Harsh Jashvantbhai Modi

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PROFILE

PhD student in Mechanical Engineering with research focus on robotics, control systems, and motion planning. Specifically highlighting, I am expert in **quickly implementing theories into mechatronics hardware**. Looking for an internship for Spring/Summer 2025.

RELEVANT SKILLS

Software	: Robot Operating System (ROS1 & ROS2), Gazebo, Rviz, sensor fusion, MATLAB, Simulink, SolidWorks, Autodesk Inventor, Python, GIT, TensorFlow, LaTeX
Hardware	: Raspberry Pi, Arduino, Pixhawk, Microcontroller Applications, Additive Manufacturing, Motion Capture

EDUCATION

Texas A&M University, College Station, TX | Doctorate – Mechanical Engineering | GPA: 4.0/4.0 **_[May'26]_**
Thesis: **Advancing robot autonomy with novel hardware designs and control algorithms**
(Relevant Courses: Robotics and Spatial Intelligence, Control Systems, Systems Analysis, Road Vehicle Dynamics)

IIT Bombay, Mumbai, India | Masters – Mechanical Engineering | GPA: 9.85/10.0 _[Aug'22]_
Thesis: **Design and development of multirotor aerial robotic platform**
(Relevant Courses: Advance Topics in Mobile, Introduction to Robotics)

IIT Gandhinagar, Gandhinagar, India | Bachelors – Mechanical Engineering | GPA: 9.05/10.0 _[Aug'18]_
Project: Design and development of wheat harvester for small farms of India
(Relevant Courses: Mechatronics, Engineering Design, Robotics: Aerial Robotics)

PUBLICATIONS

- H. Modi, Z. Chen, X. Liang and M. Zheng, "Improving Disturbance Estimation and Suppression via Learning Among Systems With Mismatched Dynamics," in _IEEE Robotics and Automation Letters_, vol. 9, no. 6, pp. 5238-5245, June 2024, doi: 10.1109/LRA.2024.3391026.
- Harsh J Modi, Mohammad R Hajidavalloo, Zhaojian Li, and Minghui Zheng, "Robust Iterative Learning for Collaborative Road Profile Estimation and Active Suspension Control in Connected Vehicles," _MECC_ 2024.
- Modi H., Vashista V. (2021) Development and Demonstration of a Wheat Harvester for Small Farms of India. In: Sen D., Mohan S., Ananthasuresh G. (eds) Mechanism and Machine Science. Lecture Notes in Mechanical Engineering. Springer, Singapore. https://doi.org/10.1007/978-981-15-4477-432

RESEARCH PROJECTS

Control and Robotics Lab, Texas A&M University / University at Buffalo _[Aug'22 –present]_
(ROS1&2, Python, Gazebo, MATLAB, Simulink, GIT, LaTeX, SolidWorks, Raspberry Pi, Pixhawk, Vicon)
- Direction 1: Developed Iterative Learning Control (ILC) with Disturbance Observer (DOB) for estimating and suppressing the disturbances via learning among systems with mismatched dynamics.
  - Implemented the iterative learning framework on quadrotor Unmanned Aerial Vehicles (UAVs), where the learning framework reduced the disturbance estimation and trajectory tracking error by about 88 % using the novel method compared to the conventional DOB. Published results in IEEE Robotics and Autonomy Letters.
  - Implemented the learning framework on active suspension vehicle simulations to collaboratively estimate the road profile. Reduced estimation error by about 85% compared to conventional DOB.
- Direction 2: Design, development and Control of novel 7 DOF UAV:
  - Designed and developed UAV having a capability to deform from quadrotor configuration to bicopter configuration or any configuration in between. Suitable for agile trajectory tracking in cluttered difficult to pass through narrow environments.

* Willing to relocate

o Working on designing advanced optimization-based path planning and motion planning algorithms to utilize the extra degree of freedom.

