# Yash Chitalia

718 Argonne Ave NE, Apt 2,
Atlanta, GA 30308, USA

Email : ychitalia3@gatech.edu
Phone : +1-734-757-0489
Website : yashchitalia.github.io


## Education

**Georgia Institute of Technology**, Atlanta, GA — 12/2020 (expected)
*Ph.D. in Robotics*, Major: Mechanical Engineering — **GPA: 3.91/4.00**
**Coursework & Research:** Robotics, Mechanical Design, Mechatronics, GD&T, Dynamics of Mechanical Systems, C++, Python, Computer Vision, Regulatory Issues in Medical Device Development, Machine Learning.

**University of Michigan**, Ann Arbor, MI — 05/2013
*M.S. in Electrical Engineering* — **GPA: 3.81/4.00**
**Coursework:** Embedded Control Systems, Linear Systems, Nonlinear Systems, Linear Feedback Systems, Probability and Random Processes, Digital Signal Processing

**University of Mumbai**, Maharashtra, India — 08/2011
*B.E. in Electronics Engineering* — **GPA: 3.86/4.00**
**Coursework:** Robotics, Mechatronics, Embedded Systems, Electronic Design, C/C++, Autodesk Inventor and AutoCAD, Classical Control Systems, Image Processing

## Experience

**Medical Robotics and Automation (RoboMed) Laboratory** — 07/2016 - present
*Ph.D. Candidate, Advisor: Dr. Jaydev P. Desai*

- Designed two **robotic guidewires** (PATENT PENDING) for assisting in endovascular procedures. These guidewires are only **0.4 mm in outer diameter** making them among the smallest robotic catheters in the world.
- Worked on the design, modeling and control of a two degree-of-freedom **robotic neuroendoscopy tool** (PATENT PENDING) with handheld controller and miniaturized force sensors for force based control.
- **Petit Scholar Mentor** for two years consecutively receiving a $5000 award to mentor two undergraduate students.

**ME 2110: Creative Decisions and Design** — 07/2016 - 07/2018
*Head Teaching Assistant, Instructor: Dr. Christopher Saldana/Dr. Thomas Kurfess*

- Led a team of approximately 15-20 Graduate and Undergraduate teaching assistants in successfully teaching a class of approximately 300 students (per semester). The class involved students building robots competing against each other in a final competition. Taught students mechatronics using the myRIO board by NI and machine shop skills.

**Healthcare Robotics Laboratory** — 08/2014 - 07/2016
*Ph.D. Student, Advisor: Dr. Charles Kemp*

- Worked on modifying a standard hospital bed, to convert it to a 'robot' capable of sensing its pose and the pressure distribution of an occupant and modified the system to communicate with a PR2 robot in ROS.
- **Petit Scholar Mentor** for one year receiving $2500 award to mentor one undergraduate student.

**Lutron Electronics** — 07/2013 - 06/2014
*Senior Project Electrical Engineer*

- Designed embedded software for the implementation of the Lutron proprietary wireless communication protocol in the mass market wireless home automation solutions.

**Controls and Powertrain Research Group, Ford Motor Company** — 06/2012 - 08/2012
*Summer Intern*

- Implemented the 'Vector Reference Governor' predictive control scheme on the linearized models of the Ford Motor Company engines. Also implemented the non-linear version of the reference governor algorithm on the Ford vehicles.

## Leadership Experience

- **Three-year Petit Scholar Mentor: $7500 travel awards** to mentor three undergraduate students. — 2015, 2018-19
- **Co-organized three workshops** at the 2019-2020 IEEE International Symposium on Medical Robotics. (ISMR 2020 workshops delayed due to COVID) — 2019-2020

## Relevant Skills

- **Coding Skills:** MATLAB, Simulink, Labview, Python, C, C++.
- **Software Skills:** Solidworks, Autodesk Inventor, Autodesk EAGLE, ROS, AutoCAD, ANSYS.
- **Machining Skills:** GD&T, Femto-second laser micromachining, Lathe and Milling machine proficiency.

