

# Large Language Model-Based Control of Festo Fluid Process Systems



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- Research Overview
- Motivation
- Approach
- Current Status
- Results & Challenges

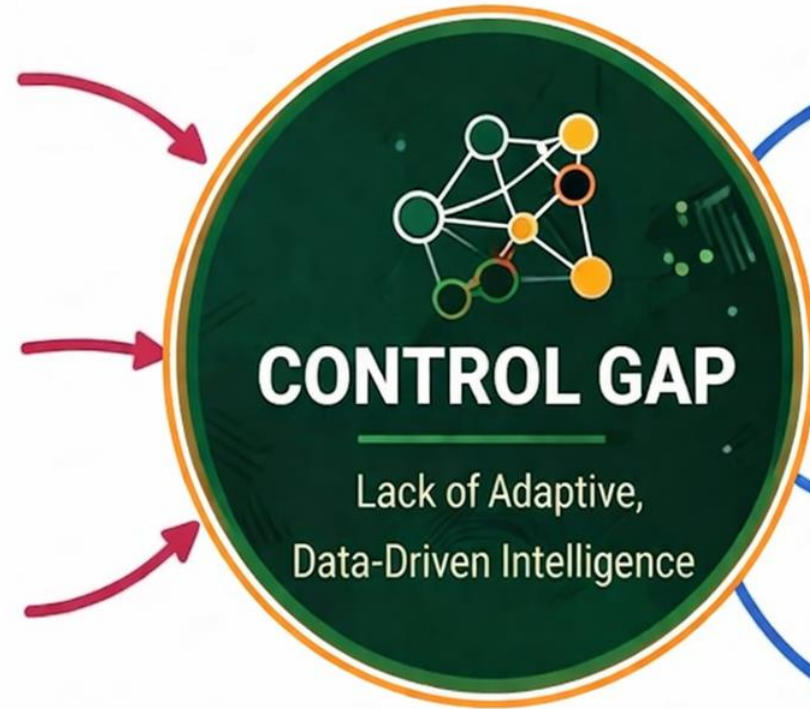


- **Can LLMs Enable Intelligent Control in Fluid Process Systems?**
- Working since: Sep 2025 (6 months)
- Expected completion: June 2026



## PROBLEM

-  **Rigid systems**
-  **Manual updates**
-  **No NL interface**



## WHY IT MATTERS

-  **Slow adaptation**  
Decreased efficiency over time
-  **Limited scalability**  
Constraints on system expansion
-  **LLMs unexplored**  
Untapped potential of language models
-  **No human-in-the-loop**  
Reduced accountability and control

