13 months Post-doc position at COSYS/ESTAS laboratory, University Gustave Eiffel – Lille Campus

Development of advanced monitoring techniques based on discrete event models - Application to railway control/command systems

Starting date: ASAP

Deadline for application : January 20th 2025

Context

This post-doc position is related to the third axis of the RITMEA project in the framework of CPER 2021-2027 program.

Fault monitoring is a crucial and challenging task in large and complex dynamic systems. The activities related to the monitoring of faults are all the more essential in critical applications such as, railway control systems, where failures could have dramatic material and human consequences. Fault diagnosis and prognosis problems have been extensively studied by both Artificial Intelligence (AI) and Control Engineering communities. In particular, an increasing amount of work has been devoted to fault diagnosis and prognosis of DES over the last two decades.

One of the main issues in fault diagnosis of DES, is diagnosability analysis. In simple terms, diagnosability refers to the ability to infer accurately, from partially observed executions, about the faulty behavior within a finite delay after a possible occurrence of a fault. On the other hand, fault prognosis consists in developing some means that allow for predicting fault occurrences in the future. In the same way as for diagnosis, two main issues can be inferred, namely prognosability analysis which refers to the ability to predict fault occurrences, and online fault prognosis which consists in predicting the occurrence of faults online and based on the observable part of the system behaviour.

In the literature, a large part of the existing works consider that faults are permanent. which means once a fault occurs, the system remains indefinitely faulty However, in many systems, faulty behavior often occurs intermittently, which can be depicted as a failure event followed by its corresponding ”reset” event, followed by new occurrences of failure events, and so forth. Indeed, intermittent faults are defined as faults that can automatically recover once they have occurred. Besides, temporal aspects may be crucial in the monitoring context; namely different occurrence dates of events may have different means in terms of supervision which requires that the monitoring processes have to consider these aspects carefully, particularly in real-time applications. As a consequence, further variants of diagnosability and prognosability features can be defined to better cope with real monitoring needs.

Mission

The COSYS/ESTAS laboratory has been developing works on the diagnosis of DES since several years, with several applications in the domain of guided transportation systems. In this work, different extensions of the results previously obtained are targeted from three viewpoints: 1) further types of failures will be investigated, while considering different failure occurrence modes (repetitive, intermittent, periodic, etc.), 2) different monitoring contexts

will be considered (untimed, timed), and 3) Further techniques will brought into play to investigate diagnosis issues. In particular, in the past we have investigated using formal methods, namely model-checking, to deal with diagnosis issues pertaining to permanent failures. We aim to continue exploring such techniques to deal with new diagnosis and prognosis issues. A particular aspect that will be investigated is related to diagnosability and prognosability enforcement. For this purpose, supervisory control techniques shall be brought into play, consisting in establishing some efficient controllers that help ensure these properties.
The efficiency and the scalability of the developed techniques will be assessed based on some railway control applications.

Required Competencies

- PhD related to some or all of the following topics: monitoring, diagnosis, discrete event systems, formal methods, linear programming, artificial intelligence.
- Knowledge of railway applications would be appreciated
- Good skills in software engineering
- Good skills in scientific writing

Procedure for recruitment

Interview
If interested, please send a detailed CV, the two most representative publications of your work, and if possible some recommandation letters to: **mohamed.ghazel@univ-eiffel.fr**
Deadline : January 20th 2025

Work location

Université Gustave Eiffel – Campus de Lille
COSYS/ESTAS

Gross salary

~ 2800 - 3400 euros/month.

The RITMEA project is co-financed by the European Union with the European Regional Development Fund, by the State and the Hauts de France Region.

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