback (UltraSpeech for speech therapy via Ultrasound Tongue Imaging), freehand 3D ultrasound reconstruction, and tumor detection/artifact reduction in photoacoustic and ultrasound imaging.

Multimodal Biosignal Encoding: Learning representations across time-series (EEG, IMU, speech) and imagery (ultrasound, photoacoustic) that preserve interpretability while outperforming rule-based baselines, towards closed-loop end-to-end real-time systems for interventional use.

Motivation: My research is primarily motivated by an overarching goal of maximizing throughput between humans and computers using Brain Computer Interfaces. My current research brings me closer to this goal by expanding my understanding related to the domain-specific complexities of each sensing modality - ultrasound, photoacoustics, EEG, IMUs, speech, tongue poses, and the prevalent dimensionality-specific techniques and models of thinking involved - Transformers (Information Retrieval), CNNs (Signal Processing), Mamba SSMs (Control Theory), Multi-task pretraining/Agentic AI (Reinforcement Learning) etc.

EDUCATION

University at Buffalo, the State University of New York (SUNY) *Aug. 2022 - Present*
Ph.D., Computer Science & Engineering — Supervised by Dr. Wenyao Xu and Dr. Jun Xia
Admitted to Candidacy: September 29, 2025

University at Buffalo, the State University of New York (SUNY) *Aug. 2017 - June 2019*
M.S., Computer Science & Engineering — Artificial Intelligence Specialization

University of Mumbai *Aug. 2013 - May 2017*
B.Eng., Information Technology

PUBLICATIONS

6 publications (**2** first-author), **2** under review · Google Scholar: https://scholar.google.com/citations?user=9xB7QGgAAAAJ

Under Review

[U1] R.W. Bing, **V. Shijo**, N. Asare, E. Zheng, S. Enam, C. Huang, W. Xu, and J. Xia, "*AI-assisted Wireless Ultrasound for Self-Directed Breast Cancer Screening: A Feasibility Study*," **SAGE Ultrasonic Imaging**, 2025. (Under Review)

[U2] S. Hou*, W. Bo*, L. Cao, C. Liu, **V. Shijo**, X. Zhang, L. Guo, and W. Xu, "*Speech Annotation and Transcription Enhancer (SATE): An Automated System for Child Language Sample Analysis*," **ACM IMWUT**, 2026. (Submitted)

Journal Articles

[J1] C. Huang, E. Zheng, W. Zheng, H. Zhang, Y. Cheng, X. Zhang, **V. Shijo**, R.W. Bing, I. Komornicki, L.M. Harris, E. Bonaccio, K. Takabe, E. Zhang, W. Xu, and J. Xia, "*Enhanced Clinical Photoacoustic Vascular Imaging through a Skin Localization Network and Adaptive Weighting*," **Photoacoustics**, vol. 42, p. 100690, 2025. doi:10.1016/j.pacs.2025.100690

[J2] W. Zheng, H. Zhang, C. Huang, **V. Shijo**, C. Xu, W. Xu, and J. Xia, "*Deep Learning Enhanced Volumetric Photoacoustic Imaging of Vasculature in Human*," **Advanced Science**, vol. 10, no. 29, p. 2301277, 2023. doi:10.1002/advs.202301277

Conference Proceedings

[C1] **V. Shijo**, T. Vu, J. Yao, W. Xu, and J. Xia, "*SwinIR for Photoacoustic Computed Tomography Artifact Reduction*," **IEEE International Ultrasonics Symposium (IUS)**, Montreal, Canada, Sep. 2023, pp. 1–4. doi:10.1109/IUS51837.2023.10307937

[C2] R.W. Bing, **V. Shijo**, E. Zheng, W. Zheng, C. Huang, and J. Xia, "*Wearable Photoacoustic/Ultrasound Imaging with a Curved Linear Array*," **IEEE International Ultrasonics Symposium (IUS)**, Montreal, Canada, Sep. 2023, pp. 1–5. doi:10.1109/IUS51837.2023.10307045

[C3] R.W. Bing, **V. Shijo**, N. Asare, E. Zheng, S. Enam, C. Huang, W. Xu, and J. Xia, "*Towards Low-Cost Wireless AI-assisted Breast Tumor Screening and Volumetric Freehand Reconstruction*," in **Proc. SPIE 13931, Medical Imaging 2026: Ultrasonic Imaging and Tomography**, 1393115, Vancouver, BC, Canada, Feb. 2026. doi:10.1117/12.3086153

