

# Baiyu Shi

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## RESEARCH INTERESTS

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**Diagnostics:** Biosensors, BioMEMS, Bioassays, Wearable Devices, and Biophotonics.

**Robotics:** Robot Learning, Manipulation and Perception, Design of Robotic Systems, and Micro/Nanorobotics.

## EDUCATION

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University of California, Berkeley

Berkeley, CA

*B.S. Bioengineering, Electrical Engineering and Computer Science*

*September 2019 – Expected May 2023*

- GPA: 3.974/4.00
- Relevant Courses:
  - EECS: Robotics Manipulation and Interaction (A+), Introduction to Robotics (A), Introduction to AI (A+), Introduction to Machine Learning (A), Machine Structures (A+), Design Information Devices and Systems 1&2 (A), Concepts of Probability (A), Data Structures (A)
  - BioE: Molecular and Cellular Biophotonics (TA for), Engineering Molecules 1&2 (A+), Biological Transport Phenomena (A+), Biomedical Physiology (A+), Organic Chemistry (A+ & A), BioMEMS and Medical Devices (in Progress)
- Honors & Awards:
  - EECS Honors Program with concentration in biomedical devices.

## PREPRINTS

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### [1] **AutoBag: Learning to Open Plastic Bags and Insert Objects.**

Lawrence Yunliang Chen, **Baiyu Shi**, Daniel Seita, Richard Cheng, Thomas Kollar, David Held, Ken Goldberg.

Under review at the *IEEE International Conference on Robotics and Automation (ICRA)*, 2023.

### [2] **Automating Vascular Shunt Insertion with the dVRK Surgical Robot.**

Karthik Dharmarajan\*, Will Panitch\*, Muyan Jiang, Kishore Srinivas, **Baiyu Shi**, Yahav Avigal, Huang Huang, Thomas Low, Danyal Fer, Ken Goldberg.

Under review at the *IEEE International Conference on Robotics and Automation (ICRA)*, 2023.

## RESEARCH EXPERIENCE

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### Designing and Fabricating Diagnostic Contact Lenses with Antigen Detection Capability

Berkeley, CA

*Advisor: Prof. Gerard Marriott*

*July 2022 – Present*

- Fabricated and compared two kinds of lenses, one based on hydrogel formula using DMA and NVP and one using PDMS.
- Coated antibodies onto self-made PDMS lenses and commercial lenses (1-day ACUVUE MOIST) with thiol-PEG and dye labeled antibody, verified with ELISA and fluorescence microscopy.
- Purposed a novel way of patterning multiple antibodies onto a lens with a UV-labile thiol protection group.

### [1] **AutoBag** and [2] **Automatic Vascular Shunt Insertion (AVSI)**

Berkeley, CA

*Advisor: Prof. Ken Goldberg*

*June 2022 – Present*

[1] **AutoBag** is an algorithm that perceives and opens an unstructured plastic bag, insert objects in the bag and lifts the bag. Autobag has partial success rate of 67% for both tier1 and tier2 train bags and tier1 test bags and 50% for tier2 test bags.

- Proposed a self-supervised data collection system that utilizes UV light and fluorescent paint that generates 120 samples per hour.
- Designed and implemented numerous action primitives, including shake, compress, flip, dilate, Pin-Pull etc.
- Modified and trained U-Net architecture to generate segmentation mask predictions for bags with IOU of 77%.
- Proposed the representation of a plastic bag with its opening size and major minor axis ratio.
- Integrated action primitives with perceptions and implemented Autobag as a finite state machine.

[2] **Automatic Vascular Shunt Insertion** is an algorithm that estimates the locus of the vessel rim, stretches the rim and performs a chamfer tilt followed with a screw motion to insert the shunt. AVSI achieves more than 80% success rate even with tight tolerances.

- Implemented a self-supervised data collection system with UV light and fluorescent paint that generates 350 samples per hour.
- Based on perception module, implemented PID-based visual servoing to combat inaccuracies caused by cable-driven systems.
- Found feasible budget vessel phantoms that mimics the shape and elasticity of the aorta.
- Helped formulate the problem of automated vascular shunt insertion with bimanual surgical robot.

