SAVING LIVES WHEN TEMPERATURES RISE

In-cabin UWB Radar to Ensure Everyone's Out of a Parked Car

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As more cars become equipped with Ultra-Wideband (UWB), automakers are investigating ways to use UWB as part of Rear Occupant Alert (ROA) systems, which protect vulnerable passengers from the dire consequences of heat exposure in parked cars. UWB can look for signs of life in the cabin and send an alert if anyone is left inside.

TABLE OF CONTENTS

PARKED CARS ATTRACT AND ABSORB HEAT

A parked car is a lot like an oven. Made of metal and outfitted with hard, plastic consoles and seats fashioned out of synthetic materials or leather, a parked car attracts heat and holds it inside. Temperatures in the cabin can rise quickly, creating an unsafe situation for anyone still inside.

Heatstroke is an especially serious issue for small children, since their bodies are more susceptible to heat. Infants, toddlers and younger children aren't as able to regulate their body temperature, making it easier for them to dehydrate and suffer the ill effects of heat exposure. Serious medical complications, including seizures and kidney failure, can begin when a child's body temperature reaches 104 °F/40 °C. At 107 °F/ 41.7 °C, children may even die.

When the outside temperature averages 61F/16.1C, the inside of a parked car can reach more than 105 °F/ 40.5 °C within one hour.

[Source: Consumer Reports Auto Test Track, 2021]

Danger can arrive quickly. Even on mild or cloudy days, the in-cabin temperature can reach life-threatening levels in less than two hours. In mid-summer, on a hot day, even with the car parked in the shade with the windows down, it can take only minutes for the cabin interior to become deadly.

PREVENTABLE TRAGEDIES

Increased awareness of the danger is due, in large part, to the work of nonprofits and consumer-advocacy groups. The most detailed statistics on the issue come from the United States, where hot-car deaths are tracked by two organizations, KidsandCars.org, which reports on vehicle-related injuries to children, and NoHeatStroke.org, which is affiliated with the National Safety Council. Their combined findings paint a clear picture of what's happening in the U.S. and, by extension, other parts of the world:

- Since the late 90s when more children started riding in the back seat to avoid injuries from airbags, at least 955 hot-car deaths have occurred in the U.S., compared to approximately 186 child front-seat passenger airbag deaths over the same period.
- About 38 children die each year in the U.S. from vehicular heatstroke, making it the leading cause of deaths in vehicles (excluding crashes) for children 14 and younger.
- More than 85% of the children who die are aged 3 or under. This is the age when children are typically buckled into specially designed, rear-facing safety seats that can be difficult to see from the front of the cabin.
- Some children gain access to the car on their own, climbing into an unlocked parked car without the parent or guardian knowing, but the majority are left inside purely by accident. A simple miscommunication, an unexpected event, or even a familiar routine, performed on mental "autopilot," can mean the driver leaves the car without realizing a sleeping infant or toddler is inside.

In places where regulations or legislation are not yet in place, some government agencies are working to help educate drivers. In the US, for example, the National Highway Traffic Safety Administration (NHTSA) urges everyone to "look before you lock," so drivers develop a routine habit of checking the back seat before walking away.

AUTOMAKERS ARE TAKING ACTION

For their part, automakers are turning to technology for ways to detect and protect vulnerable passengers. To help encourage this work, the European New Car Assessment Program, popularly known as Euro NCAP, has updated the requirements for their safety ratings. Starting in 2022, Euro NCAP will begin awarding ratings points for child-presence detection, a feature they define as being able to "detect a child left alone in a car and alert the owner and/or the emergency services, to avoid heatstroke fatalities."

The Euro NCAP rating system is highly respected and trusted by consumers, and automakers often design with Euro NCAP requirements in mind. As a result, the updated Euro NCAP requirement for child-presence detection can be expected to increase adoption of such mechanisms.

THE POWER OF IN-CABIN RADAR

Having detected signs of life in a parked car, the Rear Occupant Alert (ROA) system can send a message to the cluster as a way to alert the driver before leaving the vehicle. If the driver door closes before the notification is dismissed, the radar system can continue to scan the rear seat or cargo space for a predetermined amount of time (e.g., 10 seconds). If signs of life are detected during this period, indicating that someone remains in the car, the system can notify the driver with a warning sound, an emergency light or a text message. Unlocking the car can silence the alarm.

