BAIJUN XIE

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LinkedIn ***Google Scholar*** ***Homepage*** ***GitHub***

EDUCATION

The George Washington University, Washington, DC, U.S.A. *09/2018 – 12/2023*

- *Doctor of Philosophy* in Biomedical Engineering
- Key courses: *Probability for Computer Science, Design & Analysis of Algorithm, Machine Learning, Pattern Recognition, Digital Image Processing, Robotics Vision & Perception, Biomedical Signal Analysis.*
- Advisor*: Chung Hyuk Park*
- Dissertation: *Empathetic Robotic Companion for Autistic Adolescents with Multimodal Human-Robot Interaction*

The George Washington University, Washington, DC, U.S.A. *09/2016 – 05/2018*

- *Master of Science* in Mechanical Engineering
- Key courses: *Electromechanical Control System, Robotic Systems, Applied Nonlinear Control, Applied Optimal Control & Estimation, Attitude Control, System Optimization, Mechatronics Design, Numerical Solution.*
- *Advisor: Adam Wickenheiser*

Shenzhen University, Guangdong, China *09/2012 - 06/2016*

- *Bachelor of Engineering* in Photoelectric Information Engineering
- Advisor*: Jun Song*
- Thesis: *Photovoltaic Performance perovskite solar cells with a nano-micro hole transporting layer*

RESEARCH EXPERIENCE

Research Focus: Machine Learning, Multimodal Emotion Recognition, Robotics, Human-Robot Interaction (HRI), Human-Computer Interaction (HCI), Large language Models (LLMs), Reinforcement Learning (RL).

The George Washington University, *Department of Biomedical Engineering*

Doctoral Researcher *09/2018 – 12/2023*

Empathetic Robotic Companion for Human-Robot Interaction

- Developed a cutting-edge multimodal framework for emotion recognition by fine-tuning backbone models and integrating a fusion module, achieving over a 2% improvement in accuracy and F1 score over baseline models.
- Integrated a robotic system with real-time pose estimation and gesture imitation for seamless HRI; employed 3D vision models to identify multimodal contextual human behaviors and achieved 92%+ accuracy in classifying emotional upper body gestures; attained multithreading for executing multiple deep learning models.
- Developed an AI chatbot on a humanoid robot to facilitate empathetic conversations using a speech-to-text engine and ChatGPT backend, personalizing interactions through ReAct prompting strategies.
- Post-trained LLMs using PEFT methods (e.g., LoRA) and integrated a reward model powered by Proximal Policy Optimization (PPO) to deliver highly personalized, context-aware responses from AI agents.
- Designed interactive HRI scenarios tailored for autistic users, aiding robot-assisted intervention in alleviating anxiety with significant outcomes (p-value < 0.05) in physiological signals and questionnaire responses; analyzed physiological signals collected from the user study, leveraging these data for action selection through RL.

Social IQ 2.0 Challenge – ICCV 2023

- Developed and presented a multimodal RoBERTa-based language model that integrates emotional and social cues from video data to enhance contextual understanding in a multiple-choice video question-answering task.
- Achieved 75%+ accuracy on the validation set of the benchmark, outperforming the baseline by 36.7%.

Medical Image Segmentation for Automated Nerve Identification, *with Children's National Hospital*

- Developed software applications to annotate the nerves from the collected medical imaging dataset.
- Segmented nerves from birefringence and RGB images via a U-Net architecture with a customized fusion module.
- Conducted a systematic evaluation of the multimodal fusion module's efficacy in nerve identification, achieving an 18% improvement in the dice coefficient and a 19.6% improvement in the F2 score over unimodal networks.

Microrobots with Haptic Control, *with Southern Methodist University*

- Established a simulated environment with a haptic device to model the contact force for the microrobot.
- Employed passive control to handle time-delay (50+ms) in remote settings and investigated RL for guidance force.

Trainable Extended Kalman Filter (EKF) for Dead Reckoning in Autonomous Ground Vehicles

- Implemented a trainable EKF for ground vehicle localization with dead reckoning, which leverages IMU inputs when the LiDAR-based SLAM is unavailable.
- Improved the EKF by integrating a developed attention-based convolutional neural network (CNN) module; obtained a 42.6% MSE reduction over the vanilla EKF baseline.

The George Washington University, *Department of Mechanical Engineering*

Graduate Researcher *02/2017 - 05/2018*

Multi-Domain Search and Rescue using Cooperative Robots

- Applied a model-based least squares pose estimation method to predict the pose of a ground robot.
- Trained custom CNN models and attained over 10 FPS for fast object detection on an embedded system.
- Conducted experiments and simulations with PID and geometric controllers for an autonomous quadrotor.

Practical Numerical Methods with Python for Shallow Water Equations (SWEs)

- Derived the full vectorization of a system of partial differential equations, SWEs, with conservative form.
- Simulated the numerical results of SWEs and analyzed the grid convergence with different numerical schemes; enhanced the order of convergence from 1 to 2 by utilizing a Lax-Wendroff scheme.

