Ao Li

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Target Roles: Embodied AI Research Scientist / Engineer · VLA Fine-Tuning and Multimodal Robot Control

Education

University of Bristol | PhD in Engineering Mathematics, fully funded CSC scholarship Sep 2023 - Mar 2027 (expected)
Research: neuromorphic tactile perception and its applications. Supervisors: Benjamin Ward-Cherrier and Nathan Lepora.

University of Bristol & UWE Bristol | MSc in Robotics, Distinction, with scholarship Sep 2022 - Nov 2023

Northeastern University | BSc in Automation Sep 2018 - Jun 2022

Publications

1. **First author · Humanoids 2025: Velocity Modulation in Robotic Texture Exploration Based on Human Perceptual Dimensions. Li, A.**, Brayshaw, G., Lu, Y., & Ward-Cherrier, B., pp. 437-443.
2. **Co-first author · IROS 2025: Exploratory Movement Strategies for Texture Discrimination with a Neuromorphic Tactile Sensor.** Xu, X.*, **Li, A.***, & Ward-Cherrier, B., pp. 17869-17874. *Equal contribution.
3. **Third author · Neuromorphic Computing and Engineering 2025: Neuromorphic Touch for Robotics - A Review.** Liu, T., Brayshaw, G., **Li, A.**, Xu, X., & Ward-Cherrier, B., 5(3), 032001.
4. **First author · Scientific Data (under review): A multimodal dataset of human tactile texture perception and exploration. Li, A.**, Pearson, M., & Ward-Cherrier, B.
5. **First author · ICRA 2027 (under review): Feeling like Humans: Predicting Tactile Textural Features from a Neuromorphic Sensor. Li, A.**, Cao, G., Liu, T., & Ward-Cherrier, B.
6. **Third author · ICRA 2027 (under review): Frequency Decoupling of Force and Position on an Ionic Hydrogel Tactile Skin.** Ranjan, A., Wu, L., **Li, A.**, & Cao, G.
7. **Third author · IEEE Transactions on Robot Learning (under review): TouchSteer: Grounding Natural Language in Tactile Perception via Steering Vectors.** Cao, G., Fu, Y., **Li, A.**, Zhou, Y., et al.

Doctoral Research Experience (Bristol Robotics Laboratory)

π0.5-DROID-Based VTLA Dual-Arm Manipulation System | Core Developer

Jun 2026 - Present

Project Background: Vision-only policies for precise tabletop manipulation are vulnerable to occlusion and lack the contact feedback needed to prevent grasp slip and instability. Integrated high-frequency tactile sensing into π0.5-DROID and built a dual-arm leader-follower demonstration platform, connecting multimodal data collection, cross-modal fine-tuning, edge inference and closed-loop robot execution for stable pick-and-place of contact-sensitive objects.

- **Multimodal Teleoperation and Demonstration Collection:** Built a **leader-follower** teleoperation system with two **Franka Panda** robots, **UMI grippers**, end-effector tactile arrays and multi-view RGB cameras. Standardised data interfaces and synchronised sensor streams to build a structured, high-quality multimodal demonstration dataset for dual-arm pick-and-place tasks.
- **VTLA Architecture Adaptation and Fine-Tuning:** Designed a tactile feature encoder for **π0.5-DROID** and used cross-modal alignment to inject tactile representations into its **flow-matching action head**. Applied **LoRA (PEFT)** on an **8×H100** cluster, keeping the vision-language backbone frozen while jointly optimising action-sequence generation.
- **Edge Inference and Closed-Loop Robot Execution:** Deployed the fine-tuned inference pipeline on a single **RTX 5090**, connecting leader-follower demonstration collection, cross-modal training, asynchronous action queues and **joint impedance control** in a low-latency end-to-end loop. Refined policies through physical robot testing on complex tabletop tasks.
- **Tactile Benefits and Real-Robot Evaluation:** Conducted tactile/no-tactile policy ablations on slippery, deformable and contact-sensitive objects. Tactile feedback improved grasp-slip suppression and stability during the contact phase of manipulation.

