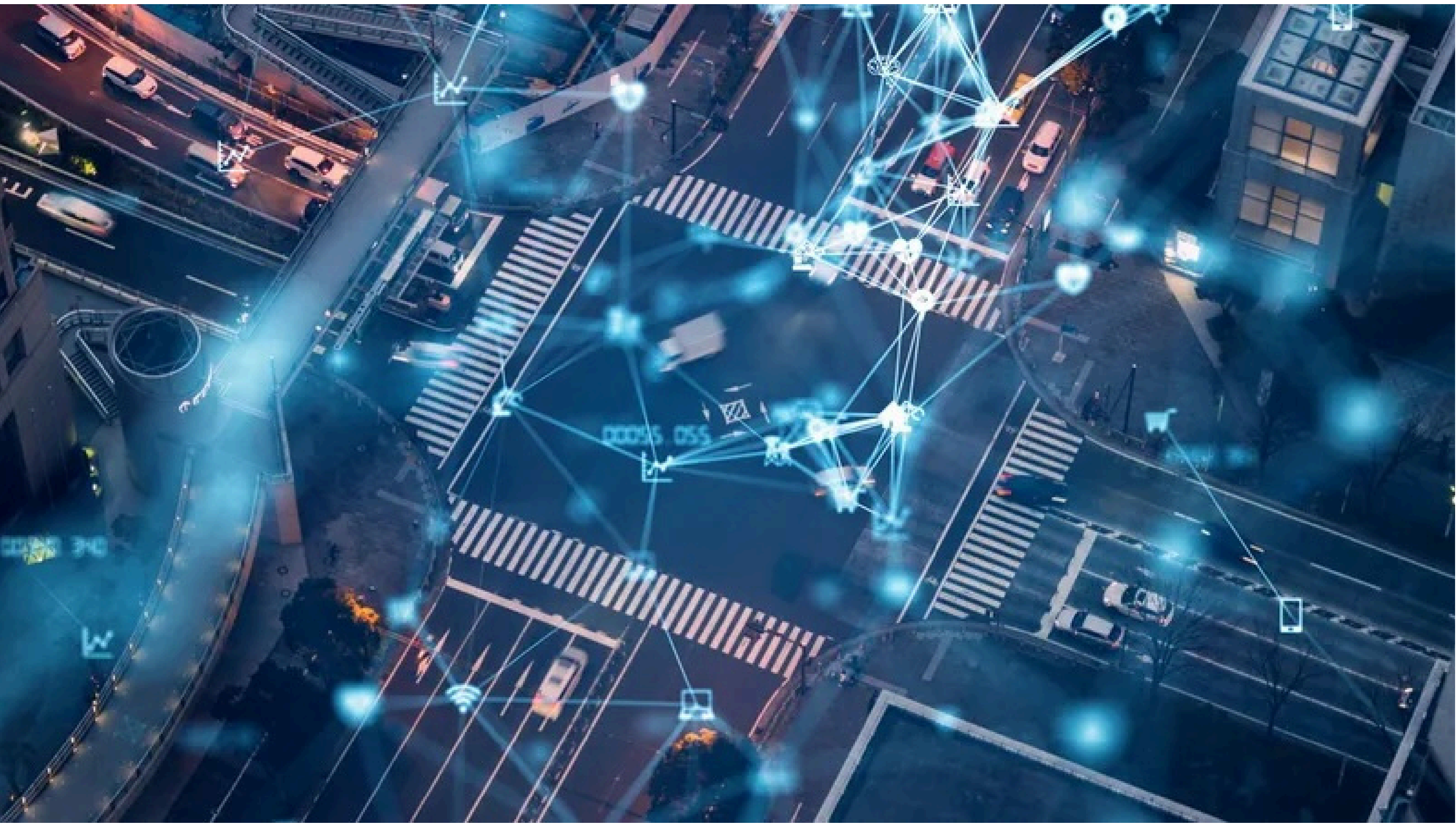
Advancing Automotive Safety and Comfort with Next-Generation Sensing Technologies

This article discusses the role of sensing in ADAS and in-cabin monitoring and how Murata supports these technologies with compact, reliable, automotive-grade components and modules that enable the functionality of camera, radar, LiDAR, and wireless systems.