## Publications

### Journal Articles

1. S. Jeong, **Y. Chitalia (co-first author)**, and J.P. Desai, "Design, Modeling, and Control of a Coaxially Aligned Steerable (COAST) Guidewire Robot," in *IEEE Robotics and Automation Letters.* 10.1109/LRA.2020.3004782
2. **Y. Chitalia**, S. Jeong (co-first author), K. K. Yamamoto, J. J. Chern, and J.P. Desai, "Modeling and Control of a Meso-scale Multi-Joint Continuum Robot for Pediatric Neurosurgery," in *IEEE Transactions on Robotics*, (accepted)
3. S. Jeong, **Y. Chitalia** and J. P. Desai, "Miniature Force Sensor based on Dual-photointerrupter with High Linearity and Disturbance Compensation," in *IEEE Sensors Journal.*
4. **Y. Chitalia**, N. J. Deaton, S. Jeong, N. Rahman and J. P. Desai, "Towards FBG-Based Shape Sensing for Micro-Scale and Meso-Scale Continuum Robots With Large Deflection," in *IEEE Robotics and Automation Letters*, vol. 5, no. 2, pp. 1712-1719, April 2020.
5. **Y. C. Chitalia**, S. Jeong, N. Deaton, J. J. Chern and J. P. Desai, "Design and Kinematics Analysis of a Robotic Pediatric Neuroendoscope Tool Body," in *IEEE/ASME Transactions on Mechatronics.*
6. A.S. Kapusta, P. M. Grice, H. M. Clever, **Y. Chitalia**, D. Park, C.C. Kemp, "A system for bedside assistance that integrates a robotic bed and a mobile manipulator," *PLoS One*, 2019;14(10):e0221854. Published 2019 Oct 16. doi:10.1371/journal.pone.0221854

### Conference Proceedings

1. A. Sarma, G. C. Collins, N. Nayar, **Y. Chitalia**, S. Jeong, B. D.Lindsey, and J. P. Desai, "Towards the development of an ultrasound-guided robotically steerable guidewire," *2020 International Symposium on Medical Robotics (ISMR), IEEE*, (accepted).
2. **Y. Chitalia**, S. Jeong, J. Bok, V. Nguyen, S. Melkote, J. J. Chern, J. P. Desai, "Towards the Design and Development of a Pediatric Neuroendoscope Tool," *2019 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, Macau, China, 2019, pp. 2998-3004.
3. **Y. Chitalia**, X. Wang, V. Nguyen, S. Melkote, J. J. Chern, and J. P. Desai, "Design and Analysis of a Bidirectional Notch Joint for a Robotic Pediatric Neuroendoscope," in *International Symposium on Experimental Robotics*, (pp. 24-33). Springer, Cham., November 2018
4. H. M. Clever, A. Kapusta, D. Park, Z. Erickson, **Y. Chitalia** and C. C. Kemp, "3D Human Pose Estimation on a Configurable Bed from a Pressure Image," *2018 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, Madrid, 2018, pp. 54-61.
5. **Y. Chitalia**, X. Wang and J. P. Desai, "Design, Modeling and Control of a 2-DoF Robotic Guidewire," *2018 IEEE International Conference on Robotics and Automation (ICRA)*, Brisbane, QLD, 2018, pp. 32-37.
6. T. Bhattacharjee, J. Wade, **Y. Chitalia** and C. C. Kemp, "Data-driven thermal recognition of contact with people and objects," *2016 IEEE Haptics Symposium (HAPTICS)*, Philadelphia, PA, 2016, pp. 297-304.
7. **Y. Chitalia**, W. Zhang, B. Hyun and A. Girard, "A revisit-based mixed-initiative nested classification scheme for Unmanned Aerial Vehicles," *2014 American Control Conference*, Portland, OR, 2014, pp. 1793-1798.
8. U. Kalabić, **Y. Chitalia**, J. Buckland and I. Kolmanovsky, "Prioritization schemes for reference and command governors," *2013 European Control Conference (ECC)*, Zurich, 2013, pp. 2734-2739.

## Patent Applications

- J. P. Desai, **Y. Chitalia**, S. Jeong, "System, Method, And Apparatus For The Control Of Multiple Degrees-Of-Freedom Bending And The Bending Length Of A Coaxially Aligned Robotically Steerable Guidewire," **Provisional patent, 63/013425** , 2020
- J. P. Desai, **Y. Chitalia**, S. Jeong, J. J. Chern, "Steerable and flexible robotic endoscopic tools for minimally invasive procedures," **PCT Patent, PCT/US20/20942, patent pending**, 2020
- J. P. Desai, **Y. Chitalia**, S. Jeong, J. J. Chern, "Multi-port, steerable, and flexible robotic endoscopic tools for minimally invasive procedures," **U.S. Patent Application No. 62/813,444, patent pending**, 2019
- J. P. Desai, **Y. Chitalia** "Systems and Methods for Steering Guidewires," **PCT Patent, PCT/US2018/021784, patent pending**, 2019
- J. P. Desai, **Y. Chitalia** "System, Method, and Apparatus for Active Control of Multiple Degrees-of-Freedom Micro-Scale Guidewires and Devices," **U.S. Patent Application No. 62/469,570, patent pending**, 2017

