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Despite their demonstrated efficacy under controlled laboratory conditions, the integration of AI with nanosensor systems in real-world environments presents a set of unique and persistent challenges. In complex, dynamic media, such as biological fluids, soil, or urban atmospheres, signal attenuation, photobleaching, and nonlinear environmental interactions can significantly degrade sensor performance and data reliability. These effects not only compromise detection sensitivity but also introduce variability that complicates real-time AI-driven interpretation. Furthermore, the heterogeneity of data from nanosensors operating under diverse conditions demands advanced AI models capable of robust generalization and adaptive learning. Ensuring synchronization between nanoscale signal acquisition and macroscopic decision-making, while maintaining low power consumption, minimal latency, and high fidelity, remains a critical bottleneck. Overcoming these hurdles requires innovations in AI model robustness, noise-aware signal processing, and context-adaptive learning algorithms that can function reliably in the presence of physical constraints inherent to nanoscale sensing.[65] Physical nanosensors, notably nano-electromechanical systems, are adept at measuring stress, pressure, or temperature with unprecedented precision.[66] However, their inherent mechanical fragility and vulnerability to environmental noise present major challenges for reliable field deployment, especially in dynamic outdoor environments or *in vivo* biomedical applications

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