

# Keshav Bimbraw

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## EDUCATION

### Worcester Polytechnic Institute, Worcester, MA

Ph. D. student in Robotics Engineering (Medical FUSION Lab)

Concentration – Ultrasound Image Processing, Medical Robotics & Human-Computer Interaction

Aug '20 – Dec '24 (tentative)

4.00/4.00 GPA

### Georgia Institute of Technology, Atlanta, GA

M. S. with Robotics Focus (Music Technology, Computer Software & Media Applications)

Concentration – Human Augmentation, Medical Robotics & Robotic Musicianship

Aug '17 – May '19

3.56/4.00 GPA

### Thapar University, Patiala, India

B. E. in Mechatronics Engineering (Research Intern - IIT Delhi, Jan – Jul '16)

Concentration – Robotics & Mechatronics

July '13 – June '17

4.00/4.00 GPA (8.34 CGPA)

## EXPERIENCE

### Worcester Polytechnic Institute (WPI)

Worcester, MA

#### Research Assistant (Medical FUSION Lab)

March '20 – now

- Funded by Amazon Robotics: Ultrasound based continuous finger force estimation, 5% error (IEEE IUS '23). [Paper](#). [Video](#).
- Developed an innovative mirror-based ultrasound system for forearm-based hand gesture classification, utilizing Convolutional Neural Networks (CNNs) and Vision Transformers (ViT), and achieving a gesture classification accuracy of 93%.
- Developed a data-driven hand gesture recognition pipeline for VR interfacing (Meta Quest Pro) using ultrasound data and CNNs, achieving online accuracy of 92% for 4 gestures, and a low pipeline latency of 59.48 ms. [Paper](#). [Video](#).
- Developed a deep learning based pipeline to predict finger angles & hand configurations from forearm ultrasound images. Achieved an error of 7.35° for finger joint angle prediction (IEEE ICRA '22). [Paper](#). [Video](#). Extended version published in [IEEE T-MRB](#).
- Conceptualized a novel augmented reality based lung ultrasound scanning guidance system (MICCAI ASMUS '20). [Paper](#). [Video](#).
- Established the real-time ultrasound data acquisition software framework for a tele-operative low-cost lung ultrasound robot. [Paper](#).

### Mitsubishi Electric Research Laboratories

Cambridge, MA

#### Research Intern (Connectivity and Information Processing Group, Mentor: Toshiaki Koike-Akino)

May '23 – Aug '23

- Designed pipelines for multi-modal biosignal data acquisition and human-machine interaction in AR/VR/XR applications.
- Incorporated adversarial regularization to bolster hand gesture classification performance in the context of domain adaptation.
- Leveraged randomized ablation techniques to optimize the performance across multiple biosignal modalities for gesture classification.

### Nokia Bell Labs

New Providence, NJ

#### Augmented Human Sensing Co-Op (Data and Devices Group, AI Research Lab)

June '22 – Dec '22

- Designed low-latency biosignal based pipelines (sEMG, IMU) to estimate bodily motion for Human-Machine Interaction. [Video](#).
- Submitted and presented a paper ([IEEE SII 2023](#)) and multiple invention reports. Offered a Co-Op extension, which was accepted.
- Developed demonstrations for biosignal-based remote multi-sensor real-time shared-autonomy industrial robotic applications.
- Investigated multi-channel sEMG based hand movement classification for robotic control using deep learning (MLP, CNN).
- Utilized transfer learning approach for improving performance of sEMG based hand configuration classification from 91% to 96%.

### Agile Resources Inc.

Peachtree City, GA

#### Audio DSP Engineer (Panasonic Automotive Systems of America)

Oct '19 – March '20

- Developed Qualcomm's Hexagon SDK for audio applications in Eclipse on Android framework development.
- Utilized Qualcomm tools to evaluate audio modules such as Bass Mid Treble, Parametric Equalizer, Fade & Balance, etc.

### Bose Corporation

Stow, MA

#### Active Noise Control Engineering Intern (Automotive Systems Division)

May '19 – Oct '19

- Designed sound synthesis framework for electric vehicles and implemented processor-optimized signal processing algorithms.
- Devised a physical car sound simulation system using Logitech pedals to evaluate models and reduce testing time.

### Georgia Institute of Technology (Georgia Tech)

Atlanta, GA

#### Research Assistant (Robotic Musicianship Lab)

Aug '17 – May '19

- Lead the [Skywalker project](#) from Aug '18 – May '19. My robot and code were featured in the first episode of The Age of A.I. [Link](#).
- Investigated a combination of Ultrasound & EMG data using supervised learning algorithms to enhance assistive robot control.
- Translated Piano playing to robots using a single DOF system and designed a robotic hand with one DOF per finger. [Link](#).
- Created an ultrasound in the loop tendon-based wearable exoskeleton for upper extremity rehabilitation of stroke survivors. [Link](#).
- Taught Computer-Aided Design (CAD), Fusion 360, 3D printing, and Mechatronics for Project Studio Course. [Link](#), [Link](#).

- Conceptualized and programmed the system framework for two KUKA KR-5 robotic arms to collaboratively play a guitar. [Link](#).
- Improved performance of a 6 DOF motion platform at Simulator Development Division, Secunderabad, India. [Link](#).
- Developed a teach pendant and a control module to control virtual robots in RoboAnalyzer software. [Link](#).
- Modified the mechanical and electrical design of Tulsi Bead making device under the rural development initiative of IIT Delhi.