Shenzhen University, *College of Photoelectric Information Engineering*

Undergraduate Researcher *10/2014 - 05/2016*

Design of Perovskite Solar Cells

- Constructed a perovskite solar cell with a nano-micro hole transporting layer through a fast crystallization method.
- Tested the devices and executed meticulous data analysis to evaluate their overall performance.

Shenzhen University 2015 Challenge Cup University Student Venture Contest

- Utilized a single-chip microcomputer to capture images from WIFI video.
- Programmed automation control for a compact intelligent car to collect 2D images for subsequent 3D modeling.

Laboratory Open Fund Project of Shenzhen University

- Employed MATLAB for dynamic simulation of joint Fourier transform correlation recognition processing.
- Designed and programmed the graphical user interface (GUI) for the system.

PROFESSIONAL EXPERIENCE

Meta Platforms, Inc., *Redmond, Washington, U.S.A*

Research Engineer *04/2024 – Present*

- Designed and implemented algorithms and software for augmented reality (AR) input prototype devices in HCI, leveraging advanced signal processing and machine learning techniques.
- Developed and maintained solutions to synchronize data and created seamless experiences across complex, multi-device wearable systems, integrating multimodal sensory inputs and hardware components.
- Enhanced user experience by leveraging LLMs for personalized interactions; rapidly prototyped AR input devices to showcase system capabilities effectively in a constellation.

The George Washington University, *Washington, DC, U.S.A.*

Graduate Research Assistant *09/2018 – 12/2023*

- Specialized in fostering collaborative innovation at the intersection of human intelligence and robotic technology.
- Developed machine learning algorithms combined with emotional intelligence to facilitate the creation of more engaging and empathetic experiences for HRI; conducted a user study to evaluate the developed companion robot.

Graduate Teaching Assistant *09/2018 – 05/2020*

- Assisted in the teaching of the classes of SEAS 1001 and BME 2825 within George Washington University.

Shenzhen JBT Smart Lighting Co., Ltd., *Guangdong, China* *07/2015 - 08/2015*

Intern

- Applied expertise of circuit design principles in designing power circuits for LED lamps and lanterns.

TEACHING EXPERIENCE

Teaching Assistant, *The George Washington University*

SEAS 1001 Engineering Orientation *09/2019 - 05/2020*

- Instructed students in MATLAB for data analysis and solving differential equations using the symbolic toolbox.

BME 2825 Biomedical Engineering Programming II *09/2018 - 05/2019*

- Guided undergraduate students in C programming with a focus on biomedical engineering problems.

Mentor, *2019 George Hacks Medical Solutions Hackathon* *01/2019*

- Assisted the participants in the Hackathon to analyze and realize their ideas of innovation.

Undergraduate Group Project Advisor, *Shenzhen University* *04/2016 - 07/2016*

- Facilitated student group projects for the Challenge Cup competition, fostering teamwork and problem-solving.

PUBLICATIONS

Journal Articles

5. Duygu, Y.C.*, **Xie, B.***, Zhang X., Kim, M.J. & Park, C.H. (2025) Real-time teleoperation of magnetic force-driven microrobots with a motion model and stable haptic force feedback for micromanipulation. ***Nanotechnology and Precision Engineering***, *8*(2). * Equally contributed
4. Milam, G., **Xie, B.**, Liu, R., Zhu, X., Park, J., Kim, G., & Park, C. H. (2022). Trainable Quaternion Extended Kalman Filter with Multi-Head Attention for Dead Reckoning in Autonomous Ground Vehicles. ***Sensors***, *22*(20), 7701.
3. **Xie, B.**, Milam, G., Ning, B., Cha, J., & Park, C. H. (2022). DXM-TransFuse U-net: Dual cross-modal transformer fusion U-net for automated nerve identification. ***Computerized Medical Imaging and Graphics***, *99*, 102090.
2. **Xie, B.**, Sidulova, M., & Park, C. H. (2021). Robust multimodal emotion recognition from conversation with transformer-based crossmodality fusion. ***Sensors***, *21*(14), 4913. **(*Feature Paper*)**
1. **Xie, B.**, Kim, J. C., & Park, C. H. (2020). Musical emotion recognition with spectral feature extraction based on a sinusoidal model with model-based and deep-learning approaches. ***Applied Sciences***, *10*(3), 902.

Conference Papers

6. **Xie, B.**, & Park, C. H. An Empathetic Social Robot with Modular Anxiety Interventions for Autistic Adolescents, In *2024 33rd IEEE* ***International Conference on Robot and Human Interactive Communication (RO-MAN)***. IEEE.
5. **Xie, B.**, & Park, C. H. (2023). Multi-Modal Correlated Network with Emotional Reasoning Knowledge for Social Intelligence Question-Answering. In *Proceedings of the* ***IEEE/CVF International Conference on Computer Vision*** (pp. 3075-3081). (***Oral Presentation***)
4. **Xie, B.**, & Park, C. H. (2023, March). "Can You Guess My Moves?" Playing Charades with a Humanoid Robot Employing Mutual Learning with Emotional Intelligence. In Companion of the 2023 ACM/IEEE International Conference on Human-Robot Interaction.
3. **Xie, B.**, & Park, C. H. (2021). A MultiModal Social Robot Toward Personalized Emotion Interaction. *arXiv preprint*

arXiv:2110.05186. (***Presented at AAAI 2021 Fall Symposium***)

2. **Xie, B.**, & Park, C. H. (2021, July). Empathetic robot with transformer-based dialogue agent. In *2021 18th **International Conference on Ubiquitous Robots (UR)***. IEEE.
1. **Xie, B.**, & Park, C. H. (2020, March). Dance with a Robot: Encoder-Decoder Neural Network for Music-Dance Learning. In *Companion of the 2020 **ACM/IEEE International Conference on Human-Robot Interaction***.

