MAX L. BALTER, PHD

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Summary

Entrepreneurial-minded engineer with a passion for developing technology to make a difference in healthcare.

Mechanical engineer by training, skilled in robotics, controls, and mechatronics, specifically applied to medical robotics, image-guided interventions, and point-of-care diagnostics.

5+ years of experience working with interdisciplinary teams of scientists, engineers, and clinicians to drive complex and fast-paced R&D projects in academic, small business, and industry settings.

Education

Rutgers University, PhD in biomedical engineering, New Brunswick, NJ **May 2017**

- GPA: **3.76/4.0**; NSF Graduate Research Fellow (<10% acceptance rate)
- Focus: Robotics, controls, medical imaging, computer vision, and entrepreneurship
- Thesis: Robotic devices for automated venipuncture and diagnostic blood analysis
- Advisor: Martin L. Yarmush, MD, PhD

Union College, BS in mechanical engineering, minor in bioengineering, Schenectady, NY **June 2012**

- GPA: **3.78/4.0**; magna cum laude with departmental honors; presidential scholarship
- Term abroad at the Czech Technical University in Prague, Czech Republic (2010)
- Elected to Tau Beta Pi (engineering honor society) and Sigma Xi (scientific research honor society)
- Thesis: The investigation of neuronal control in dragonflies in response to a 3D flying prey robot

Professional Experience

Senior Research and Development Engineer Medtronic, Boston, MA **May 2017 – present**

- Minimally invasive therapies group – early technologies
- Developing control software for next-generation surgical robots

Controls Engineering Co-op Medtronic, Boston, MA **Jan 2017 – May 2017**

- Designed, modeled, and evaluated control algorithms in Simulink for the Einstein surgical robotic system
- Implemented signal verification, dual surgeon console switching, and instrument flipping code blocks
- Worked with a team of 5 engineers to debug key subsystems, including motion scaling and realignment
- Collaborated with lead engineers to evaluate instrument tool tracking errors and jaw clamp force variation
- Analyzed impulse response data, extracting resonant frequencies for use in a vibration damping algorithm

Lead Mechanical Engineer VascuLogic, LLC, Piscataway, NJ **Mar 2013 – Jan 2017**

- Engineer for a biotech start-up while in graduate school, developing an automated venipuncture device
- Led a team of 3 engineers to create robotic prototypes validated through bench-top and small animal testing
- Developed ultrasound-guided motion control software for real-time vessel tracking and needle guidance
- Engineered needle tracking and force sensing algorithms for enhanced safety and vessel puncture detection
- Designed core robotic sub-systems using SolidWorks, including drive trains, end-effectors, and consumables
- Implemented design control documentation in compliance with FDA guidelines for a class II medical device
- Presented technology and development strategy in fundraising pitches to prospective corporate investors

Research Scientist Rutgers University, Piscataway, NJ **Sep 2012 – May 2017**

- Key contributor on a $2.7M NIH grant to integrate robotic phlebotomy devices with rapid diagnostic testing
- Developed a point-of-care blood testing device using centrifugal microfluidics and fluorescence microscopy
- Implemented image processing techniques in Matlab to extract accurate and reliable white blood cell counts
- Oversaw 20 undergraduate students, launching multiple research projects, including an mobile vein imaging device, laryngoscope for anesthesiology applications and needle insertion device for at-home dialysis

Bioengineering Research Assistant Union College, Schenectady, NY **Jun 2011 – Jun 2012**

- Built a 3D positioning device to investigate neuronal control in dragonflies during flying prey interception
- Extensively used Matlab/Simulink to create a position control system for varying insect flight trajectories
- Conducted biological experiments to elucidate dragonfly neuronal responses to rapid prey motions

Biomechanics Research Internship Union College, Schenectady, NY **Jun 2010 – Jun 2011**

- Examined mandibular stresses on gorilla and orangutan jaw bones to reveal metabolic activity of the tissue
- Utilized Matlab simulations to model cercopithecoid mandibles and verify experimental results

Honors and Awards

Fellowships

- GAANN Fellowship in Precision Medicine, Rutgers University, 2016 – 2017
- NSF Graduate Research Fellowship, Rutgers University, 2013 – 2016
- DoEd GAANN Graduate Fellowship, Rutgers University, 2012 – 2013
- Booth Ferris Foundation Research Fellowship, Union College, 2011
- Davis Projects for Peace Fellowship, Union College, 2011