Neuromorphic Tactile Perception and Robotic Active Exploration | Algorithm Development

Jun 2023 - Jul 2026

Project Background: Investigated active exploration with the NeuroTac neuromorphic vision-based tactile sensor to address perception degradation caused by changes in exploratory motion, speed and contact depth. Developed a spiking convolutional neural network (SCNN) and deployed it on SynSense Speck2f hardware to evaluate classification robustness across contact conditions and on-chip power consumption.

- **Active Exploration Strategies:** Designed and compared **six robotic exploratory motions**, including sliding, rotation, tapping and compound motions, and systematically evaluated asynchronous event-stream features over **50-1,000 ms** sampling windows. Under fixed contact conditions with a 1,000 ms window, sliding and sliding-plus-rotation both approached **99.5% classification accuracy** across 10 natural textures.
- **Generalisation Under Variable Conditions:** Evaluated generalisation under changing motion speeds and contact depths using 1,000 ms inputs. Sliding-plus-rotation achieved **87.33% accuracy**, compared with **79.67%** for sliding alone, an improvement of **7.66 percentage points**, demonstrating the robustness of compound exploration under variable contact conditions.
- **Spiking Neural Network Architecture:** Applied spatial cropping, spatiotemporal aggregation and pooling, and temporal clipping to **NeuroTac** event streams. Built a lightweight **SCNN** with **integrate-and-fire (IF)** neurons and a **2Conv + 2Pool + 3FC** architecture to classify 10 similar natural textures.
- **Neuromorphic Edge Deployment:** Used **Sinabs** for SCNN quantisation and weight mapping, deploying the model on the **SynSense Speck2f** asynchronous neuromorphic processor for real-time on-chip texture inference. Measured average **on-chip inference operating power of 8.04 mW** for sliding-plus-rotation inputs.

Neuromorphic Tactile Sensor Design and Hardware Prototyping | Hardware and Mechanical Development

Oct 2023 - Dec 2025

Project Background: Developed optomechanical structures, robot flange adapters and rapid prototypes for TacTip/NeuroTac sensors, addressing space constraints, optical mounting and stability during high-frequency contact at robot end effectors. Provided reliable experimental hardware for active exploration and neuromorphic tactile perception.

- **Optomechanical Modelling and Iteration:** Used **Fusion 360** for parametric modelling and tolerance refinement of **TacTip/NeuroTac** housings, internal optical supports and robot end-effector flanges. Maintained stable event-camera and lens fields of view during repeated high-frequency contact and tangential sliding.
- **Multi-Material Prototyping and Integration:** Used **multi-material 3D printing (PolyJet/FDM)** to fabricate biomimetic elastomer skins, internal marker-pin arrays and rigid connectors. Assembled and integrated sensors on robot end effectors to support texture exploration under varied conditions and large-scale tactile data collection.

Industrial Projects

NCC Technology Pull Through Programme | Project Lead (Co-I / Lead)

Apr 2026 - Mar 2027

Funder: National Composites Centre (NCC), UK | Funding Awarded: £150,000
Project Background: Led proposal development and engagement with a national advanced-manufacturing technology-transfer programme to address in-process quality inspection of large, complex curved aerospace composite lay-ups. Developed an industrial robotic non-destructive inspection system using neuromorphic vision-based tactile sensing, advancing laboratory technology towards industrial application at **TRL 5-6: validation and prototype demonstration in a relevant environment**.

- **Sensor Development and Millimetre-Scale Defect Detection:** Led the team in robust industrial tactile-sensor hardware iterations and contact-dynamics testing. Developed high-frequency event-stream recognition models for composite lay-up defects, including wrinkles, bridging and foreign-material inclusions, enabling precise online detection of **millimetre-scale** surface and lay-up defects.
- **Digital Twins and Cross-Platform Robot Integration:** Built a digital-twin workflow for curved-surface inspection in **ABB RobotStudio**. Implemented adaptive surface-normal tracking and constant-force contact scanning on **ABB IRB 120 / IRB 2600** robots, connecting offline trajectory planning, simulation validation and continuous tactile inspection on physical hardware.

