U.S Citizen

Nathan Boyd

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Technical Skills Summary:

- **Software & Simulation**: Linux, C++, C, C#, Python, Java, MATLAB, Simulink, Docker, ROS, Drake, Unreal Engine, Unity, PX4, Crocoddyl, OCS2, Pinocchio, VISP, CppAD, CasADi
- **Sensor & Vision**: State Estimation, LIDAR processing, SLAM, Visual SLAM, Visual Depth Estimation, Object Detection
- **Control Systems**: Classical Control, Process Control, Optimal Control, Motion Control and Planning, Reinforcement Learning
- **Embedded Systems**: Digital & Analog Circuitry, Signal Processing, ARM Microcontrollers, Arduino, Raspberry Pi, Nvidia Jetson, Pixhawk, Ardupilot, CAN, SPI, I2C, UART
- **Design**: GD&T, FEA Analysis, Solidworks, Ansys, AutoCAD, Fusion360, 3D Printing, Molding/Casting, Topology Optimization, Motion Control Design, System Validation (NPI, EVT, DVT, PVT)

Education

Georgia Institute of Technology: M.S, Mechanical Engineering GPA 3.75
California State University Northridge (CSUN): B.S, Mechanical Engineering GPA 3.64

Work Experience

Apptronik

Senior Software & Control Engineer | Humanoid Mobile Manipulation | Autonomy Team Lead *June 2022 – Present*

- Led the Manipulation and Navigation Autonomy efforts for end-to-end palletizing and depalletization
- Led the efforts for creating a Behavior Library consisting of dozens of actions and transitions with execution management tools
- Created hierarchical and whole-body kinodynamic locomotion and manipulation MPC's
- Collaborated with the hardware and systems team for the design of the ODH, Apollo Alpha, and Apollo Beta robots
- Built a VR integrated whole-body teleoperation control stack for training and tracking learned Diffusion Policies
- Collaborated with industry research partners to prototype learning-based manipulation and locomotion policies
- Developed 3D motion planning & perception algorithms for humanoid navigation in unstructured environments
- Developed online manipulation actions based on affordance and learning-based grasp planners for reliable manipulation
- Created a software library for managing and controlling multi-dof control systems (MIMO, SISO, Virtual, and Imaginary control spaces)
- Implemented a real-time safe distributed Autonomy and Motion Control architecture for robots to leverage multiple onboard computers
- Oversaw the integration of robot safety standards ISO 15066, ISO 10218, IEC 61598, ISO 13849, ANSI 12100, and ANSI R15.08

Georgia Tech Research Institute

Research Engineer | Robot Manipulation *December 2020 – June 2022*

- Led a robotics team to design a framework for automating space habitat electromechanical maintenance and repair tasks
- Created an affordance based keypoint perception-manipulation framework for classifying, grasping, and inserting electrical connectors
- Developed adaptive grasping algorithms for electrical cable sliding manipulation and a constrained multi-point A* for route planning

Laboratory for Intelligent Decision and Autonomous Robots (LIDAR)

Research Engineer | Design and Control of Legged Robots *May 2020 – June 2022*

- Developed optimal motion planning and control algorithms for the Cassie Biped, Digit Humanoid, MIT Mini Cheetah, and A1 Quadruped.
- Trajectory optimization for dynamic locomotion with Whole-Body Model Predictive Control under a navigation framework
- Implemented an Extended Kalman Filter for dynamic legged locomotion using proprioceptive sensor feedback
- Developed a tactile-sensor based gripper with a Transformer based grasping strategy for fruit sorting
- Designed a low weight and affordable dual arm upper body for locomotion and manipulation tasks

HRL Labs

Robotics Research Engineer/Scientist | Level 4 Autonomous Car, DARPA Off Road Autonomous Vehicle *May 2019 – July 2020*

- Built a software architecture that encompassed numerous vehicles, simulation environments, and test platforms
- Designed a custom sensor carriage with multiple cameras, radars, and LIDAR's to optimize vehicle perception for road scenarios
- Implemented optimal trajectory planning, Extended Kalman Filter state estimation, and PID controllers for autonomous driving in unstructured city environments
- Implemented a multi-layered SLAM algorithm for real time outdoor terrain traversability, roughness, and force/slip analysis
- Created an optimal off-road trajectory planner for a (10 ton) armored vehicle based on vehicle and terrain dynamics

