Eigenfrequency-App for University Laboratory Education

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Abstract

Laboratories are essential parts of the engineering education at Universities of Applied Science. Students have the chance to practically apply theoretical concepts known from lectures. Sometimes the lab experiments require additional theoretical background. This is particularly true for experiments which combine topics from different disciplines. For example students of electrical engineering are familiar with the working principle of a strain gauge. But, for applying this sensor to Eigenfrequencies measurements, e.g. of a steel girder, the students should have also an idea about resonant modes of such a 3D structure. Typically, a student of mechanical engineering would have an intuitive idea here, while the student of electrical engineering might not. A COMSOL-app can be an efficient mean to provide the required knowledge in a very intuitive way during the lab class. In this paper the setup of an app for calculating structural Eigenfrequencies is described. It is developed for use in an electrical instrumentation lab.

The COMSOL Multiphysics® model setup for the application described above is straight forward: Solid Mechanics interface with a Fixed Constraint boundary condition; parameterized Block geometry to represent the steel girder; material defined by Young's modulus, Poisson's ratio, Density; Physics-Controlled Mesh of fine size and an Eigenfrequency study.
The COMSOL Application Builder is used for the app design. The app allows to simultaneously visualize six resonant modes. Beside the mode shape, which can also be animated, the calculated Eigenfrequency values are displayed. In order to adapt the simulation model to the lab-structure, the student has to enter values for the geometry of the steel girder and the according material properties. In the final paper focus is taken on describing the detailed steps to setup the app.

The developed app provides results in reasonable accordance with experimental data. Details will be presented in the final paper. The app is currently used in the instrumentation laboratory of the electrical engineering department of the University of Applied Science in Augsburg. First experiences with the app during the lab indicate, that students benefit from the graphical visualization of the oscillation modes in several ways. For example questions can be answered like: "Which frequencies can be measured with the strain gages setup in the lab?" or "How should a particular Eigenfrequency be excited?". The app also allows for a proof of reasonability for the experimentally determined frequencies values. Overall, based on the simulation results, the students are

able to plan and perform the experiments more systematically and gain more vivid insight to the learning content.

Figures used in the abstract

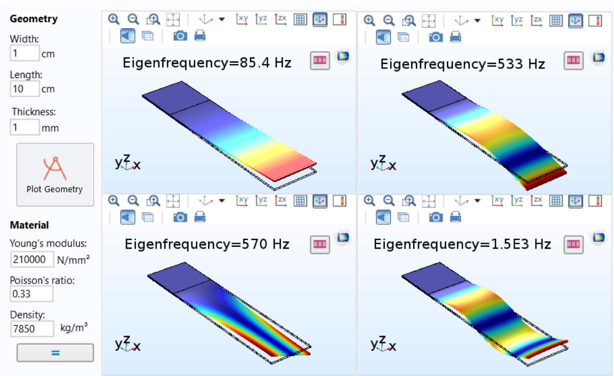

Figure 1: COMSOL-App for calculating structural Eigenfrequencies of an instrumentation laboratory experiment.