From 2022, Euro NCAP will reward manufacturers that offer Child Presence Detection as standard.

[Source: Euro NCAP Roadmap 2025]

Some of the earliest ROA systems use ultrasound to scan the cabin. A 3D ultrasound sensor is mounted in the overhead console or the B-pillar located between the driver and passenger areas of the cabin. To determine how many living organisms are present in the car, the sensor sends out pulses of acoustic waves and uses digital signal processing to analyze how the waves are reflected back by objects in the car. Adjusting the calculations to account for external vibration and noise can make it difficult to obtain accurate readings.

Radar, by contrast, uses electromagnetic waves instead of acoustic waves to determine the presence of objects, and is less susceptible to external vibration and noise. Similar to an ROA system based on ultrasound, a ROA system based on radar uses complex signal processing functions to detect objects, identify movement patterns, track changes in movement and remove noise.

One format of radar in particular, based on the recently released Ultra-Wideband (UWB) wireless specification, works especially well in automotive applications and is being considered for child-presence detection.

UNIQUE PROPERTIES OF UWB RADAR

There are two reasons why UWB radar is attracting attention as a possible choice for child-presence detection and ROA systems.

Robustness

- UWB radar works at comparatively low frequencies (in the 6 to 8 GHz range), which means it's quite good at passing through the solid material found inside a car, including metal barriers, car seats and even baby blankets. The ability to penetrate hard surfaces means UWB radar can also be used to scan beyond the rear seat, into the cargo space or trunk.

Precision

- UWB radar delivers highly precise readings for location, distance and velocity, which makes it an excellent choice for detecting signs of life. UWB radar can accurately detect even very small movements, including the tiny rise and fall of an infant's chest when it breathes. UWB radar has already been used by search-and-rescue teams to find people behind walls or buried in rubble, and by medical practitioners for no-contact monitoring of vital signs, including heart and breathing rates.

OTHER AUTOMOTIVE USE CASES FOR UWB

UWB is an emerging technology in automotive applications. It creates spatial awareness, for a sense of where objects and people are in relation to the car, and that gives rise to a number of interesting new use cases.

Two features of UWB radar combine to detect life signs:

Time of Flight — Impulses issued by the UWB module reach an object and are reflected back to the module. The time it takes to complete the round trip is measured to calculate distance.

Doppler Effect — A moving object reflects an electromagnetic wave and, as a result, imposes a frequency shift on to the wave. The shift is measured to calculate velocity.

For example, UWB is turning smartphones into secure, state-of-the-art key fobs. Users can open and start cars while leaving their phones in their pockets or bags, and enjoy secure remote parking via smartphone. Automotive UWB is also being used for things like automated trailer-hitch activation, automated valet parking, hands-free parking, lot access and drive-through payment.

THE NXP APPROACH TO IN-CABIN UWB RADAR

NXP is a leading proponent of UWB technology and an early innovator for UWB in automotive. We are a founding member of the FiRa Consortium, an industry collaboration designed to grow the ecosystem for UWB technology, and we are a board member of the Car Connectivity Consortium, a cross-industry organization dedicated to technologies for smartphone-to-car connectivity solutions. In terms of technology solutions, the NXP Trimension™ portfolio includes a rich collection of UWB options that enable secure fine ranging and sensing across automotive, mobile and Internet of Things (IoT) applications.

To support ROA use cases, NXP will offer UWB Radar IC solutions designed for precision, quick integration and cost-effective deployment. These solutions will combine high motion sensitivity and gesture recognition, so they can also be used as a kick sensor for easy opening of the trunk.

Supported by a complete evaluation kit and sample application, the Auto UWB Radar System is also compatible with the car's UWB-based smart access system, thereby maximizing the investment in UWB, making it easy to extend functionality and reducing system cost for the OEM.

Figure 1: UWB Radar Child Presence Detection

BROADER SAFETY IMPLICATIONS

With ROA systems based on UWB radar, automakers have a way to meet the 5-star safety ratings defined by Euro NCAP regulations, while taking safety a step further by not only detecting vulnerable passengers but also confirming signs of life.

There is also the potential to build on the foundation created by child-presence detection functions. In-cabin UWB radar can be used to create other life-saving features, with broader health-monitoring systems.

TAKE THE NEXT STEP

To learn more about UWB radar and its ability to help protect children from heatstroke in parked cars, visit www.nxp.com or reach out to your local NXP sales representative.

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