

Crash Avoidance Goes High-Tech

■ Taking lane departure warning systems to the next level.

by John McCormick

Lane departure warning systems are among the hot trends in new technology reaching dealer showrooms for the 2005 model year. Already, Nissan's luxury division, Infiniti, is offering a system, supplied by Valeo, on its 2005 FX45 sport utility vehicle. Infiniti's second application of the Valeo LaneVue system will be on its 2006 M performance sedan, which goes on sale next spring. In Europe, lane departure warning systems will be appearing on the 2005 C4 and C5 sedans from Citroen, recently introduced at the Paris auto show.

Similar systems to these passenger vehicle applications have been in production for some time on commercial vehicles and behind-the-scenes large automakers, including Ford and DaimlerChrysler, are working on more widespread use of the technology.

Looking even further ahead is a \$20.5 million project under study by Visteon Corp., AssistWare Technology, the University of Michigan Transportation Research Institute (UMTRI), and the U.S. Department of Transport (USDOT). While existing lane departure systems rely on optical and/or infrared sensors to determine a vehicle's position relative to road markings, the Visteon / AssistWare / UMTRI project integrates vision with radar and GPS technology to provide a more comprehensive driver assistance system. Dubbed "road departure crash warning" (RDCW) technology, the system under development warns drivers drifting out of



their lane and helps drivers adjust speed for negotiating curves.

The impetus for the program is the increasing toll of vehicle crashes in the U.S. and the resulting impact in terms of loss of life and financial cost. Annually, the number of fatal crashes has climbed every year since 1998, reaching more than 42,000 in 2002. It is estimated that 41 percent of fatalities happened when vehicles left the road. The financial burden is pegged at between \$200 and \$300 billion per year.

"Safety is a priority, and Visteon is committed to developing systems that help make drivers better drivers," says Bob Vallance, Visteon's Product Planning Director. "Road Departure Crash Warning is one example of the many Visteon technologies designed to help improve visibility, vehicle response and provide driver assistance. We are pleased with the learning achieved through our partnership with AssistWare, UMTRI and USDOT. Industry-industry and industry-government partnerships like this are key to the continued advancement of technology that will help make drivers better drivers."

Currently, the RDCW system is undergoing a field test that involves a fleet of 11 Nissan Altimas and a group of 78 volunteer drivers recruited at random in the lower Michigan area. According to James Sayer, a UMTRI

human factors scientist involved in the program, the Altima was chosen because the vehicle has an electrical BUS system that made it possible to link the various pieces of on-board experimental equipment. The basic purpose of the test, which lasts through next February, is to assess the safety benefits, driver acceptance, system performance and capability and the market potential and pricing range.

According to Tim Tiernan, senior manager for driver awareness systems at Visteon, early feedback from the UMTRI field test is "very encouraging." Test drivers are reporting increased awareness of their position within lanes, says Tiernan. "We are also hearing comments about how people realize that their driving deteriorates when eating talking on the phone and so are cutting back on distractions."

The RDCW system provides two distinct modes of driver warning that are designed to minimize nuisance and gain credibility with driver for the time when a road departure warning is truly needed. The first type of warning is to prevent the drift-off-road problem that arises from inattention or drowsiness. A second type of warning is to alert person who is driving too fast for an upcoming curve. Both functions provide warning, only, and do not intervene in vehicle control.

Assistware's 'lateral drift warning' (LDW) function operates in similar fashion to other lane departure warning systems in that it relies on a forward-looking video camera in order to measure vehicle position and lateral velocity relative to lane and road-edge markings. However, the system adds another layer of sophistication through the use of four radar units mounted in the front fascia. These forward and side facing radar units assess the room available on the shoulder for performing a recovery maneuver. When ample room is present, warnings are delayed to avoid nuisance alarms that often result from early warnings. However, when little room is available, the warnings are given early so that the driver enough time to respond and avoid a crash.

When drift-off is detected, the LDW system provides audio, visual, and seat vibration warnings. Drivers receive either a cautionary or imminent alert, based on lane position, lateral movement, and the type of lane boundary. A cautionary alert occurs when the driver is crossing a dashed line boundary with no vehicles in the drift path. The alert appears as a yellow icon on the