Intelligent Dynamical Ubiquitous Systems Lab, IIT Bombay *[Dec'20-Jun'22]*
(ROS1, Python, Gazebo, MATLAB, Simulink, GIT, LaTeX, Autodesk Inventor, Arduino IDE, Arduino, Pixhawk, Vicon)
- Designed and implemented robust controller with failsafe algorithms using ROS for precise trajectory tracking of the aerial robotic platform (i.e. quadrotor).
- Designed and implemented a controller to control the oscillations of an unactuated pendulum attached to the quadrotor. Designed algorithm to gradually store the kinetic energy in the pendulum by increasing the oscillations and hit a plastic ball so that it passes through a target hoop; Achieved 90% repeatability.

Human Centered Robotics Lab, IIT Gandhinagar *(Jan'18-Apr'18)*
Project Course; "**Affordable Small Scale Wheat Harvester**"
- Designed and manufactured pedal-powered wheat harvester using scythe blade, quick return mechanism, Geneva wheel mechanism etc. Analyzed the drawbacks and revamped design with chainsaw as a primary cutter driven by a DC motor.
- Manufactured the prototype and assessed successfully in the wheat farm, presented a conference paper in December'18

School of Mechanical and Aerospace Engineering, NTU Singapore *(May'17-Jul'17)*
Research Internship; "**Design and Manufacturing of VTOL Fixed-Wing UAV with a Bicopter Mechanism**"
- Designed a mechanism to precisely control the attitude and to enable the transition between hover mode and fixed-wing mode of the Vertical Takeoff and Landing fixed-wing UAV. Optimized the design by achieving coinciding thrust and rotation axes and compactly packing the mechanism. Ensured the strength requirement with stress and deformation analysis in ANSYS during various iterations.
- Manufactured the final mechanism using additive manufacturing and assembled the bicopter components such as Pixhawk flight controller, ESC, BLDC Motors etc. and performed ground tests to evaluate the roll/pitch/yaw control.

INDUSTRIAL EXPERIENCE

Tata Motors Ltd. – **Commercial Vehicle Business Unit**, Pune, India *(Aug'18-Aug'20)*
Senior Manager; "Advance Quality – Purchase & Supplier Quality"
- Developed about 150 automobile parts with tier-1 suppliers for implementation of BS VI emission norms in India. Participated in supplier selection, monitored continuous timely development of the tools, ensured adherence to the quality standards with various labs in the company. Also conducted onsite PPAP assessment for ensuring the production at required rate with quality and managed initial supply to the production line before handing over to supply chain department.
- Monitored timeline of the development of all the modification parts (about 3000) of "Intermediate and Light Commercial Vehicles" for BS VI implementation. Improved the efficiency of the tracking using extensive automation with Microsoft Excel.
- Improved designs of about 50 parts by providing "Design for Manufacturing" feedback to the design team for future projects.

CURRICULAR PROJECTS

Robotics and Spatial Intelligence (ROS2, Python, GIT, Rviz, MATLAB) *[Jan'24-Apr'24]*
- Using noisy 2D LiDAR data, detected the moving objects among the background stationary objects, and tracked each unique object. The algorithm was also able to track each unique object even if they were "shadowed" by other objects temporarily.
- Using very low resolution and low refresh rate 2D LiDAR data, accurately created a probabilistic occupancy grid map of the environment the robot was moving in.
- Localized the robot inside one of the known stored maps using the created occupancy grid with 100% accuracy after a few scans.
- Implemented the visibility graph-based motion planning algorithm to move the robot to the goal location avoiding the obstacles, used Dijkstra's algorithm to find the shortest path.

Road Vehicle Dynamics   *(Sep'22-Dec'22)*
- Performed a literature review of the existing state of the art algorithms for obstacle avoidance systems of the cars and analyzed the shortcomings of the existing algorithms.
- Modeled 4-wheel planar model of the car and simplified it to a bicycle model. Designed a decision making and control algorithm to avoid a collision due to sudden obstacle appearance (e.g. pedestrian). The algorithm considered the locations of the obstacle, ego car, and other cars in a 2-lane highway.
- Evaluated the algorithm in the MATLAB simulation for different scenarios, the algorithm completely avoided the collision in 67% of the scenarios and mitigated the damage in the rest of the scenarios.

