(12) PATENT APPLICATION PUBLICATION

(19) INDIA

(22) Date of filing of Application :08/05/2025

(21) Application No.202541044565 A

(43) Publication Date : 30/05/2025

(54) Title of the invention : Self-Sensing Roadway Infrastructure for Real-Time Monitoring

(51) International classification :G08G0001010000, G06Q0010200000, G06N0020000000, G06N0003080000, G01M0005000000

(86) International Application No :NA
Filing Date :NA

(87) International Publication No : NA

(61) Patent of Addition to Application Number :NA
Filing Date :NA

(62) Divisional to Application Number :NA
Filing Date :NA

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(57) Abstract :
The present invention relates to a self-sensing roadway infrastructure system capable of real-time monitoring and intelligent analysis of vehicular traffic, structural health, and environmental conditions. This system comprises a network of smart, durable sensors embedded within the pavement structure, including but not limited to strain gauges, piezoelectric transducers, temperature and moisture sensors, and fiber optic cables. These sensors are strategically distributed across the roadway to continuously capture data such as load impact, deformation, temperature variations, and material fatigue. The collected data is wirelessly transmitted to edge computing nodes or a centralized cloud-based platform for immediate processing and analysis. Advanced analytics, including machine learning algorithms, are applied to interpret sensor data, detect anomalies, identify patterns of wear and damage, and forecast future roadway conditions. The processed insights are presented through a real-time visualization dashboard accessible to infrastructure managers, city planners, and autonomous vehicle systems. The system supports a variety of applications such as predictive maintenance scheduling, traffic flow optimization, autonomous navigation support, emergency event detection, and overall enhancement of roadway safety and lifespan. Its modular and scalable architecture ensures compatibility with existing smart city ecosystems and transportation networks. By enabling proactive and data-driven infrastructure management, the invention significantly reduces maintenance costs, minimizes road closures, and improves public safety and transportation efficiency.

No. of Pages : 14 No. of Claims : 10