[C4] **V. Shijo**, A. Das, W. Bo, S. Hou, L. Guo, J. Xia, and W. Xu, "*PULSE: A Principled Framework for Multimodal Speech Sound Disorder Assessment Using Ultrasound Tongue Imaging*," **IEEE/ACM International Conference on Connected Health: Applications, Systems and Engineering Technologies (CHASE)**, Pittsburgh, PA, 2026. (Accepted, to appear in **Elsevier Smart Health**)

Selected Projects

- **UltraSpeech** – Real-time Ultrasound Tongue Imaging
  Zero-to-one clinical biofeedback system for speech therapy using direct wireless ultrasound, built on a custom reactive DAG framework (`sigflow-rt`) that abstracts modalities by tensor shape and supports real-time inference in the loop. End-to-end pipeline: B-mode ultrasound, audio, and video capture; ONNX inference for DeepLabCut tongue/lip pose, MediaPipe face mesh, and wav2vec2 phoneme transcription; real-time landmark and 3D tongue model visualization; Procrustes-aligned scoring against UltraSuite TD references; all stream-synchronized via LSL for recording and playback. Zero-copy architecture (SIMD, shared memory, triple buffering) with async inference achieves 12-13 ms median latency on CPU-only (no GPU required). Validated across 19,716 clinical inference operations (14 tongue landmarks, 0.90 confidence). Demoed at ASHA Convention 2025 (Auspex Medix exhibitor).
- **MGNAT-SignalJEPA** – NeurIPS 2025 EEG Foundation Challenge [Code]
  Self-supervised EEG representation learning with novel spatial block masking strategy. Ranked 55/184 valid submissions (1,202 participants) with minimal training (1 epoch, partial data). Built comprehensive interpretability toolkit: attribution analysis (Integrated Gradients, GradCAM), systematic ablation studies, and neuroscience-grounded validation.

Honors & Awards

- **3rd Place**, Poster Presentation, RCBU Biomedical Ultrasound Symposium, Rochester, NY 2025

Teaching Experiences

CSE574: Intro. to Machine Learning (TA - Dr. Asif Imran) [Spring 2025]
CSE573: Intro. to Computer Vision and Image Processing (TA - Dr. Chen Wang) [Fall 2024]
CSE573: Intro. to Computer Vision and Image Processing (**Instructor**) [Summer 2024]
CSE560: Data Models and Query Languages (TA - Dr. Sreyasee Das Bhatttacharjee) [Spring 2024]
CSE666: Biometrics Image Analysis (TA - Dr. Nalini Ratha) [Spring 2023]

Mentoring Experiences

- Nihar Asare (MS Student, Robotics@UB)
  *Wireless Self-directed 3D Freehand Breast Ultrasound**
- Arianna Dougherty (MS Student, BE@UB)
  *Breast PACT for Tumor Detection and Localization**
- Michelle Lin (High School Student, Williamsville North High School)
  Camera-based PPG for pulsatile signal estimation
- Emma Zhang (High School Student, Williamsville North High School)
  SWIR for moisture quantification
- Emma Durham (Senior Undergraduate BE@UB)
  Robotic Arm-based position tracking for Self-Directed Ultrasound Scanning
- Hannah Pham (Senior Undergraduate BE@UB)
  Face Spoofing Detection using SWIR Imaging
- Chaeyeon Kim (Undergraduate, Industrial Engineering → CSE @ UB)
  Brain-Computer Interface fundamentals, OpenBCI Ganglion recording
  Team placed 2nd at UBHacking 2025 (SSVEP/motor imagery for game UI)
- Nhat Dinh (Undergraduate, Computer Engineering @ UB)
  UltraSpeech: finetuning experiments and PyQt acquisition app development

Professional Service

Technical Program Committee

- IEEE-EMBS International Conference on Body Sensor Networks (IEEE BSN) 2023

Journal Reviewer

- ACM Transactions on Computing for Healthcare (11 manuscripts) 2022–2025
- PLOS ONE 2025
- Elsevier Smart Health 2024
- World Scientific Journal of Innovative Optical Health Sciences (JIOHS) 2023

Conference Reviewer

- IEEE-EMBS International Conference on Biomedical and Health Informatics (IEEE BHI) 2024, 2025
- IEEE/ACM Conference on Connected Health (CHASE) 2025
- IEEE-EMBS International Conference on Body Sensor Networks (IEEE BSN) 2024

Presentations

Oral Presentations

[O1] R.W. Bing, **V. Shijo**, N. Asare, E. Zheng, S. Enam, C. Huang, W. Xu, J. Xia, "*AI-assisted Wireless Ultrasound for Self-Directed Breast Cancer Screening: A Feasibility Study*," SPIE Medical Imaging Conference, Vancouver, BC, Feb. 2026.

