

# Niravkumar Patel, Ph.D.

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## Education

- 2012 – 2017    **Ph.D., Worcester Polytechnic Institute, USA** in Robotics Engineering (GPA 3.85)  
Thesis title: *Towards Closed-loop Robot Assisted, Percutaneous Interventions Under MRI Guidance*  
Advisor: Dr. Gregory S. Fischer
- 2005 – 2007    **M.Tech., Nirma University of Science and Technology, India** in Computer Science and Engineering (GPA 7.94)  
Thesis title: *Two legged robot design, simulation and realization*  
Gold Medal: *Best Student Award*
- 2001 – 2005    **B.E., North Gujarat University, India** in Computer Engineering (GPA 3.85)

## Research Experience

- 2017 – .....    **Postdoctoral Fellow**, Johns Hopkins University  
**Developed** MRI guided robotic system for shoulder arthrography which has been evaluated in cadaver trials and will be beginning clinical trials from July 2019. Also, involved in development of robot control strategies and machine learning techniques for safety in robot assisted retinal surgeries. **Collaborators:** Children's National Health System, USA, University of Dundee, UK.  
**Evaluated** safety in robot assisted retinal surgeries in 14 *in vivo* rabbit studies comparing various control schemes in an ophthalmic operating room setup while a retinal surgeon performed clinically relevant surgical tasks on the retina.  
**Collaborators:** Wilmer Eye Institute, Baltimore, MD, USA.  
**Supervisor:** Dr. Iulian Iordachita
- 2013 – 2017    **Research Assistant**, Robotics Engineering Program, Worcester Polytechnic Institute  
**Developed** MRI guided robotic systems for needle steering, prostate biopsy and stereotactic neurosurgery for tumor ablation. The prostate biopsy system has been used for 30 patient trials at Brigham and Womens' Hospital, Boston, USA, while the neurosurgery system has been evaluated 10 porcine trials.  
**Collaborators:** Brigham and Women's Hospital and Harvard Medical School, Johns Hopkins University, Acoustic MedSystems, Albany Medical Center and University of Massachusetts Medical School.  
**Developed** Gazebo-ROS based simulation for daVinci Research Kit (DVRK) and created preliminary MATLAB interface for the daVinci Patient Side Manipulators (PSM).  
**Supervisor:** Dr. Gregory Fischer

## Teaching and Mentoring Experience

- 2017 – .....    **Postdoctoral Fellow**, Johns Hopkins University  
**Mentoring** four graduate students in AMIRO research lab. Two of them are working on MRI guided robotic systems while other two are working on safety in robot assisted retinal surgeries.  
**Developed and delivered** a course on "Robots that work inside MRI machines" to first year undergraduate students.

## Teaching and Mentoring Experience (continued)

- 2013 – 2013    **Teaching Assistant**, Worcester Polytechnic Institute  
**Conducted** lab sessions and graded assignments for undergraduate level course on “UNIFIED ROBOTICS II”
- 2010 – 2012    **Lecturer**, Department of Computer Engineering, Nirma University of Science and Technology  
**Delivered** following courses at undergraduate level: digital electronic, design of operating systems and computer graphics.  
**Designed and conducted** laboratory sessions for the following courses at undergraduate level: digital electronic and design of operating systems .  
**Designed and conducted** laboratory sessions for the following courses at graduate level: embedded systems.

## Professional Experience

- 2008 – 2009    **Software Engineer** ABB - Corporate Research Center, Bangalore, India. **Played** key role in establishing Fieldbus testing capabilities and lab setup at ABB’s Corporate Research Center, Bangalore, India. Transferred testing capabilities for DeviceNet, Profibus, ProfiNet, Interbus and Ethernet I/P from Swedish counterpart.  
**Developed** functionalities in ABB Robot Studio for preparing paint jobs and estimating paint consumption.
- 2007 – 2008    **Software Engineer** Hewlett Packard, Bangalore, India.  
**Developed** a JAVA/J2EE module which enables HP customers to purchase Printer consumables online and helps HP to maintain their product information.