AeroVironment

Embedded Systems Engineer | VTOL and Quadrotors *October 2018 – May 2019*

- Developed hardware, DO-178C flight software, and firmware for Mars Helicopter, VTOL, and Quadrotor platforms with gimbal tracking
- Created safety critical redundant CAN-bus, UART, and I2C communication for system bootup and message transfer between subsystems

Robotics and Biomedical Engineering Research Laboratory

Research Assistant | Multi-Legged Robot *January 2017 – October 2019*

- Designed compact, lightweight, and high torque back drivable gear transmission systems for dynamic motion
- Developed optimal, PID, and impedance controllers for an 18 Degree of Freedom legged robotic system

- Used Kalman Filters to reduce effects of sensor uncertainty and increase predictability of system measurements.

Systems Engineering and Research Laboratory (SERL)

Research Engineer | Software Manager | Multi-Drone Human Machine Teaming *October 2016 – May 2018*

- Designed low-cost Quadrotor UAV's capable of flying for thirty minutes to navigate and survey building windows
- VTOL, Octorotor, Quadrotor, and wheeled autonomous navigation and control in a scaled search and rescue environment
- Tuned PID controllers with MATLAB, analyzed error response, and localization error accumulation
- Collaborated with C.E.M.P Search & Rescue and US Air Force to design and conduct experiments that examined human-robot teamwork

Human Automation and Teaming Solutions (HATS)

Mechatronics Engineer | VTOL, Tricopters, and Quadrotors *February – October 2016*

- Wrote motor and flight controllers for stable flight in different weather conditions
- Developed autonomous Unmanned Aerial Vehicles (UAV) waypoint navigation planners with the PX4 software stack

Publications

- **Nathan B.**, Christopher L., William F., Benjamin B., Stephen B., "A Unified Robot Framework for Task Planning with Category based Symbol Grounding." *IEEE Robotics and Automation Letters, 2022*
- Yunhai H., **Nathan B.**, Rahul B., Tuo Z., Yu S., Seth H., Ye Z. "Learning Generalizable Vision-Tactile Robotic Grasping Strategy for Deformable Objects via Transformer." *IEEE Robotics and Automation Letters, 2022*
- Ziyi Z.*, Bruce W.*, **Nathan B.**, Seth H., Ye Z. "Momentum-Aware Trajectory Optimization and Control for Agile Quadrupedal Locomotion." *IEEE Robotics and Automation Letters, 2022*
- Zhaoyuan G.*, **Nathan B.***, "Reactive Locomotion Decision-Making and Robust Motion Planning for Real-Time Perturbation Recovery," *International Conference of Robotics and Automation (ICRA)*, 2022; Philadelphia, US
- Ziyi Z., **Nathan B.**, Vishwa R., Max A., Ye Z., "Agile Locomotion and Backflip Demonstrations on Mini Cheetah." *American Control Conference (ACC)*, 2022
- Yunhai H., **Nathan B.**, Xinpei N., Ye Z., "Multi-Robot Collaboration with Heterogeneous Capabilities." *American Control Conference (ACC)*, 2022
- Hongwu Z., Dong W., **Nathan B.**, et al. "Terrain-Perception-Free Quadrupedal Spinning Locomotion on Versatile Terrains: Modeling, Analysis, and Experimental Validation." *Frontiers in Robotics and AI*, vol. 8, 2021
- Gabrael L., **Nathan B.,** "Blackbird: Design and Control of a Low-Cost Compliant Bipedal Robot," *International Conference of Robotics and Automation (ICRA)*, 2020 May; Paris, FR
- **Nathan B.**, Holland M., Amiel H., "Development of a Multi-Legged Walking Robot for Unstructured Terrain," *International Mechanical Engineering Congress & Exposition (IMECE)*; 2019, Salt Lake City, UT.
- Michael C., **Nathan B.**, Gilbert R., "Design of a Deformable Smart Tire using Soft Actuators," *International Mechanical Engineering Congress & Exposition (IMECE)*; 2019, Salt Lake City, UT.
- **Nathan B.**, Sergio A., Michael C., Vidya N. "Vector Field Histogram Obstacle Avoidance in Autonomous Vehicles with Front Wheel Steering," *29th Annual HENAAC Conference*; 2017; Pasadena, CA.