College of Engineering and Computer Science
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Announces the Ph.D. Dissertation Defense of

Matthew Acs

for the degree of Doctor of Philosophy (Ph.D.)

Reinforcement Learning for Robotic Manipulation with Sparse Rewards, Demonstrations, and Long-Horizon Task Structures

Monday, November 2, 2026, 1:00–3:00 p.m.
Engineering East, 405
777 Glades Road
Boca Raton, FL

DEPARTMENT:
Electrical Engineering and Computer Science

ADVISOR:
Dr. Xiangnan Zhong

PH.D. SUPERVISORY COMMITTEE:
Dr. Michael DeGiorgio
Dr. Mahsa Ranji
Dr. Yufei Tang

LINK TO DISSERTATION DRAFT:
https://drive.google.com/file/d/1aTvzN7JTG_dPCVHf-9vY3bgSJPOAW-g3

ABSTRACT OF DISSERTATION
Reinforcement learning offers a promising framework for robotic manipulation, but practical robotic tasks often involve sparse rewards, high-dimensional observations, limited demonstrations, and long-horizon structure. These challenges are especially difficult in surgical robotics and multi-step manipulation, where successful behavior depends on precise perception, effective use of demonstration data, and correct sequencing across task phases.

This dissertation investigates reinforcement learning for robotic manipulation under sparse rewards, demonstrations, and long-horizon task structure. First, it evaluates visual demonstration learning for surgical robotic reaching using image-based observations. The results show that behavior cloning and TD3+BC learn strong reaching policies from visual demonstrations, while online reinforcement learning struggles under sparse rewards.

Second, this dissertation examines the broader landscape of long-horizon reinforcement learning for robotic manipulation through a scoping review. The review identifies major trends in task domains, observation spaces, algorithmic components, and evaluation practices, while highlighting gaps in horizon definition, reproducibility, and standardized reporting.

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Finally, the dissertation introduces algorithmic frameworks for improving long-horizon manipulation learning. Reward-Aligned Expert Sequencing decomposes a block-stacking task into semantically meaningful sequential reward-paired phases, improving performance relative to standard model-free baselines under identical training budgets. Equivalent-State Q-Learning addresses mixed-quality demonstrations by linking recoverable states in failed or partial trajectories to equivalent states in successful demonstrations, allowing imperfect data to provide useful learning signals.

Together, these studies show that robotic reinforcement learning can benefit from explicitly exploiting structure in visual observations, demonstrations, rewards, and task progression. The dissertation contributes empirical evidence on visual demonstration learning in surgical robotics, a scoping review of long-horizon reinforcement learning for robotic manipulation, and algorithmic frameworks for learning under sparse rewards and imperfect demonstrations.

BIOGRAPHICAL SKETCH

Matthew Acs is a Ph.D. candidate in Computer Science at Florida Atlantic University, where he previously earned his B.S. in Computer Science and M.S. in Artificial Intelligence. His doctoral research focuses on reinforcement learning for robotic manipulation, with an emphasis on surgical robotics and long-horizon manipulation. His research has resulted in four peer-reviewed papers spanning robotic control, surgical robotics, and reinforcement learning. He currently works as a Research Scientist at PeritasAI.

CONCERNING PERIOD OF PREPARATION
& QUALIFYING EXAMINATION

Time in Preparation: Spring 2024 - Fall 2026

Qualifying Examination Passed: 3/29/2024

Publications and Accepted Papers:

1. M. Acs and X. Zhong, “Assessing behavior cloning with RGB inputs in surgical robotics through dataset ablation,” Advanced Robotics, vol. 39, no. 13, pp. 817– 828, 2025. [Online]. Available: https://doi.org/10.1080/01691864.2025.2532606
2. M. Acs and X. Zhong, “RAES: a reward-aligned expert sequencing framework for long-horizon robotics,” International Journal of Intelligent Robotics and Applications, 2026. [Online]. Available: https://doi.org/10.1007/s41315-026-00524-z
3. M. Acs and X. Zhong, “A scoping review of reinforcement learning methods for long horizon robotic manipulation,” Discover Robotics, vol. 2, no. 1, p. 22, Jul. 2026. [Online]. Available: https://doi.org/10.1007/s44430-026-00037-1
4. M. Acs and X. Zhong, “Equivalent-State Q-Learning: Non-Local Credit Assignment for mixed-quality robotic demonstrations,” in Proceedings of the 38th IEEE International Conference on Tools with Artificial Intelligence (ICTAI), Boca Raton, FL, USA, Nov. 2026, accepted as a full paper.