Vibration-based fault diagnosis of planetary gearbox using deep learning and health data map

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Planetary gearbox is widely used for a large-scale engineering system such as excavator, helicopter, and wind turbine. However, it suffers from high maintenance cost, which requires an on-line condition monitoring to prevent a sudden catastrophic failure. To solve this challenge, this paper presents a vibration-based fault diagnosis method for a planetary gearbox using health data map and deep learning. Vibration-based fault diagnosis of the planetary gearbox is challenging due to the complicated vibration characteristics from multiple components in the gearbox including ring gear, sun gear, planet gears that revolve around the sun gear, and carrier that carries the planet gears. Conventional vibration-based fault diagnosis of planetary gearbox method employs a window function to extract the vibration signal where the planet gear of interest is adjacent to the vibration sensor which is typically attached on top of the gearbox housing. However, this method loss most of information where the planet gear is positioned far from the sensor where the signal may contain useful information. In this paper, vibration signal is transformed to two dimensional health data map without vibration extraction window function, enabling to visually identify the health stage of the gearbox from an image. For an automated fault identification from the health data map, this paper employs a deep learning method. However, deep learning model requires an amount of data for training. To prevent data insufficiency and unbalance between healthy and faulty signal, this paper proposes to augment data using an analytical simulation model that imitate the gearbox in health data domain. A simple convolutional neural network (CNN) and gradient-weighted class activation map (Grad-cam) are employed to identify the fault type and location of the gearbox.