Balark Tiwari

South Bend, Indiana | btiwari2@nd.edu | (574) 386-4687 | linkedin.com/in/balarktiwari | Portfolio

Summary

Ph.D. researcher in Robotics & Dynamics with 3+ years building robotics software and control systems in C++/Python on Linux real-time platforms. Hands-on experience in robot kinematics/dynamics, trajectory generation, model-based control, and closed-loop validation on physical multi-axis robotic systems. Built deterministic real-time sensing and control pipelines, integrated hardware and simulation workflows, and achieved tracking improvement in manufacturing environments.

Education

University of Notre Dame — **Notre Dame, United States**
Ph.D. in Aerospace and Mechanical Engineering, Robotics and Dynamics — 2021-Present

University of Notre Dame — **Notre Dame, United States**
M.S. in Aerospace and Mechanical Engineering, GPA: 3.8/4 — 2021-2024

Delhi Technological University — **New Delhi, India**
B.Tech. in Engineering Physics, GPA: 8.6/10 — 2014-2018

Technical Skills

Programming: C++, C, Python, MATLAB/Simulink
Robotics & Controls: Forward/inverse kinematics, Jacobians, rigid-body dynamics, trajectory generation, computed-torque control, state-space control, Iterative Learning Control (causal/non-causal filters), system identification, human biomechanics, models of walking, optimization
Middleware & Simulation: Linux (Ubuntu with rt-preempt patch), NI LabVIEW Real-Time, ROS2/ROS, MATLAB/Simulink, Gazebo
Hardware Integration & Debugging: Multi-sensor bring-up and integration: encoders, FLIR GigE Vision cameras, Bota Systems MegaONE (RS-232), NI PCIe DAQ (analog/digital I/O, counters), EtherCAT fieldbus, Aerotech motion stages

Experience

Graduate Research Assistant - Robotics — 2021 - Present
University of Notre Dame - Advanced Manufacturing Laboratory — *Notre Dame, United States*

- Built and maintained a multi-threaded C++/Python software stack on rt-preempt Linux for a multi-axis robotic workcell, supporting kHz-rate control loops with sub-ms timing jitter. **Github**
- Designed trajectory generation and closed-loop tracking control (feedback + feedforward), reducing temperature-tracking RMSE by 40%.
- Integrated servo drives,encoders, and thermal/vision/confocal sensors into a synchronized acquisition and control pipeline for repeatable hardware operation.
- Collaborated with mechanical design, and optics/metrology peers to integrate subsystems; co-authored a patent and peer-reviewed publications.

Graduate Teaching Assistant - Mechanical Engineering — 2021 - 2024
University of Notre Dame, Department of Aerospace and Mechanical Engineering — *Notre Dame, United States*

- Mentored students in hands-on projects on servo control, motion interpolation, and trajectory planning, delivering practical experience in sensor integration and real-time control system implementation.
- Supported instructors in preparing assignments, exams, lectures, and course materials for undergraduate courses in Mechanics, Analytical Dynamics, Differential Equations, Vibrations, and Controls, while also grading and hosting office hours.

Selected Projects

KUKA iiwa 7-DOF Manipulator Control | *Forward/Inverse Kinematics, Trajectory Planning, Computed-Torque Control*

- Modeled a 7-DOF KUKA iiwa arm using URDF and Denavit-Hartenberg parameters, and implemented forward/inverse kinematics with Jacobian-based numerical IK in SE(3).
- Generated joint-space trajectories from task-space waypoints and implemented computed-torque control using full rigid-body dynamics (mass, Coriolis, gravity) from MATLAB Robotics System Toolbox.

Digital Glass Forming | *Real-Time Linux, Trajectory Control, ILC*

- Identified reduced-order thermal dynamics and replaced baseline PID with a z-domain tracking controller for better layer-to-layer temperature regulation.
- Added feedback/feedforward and non-causal spatial-horizon Iterative Learning Control (ILC) to compensate repeatable disturbances, reducing temperature-tracking RMSE by 40%.

Digital Metal Forming | *Computer Vision, ILC, EtherCAT, Real-Time Control*

- Built an OpenCV pipeline for tool-deflection and part-shape estimation from camera and laser-line data to support in-process decision making to shape metal parts.
- Implemented pass-to-pass ILC updates using force/motion feedback to reduce springback and improve geometric accuracy of shaped parts.
- Integrated Yaskawa Sigma-7 EtherCAT drives with mixed digital/analog I/O for closed-loop machine control on physical hardware.

User Intent Recognition for EksoGT Exoskeletons | *PyTorch, LSTMs*

- Compared LSTM-based intent recognition in able-bodied and non-able-bodied subjects against a linear baseline, and used feature-importance analysis to identify key temporal precursors of user intent.

Selected Publications

- **Research Impact Award 2026**, Institute for Control, Optimization and Networks (ICON) Conference, Purdue University.
- **PCT International Patent Application** - "Systems and Methods of Printing 3D Lattices" (Application No. PCT/US2026/010502, filed January 7, 2026; University of Notre Dame assignee). Patent pending.
- **Development of a Digital Metal Forming System**, ASME International Symposium on Flexible Automation.
- **Real Time Vision-Based Morphology Tracking of Glass Additive Manufacturing Processes**, SFF Symposium.