## Human-in-the-Loop

Integrating natural language interaction

## Closed-Loop Control evaluation

Assessing system performance under feedback-driven control

## QLoRA Quantization

Reducing model size with 4-bit quantization

## Festo Data Simulation

Real-world physics data for accurate modeling

## Llama 3.2 Adaptation

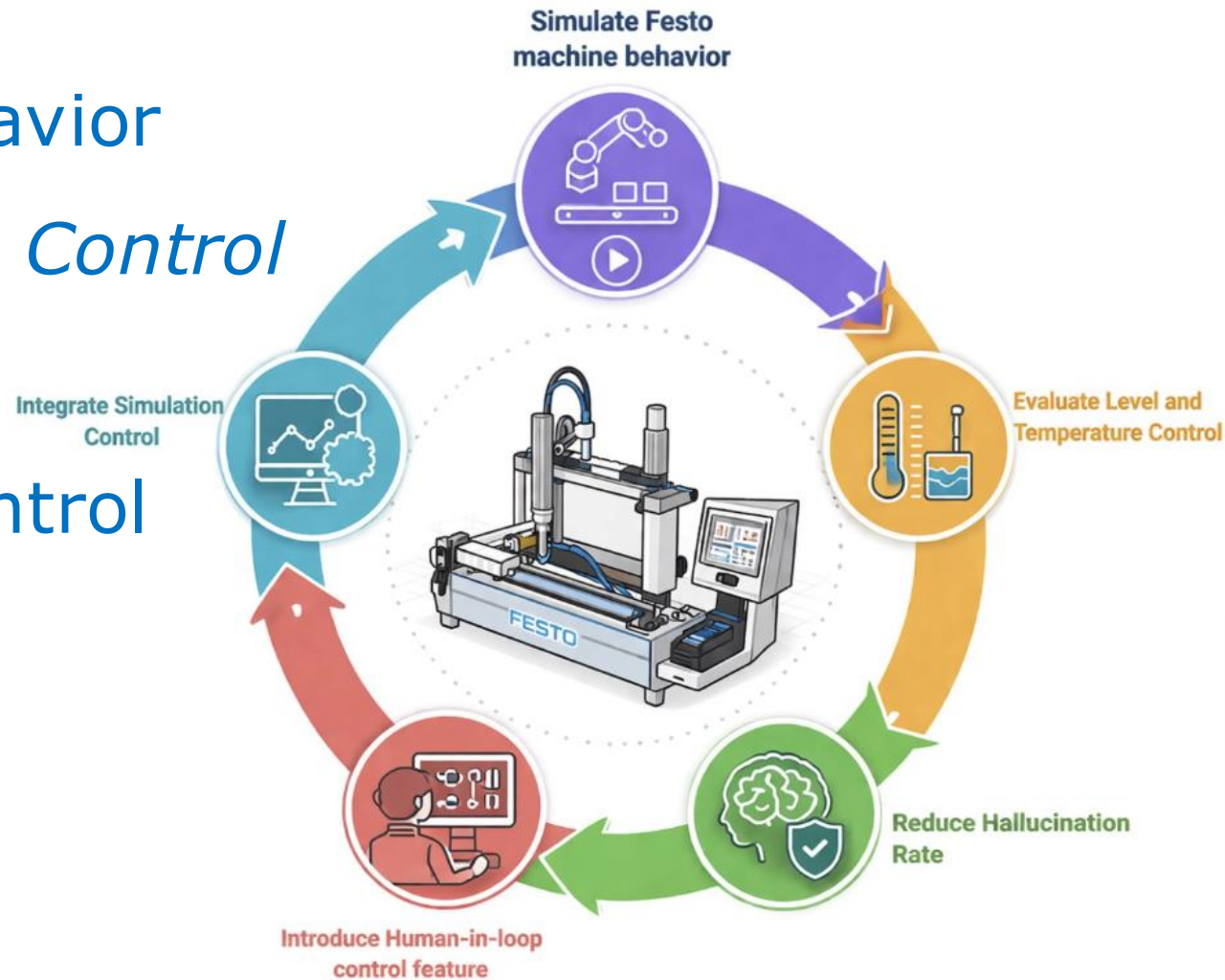
Domain-adapted LLM for control decisions

