Misha Rubanov

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Molecular, software, and robotics programmer dedicated to evolving laboratory R&D from static automation to dynamic, autonomous orchestration. I architect closed-loop experimental frameworks that treat laboratory hardware as a distributed compute environment, bridging the gap between high-level scientific hypotheses and high-availability robotic execution. By building "born-digital" infrastructure and physics-aware simulations, I enable scalable, model-ready experimentation where data is captured at the most granular level to drive reproducible discovery.

RESEARCH AND PROJECT EXPERIENCE

Principle Software Engineer, Automation, Lila Sciences May 2025 – Present

- **Architected a closed-loop, ML-driven experimentation framework** that bridged the gap between AI-driven hypotheses and physical execution, achieving significant gains in experimental efficiency.
    - **Engineered a "well-level" liquid handling infrastructure**, shifting lab robotics from rigid plate-based scripts to dynamic, granular orchestration capable of real-time protocol adjustment.
    - **Directed an engineering team** in applying GNNs and Bayesian optimization to navigate high-dimensional parameter spaces, managing complex trade-offs between physical constraints and resource costs.
    - **Led the design of a hardware-agnostic digital twin environment**, utilizing experiment-aware simulations to pre-validate "simulation-to-reality" transfers and ensure high-reliability execution.
    - **Developed low-code abstraction layers** (UI/UX) that translated complex robotic instructions into intuitive scientific intent, empowering non-computational scientists to program sophisticated workflows.
    - **Scaled engineering velocity by designing a modular monorepo and CI/CD infrastructure** tailored for hardware-in-the-loop environments, supporting team growth from 1 to 7 engineers.
    - **Partnered with scientific leadership** to prioritize and translate high-impact biological questions into modelable, automated experimental pipelines.

Senior High-Throughput Imaging/Automation Engineer, Digital Biology June 2024 – November 2024

- **Led a multidisciplinary computational team for developing computer vision-guided closed-loop microscopy for spatial transcriptomics using photochemistry (light-seq)**
    - Architected a software package for ML + human in the loop segmentation and photoillumination of biological tissue, scaling biological workflows by 4 orders of magnitude with respect to processing and analysis of tissues, unlocking scaled single-cell spatial transcriptomics.
    - Replaced a commercial software package which was prone to crashing, with an in-house tool with 100% success rate.
    - Developed a mono-repo SDK that is fully cross-platform with strict data hygiene that allowed for full traceability of all performed steps after an experiment.
    - Parallelized the microscopy platform across different microscopes, leading to a simpler developer interface for adding custom microscopes or other hardware
    - Interfaced with contractors and vendors to scale spatial transcriptomic experimentation (i.e., photoillumination) and liquid handling
    - Designed, built, and integrated a unified Python API within a single Bazel ecosystem for scientist control of automated microscopes, Hamilton liquid handlers, and Inheco thermocyclers.
- Developed data infrastructure (SQL databases) for combining image and NGS sequencing data for analysis pipelines
- Integrated LIMS (Benchling) schemas to automate kick-off of image-analysis and NGS
- Designed and built image analysis GUIs in Napari for rapid iteration by scientists

Scientist/Automation Engineer, Digital Biology May 2023 - June 2024

- Built a custom python-based microscopy platform for spatial illumination of tissues using custom workflows built in real-time during experiment runs
    - Developed and built a custom on-microscope Python-controlled liquid handler for automated liquid exchanges working in-tandem with scientists, contractors, and interns

- Designed experiments to optimize and understand underlying molecular mechanisms for light-seq
- Debugged both hardware and software problems related to the microscopes and Hamilton liquid handler both during and after experiments with scientists and research assistants
    - Led effort to develop and integrate Python-based SDKs onto a Hamilton STARlet liquid handler for sample processing workflows related to light-seq
- Optimized in-lab protocols using in-house built consumables (PDMS) for custom workflows

PhD Researcher, Johns Hopkins University, Schulman Lab January 2019 – February 2023

- Led a series of applied research projects within a biomolecular engineering lab known for research in DNA nanotechnology, intelligent soft materials, and genetic regulatory networks
    - Developed machine learning algorithms (convolutional neural networks) for designing new chemical reaction networks within DNA-functionalized hydrogels
    - Constructed an **automated digital photolithography-based printer** with a Python interface for fabricating multi-domain DNA-functionalized hydrogels (MAPDH)
    - Developed and characterized new modeling techniques for RNA concentration field formation
    - Designed DNA and enzymatic reaction networks for a variety of applications, including dissipative self-assembly, nucleic acid amplification, bistable switches, and RNA gradient generation
- Filed disclosure for a novel **RNA concentration field printing method**
- Developed an optimization algorithm for the discovery of new chemical reaction networks using the Maryland Advanced Research Computing Center (MARCC)
- Mentored 4 PhD students, 2 Master's students and 1 undergraduate student over 4 years on experimental and modeling research

Intern, Applied Physics Laboratory (APL) May 2019 - August 2020

- Investigated the feasibility of building DNA-driven magnetic microbots funded with a Combustion Grant
- Collaborated on designing a microfluidic platform for salt separation and sample preparation for future astrobiology missions
- Utilized aerosol jet printing (AJP) for flexible electronics and silicon photonics applications