## Neuromechanics Analysis of Dynamic Ground Righting Maneuvers in Lizards

Berkeley, CA

*Advisor: Prof. Robert J. Full*

*June 2021 – Present*

- Aims at recovering underlying templates for three modes of lizard righting behavior, tail-contact, tail-swing and tailless through high-speed camera recorded trials.
- Trained Resnet50 CNNs (with DEEPLABCUT) on 2,500 fully annotated frames for pose estimation.
- Developed a pipeline for extracting poses from lizard videos that involves (Viterbi, Butterworth, etc.) filters for CNN generated labels, a GUI for inspecting and correcting frames with low confidence, and scripts to reconstruct 3D poses using DLT method. The pipeline provides comparable accuracy to complete human labeling but reduces manual labor on average by a factor of 5.
- Conducted kinematics analysis on tail-contact, tail-swing and tailless righting trials to compare efficiency.

## TEACHING EXPERIENCE

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### BioE 163 Principles of Molecular and Cellular Biophotonics

Berkeley, CA

*Role: Graduate Student Instructor (GSI)*

*Aug 2022 – Present*

- Lead weekly discussions of 30 students covering lecture contents, self-drafted worksheets, and relevant publications.
- Draft and grade assignments on Gradescope.
- Helped setup course website and answer students' questions on Ed Discussion/ Piazza.

### BioE 163L Molecular and Cellular Biophotonics Laboratory

Berkeley, CA

*Role: Graduate Student Instructor (GSI)*

*Starting Jan 2023*

## PROFESSORIAL SERVICE

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Conference Reviewer for IEEE International Conference on Robotics and Automation (ICRA), 2023

## PROJECTS

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### Exploring Bilateral Symmetry for Parallel-Jaw Grasping

Berkeley, CA, *Feb 2022 – May 2022*

- Adapted NeRD, a neural 3D reflection symmetry detector on sim data, to predict symmetry planes on real-world RGBD images.
- Showed a large sim-to-real gap and proposed a refinement procedure that samples around the initial prediction and picks the plane scoring the highest with our symmetry plane evaluation metrics.
- Coded scripts that completed the antipodal region of the point cloud and reconstructed 3D meshes for grasp sampling.
- Demonstrated success in physical experiments where classical method failed due to best available grasps being antipodal.

### Turtle Bot Astro with Following and Searching Capability

Berkeley, CA, *Oct 2021 – Dec 2021*

- Led a team of 3 to equip a turtle bot 2 with following and searching capability using the Kinect and RGB cameras on board.
- Built a PID-controlled following module that achieved object avoidance module with Kinect-produced point cloud and an object and object detection using the YOLOv3 model.
- Achieved searching capability with a finite-state machine that transitions among exploring state doing frontier-based exploration, searching state doing object detection and spinning, and goal state doing object avoidance and target approaching.

### A New Method of Inner Ear Drug Delivery using Magnetically Directed Synthetic Peptide Hydrogel

Berkeley, CA

*March 2022 – May 2022*

- Led a team of 4 to evaluate the feasibility of a needle-injected hydrogel inner ear drug delivery system to replace the conventional method that may puncture the cochlear membrane or fail to maintain the effective concentration.
- Built a 3D time dependent COMSOL molecular transport model using previous anatomies of the cochlea.
- Simulated concentration-time profile for different candidates of hydrogels and metal nanoparticles to compare their effective time and toxicity levels, and found a feasible pair, RAD16II peptide with iron oxide.

## SKILLS AND TEST SCORES

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- **Programming Languages (with descending proficiency):** Python, MATLAB, Robot Operating System (ROS), Java, C++, R
- **Software:** LaTeX, COMSOL, AutoCAD, ImageJ, Excel
- **Skills:** PCR, ELISA, Fluorescence Microscopy, 3D Printing, Western Blots, BioMEMS Design and Fabrication, Circuits
- **GRE:** Verbal - 162; Quantitative – 170

## ACTIVITIES

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### Berkeley Showcase Volunteer

Berkeley, CA, *Oct. 8<sup>th</sup>*

- Conducted robotics demos for Bay Area/Northern California students who are underrepresented, first generation, or attend an under-resourced school.