Baiyu Shi

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RESEARCH INTERESTS

Robotics: Medical Robotics, Robot Learning and Manipulation, Chemical and Haptics Sensing Modalities, Mechanical Design of Robotic Systems, and Micro/Nanorobotics.
Diagnostics: Biosensors, BioMEMS, Bioassays, Wearable Devices, and Biophotonics.

EDUCATION

University of California, Berkeley   **Berkeley, CA**
B.S. Bioengineering, Electrical Engineering and Computer Science   *September 2019 – Expected May 2023*

- GPA: **3.974**/4.00 with Dean's List for 4 semesters and Honors to Date for all semesters. Admitted to EECS Honors Program with concentration of biomedical devices.
- Relevant Courses:
    - EECS: Robotics Manipulation and Interaction (A+), Introduction to AI (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), Engineering Molecules 1&2 (A+), Biological Transport (A+), Biomedical Physiology (A+), BioMEMS and Medical Devices (in Progress)

PREPRINTS

[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.

[3] **A Trimodal Framework for Robot-Assisted Vascular Shunt Insertion When a Supervising Surgeon is Local, Remote, or Unavailable.**
Karthik Dharmarajan*, Will Panitch*, **Baiyu Shi**, Huang Huang, Lawrence Yunliang Chen, Thomas Low, Danyal Fer,
Ken Goldberg.   Under review at the IEEE International Symposium on Medical Robotics (ISMR), 2023.

RESEARCH EXPERIENCE

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 lizard righting behavior through high-speed camera recorded trials with novel data-driven approach.
- Developed an efficient pipeline based on ensembled Resnet50 CNNs (DEEPLABCUT) for 3D pose estimation from lizard videos that involves filtering, manual inspection and correction, and DLT reconstruction. It offers equal accuracy as complete manual labeling with 5X speedup.
- Pipeline currently in use by other PhD students investigating squirrels and crabs.

Designing and Fabricating Diagnostic Contact Lenses with Antigen Detection Capability   **Berkeley, CA**
Advisor: Prof. Gerard Marriott   *July 2022 – Present*

- Fabricated and compared lenses based on different formulas DMAA and NVP, and vinyl terminated PDMS.
- Purposed using UV-labile thiol protection groups to selectively pattern multiple antibodies onto contact lenses for multiplex biosensing contact lenses with quantitative concentration readout.
- Demonstrated success of the UV-based antibody patterning system on self-made PDMS lenses and commercial lenses with ELISA and fluorescence microscopy.

[1] AutoBag and [2], [3] Automatic Vascular Shunt Insertion (AVSI)   **Berkeley, CA**
Advisor: Prof. Ken Goldberg   *May 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 UV-based self-supervised data collection system at 110 samples per hour for bag segmentation.
- Modified and trained ensemble U-Nets to generate semantic segmentations for bags with IOU of 77%.
- Proposed the representation of a plastic bag with its opening size and major minor axis ratio.
- Integrated self-designed action primitives with perceptions and implemented Autobag as a finite state machine.

[2], [3] Automatic Vascular Shunt Insertion and the **Trimodal Framework** is a system that assigns robotic surgical assistants different roles based on local surgeon availability with success rates of 80% on tight shunt insertion and xx% on vessel dilation.

- Implemented PID and gripper recognition network-based and ensemble neural network based visual servoing to combat slips and hysteresis caused by cable-driven systems.
- Proposed a UV-based self-supervised data collection system at 300 samples per hour for rim opening recognition.
- Helped formulate the problem of automated vascular shunt insertion with bimanual surgical robot.

OTHER EXPERIENCE

Shanghai View Precision Machinary Co.   **Shanghai, China**
Role: Mechanical Engineer Intern in Mold Design and Quality Control   *Jan 2021- Mar2021*

- Design molds using AUTOCAD for cold forging presses and code Mazak CNC machines to manufacture gears for transmissions in electrical tools.
- Conduct metallographic analysis using microscopes to examine purity of metals and the quality of heat treatment.

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.

BioE 163L Molecular and Cellular Biophotonics Laboratory   **Berkeley, CA**
Role: Graduate Student Instructor (GSI)   *Starting Jan 2023*

PROFESSORIONAL SERVICE

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

PROJECTS

Developing a Microfluidic Double Emulsion Droplet Maker and Magnetic-based Sorter for Superferromagnetic Iron Oxide (SFMIO) Tracers for Magnetic Particle Imaging (MPI)   **Berkeley, CA**, *Sep 2022 – Current*

- Designed and fabricated PDMS-based droplet maker and sorter to synthesize O-W-O droplets containing SFMIOs with a polymerizable biocompatible middle shell to push MPI's spatial resolution into micron range.
- The sorter includes a reservoir of ferrofluids and a permanent magnet to achieve magnetic field gradient in micron scale.
- Achieved stable double-emulsion droplets with no surfactant in the innermost oleic acid phase.

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 using our evaluation metrics
- that samples around the initial prediction and picks the highest-scoring plane with our symmetry plane evaluation metrics.
- Implemented 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*

- Built a PID-controlled following module with pointcloud-based object avoidance and YOLOv3 based object detection.
- Achieved searching capability with a finite-state machine that transitions among frontier-based exploration, object detection and spinning, and 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.
- Built a 3D time dependent COMSOL molecular transport model using anatomies of the cochlea and simulated concentration-time profiles for candidates of hydrogels and metal nanoparticles to compare their effective time and toxicity levels.

SKILLS AND TEST SCORES

- **Programming Languages (with descending proficiency):** Python, MATLAB, Robot Operating System (ROS), C++, Java, R.
- **Software:** AutoCAD, COMSOL, Finite Element Method Magnetics, ImageJ, LaTeX, SolidWorks.
- **Skills:** BioMEMS Design and Fabrication, Mazak CNC fabrication, 3D printing, Circuit Design, PCR, ELISA, Fluorescence Microscopy, Western Blots, Metallographic analysis.

ACTIVITIES

Berkeley Showcase *Volunteer*   **Berkeley, CA**, *Oct.8th*

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