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Artwork

Thermal Sense: Privacy Focused Cabin Monitoring System

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Artwork Description

Thermal Sense Cabin Monitor is a privacy-preserving in-cabin monitoring system that replaces conventional optical cameras with rearview mirror – integrated thermal imaging. Instead of capturing identifiable visual features, the system generates non-identifiable thermal heat maps to detect occupant presence, assess driver attentiveness, and identify anomalous cabin events. By relying exclusively on thermal signatures, it enables real-time safety monitoring while fundamentally safeguarding user privacy, directly addressing growing concerns over surveillance in intelligent vehicle environments. Thermal Sense integrates seamlessly with vehicle dashboards and mobile interfaces, providing intuitive thermal visualizations of occupancy and activity status. Upon detecting critical anomalies—including driver fatigue, unattended children, or sudden medical emergencies—the system triggers immediate alerts to onboard users or designated remote contacts. Its embedded rearview mirror design preserves interior aesthetics and supports a minimalist, user-centered interaction experience. Aligned with global data protection regulations and ethical AI frameworks, Thermal Sense reframes in-cabin intelligence from intrusive surveillance to human-centric, privacy-first sensing, establishing a new benchmark for responsible design in next-generation smart mobility systems.

Keywords

In-cabin interaction; Driver state monitoring; Occupant detection; Automotive HCI; Human-centered AI; Privacy-preserving systems; Intelligent vehicles; Multimodal sensing; Driver safety; Trust in automation

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Biography of the First Author

Zeyuan Zhang is a Senior User Experience Designer and interdisciplinary researcher specializing in human–computer interaction, intelligent vehicle interfaces, and privacy-preserving interaction systems. He received his M.Sc. degree in Human–Computer Interaction from University College London. He is currently engaged in the design and research of intelligent systems spanning financial technology and smart mobility applications, with a research focus on automotive HCI, ethical AI, multimodal sensing, and human-centered system design. He has published first-author research papers in leading international HCI venues, including CHI and ASSETS. In addition to his research contributions, he actively serves as a peer reviewer for more than 10 international academic journals and conferences, including CHI and CSCW. His work bridges rigorous academic inquiry and industrial practice, with recognized contributions to in-cabin interaction, privacy-aware sensing technologies, and next-generation intelligent transportation systems.

Figure 1. Thermal Sense system overview, combining the in-cabin UI display with a rearview mirror–embedded thermal sensing module.

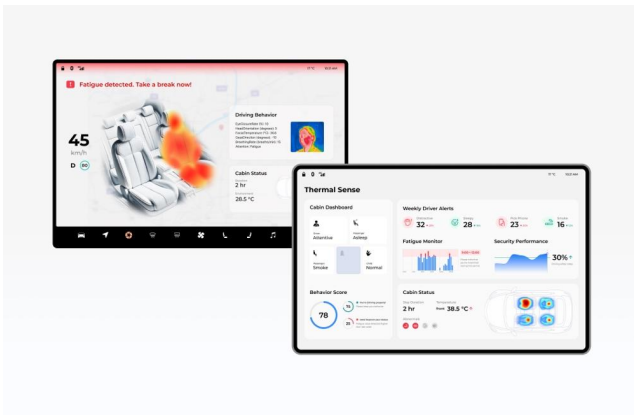

Figure 2. Thermal Sense in-vehicle user interface, visualizing real-time thermal-based occupancy and driver status.

Figure 3. In-cabin monitoring architecture based entirely on non-identifiable thermal imaging data, with no personal visual features captured.

Figure 4. Thermal Sense operating scenario illustrating real-time cabin monitoring in a daily driving environment.

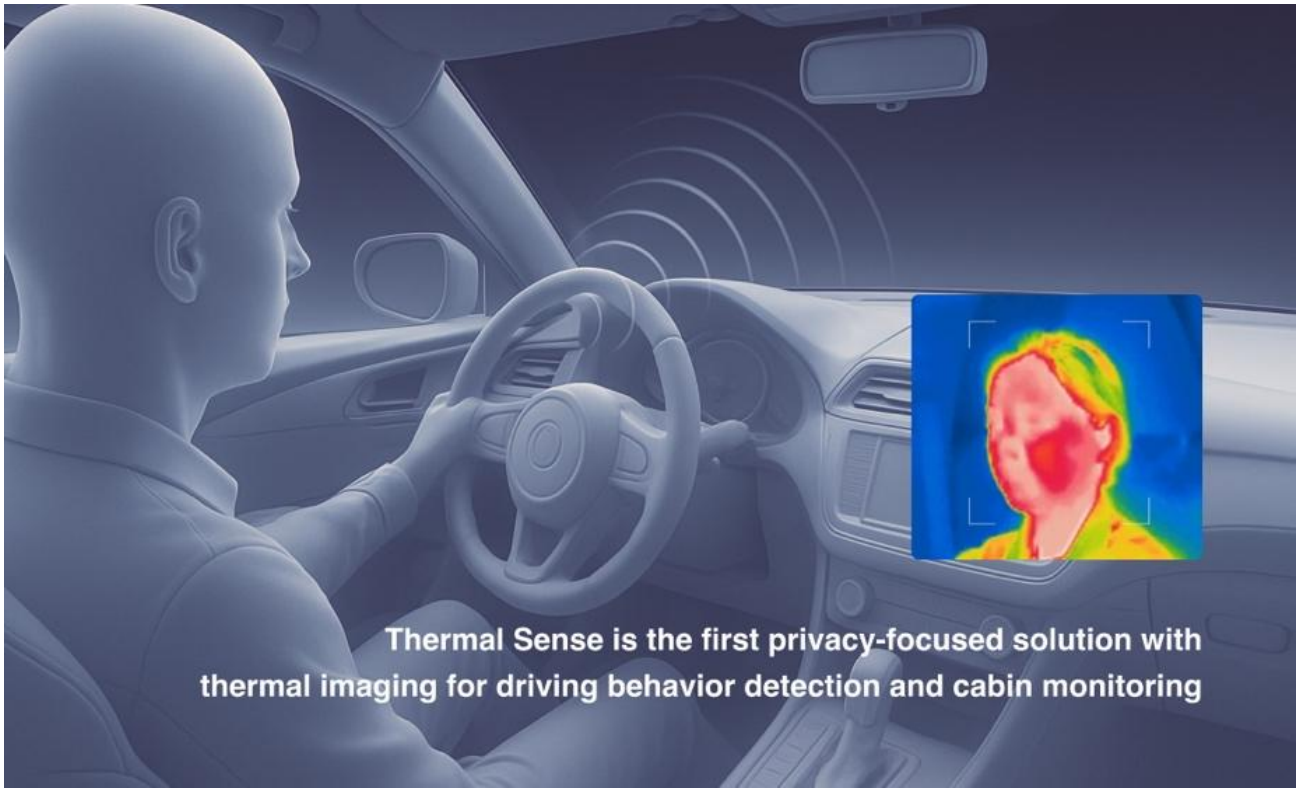

Figure 5. Thermal-based driver condition detection, visualizing physiological and attentiveness cues through heat signatures.