Advanced Topics in Mobile Robotics (ROS1, Python, Gazebo)   *[Jan'21-Apr'21]*
- Designed a controller using ROS to move a wheeled robot to a desired location based on target setpoints.
- Designed Extended Kalman Filter based estimation algorithm to use the trilateration data to localize the robot.
- Thoroughly analyzed and recreated the paper focusing on monitoring and mapping the aggressive fire spread using multiagent UAVs. Designed a MATLAB simulation to recreate the algorithm, UAV agents schedule a meeting to exchange their beliefs on the state of each grid points as healthy/on fire/burnt in a de-centralized manner.

Detection of American Sign Language Letters using Machine Learning   *(Mar'21-May'21)*
- Collected sign language letters' image data from an online dataset and some volunteers with approximately 10000 images, including different lighting conditions and orientations.
- Designed convoluted Neural network with 2 convolutional+maxpooling layers and 3 flattened layers with 26 letter output nodes. Trained Convolution Neural Network (CNN) with TensorFlow to recognize sign language letters using webcam in real time.

Vibration Analysis and Mitigation in Ceiling Fans   *(Oct'20-Nov'20)*
- Gathered vibration data of a ceiling fan using **sensors of the mobile phone** such as accelerometer and gyroscope.
- Analyzed the root cause of the vibration using FFT analysis of the data, and reduced vibration by around 65% using balancing masses.

Tracking Control and System Behavior Analysis of Underactuated Swirling Pendulum   *(Jan'17-Apr'17)*
- Designed a robust 2-DOF swirling pendulum setup with one rotating arm mounted to un-actuated oscillatory arm.
- Analyzed the behavior of the unactuated arm to various initial conditions and input signal frequency of the actuated arm motor rotation. Designed a reverse function to control the unactuated arm using actuated arm motor rotation.

Simulation of Car Suspension System   *(Oct'16-Nov'16)*
- Created a mathematical model of a quarter car and a half car suspension systems.
- Used Simulink to simulate the dynamics of the modelled suspension systems. Analyzed the behavior over trapezoidal speed-hump of various sizes at various speeds with various suspension parameters.
- Optimized the parameters based on the displacement and rotation of the suspended mass.

Electrical and Electronics Laboratory   *(Ma'15r-Apr'15)*
- Made a prototype circuit of digital password locking system using bread board, multiplexer, logic gates.

Simulation of Trailing Edge Flap Mechanism   *(Jan – Apr 2021)*
- Modeled the trailing edge flap mechanism (fowler flaps) of Airbus A320 in SolidWorks based on data available in the literature.
- Simulated and analyzed the motion for required torques in ADAMS with various motor speeds for various flap levels.

Senior Structural Engineer – Structures Subsystem - Hyperloop IITB   *(Oct'20 – Apr'21)*
- Designed ready to manufacture support structure to hold high pressure cylinders of the pod for European Hyperloop Week.

- Analyzed factor of safety and stress concentration in ANSYS at each iteration to achieve optimum design.
- Contributed towards the full assembly of the pod combining various subsystems, improved the pod base design in the process.

ACHIEVEMENTS

- **Director's Silver Medal** for outstanding overall performance among all the recipients of the degree of Bachelor of Technology in Mechanical Engineering – 7th Convocation, IIT Gandhinagar   *(Jul'18)*
- Award for the best performance in the core courses of engineering graphics, and manufacturing and workshop practice – 7th Convocation, IIT Gandhinagar   *(Jul'18)*
- Dean's List Award for excellent academic performance – Semesters I & II – AY 2014-15 and Semester I – AY 2016-17, IIT Gandhinagar

OTHER EXPERIENCES

- Teaching Assistant – Design Optimization – IIT *Bombay*   *(Jan'22-Apr'22*)
- Teaching Assistant – Strength of Materials – IIT Bombay   *(Aug'21-Nov'21)*
- Teaching Assistant – Engineering Drawing and Graphics – IIT Bombay   *(Jan'21-Apr'21)*
- Teaching Assistant of "Engineering Graphics" course in semester I of academic year 2015-16 at IIT Gandhinagar.
- Joint Secretary, Odyssey – The Astronomy Club – IIT Gandhinagar   *(Apr'16-Apr'17)*