## Awards/Achievements/Service roles

- **Intuitive Surgical Grant Application**, Letter of intent was accepted for submission of full grant proposal of USD 60,000 -2019
- **Best Paper Award in Medical Robotics**, International Conference on Robotics and Automation-2019, Montreal, Canada
- **Best Paper Finalist**, International Symposium on Medical Robotics-2019, Atlanta, USA
- **Best Poster Winner**, International Symposium on Medical Robotics-2019, Atlanta, USA
- **Best Paper Finalist**, International Symposium on Medical Robotics-2018, Atlanta, USA
- **Best Student Gold Medal**, M.Tech 2007, Nirma University of Science and Technology, Ahmedabad, India.
- **1<sup>st</sup> Prize** in Project presentation competition, Convergence-2003, U V Patel College of Engineering, Gujarat, India.
- **1<sup>st</sup> Prize** in Project presentation competition, Technigma-2003, Sankalchand Patel College of Engineering, Gujarat, India.
- **Reviewer** for IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), IEEE International Conference on Robotics and Automation (ICRA), IEEE Engineering in Medicine and Biology Conference (EMBC), IEEE-Robotics and Automation Letters (RA-L), IEEE Transactions on Robotics (TRO), International Journal of Computer Assisted Radiology and Surgery (IJCARS), Journal of Medical Robotics Research (JMRR), International Symposium on Medical Robotics (ISMR).
- **Represented** Laboratory for Computational Sensing and Robotics (LCSR) at **2017 Frontiers in Optics/Laser Science** held at Washington DC, USA
- **Represented** Laboratory for Computational Sensing and Robotics (LCSR) at **2019 Johns Hopkins Research Symposium on Engineering in Healthcare** held at Baltimore, USA

## Invited/Conference Talks

- **Mar 2018, The International Symposium on Medical Robotics (ISMR), Atlanta, USA,** Robotic System for MRI-Guided Shoulder Arthrography: Accuracy Evaluation.
- **Oct 2018, IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), Madrid, Spain,** Body-Mounted Robot for Image-Guided Percutaneous Interventions: Mechanical Design and Preliminary Accuracy Evaluation.
- **Oct 2018, IEEE SENSORS, New Delhi, India,** Towards Bimanual Robot-Assisted Retinal Surgery: Tool-to-Sclera Force Evaluation.
- **Nov 2018, IISc Bangalore,** Robotic Systems for MRI-Guided Percutaneous Interventions.
- **Jul 2019, IISc Bangalore,** Robotic systems for MRI-guided Interventions and Retinal Surgeries.
- **Oct 2019, The 28th IEEE International Conference on Robot and Human Interactive Communication, New Delhi, India,** Towards Securing the Sclera Against Patient Involuntary Head Movement in Robotic Retinal Surgery.
- **Oct 2019, IIT Bangalore,** Robotic systems for MRI-guided Interventions and Retinal Surgeries.
- **Oct 2019, IIT Vadodara,** Robotic systems for MRI-guided Interventions and Retinal Surgeries.
- **Feb 2020, IIT Madras,** Robotic systems for MRI-guided Interventions and Retinal Surgeries.
- **Feb 2020, IIT Jodhpur,** Robotic systems for MRI-guided Interventions and Retinal Surgeries.

## Funding

- **Project title:** Hybrid Force and Position Control of Bimanual Robotic Assistance with Multi-Function Force Sensing Instruments for Retinal Microsurgery.
- **Project summary:** With this proposal, we intend to develop for the first time a bimanual robotic system that could assist surgeons during retinal surgery. Hybrid force and position control strategies will be integrated into the system to ensure safe (force control) and precise (position control) robot manipulation inside the eye. Furthermore, to investigate bimanual semi-autonomous manipulation, a robot-assisted light pipe holding will be developed.
- **Funding agency:** Intuitive Surgical Foundation, CA, USA
- **Cost:** USD 60,000
- **Duration:** January 2020 - December 2020
- **Status:** Not approved

