VRIJE UNIVERSITEIT BRUSSEL

The faculty of Engineering of the Vrije Universiteit Brussel invites you to attend the public defense leading to the degree of

DOCTOR OF ENGINEERING SCIENCES

of **Yacine Bel-Hadj**

The public defense will take place on **Monday 27th May 2026 at 5pm** in the **Green Room** (U-Residence, VUB Main Campus)

To join the digital defense, please click here

SELF-SUPERVISED LEARNING FOR SCALABLE STRUCTURAL HEALTH MONITORING

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Abstract of the PhD research

Structures such as bridges, towers, and wind turbines are used every day and are expected to remain safe over long periods of time. Damage in these structures often develops slowly and without visible warning, which makes early detection difficult.

To assess the condition of a structure, vibration measurements are often used as an indirect indicator of its health. However, these measurements are influenced not only by the structure itself, but also by environmental conditions such as weather and by how the structure is being used. This makes vibration data difficult to interpret in real-world conditions.

Today, the interpretation of vibration measurements is often done on a case-by-case basis. It typically requires expert judgement, extensive manual analysis, and solutions tailored to a specific structure. This approach is time-consuming and does not scale well when many similar structures need to be monitored. In addition, the way damage affects a structure is usually unknown in advance, which limits the evaluation models.

This work aims to automate the interpretation of vibration data by using data-driven neural network models trained directly on measured data. These models are designed with different constraints to capture the normal behaviour of a structure while remaining robust to changes in environment and operation. Rather than relying on detailed physical models or prior knowledge of damage, the behaviour of the structure is learned from data.

The goal is to develop a shared monitoring framework that can be applied across different structures. By combining automated data interpretation with constrained data-driven models, the proposed approach reduces manual effort and asset-specific tuning while remaining effective under realistic operating conditions.