Washington University in St. Louis
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LOW-POWER, FAST SENSORS FOR INFRASTRUCTURE-TO-VEHICLE COMMUNICATIONS IN AUTONOMOUS DRIVING

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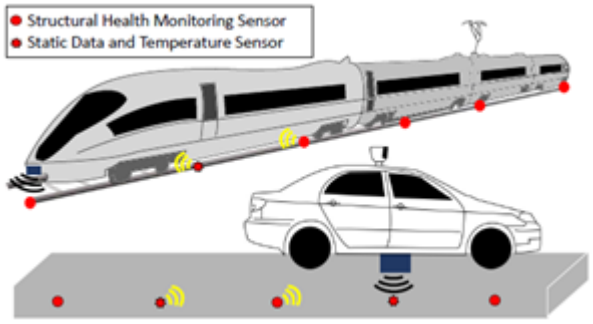
Engineers in Prof. Shantanu Chakrabarty's laboratory have developed an RFID embedded sensor system for infrastructure-to-vehicle (I2V) communications that uses near-zero standby energy and offers the robust performance of actively powered communications. This technology is designed to provide a long operational lifespan (20 years) on a small battery with only 100 ms latency, delivering enhanced decision-making information to moving vehicles, particularly in adverse conditions (e.g., blizzards, heavy rain, unexpected infrastructure damage).

Wireless sensor networks in roads, train tracks, signs and other infrastructure can measure and relay valuable information to help automated vehicles interpret their environment for safer operation and improved mobility. However, a major challenge to implementing these types of "smart city" I2V sensors is the limited power supply - it is not feasible to replace batteries frequently. This technology solves that problem with a hybrid power system that combines the long lifetime of passive RFID tags with the responsiveness of active tags. This RF-triggered I2V device has a passive front end that "wakes up" the active battery-powered back-end responsible for quickly transmitting data to a moving vehicle. This design conserves battery power for a long lifespan while still achieving robust data transmission in near-real-time at high speeds with applications in infrastructure-assisted autonomous and semi-autonomous vehicles.



Schematic for Infrastructure-to-Vehicular (I2V) communication: *sensor nodes embedded in the infrastructure (e.g., tracks or pavement) provide wireless information pertinent to real-time decisions in moving vehicles.*

Stage of Research

The inventors have built a prototype device with battery supply usage that meet the specifications to enable decades-long operation. In field tests, this device could communicate with a vehicle operating at interrogation speeds up to 120 km/h.

Publication

Pochettino, O., Kondapalli, S. H., Aono, K., & Chakrabartty, S. (2019, August). Real-time Infrastructure-to-Vehicle Communication using RF-Triggered Wireless Sensors. In 2019 IEEE 62nd International Midwest Symposium on Circuits and Systems (MWSCAS) (pp. 556-559). IEEE.

Applications

- **Wireless sensors** – Infrastructure-to-Vehicular (I2V) communication for real-time decision making in autonomous vehicles

Key Advantages

- **Superior energy performance:**
  - low energy requirements because power source for transmission is dormant until triggered with energy from the front-end reader
  - expected to allow the device to operate for decades
- **Fast activation time with long range communication -** hybrid design minimizes latency of transmission, enabling communication in the time frame of a passing vehicle
- **Enhanced sensing in adverse conditions –** infrastructure-based sensors can provide additional information (e.g., geolocation, infrastructure conditions) to vehicles, especially in sub-optimal conditions (e.g., heavy snow, fog, loss of wireless, unexpected infrastructure changes)

Patents – Patent application pending

Related Web Links – AIM Lab