## Publications

### Journal Articles

- 1 **Patel, N., Nycz, C., Gondokaryono, R., Carvalho, P., Li, G., Gandomi, K., ... Fischer, G. (2020).** An integrated robotic system for mri-guided neuroablation: Preclinical evaluation. *IEEE Transactions on Biomedical Engineering*. <https://doi.org/10.1109/TBME.2020.2974583>
- 2 **He, C., Patel, N., Ebrahimi, A., Kobilarov, M. & Iordachita, I. (2019).** Preliminary study of an rnn based active interventional robotic system (airs) in retinal microsurgery. *International journal of computer assisted radiology and surgery*, 1–10. <https://doi.org/10.1007/s11548-019-01947-9>
- 3 **He, C., Patel, N., Shahbazi, M., Yang, Y., Gehlbach, P. L., Kobilarov, M. & Iordachita, I. (2019).** Toward safe retinal microsurgery: Development and evaluation of an rnn-based active interventional control framework. *IEEE Transactions on Biomedical Engineering*. <https://doi.org/10.1109/TBME.2019.2926060>
- 4 **Li, G., Patel, N., Hagemester, J., Yan, J., Wu, D., Sharma, K., ... Iordachita, I. (2019).** Body-mounted robotic assistant for mri-guided low back pain injection. *International Journal of Computer Assisted Radiology and Surgery*, 1–11. <https://doi.org/10.1007/s11548-019-02080-3>

- 5 Patel, N., Yan, J., Monfaredi, R., Sharma, K., Cleary, K. & Iordachita, I. I. (2019). Preclinical evaluation of an integrated robotic system for magnetic resonance imaging guided shoulder arthrography. *Journal of Medical Imaging*, 6(2), 025006. <https://doi.org/10.1117/1.JMI.6.2.025006>
- 6 Urias, M. G., Patel, N., He, C., Ebrahimi, A., Kim, J. W., Iordachita, I. & Gehlbach, P. L. (2019). Artificial intelligence, robotics and eye surgery: Are we overfitted? *International Journal of Retina and Vitreous*, 5(1), 1–4. <https://doi.org/10.1186/s40942-019-0202-y>
- 7 MacDonell, J., Patel, N., Fischer, G., Burdette, E. C., Qian, J., Chumbalkar, V., ..., Gounis, M. et al. (2018). Robotic assisted mri-guided interventional interstitial mr guided focused ultrasound ablation in a swine model. *Neurosurgery*. <https://doi.org/10.1093/neuros/nyy266>
- 8 MacDonell, J., Patel, N., Rubino, S., Ghoshal, G., Fischer, G., Burdette, E. C., ... Pilitsis, J. G. (2018). Magnetic resonance-guided interstitial high-intensity focused ultrasound for brain tumor ablation. *Neurosurgical focus*, 44(2), E11. <https://doi.org/10.3171/2017.11.FOCUS17613>
- 9 Moreira, P., Patel, N., Wartenberg, M., Li, G., Tuncali, K., Heffter, T., ..., Hata, N. et al. (2018). Evaluation of robot-assisted mri-guided prostate biopsy: Needle path analysis during clinical trials. *Physics in Medicine and Biology*. <https://doi.org/10.1088/1361-6560/aae214>
- 10 Patel, N., Li, G., Shang, W., Wartenberg, M., Heffter, T., Burdette, E. C., ..., Tempany, C. M. et al. (2018). System integration and preliminary clinical evaluation of a robotic system for mri-guided transperineal prostate biopsy. *Journal of Medical Robotics Research*, 1950001. <https://doi.org/10.1142/S2424905X19500016>
- 11 Roizenblatt, M., Ebrahimi, A., He, C., Patel, N., Iordachita, I. & Gehlbach, P. L. (2018). Quantitative evaluation of tool-to-sclera forces, in a model of retinal microsurgery. *Investigative Ophthalmology & Visual Science*, 59(9), 5926–5926.
- 12 Wartenberg, M., Schornak, J., Gandomi, K., Carvalho, P., Nycz, C., Patel, N., ..., Tokuda, J. et al. (2018). Closed-loop active compensation for needle deflection and target shift during cooperatively controlled robotic needle insertion. *Annals of Biomedical Engineering*, 1–13. <https://doi.org/10.1007/s10439-018-2070-2>
- 13 Frank, T., Krieger, A., Leonard, S., Patel, N. & Tokuda, J. (2017). Ros-igtl-bridge: An open network interface for image-guided therapy using the ros environment. *International journal of computer assisted radiology and surgery*, 12(8), 1451–1460. <https://doi.org/10.1007/s11548-017-1618-1>
- 14 Su, H., Shang, W., Li, G., Patel, N. & Fischer, G. S. (2017). An mri-guided telesurgery system using a fabry-perot interferometry force sensor and a pneumatic haptic device. *Annals of biomedical engineering*, 45(8), 1917–1928. <https://doi.org/10.1007/s10439-017-1839-z>
- 15 Eslami, S., Shang, W., Li, G., Patel, N., Fischer, G. S., Tokuda, J., ... Iordachita, I. (2016). In-bore prostate transperineal interventions with an mri-guided parallel manipulator: System development and preliminary evaluation. *The International Journal of Medical Robotics and Computer Assisted Surgery*, 12(2), 199–213. <https://doi.org/10.1002/rcs.1671>

