Researchers realize continuous-control-set model-free predictive control for synchronous motors

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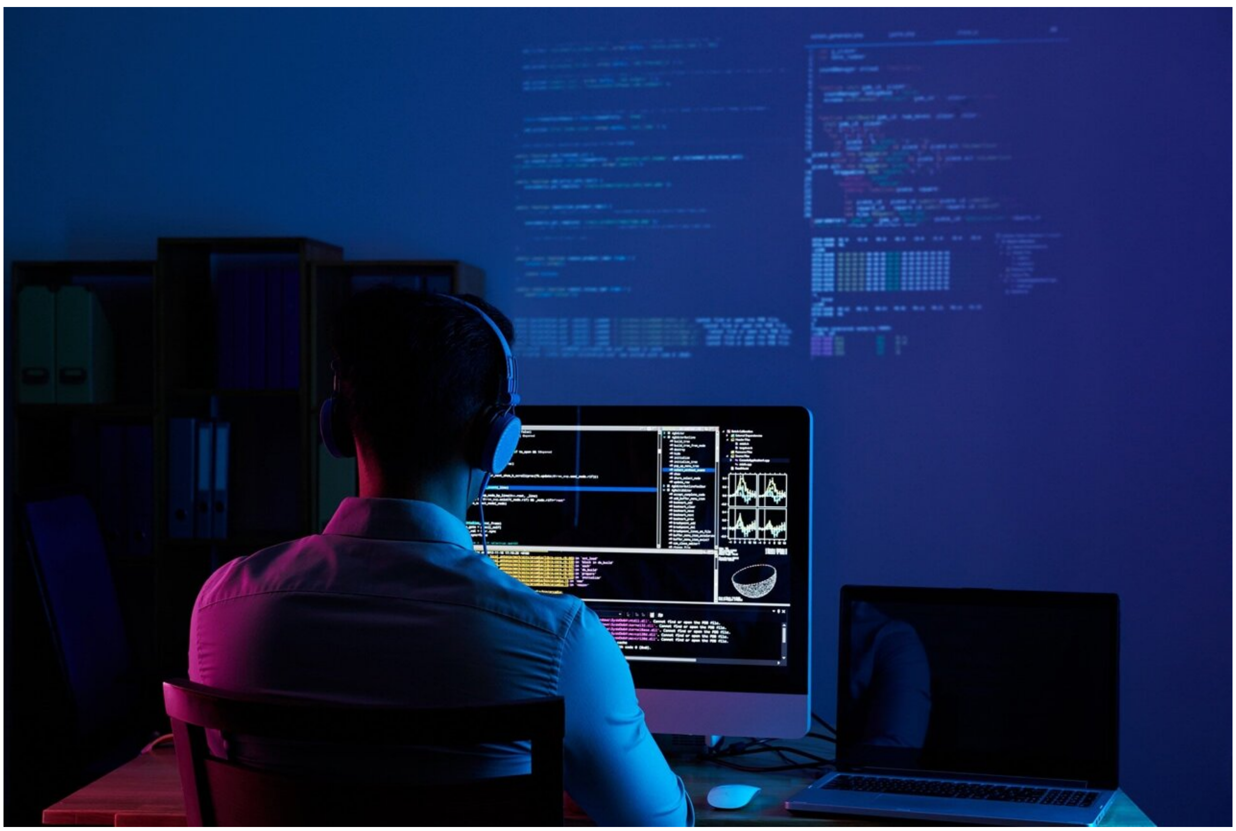

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Permanent magnet synchronous motors (PMSMs) are widely used in high-end equipment manufacturing, and model-free predictive control

(MFPC) is applied to essentially enhance robustness.

However, the MFPC strategy based on ultra-local cannot fully meet the requirements due to limited model accuracy and objective quality. Adjusting the data-driven model structure to improve model accuracy and implementing it under continuous-control-set (CCS) condition is an effective way to meet harsh requirements.

In a study published in *IEEE Transactions on Industrial Electronics*, Prof. Wang Fengxiang's group from the Fujian Institute of Research on the Structure of Matter of the Chinese Academy of Sciences has designed a novel MFPC strategy using time-series subspace in a PMSM driving system.

This strategy avoids the difficulty of matrix inverting and partial derivative calculations under CCS condition, addressing the issue of hard realization of the time-series subspace model, and achieving better model and control accuracies.

The researchers adjusted the input and output signals and designed a time-series subspace model in MFPC with a group of discrete-time transfer functions in reverse to clarify the meaning of signals.

They adopted a recursive least-squares algorithm to online estimate the coefficients in the model within each sampling period and maintain the accuracy of the model. Due to the small-enough sampling period, a time-shift consideration was applied to generate the future output signal, where the future input signal is replaced by its future reference tuned by the Lagrange algorithm since it wishes to reach the reference value at the next sampling period.

Furthermore, the researcher analyzed the locations of system poles and zeros to determine the stability under the conditions of parameter mismatches. The poles' locations for the model-based predictive control (MBPC) had obvious moving distances toward to the imaginary axis, and some conjugate poles entered into the unstable range if the mismatch degree increased continuously. Compared to MBPC, the poles from the proposed method had almost the same location with enough gains, which is not affected by parameter mismatches.

Experimental results indicated that, compared to the conventional MFPC based on ultra-local under the same operating conditions, the proposed method obtains improved current sine degree, model quality, and system noises, and the robustness is effectively enhanced.

More information: Fengxiang Wang et al, Continuous-Control-Set Model-Free Predictive Control Using Time-Series Subspace for PMSM Drives, *IEEE Transactions on Industrial Electronics* (2023). DOI: 10.1109/TIE.2023.3310017

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