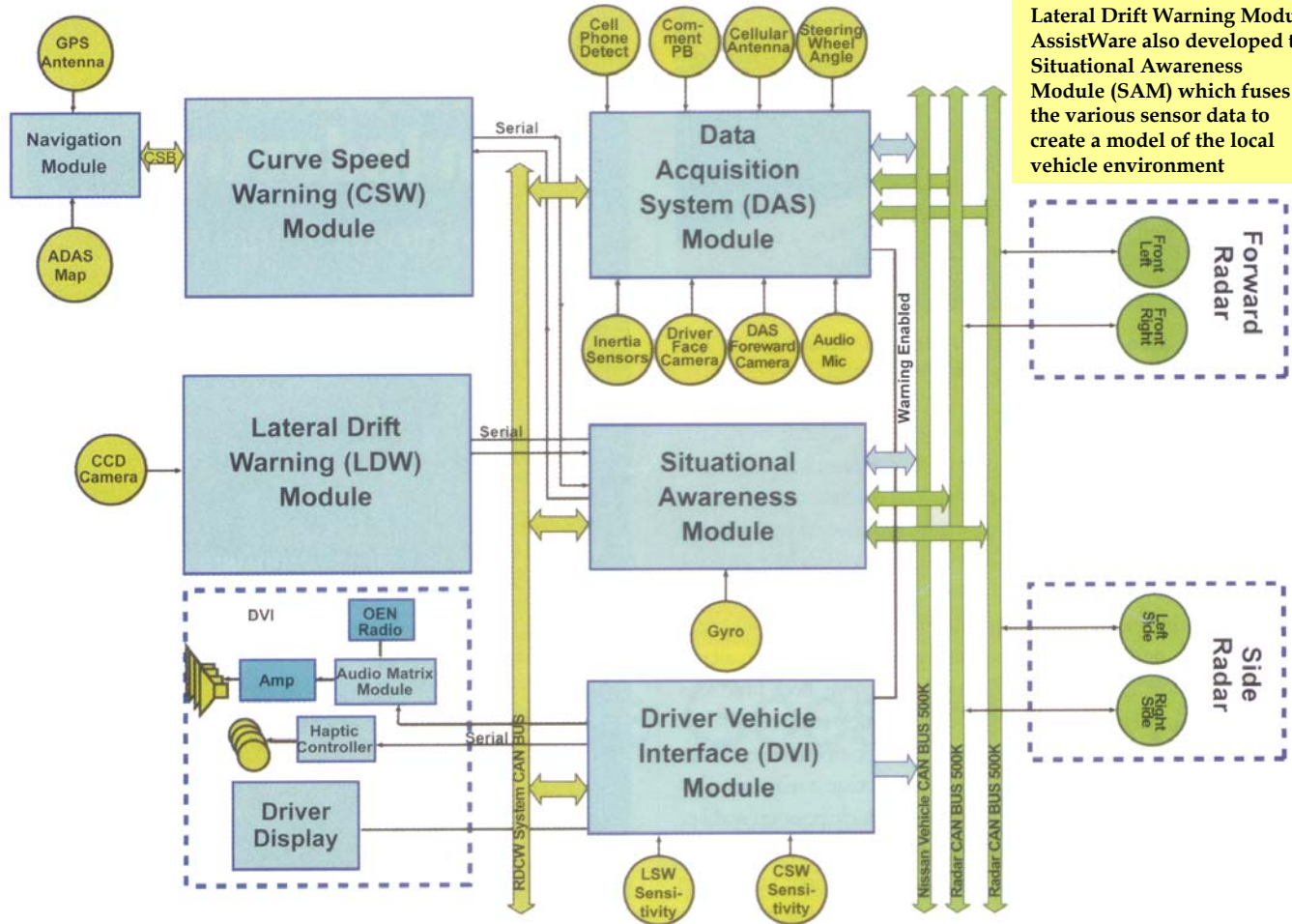
Forward and side facing radar units are mounted at the front corners of the vehicle behind the fascia.

dashboard display and as a vibration on the left or right side of the driver's seat, depending on the direction of lateral drift. An imminent alert occurs when the driver approaches or has crossed a solid-line boundary or when crossing a dashed-line boundary while a vehicle present in the drift path. A red icon appears on the display and a buzz sounds on the side of the vehicle at which the threat is developing.

LDW becomes inactive in the following conditions: on unpaved roads, roads with poor lane markings or badly defined road edges, and at speeds below 25 mph. LDW automatically turns off when drivers engage turn signal so that they can change lanes without receiving a warning. Among the issues being analyzed by Sayer and the UMTRI team is question of driver distraction. "People ignore warnings, it's the cry wolf phenomenon," says Sayer. "We have to be careful not to give false warnings or else people will switch the system off. Another consideration is what is the best type of auditory warning system. Also, we have to consider whether people will rely on the system and take on extra tasks."

A separate element to the RDCW system is known as curve speed warning (CSW). This function alerts drivers if they are traveling too fast to successfully negotiate an upcoming curve. The CSW function uses GPS data and a precise, on-board map database to determine the current vehicle position, the most likely future path, and the geometry of the road along that path. A CSW alert would be issued when, based on the current vehicle position and speed, a substantial level of braking is needed to achieve a safely controllable speed in the curve ahead.