## Conference Proceedings

- 1 Ebrahimi, A., Urias, M., Patel, N., Gehlbach, P., Alambeigi, F. & Iordachita, I. (2020). Fbg-based kalman filtering and control of tool insertion depth for safe robot-assisted vitrectomy. In *2020 international symposium on medical robotics (ismr)*. (Accepted). IEEE.
- 2 Li, G., Patel, N., Liu, W., Wu, D., Sharma, K., Cleary, K., ... Iordachita, I. (2020). A fully actuated body-mounted robotic assistant for mri-guided low back pain injection. In *2020 international conference on robotics and automation (icra)*. (Accepted). IEEE.
- 3 Wu, J., He, C., Ebrahimi, A., Urias, M., Patel, N., Liu, Y., ... Iordachita, I. (2020). Force-based safe vein cannulation in robot-assisted retinal surgery: A preliminary study. In *2020 international symposium on medical robotics (ismr)*. (Accepted). IEEE.

- 4 Zhou, M., Wu, J., Ebrahimi, A., **Patel, N.**, He, C., Gehlbach, P., ... Iordachita, I. (2020). Spotlight-based 3d instrument guidance for retinal surgery. In *2020 international symposium on medical robotics (ismr)*. (Accepted). IEEE.
- 5 Ebrahimi, A., He, C., **Patel, N.**, Kobilarov, M., Gehlbach, P. & Iordachita, I. (2019). Sclera force control in robot-assisted eye surgery: Adaptive force control vs. auditory feedback. In *2019 international symposium on medical robotics (ismr)* (pp. 1–7). IEEE.
- 6 Ebrahimi, A., **Patel, N.**, He, C., Gehlbach, P., Kobilarov, M. & Iordachita, I. (2019). Adaptive control of sclera force and insertion depth for safe robot-assisted retinal surgery. In *2019 international conference on robotics and automation (icra)* (pp. 9073–9079). IEEE (**Best Paper Award in Medical Robotics**).
- 7 Ebrahimi, A., Urias, M., **Patel, N.**, He, C., Taylor, R., Gehlbach, P. & Iordachita, I. (2019). Towards securing the sclera against patient involuntary head movement in robotic retinal surgery. In *2019 28th IEEE international symposium on robot and human interactive communication (ro-man)*. IEEE.
- 8 He, C., **Patel, N.**, Iordachita, I. & Kobilarov, M. (2019). Enabling technology for safe robot-assisted retinal surgery: Early warning for unsafe scleral force. In *2019 international conference on robotics and automation (icra)* (pp. 3889–3894). IEEE.
- 9 Kim, G. H., **Patel, N.**, Yan, J., Wu, D., Li, G., Cleary, K. & Iordachita, I. (2019). Shoulder-mounted robot for mri-guided arthrography: Clinically optimized system. In *2019 41st annual international conference of the IEEE engineering in medicine and biology society (embc)* (pp. 1977–1980). IEEE.
- 10 Li, Z., Shahbazi, M., **Patel, N.**, Sullivan, E. O., Zhang, H., Vyas, K., ... Taylor, R. H. (2019a). A novel semi-autonomous control framework for retina confocal endomicroscopy scanning. In *Intelligent robots and systems (iros), 2019 IEEE/rsj international conference on*. IEEE.
- 11 Li, Z., Shahbazi, M., **Patel, N.**, Sullivan, E. O., Zhang, H., Vyas, K., ... Taylor, R. H. (2019b). A novel semi-autonomous control framework for retina confocal endomicroscopy scanning. In *2019 international symposium on medical robotics (ismr)*. IEEE(**Best Poster Winner**).
- 12 **Patel, N.**, Urias, M., Ebrahimi, A., He, C., Gehlbach, P. & Iordachita, I. (2019). Sclera force evaluation during vitreoretinal surgeries in ex vivo porcine eye model. In *Sensors, 2019 IEEE*. IEEE.
- 13 Wu, D., Li, G., **Patel, N.**, Yan, J., Kim, G. H., Monfaredi, R., ... Iordachita, I. (2019). Remotely actuated needle driving device for mri-guided percutaneous interventions: Force and accuracy evaluation. In *2019 41st annual international conference of the IEEE engineering in medicine and biology society (embc)* (pp. 1985–1989). IEEE.
- 14 Wu, D., Li, G., **Patel, N.**, Yan, J., Monfaredi, R., Cleary, K. & Iordachita, I. (2019). Remotely actuated needle driving device for mri-guided percutaneous interventions. In *2019 international symposium on medical robotics (ismr)* (pp. 1–7). IEEE (**Best Paper Finalist**).
- 15 Yan, J., **Patel, N.**, Li, G., Wu, D., Cleary, K. & Iordachita, I. (2019). Body-mounted mri-conditional parallel robot for percutaneous interventions structural improvement, calibration, and accuracy analysis. In *2019 41st annual international conference of the IEEE engineering in medicine and biology society (embc)* (pp. 1990–1993). IEEE.
- 16 Ebrahimi, A., He, C., Roizenblatt, M., **Patel, N.**, Sefati, S., Gehlbach, P. & Iordachita, I. (2018). Real-time sclera force feedback for enabling safe robot-assisted vitreoretinal surgery. In *2018 40th annual international conference of the IEEE engineering in medicine and biology society (embc)* (pp. 3650–3655). IEEE. <https://doi.org/10.1109/EMBC.2018.8513255>
- 17 Gonenc, B., **Patel, N.** & Iordachita, I. (2018). Evaluation of a force-sensing handheld robot for assisted retinal vein cannulation. In *2018 40th annual international conference of the IEEE engineering in medicine and biology society (embc)* (pp. 1–5). IEEE. <https://doi.org/10.1109/EMBC.2018.8513304>
- 18 He, C., Ebrahimi, A., Roizenblatt, M., **Patel, N.**, Yang, Y., Gehlbach, P. L. & Iordachita, I. (2018). User behavior evaluation in robot-assisted retinal surgery. In *2018 27th IEEE international symposium on robot and human interactive communication (ro-man)* (pp. 174–179). IEEE.

