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Post-doctoral position

Design of Lyapunov-stable neural-network-based controllers for nonlinear time-varying dynamical systems

(Reference WCSFT030)

Overall context:

Set up in the middle of the scientific campus of Rennes, the capital of Brittany, the French branch of Mitsubishi Electric R&D Centre Europe provides advanced R&D support to the Japanese R&D centres and to the business units of Mitsubishi Electric Corporation. Within the Communications and Information Systems division, our Wireless Communication Systems team focuses its research interests on wireless communications for factory automation, automotive, railway, satellite, and access network fields. We combine long-term research with applied research resulting in contributions in international standards and development of proprietary technologies for in-house products.

Description of the research project:

Learning algorithms have demonstrated significant control capabilities in simulations by enabling robots to adapt to unpredictable environments and enhance their performance. However, these algorithms are rarely applied in practice to safety-critical systems because the learned policies typically do not provide any safety guarantees. The use of such controllers could potentially cause physical harm to the robot or its environment. In this project, we aim to study the stability properties of nonlinear systems including neural-network-based controllers, and to develop a method to infer accurate safety certificates for nonlinear, closed-loop dynamical systems.

Objectives:

To tackle the problem of uncertified safety and unproven stability of learning-based control policies, the associate researcher shall propose a generic method to design neural-network-based Lyapunov functions for nonlinear time-varying dynamical systems allowing to prove their stability. Afterwards, the research framework shall be extended to synthesize Lyapunov-stable neural-network-based controllers by relying on the developed method for Lyapunov function design to certify their stability. Overall, the objective shall be to design a safety-guaranteed training method for neural-network-based controllers.

A preferable application would be the stability analysis of consensus-like algorithms for the control of multi-agent systems under the constraint of time-varying network topology which is used to model the effects of wireless communications imperfections.

Job description:

- Conduct research and develop innovative concepts for stability analysis of neural-network-based controllers by exploring the framework of neural-network-based Lyapunov functions.
- Propose a generic method to synthesize Lyapunov-stable neural-network-based controllers for nonlinear time-varying dynamical systems. In a second time, propose a safety-guaranteed training method for neural-network-based controllers.
- Interact with the experts in the group to understand the frameworks and architectures that would enable the implementation of original concepts.
- Disseminate the proposed solutions through technical papers in international conferences and/or journals.

Required education and experience:

Mandatory:

- A PhD degree in Control Theory,
- At least 3 years of experience (including the PhD experience) in research, within public or private R&D laboratories,
- Research experience marked by publications in high-rank conferences or journals,
- High-level skills in machine learning algorithms.

Preferably:

- A PhD degree with a particular interest in neural-network-based control,
- Research experience marked by patent filing,
- Expertise in unsupervised learning and reinforcement learning.

Personal profile:

- Open-mindedness, capacity to work in a multicultural and international environment.
- Motivation to work in a dynamic industrial research environment.
- Excellent communication and interpersonal skills.
- Fluent English.

Duration: at least 12 months

Dates: as soon as possible

Contact: Magali BRANCHEREAU (jobs@fr.merce.mee.com) + Adel BECHIHI (a.bechihi@fr.merce.mee.com)

Please send us your application (resume and cover letter) including the job opening reference (**WCSFT030**).