Applications

Hearing Defects in Wind Turbine Blades

Making machines listen to sound has a long tradition: early systems to understand selected words go back to the 1960s, though the widespread use of speech recognition came only recently with the advent of robust and versatile approaches for mobile devices. Less known is that machines are also used to identify faults in mechanical systems from listening to their acoustic signature. Most tests were developed for rotating machinery to monitor the amplitude of harmonics.

The Audio Information Processing group of Bernhard Seeber at the Technical University of Munich (TUM) focuses on understanding and modeling the normal and impaired auditory system through psychophysical experiments and neuronal and behavioral models. Such auditory models mimic the processing of the human (peripheral) auditory system and thus reproduce capabilities and limitations of hearing. They can, for instance, predict how loud sounds are perceived, which helps to optimize the processing in neuronal auditory prostheses, such as cochlear implants. But could they hear faults in technical systems?

There are numerous examples where humans test products by listening to their response: we hear if glass has a crack or if the car engine has a problem – simply by listening. In professional quality control, the wheels of a train are tapped to verify their integrity. Similarly, internal structural faults in rotor blades of wind turbines can be spotted in the yearly inspection by listening to the blades' sound after hammering on it. However, the sound differs strongly from model to model and depends on the location of the test point on the blade. Experienced testers know the common blade models and they know where faults typically occur and which sound to expect.

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Even without this prior knowledge, it is now possible to identify faults in rotor blades by a single tap. A new perception-inspired test system incorporates robust features, which derive from perceptual models, such as the specific loudness of sounds. It is as reliable as the human tester and it can additionally predict the size of the defect from a single tap – all with a very small training data set. The system was developed by Gaetano Andreisek and Bernhard Seeber of TUM's Audio Information Processing group in collaboration with Christian Grosse (TUM) and DTU Wind Energy.
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