EDUCATION

Johns Hopkins University Baltimore, Maryland
Doctor of Philosophy Graduated 2023

- Chemical and Biomolecular Engineering

Johns Hopkins University Baltimore, Maryland
Master of Science and Engineering Graduated 2019

- Chemical and Biomolecular Engineering

University of Texas at Dallas (UTDallas) Richardson, Texas
Bachelor of Science, Cum Laude Graduated 2016

- Biomedical Engineering with a minor in Chemistry

SPECIALIZED SKILLS

- **Software:** Software engineering (L3/L4), mechanistic and ML modeling, and UX design.
    - **Software Engineering:** Proficient with Git, Github, Bazel, CI/CD, Linux, WSL, SQL
    - **UX design:** Proficient in design of scientist-facing APIs
    - **Python:** Tensorflow, Keras, PyMOO (multi-objective optimization), packages for microscopy hardware integration (Pycro-manager), modeling DNA/RNA/enzymatic reaction networks as ordinary (PDE/ODEs), Napari, PyQT
    - **COMSOL:** Partial differential equation modeling of DNA/RNA reaction networks
        - PK/PD-type models
- **Wet lab:** qPCR, PCR, microfluidic device design and fabrication, running well-mixed DNA and cell-free reaction networks, digital photolithography, soft lithography

- **Automation:** custom-built microfluidic flow controller, Tecan Fluent, Biotek plate readers, fluorescence microscopy, Hamilton STAR, Inheco ODTC, custom on-microscope liquid handling, LIMS integration (Benchling)
- **Engineering Design:** PCB design, microcontroller programming, breadboarding
- **Languages:** Fluent in Spanish, Russian

GRANTS AND AWARDS

Carver Mead New Adventures Fund May 2023
- Awarded for the proposal for building matrix chemical reaction networks for advanced control of hydrogel soft robots

Defense Advanced Research Projects Agency (DARPA) Grant January 2022
- Awarded for the proposal for the directed assembly of DNA-coated microparticles using programmable RNA gradient-generating hydrogel posts

Mightex Annual Research Excellence Award November 2021
- Awarded for the use of the Mightex Polygon 400 digital micromirror device for fabricating multi-domain DNA-functionalized hydrogels for sequential activation

Army Research Office (ARO) Grant June 2020
- Awarded for the proposal of a novel 3D microfabrication method to create autonomous, DNA controlled hydrogels for combinatorial shape change and responsivity

Combustion Grant: Applied Physics Lab at Johns Hopkins University (JHUAPL) October 2019
- Internal Grant at APL awarded for an innovative idea to create DNA controlled, magneto-responsive micro-robots

PEER-REVIEWED PUBLICATIONS

- Rubanov, M., Moerman, P., Schulman, R., Programmable RNA Gradient Formation using Photopatterned Hydrogel Generators. In preparation.
- Chen, K.-L. et al. Hydrogels with Tethered Transcription Circuit Elements for Chemical Communication and Collective Computation. Preprint at https://doi.org/10.26434/chemrxiv-2024-1fk8r (2024).
- Rubanov, M. et al. Multi-domain automated patterning of DNA-functionalized hydrogels. PLOS ONE 19, e0295923 (2024).
- Rubanov, M., Dorsey, P. J., Scalise, D. & Schulman, R. Sequential Activation of Spatially Localized Oligonucleotides. ACS Materials Lett. 1807–1814 (2022).
- Scalise, D., Rubanov, M., Miller, K., Potters, L., Noble, M., Schulman, R. Programming the Sequential Release of DNA. *ACS Synth*. Biol. 9, 749-755 (2020).
- Dorsey, P. J., Rubanov, M., Wang, W. & Schulman, R. Digital Maskless Photolithographic Patterning of DNA- Functionalized Poly(ethylene glycol) Diacrylate Hydrogels with Visible Light Enabling Photodirected Release of Oligonucleotides. *ACS Macro Lett*. 8, 1133-1140 (2019).

PATENTS

- Filed disclosure titled “Systems and Methods for RNA Gradient Pattern Generation” December 2022

CONFERENCE PRESENTATIONS

SynCell 2022 May 2022
- Oral Presentation titled *An automated DNA-functionalized hydrogel photopatterning system for RNA gradient generation using localized transcription*

Synthetic Biology: Engineering, Evolution & Design (SEED) 2022 May 2022
- Poster Presentation titled *Constructing a Tunable RNA Gradient Generator using Photopatterned Hydrogels*

Gordon Research Seminar: Complex Active and Adaptive Material Systems January 2019
- Oral Presentation titled *Spatiotemporal Release of Oligonucleotides for Soft Material Programming*

Material Research Society 2019 April 2019
- Oral Presentation titled *Spatiotemporal Release of Oligonucleotides for Soft Material Programming*

TEACHING EXPERIENCE

Johns Hopkins MATLAB Bootcamp January 2019 - Present

Course Teacher and Curriculum Designer Baltimore, Maryland

- Develop a coding curriculum in MATLAB that captivates students' interests through exciting programming applications (through the week-by-week development of a cellular automata simulator)
- Teach the online course every semester for 8+ semesters
- Incorporate student and supervisor feedback for iterative program improvement

UT Dallas Student Success Center January 2016 - May 2016
Super Leader Richardson, Texas

- Held semester observations to give feedback to the tutors based on student reviews
- Led weekly one-on-one and group tutoring sessions in biochemistry and organic chemistry