2025-11-01

E021: Future Work and Roadmap

DIP-SMC-PSO Educational Series

January 25, 2026

Overview

This episode covers future work and roadmap from the DIP-SMC-PSO project.

Part: Part4 Professional

Duration: 15-20 minutes

Source: Comprehensive Presentation Materials

section0 Academic References

39 Academic Citations:

Foundational SMC Theory:

- Utkin (1977, 1992) – Original SMC formulation - Slotine & Li (1991) – Applied sliding modes - Edwards & Spurgeon (1998) – Robust control theory

Higher-Order SMC:

- Levant (1993, 2005) – Super-Twisting algorithm - Moreno & Osorio (2008) – Homogeneous finite-time convergence

Adaptive SMC:

- Slotine & Coetsee (1986) – Adaptive sliding mode control - Plestan et al. (2010) – New methodologies

PSO Optimization:

- Kennedy & Eberhart (1995) – Original PSO paper - Shi & Eberhart (1998) – Inertia weight modification - Clerc & Kennedy (2002) – Constriction factor

section0 Software Libraries (30+ Dependencies)

Core Scientific Computing:

- **NumPy** (1.21+) – Array operations, linear algebra - **SciPy** (1.7+) – ODE integration (RK45), optimization - **Matplotlib** (3.4+) – Visualization, publication plots

Performance & Optimization:

- **Numba** (0.54+) – JIT compilation, vectorization - **PySwarms** (1.3+) – PSO implementation - **Optuna** (2.10+) – Alternative optimization (planned)

Validation & Configuration:

- **Pydantic** (1.8+) – Config validation, type checking - **pytest** (6.2+) – Testing framework - **pytest-benchmark** (3.4+) – Performance benchmarks - **Hypothesis** (6.14+) – Property-based testing

UI & Web:

- **Streamlit** (1.10+) – Interactive dashboard - **Plotly** (5.3+) – Interactive charts

section0 Design Patterns & Architectural Influences

Software Engineering Patterns:

- **Factory Pattern**
- ‘create_controller()‘ abstraction - Polymorphic controller instantiation
- **Strategy Pattern**
- Interchangeable control algorithms - Common interface (‘compute_control()‘)
- **Observer Pattern**
- Real-time monitoring callbacks - Event-driven latency tracking
- **Singleton Pattern**
- Configuration loader (single instance) - Logging infrastructure
- **Repository Pattern**
- PSO results database abstraction - SQLite persistence layer

section0 Open-Source Community Contributions

Giving Back:

Documentation Contributions:

- Comprehensive SMC tutorials (open access) - Beginner roadmap (125-150 hours curriculum) - NotebookLM podcast methodology

Code Examples:

- 100+ runnable code snippets - Complete controller implementations - PSO tuning scripts

Infrastructure Templates:

- Multi-agent orchestration system - Checkpoint-based recovery workflow - MCP server integration patterns

GitHub: https://github.com/theSadeQ/dip-smc-pso.git

Resources

- **Repository:** `https://github.com/theSadeQ/dip-smc-pso.git`
- **Documentation:** See `docs/` directory
- **Getting Started:** `docs/guides/getting-started.md`

Educational podcast episode generated from comprehensive presentation materials