## LoRA Adaptation

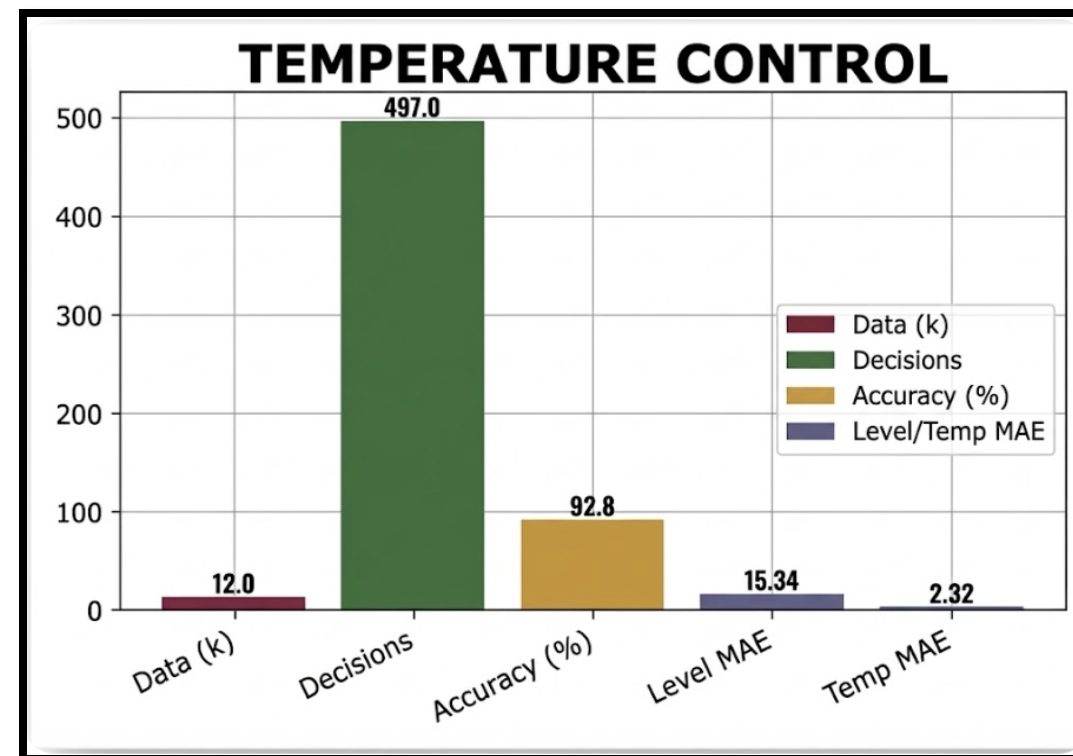
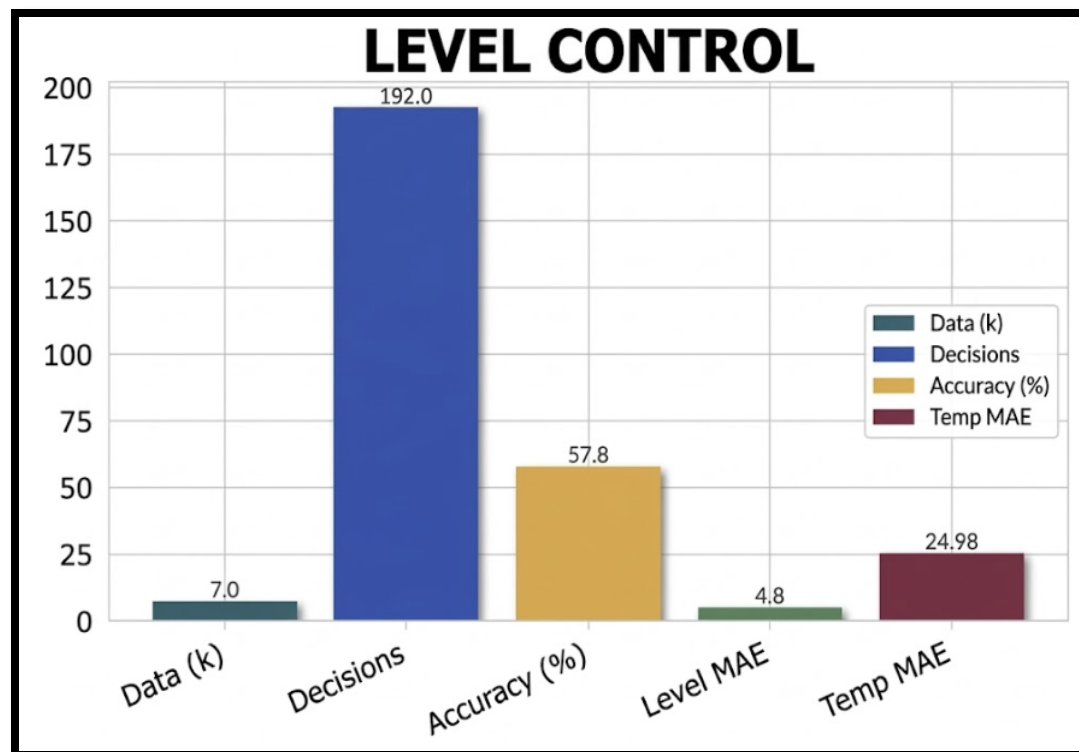
Efficiently adapting the model with low-rank matrices



