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In-Cabin Sensing - Advanced Driver Distraction and Occupant Safety Solutions

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Increasingly, driving safety improvements begin to rely on information about the driver and passenger(s) in a car. In the case of the driver, it is important to know, if the person behind the steering wheel is distracted in any way or tired so that his/her driving capability will be temporarily affected. A suitable sensor (for the driver monitoring use case typically a camera) provides the data for detecting distraction. Once this information is available, a suitable human machine interface can be activated to guide the driver's attention back to the traffic situation.

In the case of passengers several use cases apply. One specific and imminent challenge is to detect the presence of a child without an adult in the vehicle (Child Presence Detection, CPD). Furthermore it will become necessary to detect the position of all passengers/occupants in the vehicle, especially to detect whether a person may be out of the standard seating position. This Occupant & PreCrash Safety Monitor (OcSM) will become instrumental in achieving an optimum crash worthiness for automated vehicles with AD capabilities of L2+ or higher as that type of car is likely to offer a greater variety of possible seating positions. Occupants which are Out-of-Position (OoP) are more prone to injuries than occupants in or close to a standard position. One purpose of an OcSM solution therefore is to bring a OoP person as close as possible to the standard position before a crash. This applies especially to the backrest position.

As of the year 2025 vehicles that shall achieve the maximum EuroNCAP rating will have to be equipped with a CPD system. Seat occupancy and the classification of the object/person in the seat(s) or in the footwell either as a child (potentially plus further differentiating the age group) or as an adult needs to be part of a direct sensing system that alerts the driver within 10sec after he/she exits the vehicle about a child left alone in the car.

This paper presents a CPD solution based on UWB technology. It should be noted in this context that vehicle maker requirements are typically even stricter than the EuroNCAP requirements. To meet such very high expectations toward the performance of a CPD solution, a sensor fusion is very likely necessary as no single sensor system will be capable of delivering 100% performance in the near future, especially when a 3/6yo child is moving around a lot and in the spontaneous manner that is so typical of the very young.

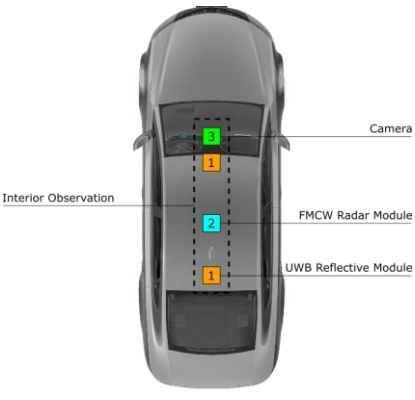

Fig. 1 Prototype UWB modules for CPD (1).

As there is no measurement standard available for CPD, the new application of UWB in reflective mode was virgin ground. In addition to adjusting UWB transceivers, antennas and algorithms to the reflective use, a suitable surrogate torso had to be developed to emulate a child's vital signs and to duplicate the signal reflecting properties of a small body. Prototype UWB modules were modified to emulate the new chipset and were installed under the roof (front and rear) of a vehicle to collect and process the signals.

Respiration rate signal interpretation of the CPD dummy was proven by simulations. Presence detection was validated through several test campaigns. During the first measurement campaign the signal was reflected back by a proprietary manikin torso. Additonally, vital signals, as a real child would emit them, were simulated by the emulator/surrogate.

At the end of 2021 the results from the surrogate measurements were followed-up by testing the CPD UWB system with 21 real families.