

Rolling Sensors: Using Tyre Pressure Monitoring to Map Road Conditions

A thought piece by OPEXA

Rethinking Road Monitoring

UK roads face ongoing challenges from potholes, subsidence and general wear. Traditional inspection programmes are costly and episodic.

Meanwhile, modern vehicles are moving platforms packed with sensors. **Tyre Pressure Monitoring Systems (TPMS)** are standard in most cars and can detect sudden changes in tyre pressure caused by rough surfaces or potholes.

At OPEXA, we have been exploring how this existing network of rolling sensors could generate **near real-time insights into road conditions**.

This is not a solution. It is a thought experiment in smart infrastructure sensing.

How It Could Work

1. Sensing layer

- Electronic tyre pressure gauges detect spikes or drops in pressure that correspond to potholes or uneven surfaces.
- Vehicle **accelerometers** (sensors that measure changes in motion and vibration), **wheel speed sensors**, and **inertial measurement units (IMUs)** can complement TPMS data.
- Each event is timestamped and geo-located using **Global Navigation Satellite Systems (GNSS)** such as GPS.

2. Data aggregation

- Onboard filtering reduces false positives, for example by ignoring speed bumps.
- Aggregated event summaries are uploaded to a cloud service when internet connectivity is available.

3. Analytics and dashboard

- Data is clustered and scored for severity.
- Local authorities and fleet operators receive visualised maps of road conditions.
- Alerts can be generated for maintenance, route planning or insurance risk assessment.

Why Tyre Pressure Gauges Are Useful Sensors

- Tyre pressure responds sensitively to vertical impacts. A pothole produces a characteristic spike detectable at high sampling frequencies.
- TPMS is already fitted in most vehicles, enabling large-scale monitoring without additional hardware.
- Unlike cameras, TPMS data raises fewer privacy concerns. Aggregated pressure events do not reveal personal information.

“Cars are already moving sensors. We just need to use the data.”

Potential Applications

- **Local authority maintenance:** Near real-time pothole detection with severity scoring and better prioritisation.
- **Fleet management:** Early warning for hazardous roads, route optimisation and vehicle protection.
- **Insurance analytics:** Event histories can help insurers understand risk patterns and adjust premiums.
- **Urban resilience:** Rapid detection of hazards after storms, freeze-thaw cycles or roadworks.
- **Environmental and safety sensors:** Vehicles could relay data from roadside sensors where coverage is patchy.

Opportunities and Challenges

Opportunities

- Leverage existing vehicle infrastructure.
- Scale quickly with fleet or urban vehicle populations.
- Provide actionable insights to local authorities and citizens.

Challenges

- Ensuring TPMS sampling rates are sufficient to reliably detect potholes.
- Filtering out false positives caused by speed bumps or debris.
- Managing bandwidth and connectivity for real-time deployments.
- Integrating with local authority systems and data privacy frameworks.

Pilot Ideas

1. Select a small urban area with a mix of fleet and private vehicles.
2. Configure TPMS and accelerometer logging at higher frequencies.
3. Aggregate and filter event data onboard before upload.
4. Compare detected potholes with manual inspections to validate the system.
5. Expand to a regional fleet, integrating mapping dashboards for local authorities.

Discussion Questions

- What sampling rate and data resolution are needed to detect potholes reliably without overloading vehicle systems?
- How can local authorities and fleet operators collaborate to maximise coverage and utility?
- Could TPMS data be combined with other vehicle sensors for richer road condition analysis?
- What privacy or regulatory issues need careful consideration?

Conclusion

Cars are already moving sensors. Using **tyre pressure monitoring as part of a road condition IoT network** is a practical way to gain near real-time insights.

This is not a turnkey solution but an invitation to explore pilots, partnerships and data strategies that could improve road safety, reduce maintenance costs and enable smarter urban planning.

OPEXA is keen to collaborate on testing, feasibility studies and practical deployments. Starting small and validating quickly will be key.

“If cars can sense the road, why not let the data help us keep it better?”