- Simulate Festo machine behavior
- Evaluate *Level, Temperature Control*
- Reduce Hallucination Rate
- Introduce Human-in-loop control
- Integrate Simulation Control



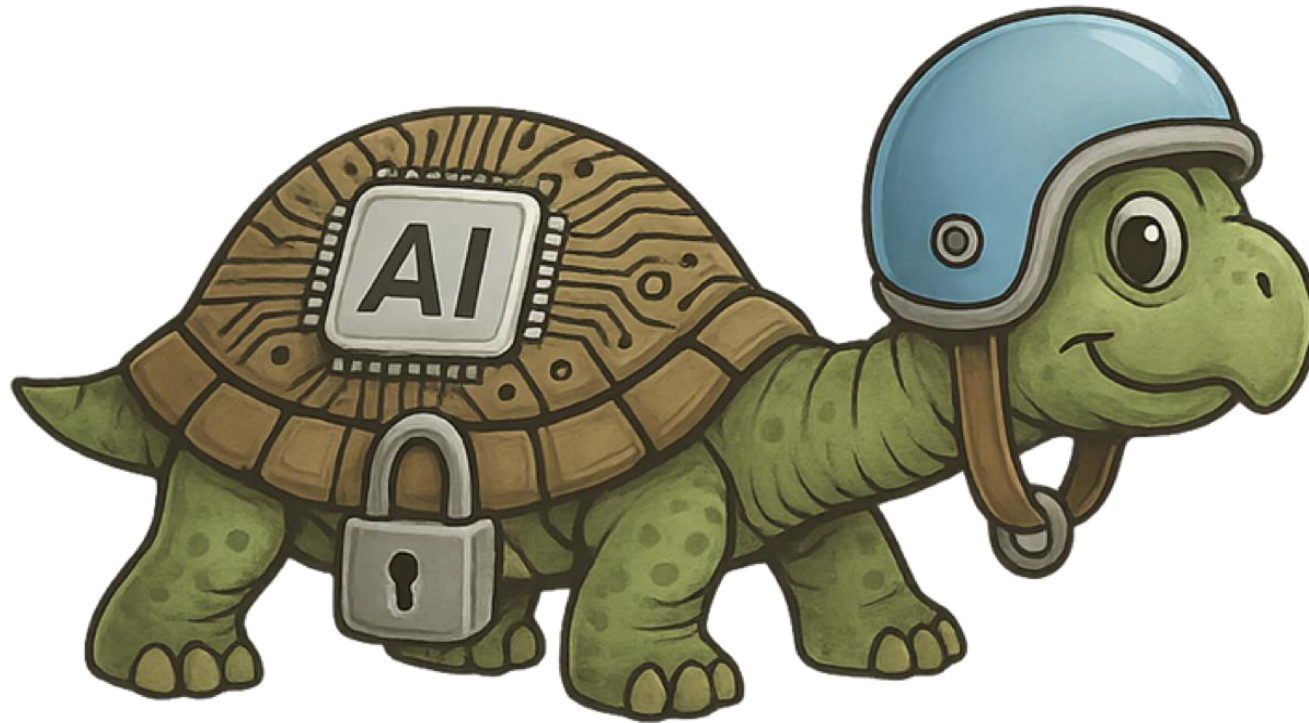
# Results & Challenges



## Challenges

- Addressing limited real-world data
- Bridging LLM control with lab systems

**THANK YOU**  
for your attention



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**“True speed is predictable, secure, and reliable execution”**



Let's Connect