Development of an energy-autonomous eddy current sensor system for in-situ component monitoring

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Energy-autonomous non-destructive testing (NDT) systems provide new opportunities for structural health monitoring. An NDT system that is energy-autonomous and transmits the recorded data wirelessly can be used in places that are not permanently accessible for inspection. In addition, it can ensure continuous monitoring, which can improve the operational safety of various components and structures. This study presents a concept that enables energy-autonomous and wireless structural health monitoring using a splined shaft as a demonstrator. To monitor mechanical overloads, a material sensor was applied to critical areas of these components by a laser heat treatment. The structural change that occurs as a result of an overload was monitored by the smart sensor system developed. This system consists of a material sensor, a low-cost eddy current sensor, an energy-efficient evaluation unit with an ultra-low power microcontroller unit and a Long-Range Wide Area Network (LoRaWAN) data transmission unit. Wireless data transmission via LoRaWAN provides access to the Industrial Internet of Things network, enabling the collection of NDT data from multiple smart sensors in a cloud and the processing of these data to assess the condition of the component from any location. The energy autonomy of the smart sensor system is achieved by an energy harvesting system integrated into the splined shaft.