Frequency-Based Fatigue Life Evaluation and Accelerated Testing of Agricultural Mower Structure

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Background

Mechanical structures used in the agricultural sector are exposed to vibrations and cyclic loading during operation and transport, which can lead to fatigue failure. One type of agricultural structure is mowers. A mower is an implement that can be mounted on a tractor and be used to cut grass grown in the fields.

Traditional fatigue life evaluation methods for these structures are tedious and time-consuming. Instead, so-called frequency-domain fatigue methods can be utilized. Although these methods are claimed to be more efficient and provide a better overview of fatigue loading, they have not consistently been evaluated on agricultural structures. Furthermore, frequency-domain fatigue methods rarely consider the multiaxial stress states or the effect of non-proportionality, which is highly important, as it can result in non-conservative fatigue life predictions. Moreover, mowers are exposed to wear and tear from the physical circumstances during operation, such as dragging on the field, impacts from rocks, and water. The harsh environment complicates the placement of sensors, such as accelerometers and strain gauges. For this, a suitable solution may be virtual sensing. The use of accelerometers is preferred to obtain less time-consuming and more accurate experimental setups.

Objectives

The project aims to investigate the **research hypothesis**: By combining frequency-based fatigue evaluation methods with virtual sensing approaches, an accurate and fast approach for determining the fatigue lives of agricultural structures can be achieved. If effects such as multiaxiality and non-proportionality can be accurately considered, it will lead to faster and more reliable design decisions and reduce the required number of large-scale tests for agricultural machines.

The hypothesis is investigated by answering the research questions:

Question 1: What are the differences between frequency-based fatigue methods and time-based fatigue methods, and how accurate are the results obtained from these methods?

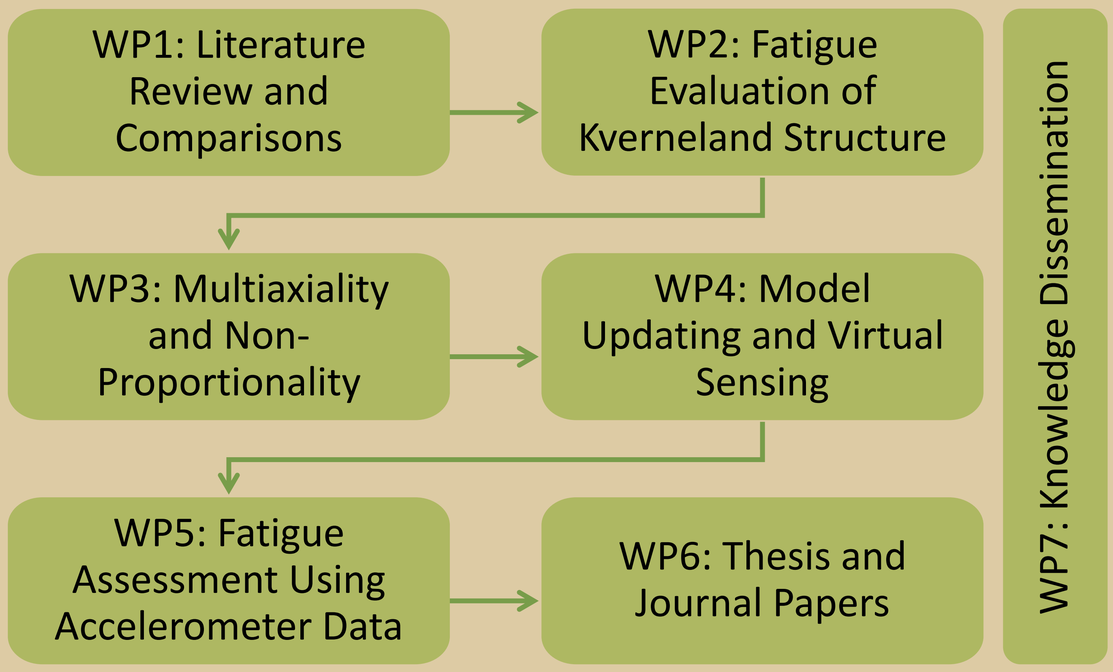
Question 2: How can frequency-based fatigue methods take the effect of multiaxial and non-proportional stress states into account?

Question 3: How can dynamic model updating and virtual sensing be used on agricultural structures as basis for fatigue analyses?

Question 4: Can accelerometer data be used as input for frequency-based fatigue analyses? And how?

Methodology

The project is divided into work packages (WPs), which seeks to answer the research questions.



To compare various time-domain and frequency-domain fatigue methods, simulated and experimental data from components at Kverneland will be used. Furthermore, a frequency-based fatigue method, incorporating the effects of multiaxiality and non-proportionality, will be developed.
Experimental vibration tests with controlled excitation will be performed to enable model updating of an agricultural structure. The updated model can then be used to perform virtual sensing based on strain measurements from a fatigue experiment. Additionally, by utilizing accelerometer measurements, the same experiment can be used for comparing fatigue results from strain gauge and accelerometer data.

Company & Funding

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