Patent

1. Milam, G., **Xie, B.**, Park, C. H., "Real Time Automated Nerve Identification System." International Publication No. WO2023/183930, published on 9/28/2023.

ACADEMIC SERVICES

Reviewer for Journals

- Springer Nature on Cognitive Computation
- IEEE Transactions on Cybernetics
- IEEE Transactions on Affective Computing
- Frontiers in Robotics and AI
- International Journal of Human-Computer Interaction

Reviewer for Conferences

- ACM/IEEE International Conference on Human Robot Interaction (HRI 2025, 2023)
- International Conference on Robotics and Automation (ICRA 2024, 2023)
- IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2024, 2019)
- International Conference on Robot and Human Interactive Communication (RO-MAN 2019-2024)
- International Conference on Ubiquitous Robots (UR 2022)
- AAAI 2021 Fall Symposium
- Joint 12th IFAC Conference on Control Applications in Marine Systems, Robotics, and Vehicles 1st IFAC Workshop on Robot Control (Joint CAMS and WROCO 2019)

AWARDS & ACCOMPLISHMENTS

- 2022-2023 Collins Distinguished Doctoral Fellowship in the Department of Biomedical Engineering at the GWU
- 2022 GW Technology Commercialization Innovation Competition (**Audience's choice posters Prize**)
- 2021 Deep Reinforcement Learning Nanodegree from Udacity
- 2016 A Hundred Excellent Final Year Theses Prize in Shenzhen University
- 2015 Shenzhen University Challenge Cup University Student Venture Contest (**2nd Prize**)
- 2014 Laboratory Open Fund Project of Shenzhen University (**3rd Prize**)

PRESENTATIONS

Oral Presentation

2023 IEEE/CVF International Conference on Computer Vision (ICCV) Workshops *at Paris, France* *10/2023*
Multi-Modal Correlated Network with Emotional Reasoning Knowledge for Social Intelligence Question-Answering

2022 BME Day in the Department of Biomedical Engineering *at the GWU* *11/2022*
Empathetic Robotic Companion with Personalized Social Games

2021 the Artificial Intelligence for Human-Robot Interaction AAAI Fall Symposium *(online)* *11/2021*
A Multimodal Social Robot Toward Personalized Emotion Interaction (Link)

2020 ACM/IEEE International Conference on Human-Robot Interaction *(online)* *04/2020*
Dance with a Robot: Encoder-Decoder Neural Network for Music-Dance Learning (Link)

Poster Presentation

2024 IEEE International Conference on Robot and Human Interactive Communication *at Pasadena, CA* *08/2024*

An Empathetic Social Robot with Modular Anxiety Interventions for Autistic Adolescents

2023 GW SEAS R&D Showcase *at the GWU* *04/2023*

Empathetic Robotic Companion with Personalized Social Games

2023 ACM/IEEE International Conference on Human-Robot Interaction *at Stockholm, SE* *03/2023*

"Can You Guess My Moves?" Playing Charades with a Humanoid Robot Employing Mutual Learning

2022 GW Technology Commercialization Innovation Competition *at the GWU* *05/2022*

AI-Driven Real-time Nerve Detection and Visualization for Surgical Precision (Link)

2021 18th International Conference on Ubiquitous Robots *(online)* *07/2021*

Empathetic Robot with transformer-based dialogue agent

2019 Biomedical Engineering Society (BMES) Annual Meeting *at Philadelphia* *10/2019*

Deep Spectrogram Learning of Emotional States in Music and Application to ASD Therapies

2019 Research and Development Showcase *at the GWU* *10/2019*

Virtual Reality for Children with Autism

2019 Research Day *at the GWU* *04/2019*

Physiological Analysis and Modeling of Stress during Human-UAV interaction

2018 GW SEAS R&D Showcase *at the GWU* *02/2018*

PTA. BOT: A SAR Physical Therapy Assistant for Cardiac Rehabilitation Patients

SKILLS

- **Programming and Tools:** Python, C/C++, MATLAB, C#.
- **Framework:** PyTorch, Transformers, LangChain OpenCV, TensorFlow, OpenPose.
- **Machine Learning:** CNN, RNN, Seq2Seq, Transformers, NLP, RL, Supervised and Self-Supervised Learning.
- **Tools:** Latex, Markdown, Git/GitHub, Jupyter Notebook, Visual Studio Code.
- **Software:** Linux/Ubuntu, MATLAB Simulink, Choregraphe (SoftBank), ROS, SolidWorks, Unity, Rerun.
- **Language:** English (Proficiency), Chinese (Native).