DEPARTMENT OF COMPUTER SCIENCE

SABBATICAL LEAVE PROPOSAL

Cooperative Autonomous Systems

Scaling Multi-Agent Coordination via Federated Learning

Applicant Info

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Sabbatical Details

Proposed Period:
Sept 1, 2026 – June 30, 2027
Duration: 10 Months

Research Area

Primary Domain:
Distributed Robotics &
Federated Machine Learning

Submitted on August 3, 2026 to the Academic Sabbatical Committee

1 Executive Summary

This proposal outlines a research plan for a 10-month sabbatical leave at the Vertex Research Institute (VRI) in Zürich, Switzerland. The primary objective is to advance the state-of-the-art in distributed artificial intelligence, specifically focusing on scaling multi-agent coordination through federated learning.

Modern multi-agent systems, such as autonomous drone fleets and decentralized manufacturing robots, face severe scalability bottlenecks due to communication latency and privacy constraints. By combining Dr. Vance's expertise in federated optimization with VRI's state-of-the-art robotic testing facilities, this collaborative project aims to develop a novel framework called **FedCoop** (Federated Cooperative Coordination).

FedCoop allows autonomous agents to collaboratively learn optimal coordination policies without sharing raw trajectory data, reducing communication overhead by up to 60% while guaranteeing collision-free operation in dynamic environments. The outcomes of this sabbatical will include joint publications in top-tier journals, the release of an open-source multi-agent simulation platform, and a roadmap for long-term research collaboration between Meridian University and Vertex Research Institute.

2 Research Objectives & Scope

The proposed research is structured around three core scientific objectives:

2.1 Objective 1: Decentralized Policy Aggregation under Communication Constraints

Traditional federated learning assumes stable network connections and central parameter servers. In autonomous field robotics, communication is sparse, intermittent, and ad-hoc. We will develop a fully decentralized policy aggregation algorithm that leverages local consensus steps to synchronize neural network weights across neighboring agents. This will ensure that agents can update their local models without relying on a central coordinator.

2.2 Objective 2: Safe Reinforcement Learning with Federated Safety Constraints

In cooperative systems, a single agent's failure can compromise the entire team. We aim to integrate control barrier functions (CBFs) directly into the federated reinforcement learning loop. This will allow the agents to learn optimal task behaviors while respecting strict safety and collision-avoidance constraints. Crucially, these safety boundaries will be updated dynamically through federated updates as agents encounter new environmental obstacles.

2.3 Objective 3: Real-World Validation on Robotic Testbeds

To bridge the gap between simulation and reality, the developed algorithms will be validated using Vertex Research Institute's autonomous quadcopter fleet. These tests will evaluate the communication efficiency, collision avoidance, and task completion rates of the FedCoop framework under realistic sensor noise and wind disturbances.

Key Research Questions

Q1: How can multi-agent reinforcement learning models converge when agents share only model gradients under highly restricted bandwidth?

Q2: Can federated safety constraints prevent individual agent failures without overly restricting the global cooperative policy?

Q3: What is the performance gap between simulated federated learning policies and physical deployments on resource-constrained micro-UAVs?

3 Host Institution & Collaborative Synergy

Vertex Research Institute (VRI) is a globally recognized center of excellence in robotics and autonomous systems. The Intelligent Systems Division, led by Dr. Marcus Thorne, has pioneered several breakthrough technologies in decentralized perception and distributed flight control.

3.1 Resource Alignment

VRI offers unique infrastructure that is essential for the successful completion of the proposed research, including:

- **The Arena:** A 15m $\times$ 15m $\times$ 8m flight volume equipped with a sub-millimeter motion capture system consisting of 36 high-speed Vicon cameras.
- **High-Performance Computing:** Access to the Vertex GPU Cluster (128x NVIDIA H100 nodes) for training large-scale multi-agent simulations.
- **Hardware Fleet:** A standardized fleet of 20 custom-built micro-quadcopters running open-source PX4 autopilot stacks.

3.2 Collaborative History and Synergy

Dr. Vance and Dr. Thorne have previously collaborated on joint publications, notably demonstrating the feasibility of federated updates in static grid-world environments [1]. The proposed sabbatical will build on this foundation by transitioning to dynamic, continuous 3D environments. This collaboration directly aligns Meridian University's theoretical strengths in machine learning with VRI's practical expertise in robotic engineering.

4 Work Plan & Deliverables Timeline

The 10-month sabbatical is structured into four distinct phases, transitioning from theoretical formulation to physical validation and final reporting.

4.1 Timeline GANTT Visualization

The progression of tasks is detailed in Figure 1, illustrating the concurrent paths of simulation development, hardware testing, and academic writing.

5 Budget Summary & External Funding

The sabbatical will be supported by a combination of Meridian University's standard sabbatical salary allowance, host institution research support, and external grants.