## SKILLS

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### Software Skills

Python, TensorFlow, PyTorch, ROS, Linux, NumPy, MATLAB, OpenCV, C++

### 3D Design/3D printing

SolidWorks, Autodesk Inventor, Autodesk Fusion 360, Unity, TinkerCAD, Cura

### Electrical/Electronic skills

Arduino, Raspberry Pi, Motors, Actuators, Hardware & software interfacing

### Programming Frameworks

Shell Scripting, Git, Visual Studio Code, PyCharm, Version Control

## RECENT ACADEMIC PROJECTS

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### Analyzing the performance of a cart pole system for different parameters for RL (WPI, Artificial Intelligence) Spring '23

- Implemented a Reinforcement Learning framework in PyTorch using OpenAI Gym where the goal is to keep a pole upright,
- Analyzed the performance of the system for Deep Q-Networks (DQN) and Q-Learning scenarios for various system parameters.

### Comparing low & high-dimensional forearm ultrasound-based hand state classification (WPI, Machine Learning) Spring '22

- Investigated the feasibility of using image compression techniques for extracting the latent structure of ultrasound images. [Link](#).
- Designed a real-time ML pipeline for training and testing models for hand motion classification based on forearm ultrasound.

## LEADERSHIP

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- Mentored high school & undergraduate students towards ongoing projects through MLSC, MQP & REU (WPI), & VIP (GT).
- Senator and representative of the Robotics Department for the Graduate Student Government for academic year '21 - '22.
- Member of the Rho Beta Epsilon Robotics Engineering society. Co-hosted a C++ workshop for beginners. ('21 - '22)
- Graduate Student Officer at The Alliance: the social, educational, & professional support network of LGBT+ students. ('21 - '22)

## HONORS & AWARDS

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- Funded through Amazon Robotics GBTI Award for the 2023-2024 academic year (Tuition support & yearly award) August '23
- Selected for the 2021B cohort of Google Research's CSRMP. The first person at WPI to have ever been selected. Sept. '21
- Awarded PhD positions at WPI & Georgia Tech. Accepted the WPI offer. (Tuition support & \$31824 yearly award). March '20
- Selected as NSF-NRT ARMS (Accessibility, Rehabilitation, & Movement Science) Trainee (\$1500 award). August '18
- Scholarship to pursue master's at Georgia Tech (Tuition support & \$14100 yearly award). August '17
- Awarded merit scholarships and grants totaling INR 336,000 at Thapar University. June '17

## RECENT PUBLICATIONS (Full list: [CV](#))

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- [1] **Bimbraw, K.**, & Zhang, H. K. Mirror-based Ultrasound System for Exploring Hand Gesture Classification through Convolutional Neural Network and Vision Transformer. Communicated to *SPIE Medical Imaging 2024*.
- [2] **Bimbraw, K.**, Rothenberg, J., & Zhang, H. K. (2023, October). Leveraging Ultrasound Sensing for Virtual Object Manipulation in Immersive Environments. Accepted to be presented at *IEEE-EMBS International Conference on Body Sensor Networks*. [Paper](#). [Video](#).
- [3] **Bimbraw, K.**, & Zhang, H. K. (2023, September). Estimating Force Exerted by the Fingers Based on Forearm Ultrasound. In *2023 IEEE International Ultrasonics Symposium (IUS)*. [Paper](#). [Video](#).
- [4] **Bimbraw, K.**, Bimbraw, K., & Zheng, M. (2023, January). Towards The Development of a Low-Latency, Biosignal-Controlled Human-Machine Interaction System. In *2023 IEEE/SICE International Symposium on System Integration (SII)* (pp. 1-7). IEEE. [Paper](#). [Video](#).
- [5] **Bimbraw, K.**, Nycz, C. J., Schueler, M. J., Zhang, Z., & Zhang, H. K. (2022, May). Prediction of Metacarpophalangeal joint angles and Classification of Hand configurations based on Ultrasound Imaging of the Forearm. In: *2022 International Conference on Robotics and Automation (ICRA)* (pp. 91-97). IEEE. [Paper Link](#). [Video](#). [Journal Paper](#) published in *IEEE Transactions on Medical Robotics and Bionics*.
- [6] **Bimbraw, K.**, Ma, X., Zhang, Z., Zhang, H. (2020). Augmented Reality-Based Lung Ultrasound Scanning Guidance. In: *Medical Ultrasound, and Preterm, Perinatal and Paediatric Image Analysis. ASMUS 2020, PIPPI 2020*. Lecture Notes in Computer Science, vol 12437. Springer, Cham. doi.org/10.1007/978-3-030-60334-2\_11. [Paper Link](#). [Video](#).
- [7] **Bimbraw, K.**, Fox, E., Weinberg, G. and Hammond, F. L. (2020). Towards Sonomyography-Based Real-Time Control of Powered Prosthesis Grasp Synergies. In: *2020 42nd Annual International Conference of the IEEE Engineering in Medicine & Biology Society (EMBC)*, Montreal, QC, Canada, 2020, pp. 4753-4757, doi: 10.1109/EMBC44109.2020.9176483. [Paper Link](#). [Video](#).