Master Thesis at UMinho within S4H research project

Where: University of Minho, Department of Civil Engineering, Guimarães
Specific Unit: Institute for Sustainability and Innovation in Structural Engineering (ISISE), STAND4HERITAGE European research project
When: February-July 2022
Duration: 6 months
Grant: Bachelor grant (836€) for a Master student
Supervising Team: Nathanaël Savalle (PhD), Ana Francisca Santos (PhD)

Control algorithms for shaking tables with fast payload dynamics changes

Context:

Earthquakes are disastrous events that lead to both human, economic, and cultural losses. In particular, masonry buildings are known to be highly vulnerable to seismic ground motions. On the other hand, they often bear high cultural value, shaping hundreds of historic city centres and UNESCO sites. The Stand4heritage (S4H) research project is led by Prof. Paulo B. Lourenço and focuses on the seismic behaviour of masonry structures, with experimental, numerical, and analytical aspects. Regarding the experimental part, a large one-dimensional shaking table (3m x 3m) is being installed at the University of Minho and will enable loading laboratory specimens of masonry structures with earthquakes ground motions. This large equipment implies large masses and is driven through a powerful hydraulic actuator. Control of hydraulic shaking tables is still an open issue in the literature. In this regard, researchers developed state-of-the-art control algorithms to accurately reproduce the desired input signal with all its characteristics (frequency content, Peak Ground Acceleration, energy, etc.). They tested them on relatively small shaking tables with rather simple payloads. On the other hand, seismically tested masonry buildings are prone to brittle out-of-plane failures that lead to a swift change in specimen dynamics. To conclude, the reproduction of the targeted input signal by the shaking table is still a complete challenge. The present research project aims to test and compare different state-of-the-art control strategies on an artificial shaking table to select the most appropriate one.

Environment:

The recruited Master student will benefit from the team spirit that exists within the S4H team. This scientific environment will be valuable for his/her scientific knowledge acquisition and developing his/her communication skills. In addition, he/she will be co-supervised by both the University of Minho and University of Coimbra, thus benefiting from the scientific expertise of both institutions.

Tasks:

After a short period of studying the selected literature (one month), the recruited fellow will familiarise himself/herself with the existing numerical model of shaking tables developed under the Simulink environment. He/she will also update the model to account for as many variable parameters as possible, including the variable payload characteristics (one month). Afterwards, he/she will implement state-of-the-art control algorithms from the literature within the model. Three algorithms will be selected and tested. Their accuracy in terms of targeted signal replication will be compared (three months). The last month will be attributed to the writing of a scientific paper based on the obtained results.

This project can then be followed by a PhD thesis focused on developing a more accurate non-linear model of shaking tables associated with the actual implementation and testing of the selected state-of-the-art control algorithms on the one-dimensional shaking table of UMinho.

Knowledge/Skills:

BSc in electronic, mechatronics, mechanical engineering or equivalent
Currently registered in a Master program
Good knowledge about classical control theories (e.g., PID) and strong familiarities with the block representation used in the field
Knowledge of the theory of dynamics
Good communication skills in English
Knowledge of Matlab/Simulink environment will be appreciated

Procedure:

Interested candidates should send their résumé, motivation letter, and a copy of their bachelor's certificate (all in English) to Dr Nathanaël Savalle (n.savalle@civil.uminho.pt) before November the 30th, 5 pm (Lisbon time). The obtained grades should be higher than 14/20.