BAIJUN XIE

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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 Learning, Artificial Intelligence (AI), Human-Robot Interaction (HRI), Robotics, Natural Language Processing, Computer Vision, 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 SOTA multimodal framework for emotion recognition achieved a 65% accuracy on the MELD dataset by fine-tuning domain-specific models and integrating a transformer-based fusion module.
- Presented a multimodal RoBERTa-based model leveraging different social cues at the Social IQ 2.0 Challenge (ICCV 2023) with a multiple-choice video QA task, achieving 75%+ accuracy on the validation set of the social intelligence benchmark, outperforming the baseline by 36.7%. (Link)
- Programmed a robotic system with real-time pose estimation and imitation modules for seamless HRI; employed advanced computer vision models to identify multimodal contextual human behaviors, achieving 92%+ accuracy on the FABO database; attained multiprocessing for simultaneous execution of multiple deep learning techniques.
- Designed interactive HRI scenarios tailored for autistic users, aiding robot-assisted intervention in mental health; analyzed physiological signals collected from the user study, leveraging these data for action selection through RL.
- Developed an AI chatbot on a humanoid robot for providing empathetic conversations utilizing a speech-to-text engine and LLMs (OpenAI API, LangChain); fine-tuned the language model by implementing PPO and LoRA.

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

- Created software applications for experts to annotate the nerves from the collected medical imaging dataset.
- Segmented nerves from birefringence images using a U-Net architecture with a transformer-based fusion module.
- Systematically assessed the efficacy of the multimodal fusion module in facilitating nerve identification and

achieved 0.76 on the F2 score, a gain of 19.6 % over single-modality networks, and 0.72 on the dice coefficient.

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 address time-delay issues 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 fails.
- Improved the EKF by integrating a developed attention-based convolutional neural network (CNN) module.

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 a custom CNN model detector for accurately recognizing the ground robot.
- Conducted experiments and simulations with a position PID controller 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 (Simulation); improved 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.

PUBLICATIONS

Journal Articles

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

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 (pp. 667-671).
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)* (pp. 290-295). 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*** (pp. 526-528).

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.

Under Review

3. **Xie, B.**, & Park, C. H. EmpathyNet: Empathy-Based Attention Network Architecture for Emotion Recognition in Conversations, 2023. (***submitted to ICRA 2024***)
2. **Xie, B.**, & Park, C. H. An Empathetic Social Robot with Modular Anxiety Interventions for Autistic Adolescents, submitted, 2023. (***submitted to HRI 2024***)
1. Duygu, Y.C.*, **Xie, B.***, Zhang X., Kim, M.J.** & Park, C.H.** Real-time Teleoperation of Magnetic Force-driven Microbots with Stable Haptic Force Feedback for Micro-manipulation, submitted, 2023. * Equally contributed ** Co-corresponding authors (***submitted to RA-L***)

ACADEMIC SERVICES

Reviewer for Journals

- 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)
- International Conference on Robotics and Automation (ICRA)
- IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)
- International Conference on Robot and Human Interactive Communication (RO-MAN)
- International Conference on Ubiquitous Robots (UR)
- 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)

JOBS & INTERNSHIPS

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

Graduate Research Assistant *06/2020 – Present*

- Specialize in fostering collaborative innovation at the intersection of human intelligence and robotic technology.

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

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

Intern

- Proficient in circuit design principles; applied expertise in designing power circuits for LED lamps and lanterns.

Shenzhen Marine Shipping & Engineering Service Co., Ltd., *Guangdong, China* *07/2014 - 08/2014*
Intern

- Learned various shipping operations, the agency business of shipping equipment, and the underwater robot.

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.

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

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, MATLAB, C/C++, C#, SQL, R.
- **Framework:** PyTorch, TensorFlow, OpenCV, HuggingFace, OpenPose, Pandas, Scikit-Learn, SciPy, Numpy.
- **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.
- **Language:** English (Proficiency), Chinese (Native).