- 19 He, C., Roizenblatt, M., **Patel, N.**, Ebrahimi, A., Yang, Y., Gehlbach, P. L. et al. (2018). Towards bimanual robot-assisted retinal surgery: Tool-to-sclera force evaluation. In *2018 IEEE Sensors* (pp. 1–4). IEEE.
- 20 **Patel, N.**, Azimi, E., Monfaredi, R., Sharma, K., Cleary, K. & Iordachita, I. (2018). Robotic system for MRI-guided shoulder arthrography: Accuracy evaluation. In *Medical Robotics (ISMR), 2018 International Symposium on* (pp. 1–6). IEEE (**Best Paper Finalist**). <https://doi.org/10.1109/ISMR.2018.8333299>
- 21 **Patel, N.**, Yan, J., Levi, D., Monfaredi, R., Cleary, K. & Iordachita, I. (2018). Body-mounted robot for image-guided percutaneous interventions: Mechanical design and preliminary accuracy evaluation. In *2018 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)* (pp. 1443–1448). IEEE.
- 22 Nycz, C. J., Gondokaryono, R., Carvalho, P., **Patel, N.**, Wartenberg, M., Pilitsis, J. G. & Fischer, G. S. (2017). Mechanical validation of an MRI compatible stereotactic neurosurgery robot in preparation for pre-clinical trials. In *Intelligent Robots and Systems (IROS), 2017 IEEE/RSJ International Conference on* (pp. 1677–1684). IEEE. <https://doi.org/10.1109/IROS.2017.8205979>
- 23 Wartenberg, M., **Patel, N.**, Li, G. & Fischer, G. S. (2016). Towards synergistic control of hands-on needle insertion with automated needle steering for MRI-guided prostate interventions. In *Engineering in Medicine and Biology Society (EMBC), 2016 IEEE 38th Annual International Conference of the* (pp. 5116–5119). IEEE. <https://doi.org/10.1109/EMBC.2016.7591878>
- 24 **Patel, N.**, van Katwijk, T., Li, G., Moreira, P., Shang, W., Misra, S. & Fischer, G. S. (2015). Closed-loop asymmetric-tip needle steering under continuous intraoperative MRI guidance. In *Engineering in Medicine and Biology Society (EMBC), 2015 37th Annual International Conference of the IEEE* (pp. 4869–4874). IEEE. <https://doi.org/10.1109/EMBC.2015.7319484>
- 25 **Patel, N.**, Pradhan, S. & Shah, K. (2009). Two legged robot design, simulation and realization. In *Autonomous Robots and Agents, 2009. ICARA 2009. 4th International Conference on* (pp. 426–429). IEEE. <https://doi.org/10.1109/ICARA.2009.4803964>