## Robotic Guidewires

**Publications: ICRA 2018, RA-L 2020, ISMR 2020 (Two US patents and one PCT patent pending)**

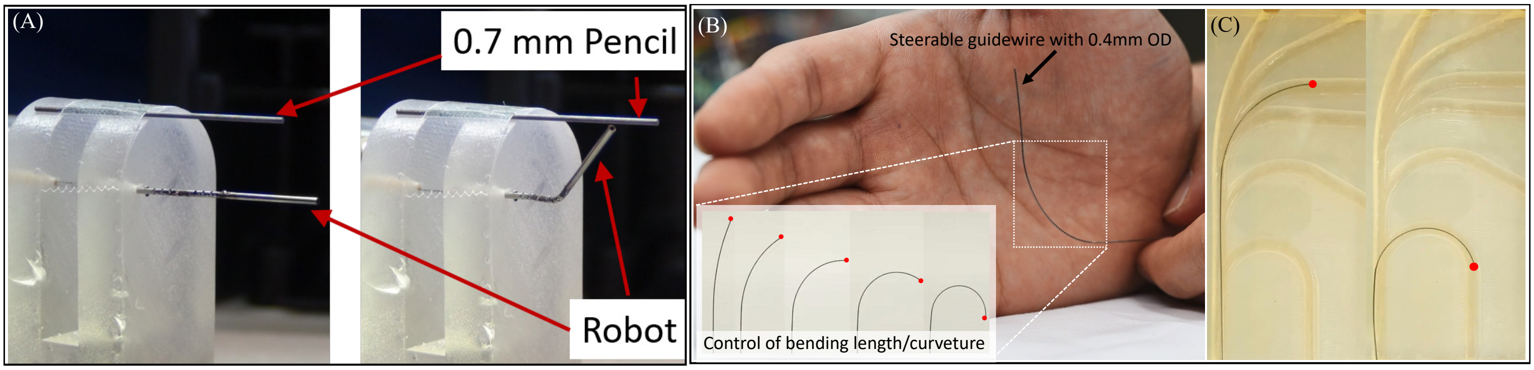


Figure 1: (A) 2-DoF robotic guidewire, 0.78 mm in Outer Diameter; (B) COAST robotic guidewire, 0.4 mm in Outer Diameter, with Follow-the-leader (FTL) capability; (C) The robotic guidewire can execute FTL motion at high curvatures.

**2-DoF Guidewire:** In this project, we have designed and analyzed a **0.78 mm two degree-of-freedom robotic guidewire** for cardiovascular applications. The guidewire is designed using femtosecond laser micromachining in a nitinol tube to create 'notch joints' allowing the tube to bend in the plane of the joint with the application of bending moment from a tendon. Internal routing of the tendon allows us to achieve 2-DoF bending of the guidewire, due to two orthogonal joints (see Fig. 1(A)).
**COAST Guidewire (Video Link):** The CO-axially Aligned STeerable (COAST) guidewire is the newest version of our robotically steerable guidewire with an **outer diameter of 0.4 mm**. The guidewire has a single degree-of-freedom and demonstrates follow-the-leader (FTL) motion along with feed-forward motion (see Fig. 1(B)). The guidewire is able to achieve high curvatures at varying bending lengths. Therefore the guidewire can be used in minimally invasive surgical procedures involving pediatric carotid arteries, aortic bifurcations or aortic arches (see Fig. 1(C)).

