Advanced Model Predictive Control for Energy-Efficient Thermal Management in Intelligent Electric Refrigerated Vans

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Abstract—**Traditional Model Predictive Control (MPC) is known for its robust decision making and precision in control. However, for systems with high inertia requiring longer prediction horizons like temperature control in intelligent electric re-frigerated vans, it suffers from heavy computational loads. To address this, a Hierarchical MPC (H-MPC) framework is proposed for the thermal management system of intelligent refrigerated vans. This approach combines a planning layer for long-term pre-dictions and an operating layer for short-term adjustments, utilizing different sampling times and prediction horizons to improve the cooling performance and computational efficiency. Simulation results demonstrate that the proposed H-MPC re-duces computational time by up to 90% compared to traditional MPC while maintaining similar energy consumption and achieving up to 10% energy savings in some scenarios. These results highlight the real-time applicability of H-MPC in the refrigerated transport industry.**

Keyword—**refrigerated transport, temperature control unit, thermal management, optimisation, model predictive control**

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