DRIVER INFORMATION SYSTEMS ARE SPEEDING TOWARD SAFETY

Advances in automotive electronics technology and systems integration expertise are enabling OEMs to provide drivers with more information and more intelligent assistance than ever before. Advanced features are available in luxury vehicles, and with continuing cost reduction, those features are migrating into mainstream vehicles.

The information available to drivers today far exceeds the standard indicators of vehicle speed and engine temperature, and the ominous “check engine” telltale. On Mercedes-Benz (www.mbusa.com) S-class vehicles, for example, the instrument cluster is a TFT LCD and the speedometer indicator is a graphic image rather than a mechanical needle. An auxiliary display within the speedometer provides information for navigation, audio, trip distance and vehicle settings.

The predominant method of backlighting LCDs in automotive displays is still the cold cathode fluorescent lamp (CCFL), according to Bill Abbott, global market strategist for Endicott Research Group Inc. (www.ergpower.com). CCFL-backlit LCDs require a high-power, low-profile dc-ac inverter, and Abbott’s company offers 10 m class devices that measure 4.32-inches (109.7 mm) long, 525-inches (13.34 mm) wide, and less than 10 mm high (Figure 1).

While CCFL-backlit LCDs powered by dc-ac inverters have been used to meet automotive brightness, durability, operating temperature range and styling requirements, advances in LED backlighting technology are changing the landscape, according to David DeAgazio, director of sales at Global Lighting Technologies Inc. (www.glthome.com).

“Now, LEDs are in everything from a simple monochrome PRNDL display to instrument clusters to fully integrated entertainment/navigation/HVAC/trip comp/messaging center console displays,” he said. “In the past, given the low transmissivity rate of automotive LCDs, sizes as small as 2.5-inch or 3.5-inch diagonal required CCFLs to backlight them—now this is easily done with LEDs.”

DeAgazio added that, for brightness, LEDs are on par with CCFLs. “When used with a light guide assembly for a seven-inch GPS display, for example, they can provide about 7,000 to 8,000 cd/m² at the surface of...
the light guide, equivalent to approximately 350 to 500 nits front-of-screen brightness. If RGB LEDs are used, they provide a wider color gamut.”

In addition to the dashboard LCD, the Mercedes-Benz cockpit management and data (COMAND) system includes a seven-inch, 16:0 color TFT LCD screen located in the center console, as well as a motor-driven “turn-and-push” controller between the front seats. The screen rotates to give either the driver or front seat passenger a better viewing angle. The COMAND system can be used to control seat adjustments, automatic locking, the “easy-entry” steering wheel, lights out delay, locator lighting, ambient lighting, outside mirrors, the rear shade, security system, and trunk lid. When the car is in reverse, an optional rear view camera located above the license plate displays the area behind the car. Lines that change with steering input are displayed to assist the driver in parking.

S-class Mercedes vehicles also feature a PRE-SAFE system that uses 24 GHz short-range radar in an information on driving conditions. Siemens VDO Automotive (www.usa.siemensvdo.com) uses 77 GHz frequency-modulated, continuous-wave (FMCW) radar technology for blind spot detection, CMOS cameras for lane departure warning, and lidar for adaptive cruise control, according to Gary Collins, North America business development manager for safety electronics. “Each technology has advantages and challenges,” Collins said. “Radar is best for blind spot detection, because we’re looking at a large area. A 3-D camera would cost too much, and lidar is better used in more limited areas.”

In the blind spot application, for 2008-2009 vehicles, Siemens mounts an FMCW radar module behind the rear bumper. The radar beam is shaped according to IEC 61508 specifications. Reflections are monitored over time, classified by volume and velocity vectors, and processed in relation to the vehicle’s speed and steering angle to determine whether and at what rate objects are moving in relation to the monitored vehicle, and whether the driver should be alerted. The type of alert depends upon each OEM’s preference. If an alert is called for, the radar module communicates with the vehicle’s network; typically a CAN bus. Collins said Siemens’ radar module is based on an MCU that incorporates DSP functionality.