Grants Co-authored

- NIH R01 EB020036, Portable automated device for rapid blood draws and point of care diagnostic analysis (PI: Martin L. Yarmush, Rutgers University), $2.7M, 2015 – 2019
- NSF SBIR Phase I, Award 1448550, Portable, image-guided robotic device for fully automated venipuncture (PI: Timothy J. Maguire, VascuLogic), $150K, 2015 – 2016

Awards

- Intl' Conference on Intelligent Robots and Systems NSF Travel Grant, 2016
- Start-up Competition Winner – IEEE/RSJ IROS Conference, 2015
- NI Engineering Impact Award Winner – Machine Control Category, 2014
- ASME District A Old Guard Oral Presentation Competition Winner, 2012

- General Electric Energy Steinmetz Award at Union College, 2012
- USTFCCCA Division III Track & Field All-Academic Team at Union College, 2012
- Senior Scholar-Athlete of the Year at Union College, 2012

Technical Skills

Engineering Software:

Matlab, Simulink, Git, LabVIEW, SolidWorks, Eagle PCB

Prototyping & Machining:

3D Printing (FDM + PolyJet), Laser Cutting, CNC-Milling

Certifications

Engineer in Training NCEES, License no. 1763684, Mar 2013 – present

Papers in Refereed Journals

1) Chen AI, **Balter ML**, Maguire TJ, Yarmush ML. Image-guided autonomous robotic device for submillimeter blood vessel cannulation, blood drawing, and fluid delivery. *Science Robotics*. 2017 (under review).

2) Fromholtz A, **Balter ML**, Chen AI, Colinco CA, Maguire TJ, Yarmush ML. Design and evaluation of a robotic device for automated tail vein cannulations in rodent models. *ASME Journal of Medical Devices*. 2017; 11(4):041008–041008-7.

3) **Balter ML**[†], Chen AI[†], Maguire TJ, Yarmush ML. Adaptive kinematic control of a robotic venipuncture device based on stereo vision, ultrasound, and force guidance. *IEEE Transactions on Industrial Electronics. Special Section on: Motion Control for Novel Emerging Robotic Devices and Systems*. 2017; 64(2):1626–1635.

4) **Balter ML**, Chen AI, Colinco CA, Gorshkov A, Bixon B, Martin V, Fromholtz A, Maguire TJ, Yarmush ML. Differential leukocyte counting via fluorescent detection and image processing on a centrifugal microfluidic platform. *Analytical Methods*. 2016; 8(47):8272–8279.

5) Chen AI, **Balter ML**, Chen MI, Gross D, Kaiser A, Maguire TJ, Yarmush ML. Multilayered tissue-mimicking skin and vessel phantoms with tunable mechanical, optical, and acoustic properties. *Medical Physics*. 2016; 43(6):3117–3131.

6) **Balter ML**, Chen AI, Maguire TJ, Yarmush ML. The system design and evaluation of a 7-DOF image-guided venipuncture robot. *IEEE Transactions on Robotics*. 2015; 31(4):1044–1053.

Papers in Non-Refereed Journals

1) Chen AI, **Balter ML**, Maguire TJ. Developing the world's first portable medical robot for autonomous venipuncture. *IEEE Robotics & Automation Magazine*. 2016; 23(1):10–11.

2) Chen AI, **Balter ML**. Developing a portable 3D vision-guided medical robot for autonomous venipuncture. *National Instruments Engineering Impact Awards*. 2014.

[†]Equal authorship

Papers in Refereed Conference Proceedings

1) Leipheimer JL, **Balter ML**, Chen AI, Maguire TJ, Yarmush ML. Investigating the use of structured light imaging for 3D reconstruction of the human forearm for automated venipuncture. *43rd Annual Northeast Bioengineering Conference*, Newark, NJ, Mar 31–Oct 2, 2017.

2) Chen AI, **Balter ML**, Maguire TJ, Yarmush ML. 3D near infrared and ultrasound imaging of peripheral blood vessels for real-time localization and needle guidance. *Proceedings of the 19th International Conference on Medical Image Computing and Computer Assisted Intervention (MICCAI)*, Athens, Greece, Oct 17–21, 2016, pp. 388–396.

