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Digital twin-driven health management and remaining useful life prediction of the gearbox transmission system

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Abstract

The gearbox transmission system plays a vital role in advanced manufacturing, aerospace, renewable energy, vehicle, and mining system. Its degradation and failure would cause unexpected economic loss and even serious accidents. For example, the degradation and failure of the gearbox will impair the performance of the machine tool, affecting the production quality and quantity significantly and resulting in enormous economic loss. Therefore, monitoring the health condition of the gearbox transmission system is of great significance. However, the gearbox transmission system usually operates in harsh working environments, and it is difficult to conduct regular manual inspections and maintenance. Thus, the use of advanced online algorithms to monitor the degradation status of the gearbox transmission system and predict its remaining useful life (RUL) can bring significant benefits to industry practices.

Digital twin (DT) is a virtual representation (mirror) of a physical structure or a system in real space along its lifecycles. Through real-time interaction between the virtual model and physical structure, the degradation status of the system and its RUL can be reflected and evaluated effectively. Thanks to its unique specialty, DT has recently received considerable attention from the research community. However, due to the complex structures and harsh operation conditions involved, research on DT-based gearbox transmission system RUL prediction is rather limited. Moreover, existing conceptual approaches have limitations in indicating the specific contact status and providing insights into the degradation stages of gearbox transmission systems, which are of great value to RUL prediction.

To this end, this work presents a systematic and practical digital-twin technology for gearbox transmission systems RUL prediction, including the development of the realistic virtual model, real-time interaction between the virtual model and physical structures, and ‘transfer learning’ for a wider mechanical transmission system RUL prediction. This work can significantly benefit the health management of the gearbox transmission system and bring significant benefits to various industrial applications, including advanced manufacturing equipment/machinery, industrial machinery, aerospace applications, and wind turbines.

About the Speaker

Dr Ke Feng is currently working at the University of British Columbia, Canada. He received a PhD degree in 2021 in Mechanical Engineering from the University of New South Wales, Australia. He was a Postdoctoral Research Associate with the University of Technology Sydney in 2021. His main research interests include digital-twin-based RUL prediction, vibration analysis, structural health monitoring, dynamics, tribology, signal processing, and machine learning. He is the editor and guest editor of several journals, including Mechanical Systems and Signal Processing, Frontiers in Materials, Sensors, etc. He is also the Vebleo Fellow and a member of the Institute of Electrical and Electronics Engineers. He serves as the section chair of the third International Conference on Sensing, Measurement & Data Analytics in the era of Artificial Intelligence. He is the invited speaker of the 2nd Digital Twin International Conference and 6th International Conference on Dynamics, Vibration and Control.

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