Introduction

Sensing technologies have become central to external perception in Advanced Driver Assistance Systems (ADAS) and autonomous driving, as well as to in-cabin monitoring. Safety, regulatory pressures, consumer expectations, and technical possibilities are encouraging automakers and suppliers to adopt holistic sensor systems that monitor both outside and inside the vehicle. This article discusses the role of sensing in ADAS and in-cabin monitoring and how Murata supports these technologies with compact, reliable, automotive-grade components and modules that enable the functionality of camera, radar, LiDAR, and wireless systems. [1]

External Vehicle Sensing for ADAS

The external environment around a vehicle should be sensed accurately for ADAS functions like detecting other vehicles, pedestrians, road markings, traffic signs, and supporting functions like forward collision warning, lane keeping, adaptive cruise control, blind-spot detection, and parking assist. Camera systems are supplemented by radar, LiDAR, inertial sensors, and other supporting sensors to serve these functions. Cameras are one of the primary sensors for ADAS as they capture detailed visual information about road markings, traffic signs, pedestrians, other vehicles, and the surrounding environment.

Murata contributes in various ways to the camera design side of ADAS. Their applicable product lines for camera include discrete components that are essential for Image sensors and ISP (image signal processing) that can withstand automotive durability and reliability requirements, such as low-ESL capacitors, inductors, thermistors, and associated electronics parts around PMICs, SerDes, and vehicle communication interfaces (CAN, Ethernet) filtering that enable reliable operation under automotive environmental conditions. These components help ensure stable signal integrity, thermal performance, and electromagnetic compatibility. [2]

Camera modules provide visual data such as color, texture, and shapes that are crucial for recognizing road signs, pedestrians, lane markings, traffic lights, and other relevant objects. However, as visual perception has limitations in adverse weather, low light, or when objects are moving, radar and LiDAR complement cameras. For instance, radar (especially mmWave radar) contributes range, relative velocity, and detection robustness in rain, fog, snow, or at night. Similarly, LiDAR provides detailed 3D point clouds to map geometry, shape, and depth. Murata's AD/ADAS provides sensor fusion architectures that integrate camera, radar, and LiDAR to improve overall object detection and decision making.

Another external sensing challenge is ensuring redundancy and accuracy in varying environmental and driving conditions. In this regard, Murata supplies supporting electronic components like capacitors, inductors, and PMICs optimized for automotive temperature ranges, vibration, and electromagnetic interference, which are essential for camera and radar/LiDAR modules to operate reliably. [2,3]

In-Cabin Monitoring Systems

Ensuring safety inside the vehicle cabin is becoming a legal and ethical imperative. Laws or evaluation criteria in regions such as the EU and the US are moving toward mandating child presence detection (CPD) so that a child accidentally left in a parked car can be identified quickly, reducing the risk of heatstroke or other harm.

Murata's Radar-Based In-Cabin Solutions

Murata has developed a suite of in-cabin radar modules specifically engineered to sense very subtle life presence indicators. Their systems use a 60 GHz radar chipset (TI AWR6844, in this case) to emit millimeter-wave signals into the cabin and analyze reflections to infer the presence of a living being. For instance, as breathing causes minute motions in the chest and torso, the radar system can pick up those periodic fluctuations even when a person is very still or partially obscured.

The system also distinguishes between a child and an inanimate object. Murata's radar approach utilizes multiple transmit and receive channels and signal processing to analyze motion signatures and location data to make this differentiation. The radar-based detection is equally effective even when the child is out of position, covered by a blanket, or sleeping. [4, 5]

Another design goal of Murata's solution is versatility across cabin layouts. The radar module is compact, with a short wavelength (around 5 mm at 60 GHz), allowing for smaller antennas and less interference. As the radar penetrates certain non-metallic surfaces, it can monitor seats or zones even when a direct line of sight is blocked. The small module size helps in integrating it into roof liners, headliners, overhead consoles, or sunroof surrounds without majorly altering interior design.

