Joint Projects

1. Robust and Safe Distributed Control of Multi-Agent Systems via Control-Informed Neural Networks

Date Posted	1st July 2024	
Home University	NTU Singapore	
Partner University	University of Groningen	
Supervisors	**Home**	**Partner**
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Project Description (200-300 words)	Physics-based models have been central to the design of complex high-tech systems such as renewable energy systems, autonomous vehicles, and autonomous robots. These models have facilitated rigorous design analysis, simulation, validation, and controller design to create high-precision, high-performance, and safety-critical systems. Due to the ever-increasing complexity and nonlinearities in autonomous systems, the development of accurate models for design optimization and controller design to guarantee safety and the desired systems performance entails a long and costly process. In recent years, the advances of Artificial Intelligence (AI) methods have shown their potential to analyze unstructured data, with minimal prior knowledge of the systems. However, these AI methods cannot be used for real-time control in complex high-tech systems due to the lack of physics-based insights, performance guarantees, and safety. In this project, we will develop generic analytical tools and control-design methods to integrate AI methods in the modelling and control of highly complex and nonlinear systems. The proposed methods will be based on the combination of classical control methods with recent physics-based AI models, namely physics-informed neural networks (PINN). We will study their mathematical topological properties that are suitable for control systems analysis and design, and investigate how they can be deployed safely and effectively in the modelling and control of ***multi-agent autonomous systems*** while providing theoretical and computational guarantees.	
Program/Center Website(s)	https://www.digital-twin-research.nl/ https://european-digital-innovation-hubs.ec.europa.eu/da/node/141	

Additional Information (e.g., files with project details)	See also the attached proposal file, where we will focus primarily on the activity for WP3 for the proposed joint work between NTU and University of Groningen. The proposal document is adapted based on projects that are currently studied at University of Groningen.

2. Design of High Performance Solid Catalysts for CO2 Conversion

Date Posted	5 Jul 2024	
Home University	Nanyang Technological University	
Partner University	University of Groningen	
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Project Description (200-300 words)	CO_2 hydrogenation using low-carbon hydrogen to liquid fuels/chemicals (Gas-to-Liquid) has become a promising route to achieve carbon circularity and neutrality. Due to the inertness of CO_2 molecule and multiple pathway for CO_2 conversion, designing active and selective catalysts is of paramount importance towards potential large-scale and tailored applications. Despite great efforts spent in the past decades, there are still substantial knowledge gap and challenges to be addressed to make the processes economically viable. The proposed PhD project will be focused on designing of high-performance CO_2 conversion catalysts for desired products and elucidation of reaction mechanism, combining isotope/reaction kinetics study and advanced characterization. NTU lab is well equipped with materials synthesis facilities including a flame synthesis system which can be used to synthesize a wide range of metal/ metal oxide active species highly dispersed on metal oxide supports. The partner lab at University of Groningen offers bench-scale reactor systems for kinetic and mechanistic study. The collaboration is expected to reveal detailed structure-activity correlations of the catalysts towards rationale design of high performance catalysts for CO_2 conversion.	
Program/Center Website(s)	N.A.	
Additional Information (e.g., files with project details)	NA	