

Quade Butler

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Education

Doctor of Philosophy in Mechanical Engineering

Dec 2025

McMaster University

Ontario Graduate Scholar, 2023 - 2024

Thesis: *Double Exponential Cubature Kalman Filtering: Theory and Applications*

Supervisor: *Dr. S. Andrew Gadsden*

GPA: 4.00/4.00

Bachelor of Engineering in Mechanical Engineering

2020

University of Guelph

Minor in Mathematics

GPA: 3.80/4.00

Experience

Research Assistant

Jan 2026 – Present

ICE Lab | McMaster University

Hamilton, ON

- Advanced doctoral research on nonlinear Bayesian state estimation by refining double exponential cubature methods for Gaussian-weighted integration and probabilistic estimation
- Developed robust filtering algorithms for nonlinear dynamic systems with measurement outliers, improving estimator accuracy, consistency, and numerical stability

PhD Researcher

Jan 2021 – Dec 2025

ICE Lab | McMaster University

Hamilton, ON

- Developed double exponential cubature for multivariate Gaussian-weighted integration, deriving deterministic cubature rules for probabilistic estimation in nonlinear dynamic systems
- Introduced the Double Exponential Cubature Kalman Filter (DECKF) extending the cubature method into a recursive Bayesian state estimator and benchmarking it against UKF, CKF, and Gauss-Hermite filtering baselines
- Developed and evaluated robust nonlinear filtering methods for state estimation under outliers and model uncertainty using Monte Carlo simulation, RMSE, NEES/NIS, and statistical consistency testing
- Built an interacting multiple model fault detection and operating regime classification workflow for nonlinear time-series data, achieving 99.2% accuracy and 99.1% macro-F1 across induced operating regimes

ICE Lab | Research collaboration with Ford Motor Company

Livonia, MI

- Collaborated with Ford and university research teams on a production-feasible condition monitoring strategy for machine tool health monitoring and maintenance planning
- Designed an industrial machine tool monitoring framework by balancing diagnostic value, sensor constraints, deployment cost, and production feasibility
- Built Python pipelines for profiling, cleaning, synchronizing, and feature engineering noisy industrial datasets, reducing measurement and analysis time by 30x through workflow redesign and degradation modeling

Undergraduate Researcher

University of Guelph

May 2019 – May 2020

Guelph, ON

- Studied strain partitioning in advanced high-strength automotive steels using in-situ SEM tensile testing and micro digital image correlation
- Prepared specimens, processed SEM image sequences, optimized DIC parameters, and contributed to peer-reviewed publication in Materials Characterization

Publications

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|------|---|-----------|
| 2025 | Gaussian Filtering Using a Spherical-Radial Double Exponential Cubature,
Q. Butler, Y. Ziada, S. A. Gadsden | IEEE OJSP |
| 2024 | Strain partitioning characterization of advanced high strength steels using in-situ tensile tests with Micro digital image correlation – Methodology and analysis,
A. Bardelcik, Q. Butler | Materials |
| 2023 | Preload Loss Detection in a Ball Screw System using Interacting Models,
B. S. Sicard, Q. Butler, Y. Ziada, E. Hughey, S. A. Gadsden | IEEE OJIM |
| 2022 | Condition Monitoring of Machine Tool Feed Drives: A Review,
Q. Butler, Y. Ziada, D. Stephenson, S. A. Gadsden | ASME JMSE |

Conferences

- | | | |
|------|--|--------------------------|
| 2025 | System identification and state estimation for magnetorheological dampers,
P. Kosierb, Y. Wu, Q. Butler, B. Sicard, S. A. Gadsden | SPIE Signal Proc. XXXIV |
| 2025 | Friction Modeling and Monitoring for Machine Tool Health Management,
B. Sicard, Y. Wu, Q. Butler, S. A. Gadsden | IEEE PHM |
| 2024 | Generating synthetic data for artificial intelligence solutions via a digital twin for condition monitoring in machine tools, B. Sicard, Q. Butler, Y. Wu, S. Abdolahi, Y. Ziada S. A. Gadsden | SPIE AI & ML II |
| 2024 | Nonlinear Filtering Using the Double Exponential Transformation,
Q. Butler, B. Sicard, W. Hilal, S. A. Gadsden, Y. Ziada | SPIE Signal Proc. XXXIII |
| 2023 | Design Considerations for Building an IoT Enabled Digital Twin Machine Tool Sub-System, B. Sicard, Q. Butler, P. Kosierb, Y. Wu, Y. Ziada, S. A. Gadsden | IEEE AIBThings |
| 2023 | ILODT: Industrial Internet of Digital Twins for Hierarchical Asset Management in Manufacturing Sub-System, B. Sicard, Q. Butler, P. Kosierb, Y. Wu, Y. Ziada, S. A. Gadsden | IEEE AIBThings |
| 2023 | Generalizing the Unscented Kalman Filter for State Estimation,
Q. Butler, W. Hilal, B. Sicard, Y. Ziada, S. A. Gadsden | SPIE Signal Proc. XXXII |
| 2023 | Cognitive dynamic digital twin: enhancements for digital twin platforms based on human cognition, B. Sicard, Q. Butler, Y. Ziada, S. A. Gadsden | SPIE Big Data V |
| 2023 | Experimental Setups for Linear Feed Drive Predictive Maintenance: A Review,
B. Sicard, Q. Butler, Y. Ziada, S. A. Gadsden | IEEE PHM |
| 2022 | Rapid Parameter Estimation and Monitoring of CNC Feed Drive Systems,
Q. Butler, B. Sicard, E. Hughey, Y. Ziada, D. Stephenson, S. A. Gadsden | SPIE Signal Proc. XXXI |

Teaching Assistantships

- 2024 **Mechanical Vibrations**, McMaster University
- 2024 **Engineering Design**, McMaster University
- 2022 **Mechatronics**, McMaster University
- 2022 **Engineering Measurements**, McMaster University
- 2020, 2021 **Differential Equations**, University of Guelph

Academic Services

- 2025 **Reviewer**, ASME Journal of Tribology