

Advanced Nanomaterials-Based Sensing Platforms for Enhanced Situational Awareness Using Augmented Artificial Intelligence

Ashok Vaseashta^{1,2,3,*}

¹Strategic Research International Clean Water Institute, 9108 Church St., Manassas, VA 20110, USA

²Research Institute, University of Bucharest, Șoseaua Panduri 90, Bucharest, 050663, Romania

³IEEN, Technical University of Moldova, bd. Stefan cel Mare 168, Chisinau 2004, Moldova

***Email:** prof.vaseashta@ieee.org

Abstract: The rapid convergence of nanotechnology, artificial intelligence (AI), and advanced materials science is revolutionizing sensing technologies, giving rise to platforms with unprecedented precision, adaptability, and intelligence. Once confined to narrow functions, traditional sensors are being reimagined as multifunctional, autonomous systems capable of thriving across diverse domains—from biomedical diagnostics and environmental monitoring to aerospace and defense. Quantum sensors, leveraging entanglement and coherence, achieve ultra-sensitive measurements of time, gravity, and magnetic fields, pushing far beyond classical limits. Bio-inspired and bio-integrated sensors, meanwhile, harness living systems or synthetic analogues to enable real-time, noninvasive physiological monitoring, driving breakthroughs in personalized healthcare and human-machine symbiosis. The infusion of AI and edge computing equips sensors with on-device intelligence, empowering context-aware decision-making, predictive analytics, and self-calibration in dynamic environments. Advances in flexible, stretchable, and self-healing materials further enhance adaptability to unconventional surfaces and extreme conditions, while energy-harvesting solutions address power constraints by enabling self-sustained operation. Together, these innovations redefine sensing as an active, networked capability rather than a passive data-collection tool, fostering the emergence of “cognitive sensing ecosystems” that autonomously learn, adapt, and evolve. Looking ahead, futuristic sensors will shape resilient societies, sustainable industries, and secure infrastructure, while simultaneously raising pressing questions about ethics, privacy, and governance. Although the full potential may await the advent of artificial general intelligence (AGI), these technologies, including neuromorphic ones, by literally sensing the unseen future, herald a new era of intelligence-driven interaction among humans, machines, and the environment.

Keywords: AI, AGI, Neuromorphic, Sensors, Edge computing, Dielectric, Energy, Biomedical

Schematics

