

Passive UHF RFID-Based Structural Temperature Monitoring in 22.5" Truck Tires Under Dynamic Loading Conditions

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Abstract

The internal temperature distribution of truck tires, particularly at critical regions such as belt edges and liner interfaces, is a key factor governing durability and failure mechanisms. However, conventional measurement methods are generally limited to bulk air or surface temperatures and fail to capture localized structural hotspots under dynamic operating conditions. In this study, a passive ultra-high radio frequency identification (UHF RFID)-based sensing system is implemented to monitor internal structural temperatures of truck tires in a wireless and battery-free manner. The system is based on embedded RFID sensor tags and evaluated through rolling resistance and high-speed tests under controlled laboratory conditions. The results demonstrate that the proposed approach enables the detection of localized temperature variations within the tire structure, revealing a clear distinction from conventional thermocouple measurements. While communication constraints were initially observed under high-speed conditions, system-level optimizations significantly improved the operational range. Overall, the study confirms that passive RFID sensing is a feasible approach for capturing internal structural temperature behavior in rotating tires and provides a strong foundation for intelligent tire monitoring and predictive maintenance applications.

Keywords

Intelligent tire systems, Passive RFID sensing, Structural hotspot detection, Tire temperature monitoring, UHF RFID systems.