RDCW System Architecture



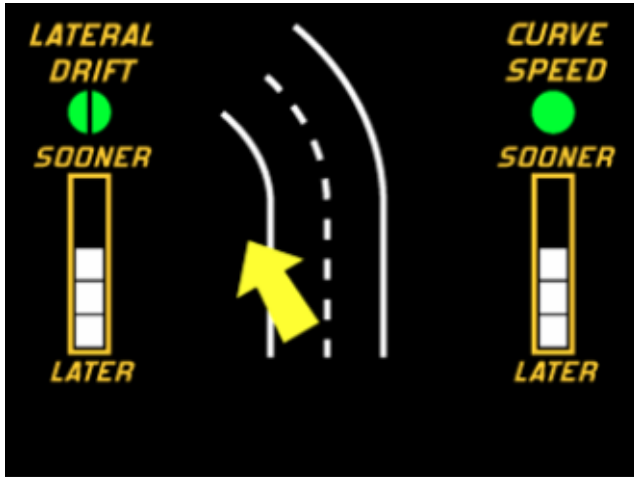
AssistWare provided SafeTRAC to serve as the Lateral Drift Warning Module. AssistWare also developed the Situational Awareness Module (SAM) which fuses the various sensor data to create a model of the local vehicle environment

Drivers receive either a cautionary or imminent alert, based on the degree of overspeed and their remaining distance to the curve. A cautionary alert indicates that a modest degree of braking is needed to avoid overspeed on the curve. The alert appears as a yellow icon on the display and as a vibration at the front of the driver's seat. An imminent alert indicates that a relatively high level of braking is required to avoid a run-offroad collision. A large red icon appears on the visual display and a voice warning says "Curve! Curve!"

CSW becomes active at speeds above 18 mph as long as GPS satellite tracking and map database coverage are available. For the purposes of the UMTRI test program in southeastern Michigan, the existing map database is fairly comprehensive, although Sayer notes that for widespread use, enhanced maps with exact curve radii will be needed in future. The system uses the turn signal and other cues to determine whether an upcoming exit

ramp, or any other roadway branch, is likely to be the selected path.

On the UMTRI test vehicles, more than 300 channels of data are collected every tenth of a second, including vehicle speed, lane position, location of lane and road edges and objects around the vehicle, plus many signals indicating the driver's actions and the state of the vehicle. Data are gathered from radar sensors pointing toward the front and sides of the vehicle, video cameras pointed through the windshield and at the driver's face, and by means of several other instruments that monitor the motion of the vehicle and whether a cell phone is in use. The data acquisition system automatically sends a data sample from the vehicle to the UMTRI facility, via a cell modem, each time the ignition is turned off. A comment button, installed in the dashboard, allows drivers to record comments and suggestions any time they drive. One intended benefit of the lane departure



An in-dash display shows system status and allows drivers to adjust system sensitivity.

systems being developed by Visteon, AssistWare, Valeo and Delphi is that they will encourage drivers to use their indicators. Failure to use turn signals is an increasing problem, especially among the U.S. driver population. According to Valeo, in some countries as many as one in 10 drivers do not use the indicator system before changing lanes.

Delphi's lane departure system was one of a portfolio of safety related technologies presented at a recent commercial vehicle show in Europe. The system uses a monocular camera mounted behind the vehicle's windshield to track lanes in front of the vehicle. It estimates lane width, road curvature and accurately determines a vehicle's heading and lateral position in the lane. If a vehicle strays out of its lane, the system detects the change and issues an audible, tactile or visual warning to the driver. "Our safety products are aware of the road, even when the driver isn't," says J.T. Battenberg, III, Delphi chairman, chief executive officer and president. "This latest portfolio of safety technologies helps keep light-, medium- and heavy-duty commercial vehicle drivers safe while also helping to protect their vehicles and loads." Delphi says recent statistics show that 36 percent of accidents on European highways are caused by unintentional lane departures. The various safety systems being developed by Delphi will, the company hopes, help the European Commission meet its goal of reducing by half the number of road fatalities by 2010.

At Ford and its Swedish subsidiary, Volvo, there are extensive research programs focusing on safety systems

and driver aids. In the case of lane departure warning systems, there are various solutions being considered, says Jeff Greenberg, staff technical specialist at vehicle design research. "We are confident that we can do it in ways that drivers will accept. The new system will be adaptive and intelligent – to sense true driver status."

Ford researchers suggest that when a lane departure is sensed, the sound of running over highway rumble strips could be broadcast to the driver, or a heads-up display could flash red LED lights on the windshield, or the steering wheel could be vibrated. The steering wheel could also be forcibly turned to keep the vehicle in the lane. "What we discovered," says Greenberg, "is that not every technology that helps combat drowsy driving is tolerated or well liked by drivers. False alerts are considered annoying and could nag the driver to the point he or she just turns the system off. And a system that is turned off is not serving any purpose whatsoever."

Ultimately, the answer to the problem of drowsy or inattentive drivers will involve a basic human function as well as advanced technology. According to Greenberg, breaks in driving – such as a stop to go to the rest room or for a quick walk – did not seem to have much effect on combating driver drowsiness during tests. Drivers swiftly reverted to their drowsy state and would soon fall back asleep.

"Nothing beats getting some sleep," says Greenberg, "either for 30 minutes, or better yet, a few hours."

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About AssistWare:

AssistWare Technology, Inc., is a spin-off of Carnegie Mellon University's Robotics Institute. Founded in October, 1995, AssistWare introduced SafeTRAC in 1999 making it the first commercially available lane departure and drowsy driver warning system.

Today, AssistWare's customer base includes automotive OEMs and end-users, commercial trucks manufacturers, and private truck fleets worldwide.

For more information please contact Mike Formica at: 724-449-SAFE (7233)

mformica@assistware.com
www.assistware.com