## In Review/Revision

- 1 Ebrahimi, A., Roizenblatt, M., **Patel, N.** & et al., a. (2020). Auditory feedback effectiveness for enabling safe sclera force in robot-assisted vitreoretinal surgery: A multi-user study. *Intelligent Robots and Systems (IROS), 2020 IEEE/RSJ International Conference on*. (Under Review). IEEE.
- 2 Ebrahimi, A., Sefati, S., **Patel, N.**, He, C., Gehlbach, P., Alambeigi, F. & Iordachita, I. (2020). Stochastic force-based insertion depth and tip position estimations of flexible fbg-equipped instruments in robotic retinal surgery. *IEEE/ASME Transactions on Mechatronics*, IEEE. (Under Review).
- 3 He, C., Yang, E., **Patel, N.**, Ebrahimi, A., Shahbazi, M. & Iordachita, I. (2020). Automatic light pipe actuating system for bimanual robot-assisted retinal surgery. *IEEE/ASME Transactions on Mechatronics*, IEEE. (Under Revision).
- 4 Jinno, M., Li, G., **Patel, N.** & et al., a. (2020). Integrated high-dexterity cooperative robotic assistant for intraocular micromanipulation. *IEEE Robotics and Automation Letters (RA-L)*. (Under Review). IEEE.
- 5 Li, G., **Patel, N.**, Burdette, C., Pilitsis, J., Su, H. & Fischer, G. (2020). A fully actuated robotic assistant for MRI-guided precision conformal ablation of brain tumors. *IEEE/ASME Transactions on Mechatronics*, IEEE. (Under Revision).
- 6 Li, G., **Patel, N.** & et al., a. (2020). Fully actuated body-mounted robotic system for MRI-guided lower back pain injections: Initial phantom and cadaver studies. *IEEE Robotics and Automation Letters (RA-L)*. (Under Review). IEEE.
- 7 Li, Z., Shahbazi, M., **Patel, N.**, Sullivan, E. O., Zhang, H., Vyas, K., ... Taylor, R. H. (2020). Hybrid robotic-assisted frameworks for endomicroscopy scanning in retinal surgeries. *IEEE Transactions on Medical Robotics and Bionics*, IEEE. (Under Review).
- 8 **Patel, N.**, Urias, M., Ebrahimi, A., Gehlbach, P. & Iordachita, I. (2020). Scleral force evaluation during vitreoretinal surgery: In an in vivo rabbit eye model. *2020 42nd Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC)*, IEEE. (Under Review).

- 9 **Patel, N.,** Urias, M., He, C., Gehlbach, P. & Iordachita, I. (2020). A comparison of manual and robot assisted retinal vein cannulation in chicken chorioallantoic membrane. *2020 42nd annual international conference of the IEEE Engineering in Medicine and Biology Society (EMBC)*, IEEE. (Under Review).
- 10 Wu, J., Li, G., Urias, M., **Patel, N.** & et al., a. (2020). An optimized tilt mechanism for a new steady-hand eye robot. *Intelligent Robots and Systems (IROS), 2020 IEEE/RSJ International Conference on*. (Under Review). IEEE.