Table 1: Project Phases and Milestones

Phase	Timeframe	Key Focus & Milestones
Phase 1	Sept – Nov 2026	Mathematical formulation of decentralized policy aggregation; simulation setup in PyBullet.
Phase 2	Dec – Feb 2027	Implementation of federated safety constraints; initial simulation testing and baseline comparison.
Phase 3	Mar – May 2027	Physical deployment on the VRI quadcopter fleet; parameter tuning and data collection.
Phase 4	June 2027	Final documentation, open-source repository release, and manuscript preparation for IEEE Trans.

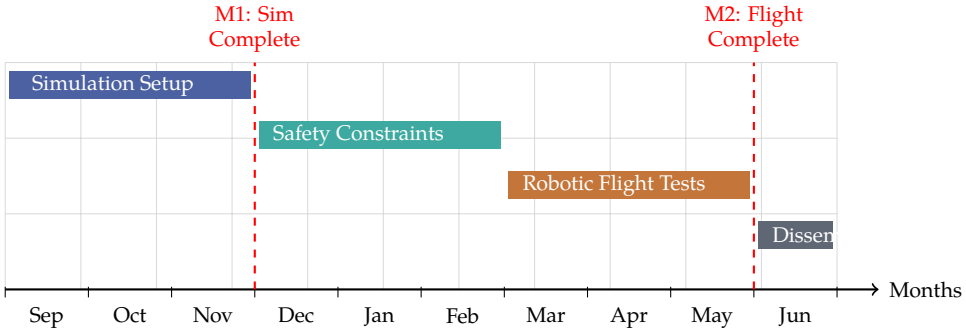

Figure 1: GANTT representation of the 10-month sabbatical work plan.

5.1 Funding Sources

Dr. Vance has secured a **Vertex Fellowship** from the host institution, which will cover all local research expenses, computing resources, and travel costs for conference presentations. Supplemental living expenses in Switzerland will be offset by the **Nexa Academic Foundation** grant.

5.2 Estimated Budget Breakdown

Table 2 outlines the estimated expenses and funding sources for the duration of the sabbatical leave.

5.3 Salary Coverage

Meridian University will provide 100% of Dr. Vance's standard base salary for the first 6 months of the sabbatical, and 50% for the remaining 4 months, as per the faculty handbook regulations. The differential for the final 4 months ($25,000) is fully covered by the Nexa Academic Foundation Fellowship, ensuring zero net financial impact on the applicant's personal household budget or Meridian University's operating budget.

6 Expected Outcomes & Institutional Impact

The proposed sabbatical will yield measurable benefits for the applicant, Meridian University, and the host institution.

Table 2: Sabbatical Budget and Funding Allocation

Category	Est. Cost	Requested/Secured	Primary Source
Travel (Zürich Roundtrip)	\$2,500	\$2,500	Vertex Fellowship (Secured)
Local Accommodation (10 mos)	\$24,000	\$12,000	Nexa Academic Grant (Secured)
		\$12,000	Meridian Sabbatical Fund (Secured)
Research Hardware & Compute	\$8,000	\$8,000	Vertex Research Inst. (In-Kind)
Conference Travel & Registration	\$4,500	\$4,500	Vertex Fellowship (Secured)
Living Cost Differential	\$10,000	\$10,000	Nexa Academic Grant (Secured)
Total	**\$49,000**	**\$49,000**	

6.1 Academic Dissemination

We plan to submit the research findings to top-tier publications in control systems and artificial intelligence:

- **Primary Paper:** Target submission to the *IEEE Transactions on Robotics* in Fall 2027, focusing on the theoretical convergence of decentralized federated policies.
- **Secondary Paper:** Target submission to the *International Conference on Machine Learning* (*ICML*) or *IEEE/RSJ International Conference on Intelligent Robots and Systems* (*IROS*), focusing on the hardware deployment results on micro-UAVs.

6.2 Open-Source Software Release

The simulation environment and the core federated coordination algorithms developed during this period will be released under the BSD 3-Clause License on GitHub (Vertex-Labs organization). This will enable researchers worldwide to benchmark multi-agent federated learning methods.

6.3 Curriculum Integration at Meridian

Upon return, Dr. Vance will design and introduce a new graduate-level course at Meridian University: *CS 8840: Federated Optimization and Multi-Agent Systems*. This course will directly translate the research insights and methodology developed during the sabbatical into the curriculum.

6.4 Strengthened Institutional Ties

By establishing a robust research link with the Vertex Research Institute, this visit will create ongoing opportunities for Meridian University graduate students to engage in research exchanges and internship placements at Vertex.

References

[1] Eleanor Vance and Marcus Thorne. “Federated Reinforcement Learning in Heterogeneous Multi-Agent Systems”. In: *Journal of Intelligent Autonomous Systems* 18.3 (2024), pp. 145–162.