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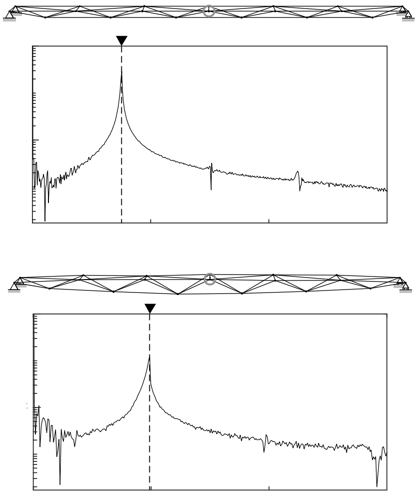

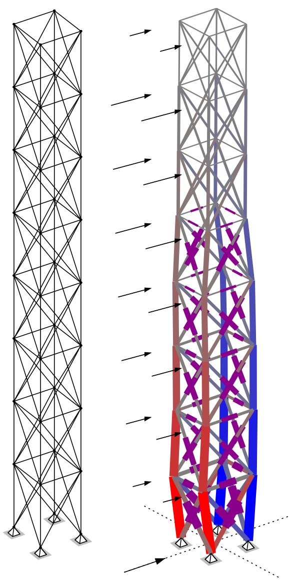

Master project

Shape morphing as a vibration mitigation strategy for lightweight structures

The current trend of ultra-slender bridges and high-rise buildings often results in structures that are more prone to excessive vibrations under extreme conditions. Although solutions through active vibration control have found several use cases, wider adoption in large-scale civil structures has been limited. This reluctance can be attributed to the high initial cost, reliance on a continuous power source as well as reliability and robustness of the control system. In addition, the application of high-frequency actuation may result in a significant reduction in fatigue life.

In fields such as energy generation, aeronautics, and automotive, shape morphing has been a key strategy to improve the performance of small- to medium-scale mechanical systems. However, the potential of shape morphing for mitigating excessive responses in civil structures has not been fully explored. An extensive body of research on structural shape optimization has demonstrated that natural frequency is generally sensitive to geometric changes. However, existing optimization techniques aim to obtain a single permanent geometry that is the best fit under the envelope of the worst-possible loads. Furthermore, the enforcement of dynamics-related constraints in shape optimization often results in a highly nonlinear problem.

In this project, a novel control strategy to mitigate vibration through shape morphing will be studied. Through appropriate geometry changes, the natural frequency of the structure can be shifted away from the frequency of extreme excitations such as peak pedestrian traffics or wind vortices. To this end, the candidate will be expected to complete the following work packages: **(1)** formulation and implementation of a computationally efficient shape optimization accounting for frequency constraints as well as the kinematics of actuation; **(2)** formulation and implementation of an appropriate controller accounting for geometric nonlinearity; **(3)** numerical case studies; **(4)** experimental validation on the adaptive truss prototype (if time permits).

Note that thesis supervision, writing, and examination shall be carried out in English.

Key requirements:

- Bachelor’s degree in civil engineering.
- Extensive knowledge of discrete systems (trusses & frames) and structural dynamics.
- Notional knowledge of mathematical optimization. Good knowledge of structural optimization is an advantage.
- Experience and interest in Python programming language
- Proficiency in spoken and written English

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Earliest starting date:
01.09.2022