3) **Balter ML**, Chen AI, Fromholtz A, Gorshkov A, Maguire TJ, Yarmush ML. System design and development of a robotic device for automated venipuncture and diagnostic blood cell analysis. *Proceedings of the 2016 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, Daejeon, Korea, Oct 9–14, 2016, pp. 514–520.

4) Chen AI†, **Balter ML**†, Maguire TJ, Yarmush ML. Real-time needle steering in response to rolling vein deformation by a 9-DOF image-guided venipuncture robot. *Proceedings of the 2015 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, Hamburg, Germany, Sept 28–Oct 2, 2015, pp. 2633–2638.

5) Zinman AR†, **Balter ML**†, Olberg RM, Ramasubramanian A, Hodgson DA. Design, construction, and testing of a flying prey simulator. *Proceedings of the 5th Annual Dynamic Systems and Control Conference and 11th Motion and Vibration Conference*, Ft. Lauderdale, FL, Oct 17–19, 2012, pp. 59–63.

6) **Balter ML**, Zinman AR. Design of a three-dimensional flying prey simulator. *Proceedings of the 26th Annual Conference on Undergraduate Research (NCUR)*, Ogden, UT, Mar 29–31, 2012, pp. 61–68.

7) Rapoff AJ, **Balter ML**, McGraw SW, Daegling JD. Relative contributions of internal reaction forces to stresses in the great ape mandibular symphysis. *American Journal of Physical Anthropology*, Minneapolis, MN, 2011, pp. 248–248.

Presentations

1) Leipheimer J, **Balter ML**, Chen AI, Maguire TJ, Yarmush ML. A robotic device for automated venipuncture. *NJ Tech Council – What's Next in Medical Devices*, Princeton, NJ, June 13, 2017.

2) Chen AI, **Balter ML**, Maguire TJ, Yarmush ML. 3D near infrared and ultrasound imaging of peripheral blood vessels for real-time localization and needle guidance. *19th International Conference on Medical Image Computing and Computer Assisted Intervention (MICCAI)*, Athens, Greece, Oct 20, 2016.

3) **Balter ML**, Chen AI, Fromholtz A, Gorshkov A, Maguire TJ, Yarmush ML. System design and development of a robotic device for automated venipuncture and diagnostic blood cell analysis. *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, Daejeon, Korea, Oct 11, 2016.

4) **Balter ML**, Chen AI, Maguire TJ, Yarmush ML. An autonomous robotic system for rapid blood draws and analysis. *Biomedical Engineering Society Annual Meeting*, Tampa, FL, Oct 8, 2015.

5) Chen AI, **Balter ML**, Maguire TJ, Yarmush ML. Bimodal 3D near infrared and ultrasound imaging of blood vessels for real-time image-guided vascular access. *Biomedical Engineering Society Annual Meeting*, Tampa, FL, Oct 8, 2015.

6) **Balter ML**, Chen AI, Maguire TJ, Yarmush ML. Real-time needle steering in response to rolling vein deformation by a 9-DOF image-guided venipuncture robot. *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, Hamburg, Germany, Sept 30, 2015.

7) Chen AI, **Balter ML**, Maguire TJ, Yarmush ML. Portable robot for autonomous venipuncture using 3D near infrared and ultrasound guidance. *Biomedical Engineering Society Annual Meeting*, San Antonio, TX, Oct 24, 2014.

8) Chen AI, **Balter ML**, Maguire TJ, Yarmush ML. Portable robotic device for autonomous peripheral venous access using near infrared guidance. *Biomedical Engineering Society Annual Meeting*, Seattle, WA, Sept 26, 2013.

†Equal authorship

9) **Balter ML**, Zinman AR, Hodgson DA. The design and application of a three-dimensional flying prey simulator. *ASME International Mechanical Engineering Congress and Exposition (IMECE)*, Houston, TX, Nov 10, 2012.

10) **Balter ML**, Zinman AR, Hodgson DA. The design and application of a three-dimensional flying prey simulator, *ASME Student Professional Development Conference (SPDC) Old Guard Competition*, Troy, NY, April 28, 2012.

