Nantes, May 1st, 2024

Ph.D. Thesis in Co-tutelle FRANCE - BRAZIL (3 years)

Thesis Title: **Control of Hospital Logistics Systems using Dioid Theory**

Keywords: Discrete-Event Systems, Logistics, Healthcare, Dioid Theory, Switching Systems, Petri Nets.

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- **Location**: IMT Atlantique (Nantes, France) and UFRJ (Rio de Janeiro, Brazil)
- **General Information**: Fully funded PhD, 36 months, starting in October 2024.
- **Application details**: Interested candidates are invited to submit to `basilio@dee.ufrj.br` and `naly.rakoto@imt-atlantique.fr` a complete CV, a cover letter, Master's degree and Transcripts, 2 reference letters, and a research statement. Selected candidates will be invited to an interview.
- **Deadline for Application**: 15 May 2024 (23h, Paris time)

Summary: The logistics flows associated with hospital centers are undergoing partial automation nowadays. This trend of applying proven solutions from the industry has allowed hospital staff to free up time while simultaneously ensuring the availability of materials and information necessary for care operations. From the perspective of healthcare system reliability, this logistic automation also ensures a certain traceability of specific medications and materials.
Thus, successive experiments in hospital settings involving automated logistics, whether for linen, cleaning and sterilization of specific equipment, or the transfer of medical records between services contribute to the coexistence of heterogeneous logistic systems. However, these systems use shared resources such as corridors and elevators. Furthermore, despite the fact that these logistic systems share critical segments, it is noteworthy that they are generally acquired from specialized suppliers, and their successive integration into the hospital center's environment occurs without necessarily reconsidering pre-existing logistic systems, imposing additional operational constraints that need to be tackled.
In summary, hospital logistic systems, both internal [8, 3, 7] and external [2], generally include shared sections allowing the crossing of flows or a choice between different routes, but these aspects must be regulated either a priori or, at the latest, upon the arrival of a carrier, to avoid the risk of collision, for instance. A relevant research direction for supervising these conflict zones would be to use the framework of switching dioids [1].
The identified study subjects include

- the robustness of trajectories for members of different fleets. The duration of a mission for vehicles and robots related to logistics may be altered due to stops for public safety or circumvention of obstacles. Thus, in the case of urgent missions with deadlines to meet, it is essential to find a route ensuring the deadline is effectively met or, at the very least, to quantify the expected delay;

- the rules for assigning different missions to fleet elements based on criteria established by managers of hospital systems;

- the possibility of breaking down the fleet management problem and using modular local control or iterative constraint integration. Dealing with supervisory control theory [6], the modular local partitionning has already been tackled [5], as well as the iterative integration [4]. But these contributions appear to be missing in the particular case of dioid rameworks and promising tracks, such as the one presented by [1], whose application cases exhibit characteristics similar to those of shared sections.

The application cases will initially be theoretical, although discussions are on the way to establish partnerships with French hospital centers. This would provide real application grounds or, at the very least, realistic datasets for subsequent in-laboratory studies, including simulations.

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