FSE Early Career Researcher Partnering Fund | Principal Investigator (PI)

May 2025 - Aug 2025

Funder: Faculty of Science and Engineering, University of Bristol | Funding Awarded: £1,000
Project Background: Independently secured early-career funding to address inefficient tactile-only exploration and the lack of global geometric information in curved composite inspection. Built a cross-modal framework combining global 3D visual guidance with local high-frequency tactile inspection, completing preliminary research for the subsequent £150,000 NCC technology-transfer project.

- **3D Point-Cloud Acquisition and Surface Reconstruction:** Built **Intel RealSense D435** depth-camera acquisition setups in eye-to-hand and eye-in-hand configurations. Registered multi-view point clouds, filtered noise and reconstructed 3D meshes and surface geometry of composite samples.
- **Visual-Tactile Guidance Validation:** Extracted surface normals and candidate defect **regions of interest (ROIs)** from global 3D point clouds to generate initial trajectories for robotic active tactile exploration, connecting global visual localisation with fine-scale neuromorphic tactile contact analysis.

Dobot (Shenzhen Yuejiang Technology Co., Ltd.) | Technical Support Engineer Intern

Oct 2021 - Jan 2022

Project Background: Integrated multiple collaborative robot models (**Dobot Magician / M1 / M1 Pro**), machine vision and PLC-controlled conveyor modules into a modular application platform for industrial automation training and manufacturing-solution validation, covering vision-guided picking, dynamic sorting and palletising.

- **Multi-Robot Coordination and Palletising:** Led development of industrial communication and control logic integrating **Siemens S7-1200 / 1500 PLCs** with collaborative robots. Completed hand-eye calibration, conveyor-tracking pick-and-place and end-to-end palletising motion planning and cycle-time optimisation.
- **Hardware Testing and Technical Delivery:** Tested robot hardware performance, calibrated positioning repeatability and diagnosed and resolved faults. Wrote standardised industrial training cases and independently delivered multiple PLC and robot-system integration training sessions for university and industry customers.

Professional Skills

- **Embodied AI and Multimodal Models:** Familiar with **π0.5-DROID**, **flow matching** and **BLIP/Transformer** architectures. Experience spans dual-arm leader-follower demonstration collection, cross-modal alignment (**ITC/LM**), parameter-efficient fine-tuning (**PEFT/LoRA**), latent-space intervention with **steering vectors**, local low-latency edge inference and closed-loop evaluation on physical robots.
- **Neuromorphic Perception and Edge Computing:** Experienced in processing asynchronous vision-based tactile events from sensors such as **NeuroTac**. Proficient in **PyTorch**, **Sinabs** and **snnTorch** for **SNN/SCNN** development, with experience in pruning, post-training quantisation (**PTQ**) and milliwatt-scale on-chip deployment on **SynSense Speck2f** neuromorphic hardware.
- **Robotic Systems and Motion Control:** Familiar with **ROS/ROS 2** communication and **Linux (Ubuntu)** development environments. Experienced in robot kinematics, joint impedance control and leader-follower teleoperation mapping for **Franka Panda**, **ABB IRB 120 / 2600** and **Dobot** robots, and digital-twin simulation in **ABB RobotStudio**.
- **Programming, Hardware Prototyping and Patents:** Proficient in **Python**, **C/C++**, **MATLAB**, **Bash** and **Git**. Skilled in precision optomechanical design and tolerancing with **Fusion 360** and **SolidWorks**, and multi-material **PolyJet/FDM 3D printing** for rapid sensor prototyping. Hold **two utility model patents in hardware design**.