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On the effects and detectability of cracks in roating shafts

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Rotating machinery is essential in industrial applications, where early fault detection is critical to prevent catastrophic failures. Shafts are mainly vulnerable to imbalances and cracks, these last ones pose a sever risk as they can lead to sudden failure if not identified during their early stages. Cracks induce progressive stiffness reduction, altering the system's mechanical properties and affecting the forces transmitted to the supports. This study analyses the effects of both cracks and imbalances on a rotating shaft using experimental data. Vibration signals from accelerometers mounted on the supports are processed to identify changes in the shaft' s response. The methodology focuses on distinguishing crack-induced alterations from those caused by imbalance by making variation in key signal features. Detection algorithms, including statistical methods and AI-based approaches, are evaluated for their effectiveness in identifying cracks before a critical failure occurs. The results highlight the distinct impact of cracks on the shaft's dynamic behaviour and demonstrate effective strategies for early detection. While different algorithms exhibit varying performance levels, all successfully detect the presence of dangerous damage. This study introduces novel approaches to crack detection, enhancing both safety and economic sustainability of rotating machinery.

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