## Conference Abstracts

- 1 Li, Z., Shahbazi, M., **Patel, N.,** Sullivan, E. O., Chalasani, P., Zhang, H., ... Taylor, R. H. (n.d.). *An image-based control framework for teleoperated semi-autonomous retina endomicroscopy scanning*. 2019 International Symposium on Medical Robotics (ISMR), Atlanta, GA, USA.
- 2 Gandomi, K., Carvalho, P., Fischer, G., Nycz, C., **Patel, N.,** Hefter, T., ... Pilitis, J. (2018). *Preclinical trials of an mri-guided robotic conformal brain tumor ablation system with real-time monitoring of interstitial therapeutic ultrasound*. 10th NCIGT Image Guided Therapy Workshop, Bethesda, MD.
- 3 Iordachita, I., **Patel, N.,** Yan, J., Jan, F., Loew, W., Dumoulin, C., ... Cleary, K. (2018). *Mri-compatible robot for pain injections in adults and children: Concept and first results*. 12th Interventional MRI Symposium, Boston, MA, USA.
- 4 Moreira, P., **Patel, N.,** Wartenberg, M., Li, G., Heffter, T., Burdette, E., ... Tokuda, J. (2018). *Transperineal mr-guided prostate biopsy: The contribution of needle deflection to the targeting error*. International Symposium on Biomedical Imaging - ISBI'18, Washington, DC,
- 5 **Patel, N.,** Iordachita, I., Melzer, A., Priba, L., Donald-Simpson, H., Joy, J., ... Sharma, K. (2018). *Thiel embalmed cadaver study of shoulder and hip arthrography with a patient-mounted mri compatible robot*. 12th Interventional MRI Symposium, Boston, MA, USA.
- 6 **Patel, N.,** Yan, J., Monfaredi, R., Sharma, K., Cleary, K. & Iordachita, I. (2018). *Preclinical evaluation of an integrated robotic system for mri-guided shoulder arthrography*. 12th Interventional MRI Symposium, Boston, MA, USA.
- 7 Fischer, G., Wartenberg, M., **Patel, N.,** Tokuda, J., Tempany, C. & Hata, N. (2017). *Towards cooperative control of mri-guided pelvic needle placement procedures*. 9th NCIGT Image Guided Therapy Workshop, Bethesda, MD.
- 8 Fischer, G., **Patel, N.,** Li, G., Tokuda, J., Tempany, C. & Hata, N. (2016). *Towards active needle trajectory compensation of mri-guided prostate interventions*. 8th NCIGT Image Guided Therapy Workshop, Bethesda, MD.
- 9 **Patel, N.,** Li, G., Bogdanov, G., Hefter, T., Komadina, B., Williams, E., ... Fischer, G. (2016). *Monitoring and control of mri-guided robot-assisted conformal brain tumor ablation*. 8th NCIGT Image Guided Therapy Workshop, Bethesda, MD.
- 10 **Patel, N.,** Li, G. & Fischer, G. (2016). *Closed-loop autonomous needle steering under imri guidance*. 11th Interventional MRI Symposium, Boston, MA, USA.
- 11 Tokuda, J., Tuncali, K., Li, G., **Patel, N.,** Heffter, T., Fischer, G., ... Tempany, C. (2016). *In-bore mri-guided transperineal prostate biopsy using 4-dof needle-guide manipulator*. 24th Scientific Meeting and Exhibition of the International Society of Magnetic Resonance in Medicine - ISMRM 2016, Singapore.
- 12 Wartenberg, M., **Patel, N.,** Li, G., Nycz, C., Tokuda, J., C, T., ... Fischer, G. (2016). *Cooperative control of robot-assisted imri-guided pelvic needle placement procedures*. 11th Interventional MRI Symposium, Boston, MA, USA.
- 13 Li, G., **Patel, N.,** Shang, W. & GS, F. (2015). *Introducing a gaussian-based continuous rotation approach to underactuated control of asymmetric tip needle steering*. International Conference on Robotics and Automation - ICRA 2015, Seattle, WA, USA.
- 14 Tokuda, J., Tuncali, K., Shang, W., **Patel, N.,** Li, G., Heffter, T., ... Tempany, C. (2015). *Clinical application of needle guiding manipulator for mri-guided transperineal prostate biopsy*. IEEE EMBC 2015, Milan, Italy.

## Textbook Chapters

- 1 MacDonell, J., Fischer, G., Burdette, E. C., Ghoshal, G., **Patel, N.** & Pilitsis, J. (2019). *Towards mr-guided precision conformal ablation therapy for brain tumors*. Bioengineering Technologies.