## Robotic Neuroendoscope

**Publications: ISER 2018, IROS 2019, TMECH 2020, TRO(accepted) (US/PCT patents pending)**

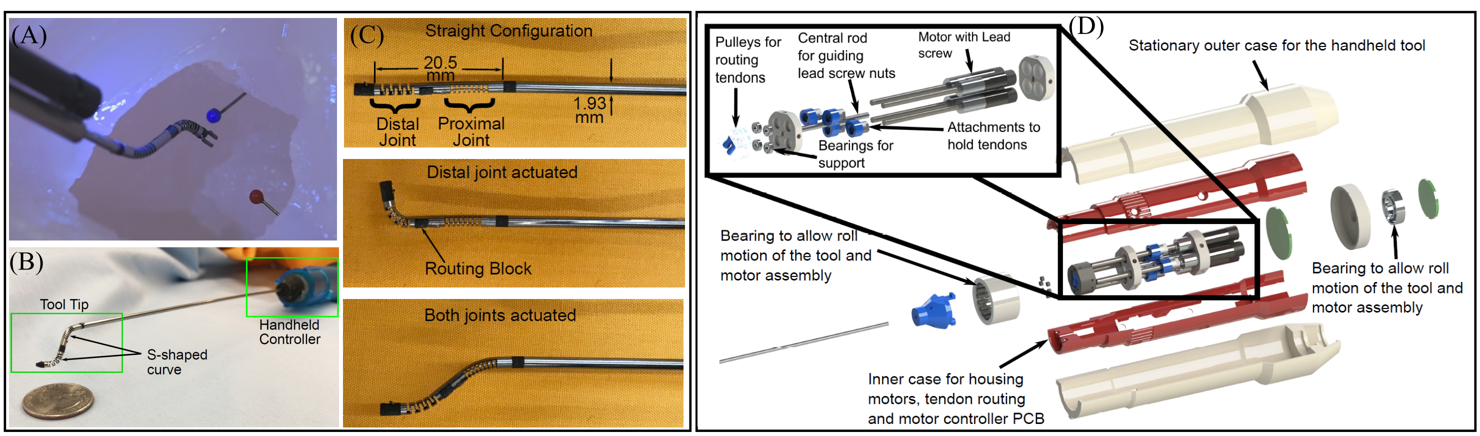


Figure 2: (A) Robotic neuroendoscope electrocauterizing sites in a phantom ventricular cavity; (B) Tool body with handheld controller; (C) Dimensions and modes of actuation of neuroendoscope tool tip; (D) CAD model of handheld controller.

The robotic pediatric neuroendoscope is a tendon-driven robotic electrocautery tool (see Fig. 2(A)) with a handheld controller (see Fig. 2(B)) designed for minimally invasive surgeries for treating pediatric hydrocephalus. The tool itself is a cylindrical tube of 1.93 mm (outer diameter) with two notch joints micromachined within it using a femtosecond laser. Both joints of the robotic tool are in the same plane, allowing the robot to make S-shaped curves in this bending plane (see Fig. 2(C)). The plane of bending can further be changed by a rolling motion capability in the handheld controller (see Fig. 2(D)). The handheld controller is very ergonomic (OD: 3 cm) and compatible with existing neuroendoscope trocars. The tool-tip is controlled using a joystick located at the back end of the handheld controller.

## Large Deflection Shape Sensing for Micro/Meso-scale Continuum Robots

**Publications: IEEE Robotics and Automation Letters 2020**

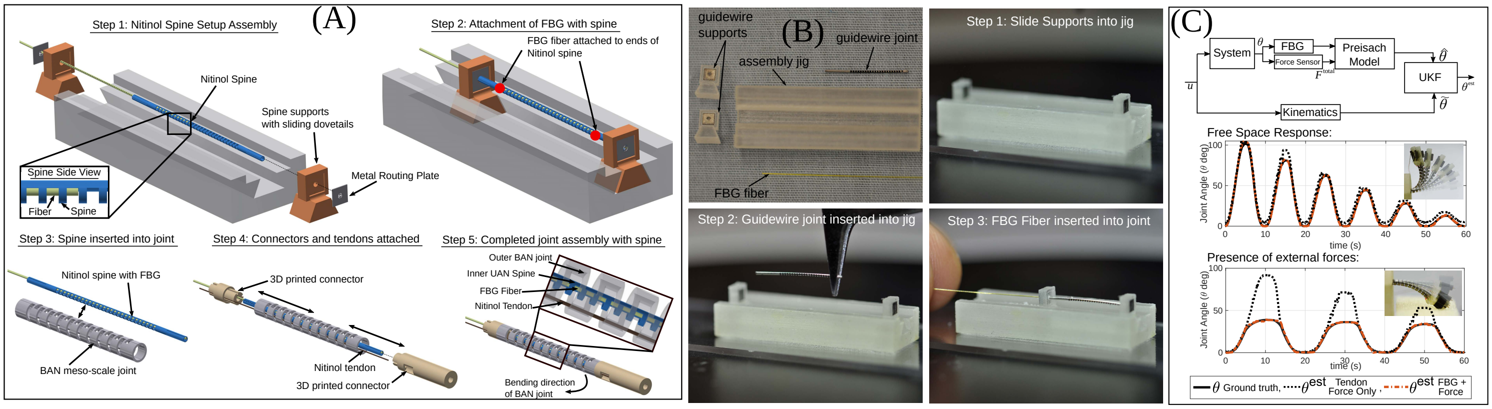


Figure 3: Fiber Bragg grating based sensing assembly to sense shape of micro/meso-scale continuum robots: (A) Design of proposed sensing assembly in meso-scale robot; (B) Design of proposed sensing assembly in micro-scale robot; (C) Preisach model for hysteresis with unscented Kalman filter demonstrates excellent tracking in free-space and external forces.