11) **Balter ML**, Zinman AR, Hodgson DA. Design of a three-dimensional flying prey simulator, *The 26th Annual Conference on Undergraduate Research (NCUR)*, Ogden, UT, March 30, 2012.

Posters

1) Leipheimer JL, **Balter ML**, Chen AI, Maguire TJ, Yarmush ML. Investigating the use of structured light imaging for 3D reconstruction of the human forearm for automated venipuncture. *Biomedical Engineering Society Annual Meeting*, Phoenix, AZ, Oct 13, 2017.

2) Leipheimer JL, **Balter ML**, Chen AI, Maguire TJ, Yarmush ML. Investigating the use of structured light imaging for 3D reconstruction of the human forearm for automated venipuncture. *43rd Annual Northeast Bioengineering Conference*, Newark, NJ, Apr 1, 2017.

3) DeMaio N, Chen AI, **Balter ML**, Maguire TJ, Yarmush ML. Development and mechanical characterization of gelatin-based synthetic blood vessel phantoms. *Biomedical Engineering Society Annual Meeting*, Minneapolis, MN, Oct 8, 2016.

4) Chen AI, **Balter ML**, Maguire TJ, Yarmush ML. Portable, image-guided robot for autonomous venipuncture and point-of-care blood analysis. *Rutgers Biotechnology Training Fellowship Symposium*, Piscataway, NJ, June 9, 2016.

5) **Balter ML**, Chen AI, Maguire TJ, Yarmush ML, Haghgooie R, Kotz K, Granier R, Toner M. Automated device for rapid blood draws and diagnostic analysis. *Johnson & Johnson Engineering Showcase*, New Brunswick, NJ, Feb 23, 2016.

6) **Balter ML**, Chen AI, Maguire TJ, Yarmush ML. The design and implementation of a 4-DOF robotic manipulator for automated venipuncture. *Biomedical Engineering Society Annual Meeting*, San Antonio, TX, Oct 23, 2014.

7) Chen AI, **Balter ML**, Maguire TJ, Yarmush ML. Portable, image-guided robotic device for automated venipuncture. *Rutgers Biotechnology Training Fellowship Symposium*, Piscataway, NJ, June 24, 2014.

8) **Balter ML**, Chen AI, Maguire TJ, Yarmush ML. Design of a modular 6-DOF robot for automated venipuncture. *Rutgers Biotechnology Training Fellowship Symposium*, Piscataway, NJ, June 26, 2013.

9) Olberg RM, **Balter ML**, Zinman AR, Ramasubramanian A, Hodgson DA. Three-dimensional visual receptive fields of target-selective descending neurons in the dragonfly. *The Tenth International Congress of Neuroethology*, College Park, MD, Aug 5-10, 2012.

10) Rapoff AJ, **Balter ML**, McGraw SW, Daegling JD. Relative contributions of internal reaction forces to stresses in the great ape mandibular symphysis. *American Journal of Physical Anthropology*, Minneapolis, MN, Aug 10, 2011.

Professional Society Associations

IEEE Robotics and Automation Society (Member: 2015 – present)

IEEE Engineering in Medicine and Biology Society (Member: 2015 – present)

IEEE Industrial Electronics Society (Member: 2015 – present)

American Society of Mechanical Engineers (Member: 2011 – present)

Biomedical Engineering Society (Member: 2011 – present)

Sigma Xi – The Scientific Research Society (Member: 2012 – present)

Pi Tau Sigma – Mechanical Engineering Honor Society (Member: 2011 – present)

Tau Beta Pi – Engineering Honorary Society (Member: 2010 – present)

Engineers Without Borders (Member: 2009 – present)

Leadership Experience

Varsity Track & Field Union College, Schenectady, NY, 2008 – 2012

- Led 23 student athletes, competed in the jumps/sprints, and served on the student athlete advisory board
- Set school-record as member of the 4x200m relay team, improving our time by 5 seconds during the season
- Recognized as DIII All-Academic in the long jump and Union College Senior Scholar Athlete of the year

Engineers Without Borders Union College, Schenectady, NY, 2009 – 2012

- Led the chapter's clean water project for Boru village in Ethiopia, directing meetings, fundraisers and events
- Awarded a $10K grant to conduct a site assessment and established a partnership with Save the Children
- Doubled chapter membership. Negotiated change to club status on campus, garnering $1,750/yr in support