TITRE DE LA THESE:

PHYSICS-AIDED MACHINE LEARNING FOR EFFICIENT AND ROBUST DYNAMIC MODELLING AND CONTROL

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Laboratoire(s) : LS2N & DTU[1]

Equipe(s) de recherche : CODEx & DTU's AUT group[2]

Département(s) IMT Atlantique : DAPI

S'agit-il d'une thèse en cotutelle internationale ?
Oui
Si oui, organisme avec lequel la cotutelle est envisagée : Technical University of Denmark

Le sujet proposé présente-il un caractère interdisciplinaire ?
Oui et non : *Automatique* et *Machine Learning* se recoupent dans des domaines comme le contrôle intelligent et la robotique, souvent avec la collaboration de spécialistes en automatique et en neurosciences computationnelles.

La source du co-financement est-elle identifiée ?
Oui
Si oui, préciser quel co-financement est envisagé : financement via nos homologues à **DTU's AUT group**.

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[1] https://www.dtu.dk/english/education/phd/intro/organization
[2] https://electro.dtu.dk/research/research-areas/electro-technology/automation-og-control

Contexte ou état de l'art scientifique :

Data-driven dynamic model learning and control are essential for autonomous robotic systems, especially those operating in constrained environments. However, despite the advancements in Nonlinear Control such as Nonlinear Model Predictive Control (NMPC) and Sliding Mode Control (SMC), effective control design for general nonlinear systems learned from data remains an open problem [1-3].

Control-oriented learning aims to unveil dynamic models and additional information [4-10], such as state physics meaning, control structure, Lyapunov stability parametric certificates, and achievable closed-loop performances, from data. This enables synthesis or reveals stabilizing control laws [11]. Initial attempts involve constrained learning processes with or without enforced parameterizations [12].

Objectifs de la thèse :
Décrire en 10 à 15 lignes les résultats attendus.

The thesis aims to explore a data-driven approach leading to a non-linear model with an appropriate incremental form improving the performance and robustness of a predictive or sliding mode adaptive model control strategy.

The tangible outcomes of this research project will include the development of a robust framework for the efficient data-driven modelling of dynamical systems. This framework, characterized by its physics-informed nature and interpretability, will provide valuable insights into the behaviours of complex systems. Complementing this, an algorithm for obtaining parametrizable data-driven equivalents of physical automation systems is anticipated. These equivalents, designed for real-time implementation, are poised to significantly enhance the performance of automation systems. Furthermore, the research aims to produce a practical framework for the easy commissioning of industrial robots. By simplifying and expediting the integration process, this framework addresses a crucial aspect of industrial automation, offering tools that contribute to the practical applicability of advanced control strategies in real-world scenarios.

WP1: Control-Oriented Physics-Informed Dynamic Model Learning through Data-Driven Methods
WP2: Simultaneous Model and Control Law Learning for Enhanced System Performance
WP3: Streamlining Autotuning: Learning-Based Efficient and Swift Commissioning

Compétences attendues du ou de la candidat·e :
Advanced control, Dynamic system modelling, Machine Learning
Autonomy, ability to work collaboratively and communicate with Franco-Danish research teams