Radar vs. Wi-Fi® Sensing Approaches

Murata, in partnership with Origin Wireless, has developed an in-vehicle CPD system employing Wi-Fi signals. In a Wi-Fi approach, the system does not emit a separate radar signal, but instead uses existing Wi-Fi signal patterns and reflections within the cabin and monitors subtle changes in the reflected Wi-Fi waves to detect micro-motions such as breathing or slight body motions. As a Wi-Fi radio is usually available in vehicles for connectivity, telematics, or infotainment, this method repurposes existing hardware or requires minimal additional components.

One advantage of Wi-Fi sensing is flexibility in sensor placement, as the signal already permeates much of the cabin, the sensor does not necessarily need to be co-located with a radar emitter. This simplifies integration. [6, 7]

On the efficiency side, Wi-Fi sensing can require lower power compared to a dedicated radar transmitter, because the system uses existing signal infrastructure and does not need to actively generate high-power radar pulses.

Integration and Reliability Considerations

Designing sensing modules that operate well both outside and inside the vehicle imposes engineering challenges. Miniaturization, placement, thermal stability, mechanical robustness, and compliance with automotive environmental conditions are all important considerations while designing sensing modules that operate well both outside and inside.

Miniaturization and Placement

In-cabin radar sensors need to be mounted where they can see across the necessary interior space, yet be compact enough that they do not intrude on vehicle aesthetics or interfere with other components. Murata’s Type 1VM mmWave radar module is ultra-small and includes optimized antenna design to allow such placements.

Similarly, camera modules require precise packaging, high integration of components, and minimizing the size of supporting electronics to ensure that the final module fits into tight external areas like mirrors, bumpers, A-pillars, or front fascia.

Thermal, Vibration, and Environmental Durability

Automotive sensors operate across wide temperature ranges, with exposure to vibration, moisture, electromagnetic noise, and other stresses. Murata explicitly targets automotive-grade reliability for its sensing components and modules. For example, its electronic components are qualified for automotive powertrain and safety equipment applications. Many of its capacitors and inductors in camera and LiDAR/radar modules are selected to maintain performance under temperature extremes and under mechanical stress.

Moreover, for in-cabin radar detection, the system must avoid false alarms from non-threat sources and maintain detection under variable cabin geometry. Murata’s in-cabin radar and Wi-Fi CPD solutions minimizes false positives, differentiate motion vs no motion, and classify between living beings and nonliving objects.

Expanding the Role of Sensing Beyond Safety

The role of sensing in automotive applications is not limited to just safety. In-cabin sensing systems can provide data that supports climate control adaptive to occupancy, position, and even physical state. For example, detecting which seats are occupied can allow HVAC systems to direct airflow more efficiently or to adjust temperature or airflow intensity depending on the location of occupants. Infotainment systems might adapt content, lighting, or alerts based on who is in the vehicle, or detect driver fatigue or distraction via monitoring movement. These applications build on the same sensor technologies used for safety, but with different processing, algorithms, and privacy precautions.

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In shared mobility, autonomous shuttles, and fleet operations, the ability to monitor inside and outside has operational and business value. For instance, CPD prevents mishaps, occupant detection helps ensure that fare or occupancy counts are correct, and life presence detection may support health monitoring (e.g., breathing, presence) for vulnerable passengers.

Future Outlook

The automotive sensing is converging on multimodal approaches that combine radar, camera, LiDAR, wireless sensing (Wi-Fi, RF), inertial sensors, etc., to compensate for the limitations of any one modality and to improve coverage, accuracy, latency, and robustness.

Murata facilitates this integration by offering reliable, small, and cost-efficient components and modules. We can expect further improvements in radar technologies with higher frequency, better angular resolution, and lower power consumption, enhancements in wireless sensing, and tighter fusion of data from multiple sensors.

Automotive design engineers looking to integrate reliable sensing into their systems can explore Murata's AD/ADAS and in-cabin sensing offerings for safer, smarter mobility on their website.

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