Large deflection shape-sensing for micro-scale and meso-scale robots is a challenging problem due to the size constraints of these robots. We attacked this problem by developing a shape-sensor designed by mounting an FBG fiber within a micromachined nitinol tube. The neutral axis of this tube is shifted due to the machining (see Fig. 3(A)-(B)). This shifting of the neutral axis allows the FBG core to experience compressive strain when the tube bends, which we can measure. By controlling the neutral axis location of the tube, we can modulate the sensitivity of the sensor very precisely. This sensor can measure curvatures as high as **145 $m^{-1}$ (which is over two times previously reported curvatures)**, and can estimate shape even in the presence of external forces or kinematic uncertainties (see Fig. 3(C)) (Video Link).

## Miniature Force Sensor for Tendon/Cable Driven Systems

**Publications: IEEE Sensors Journal 2020**

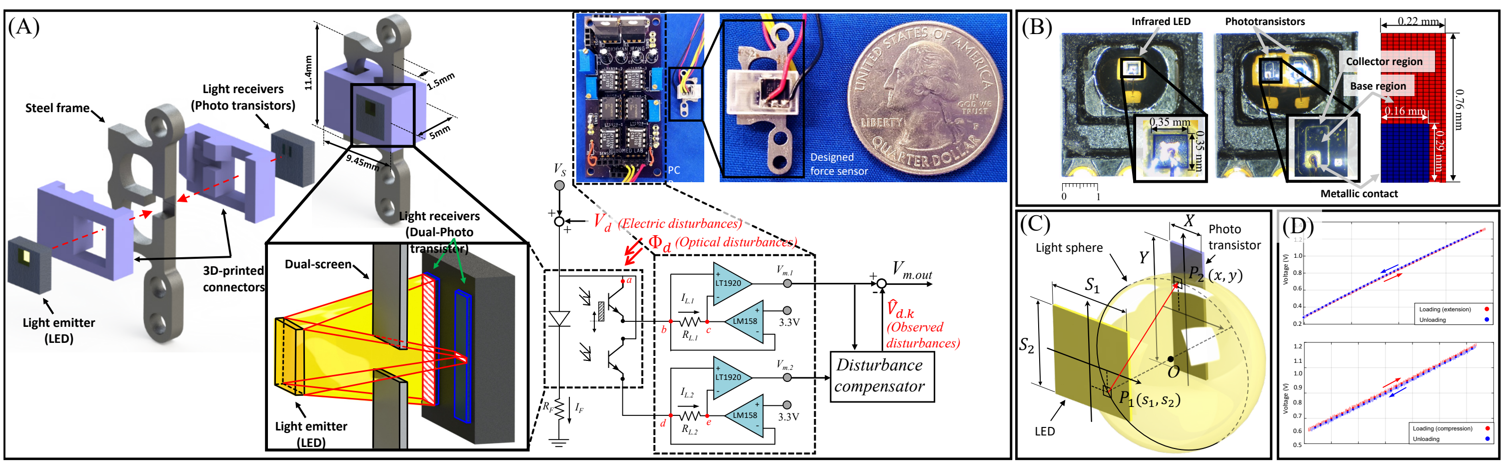


Figure 4: Photo-interrupter based miniature force sensor for cable/tendon-driven robots or prosthesis: (A) Design, electronic circuit, disturbance observer, and working principle of the proposed force sensor; (B) Microscopic image of the photo-interrupter; (C) Lambertian distribution optic model; (D) Output of the sensor with high linearity and low hysteresis.

Sensing the cable tension is critical for cable driven robots/prosthesis. Most force sensors are either too bulky or have a narrow linear range, and are vulnerable to external disturbances. This makes it difficult to use these sensors in precision force measurement and feedback control, especially in handheld medical robotics or compact prosthesis/exoskeletons. This work presents a photointerrupter (LED + phototransistor) based force sensing mechanism to implement a low-cost, high accuracy, and reliable sensor with a miniaturized design. The geometry of the sensor is optimized and a novel dual-screen arrangement is used to increase the linear range of the sensor output. A dual-phototransistor signal acquisition is introduced to compensate the external disturbances and provide robust sensor output. The sensor has the ability to measure **forces up to 21 N, having 1.08% nonlinearity, 0.83% hysteresis, and 99.58% accuracy**.