[O2] **V. Shijo**, "*Brain-Computer Interfaces and Deep Learning*," Developers' Summit, SIES GST, Navi Mumbai, India, Apr. 2022.

Poster Presentations

[P1] R.W. Bing, Z. Tan, **V. Shijo**, E. Zheng, S. Enam, C. Huang, W. Xu, J. Xia, "*Multispectral Photoacoustic Tomography for Tissue and Vascular Oxygenation Imaging*," RCBU Biomedical Ultrasound Symposium, Rochester, NY, Nov. 2025. **(3rd Place)**

[P2] R.W. Bing, Z. Tan, **V. Shijo**, E. Zheng, S. Enam, C. Huang, W. Xu, J. Xia, "*Multispectral Photoacoustic Tomography for Tissue and Vascular Oxygenation Imaging*," University at Buffalo BME Poster Competition, Buffalo, NY, Nov. 2025.

[P3] R.W. Bing, **V. Shijo**, N. Asare, E. Zheng, S. Enam, C. Huang, W. Xu, J. Xia, "*Wireless 3D Freehand Ultrasound*," RCBU Biomedical Ultrasound Symposium Day, Buffalo, NY, Nov. 2024. (Co-lead)

[P4] C. Huang, E. Zheng, W. Zheng, H. Zhang, Y. Cheng, X. Zhang, **V. Shijo**, et al., "*Skin Segmentation for Photoacoustic Imaging*," RCBU Biomedical Ultrasound Symposium Day, Buffalo, NY,

Nov. 2024.

[P5] **V. Shijo**, T. Vu, J. Yao, W. Xu, J. Xia, "*SwinIR for Photoacoustic Computed Tomography Artifact Reduction*," IEEE International Ultrasonics Symposium (IUS), Montreal, Canada, Sep. 2023.

[P6] R.W. Bing, **V. Shijo**, E. Zheng, W. Zheng, C. Huang, J. Xia, "*Wearable Photoacoustic/Ultrasound Imaging with a Curved Linear Array*," IEEE International Ultrasonics Symposium (IUS), Montreal, Canada, Sep. 2023.

Demonstrations

[D1] **V. Shijo**, "*UltraSpeech: Real-time Ultrasound Tongue Imaging for Speech Therapy*," ASHA Convention 2025, Exhibitor Demo (Auspex Medix), Nov. 2025.

Technical Skills

Languages	Python (primary), Go, C
ML/DL	PyTorch, scikit-learn, NumPy, Pandas
Focus Areas	Deep learning for medical imaging, system design, research architecture

Industry Experience

TATA AIG General Insurance Company, Mumbai *June 2021 – June 2022*
Software Engineer - Innovations Lab

- Scene text recognition pipeline: YOLOv5 detector, custom EasyOCR model, serverless API (Lambda + Flask)
- Implemented MobileNetv3 in PyTorch for document classification (5.4x faster than TensorFlow VGG)
- Built document parser POC: FastAPI server, layout detection (YOLOv5), OCR (Tesseract), regex extraction
- MLOps: Reduced Docker image 9GB→4.7GB, automated CI/CD (CodePipeline), model monitoring (Streamlit)

CentralSquare Technologies, Greensboro, NC *Aug 2019 – Oct 2020*
Software Developer II - LABS

- Built cloud-native data processing in Go (2x faster than Python) with async patterns
- Implemented focal loss for XGBoost on imbalanced crime prediction dataset
- NLP: Surveyed SotA, built BERT-based scrum story point estimator
- Integrated TPOT AutoML, Metaflow DAG pipelines, Terraform deployments
- Conducted AI Ethics review using Ethics Toolkit; served as rotating Scrum Master

Drona Aviation, IIT Bombay *June 2016*
Research Intern - Embedded Systems

- Nano-drone firmware development (Cleanflight, Embedded C)
- Integrated mouse sensor (ADNS5700/9800) for optical flow drift correction
- Implemented failsafe landing protocols based on RSSI and battery voltage

References

Dr. Wenyao Xu (Co-Advisor)
Professor & Director of Research, CSE
IEEE/AIMBE/AAIS Fellow
University at Buffalo
wenyaoxu@buffalo.edu

Dr. Jun Xia (Co-Advisor)
Professor, Biomedical Engineering
University at Buffalo
junxia@buffalo.edu

Jeremy Heffner (Former Manager)
CentralSquare Technologies
jerheff@gmail.com