For its LDW system, Siemens mounts a CMOS camera near a vehicle’s rear-view mirror. A 32-bit, 1500 MIPS MCU controls the recording and processing of image data; finding lane markers on the road and alerting the driver if the vehicle begins to move outside of the markers.

Siemens’ lidar-based ACC system measures the distance to the vehicle in front, as well as the relative speeds of both vehicles. When the vehicle in front is too close, the ACC system signals the engine management system to slow the vehicle down. “Some firms use radar for ACC, but 77 GHz radar is costly, and lower-frequency radar beams can’t be focused as directly on the vehicle ahead,” said Collins, “and at high speeds, the ability to focus directly at long distances—to see whether the vehicle ahead is in the driver’s lane, or another lane, becomes important.” To conserve windshield space, Siemens has combined its ACC lidar system with the LDW camera.

Gunter Rottner, engineering manager for automotive electronics
systems at Robert Bosch North America (www.us.bosch.com), counters that 77 GHz, FMCW radar is preferable to lidar for ACC. “Lidar is too easily hampered by water, fog or slush,” he said. “Radar has no issue with that.” Delphi (www.delphi.com) also uses 77 GHz radar for its Forewarn ACC system.

Bosch’s ACC control unit combines a sensor and a controller, and Rottner said the unit is one of the smallest available. It’s available on the BMW 7 series and on the Audi A8, A6 and Q7, among other vehicles. Rottner said the Audi A6 also comes with Bosch’s predictive safety system (PSS) 1, which prefills the brakes when the radar system detects a critical situation. Predictive safety system 2, on the Audi Q7, consists of a “brake jerk” intended to awaken a drowsy driver who fails to react to predictive safety system 1. Standard adaptive cruise control slows the vehicle to 20 to 25 mph, but the ACC on the Q7 can bring the vehicle to a full stop. Predictive safety system 3 is in development as is a prototype LDW system.

“There is a big push under way (toward safety), and by 2009 or 2010 we’ll see much more than is available today. Information will be integrated from various types of sensors and will result in features we can’t even think about today. Just like the PC evolved from a computer to a media center, we’ll see the same kind of thing in driver information and assistance,” Rottner said.

Driver information and assistance systems are creating demand for 32-bit microcontrollers, DSPs and related circuitry. Matthias Poppel, automotive marketing manager in Texas Instruments’ (www.ti.com) advanced embedded control group, said that TI products for adaptive cruise control are in production, and a blind spot detection system is in development with a customer he declined to name. Lane departure warning, night-vision and park assist systems are in earlier stages of development.

“At first, customers wanted a blind spot detection system that would look close to the car, but now they want to extend the range of the system and look further behind the vehicle,” Poppel said, adding that views within the industry differ on the ways that blind spot detection and lane departure warning systems, for example, or night vision and adaptive cruise control, both of which use radar, can be merged.

“Adaptive cruise control can be deployed at a reasonable price, while night vision coupled with a heads-up display is very expensive,” Poppel said. “Integrating applications can make them more affordable and increase consumer acceptance.”

For blind spot detection, TI offers a 32-bit TMS470-based MCU with 128 KB of flash (Figure 2). A number-crunching slave device gets signals from a radar or vision system and provides information about the object to the MCU. “We believe that a DSP is best equipped to handle high data rates in real time, do the analog to digital conversion and edge detection, run complicated algorithms, and tell the MCU if an object is a car or only a shadow,” Poppel said. TI’s TMS320C28xx DSP includes a high-speed, 12-bit A/D converter on chip and offers 150 MIPS performance for computation. Its TMS320C6x operates in the 300 MHz to 500 MHz range, with performance of approximately 200 MIPS, and is used in vision systems.

The DSP communicates with the MCU through a serial interface and the MCU is connected to a host through the in-vehicle network, with a PWM signal as its output. Poppel said the MCU and DSP devices may,
Figure 3. The display unit (DU) in Renesas’ 600 MHz, 1080 MIPS SH7785 MCU can produce an annotated 3-D picture of what the driver can see through the windshield, based on the vehicle’s location, speed and direction. A 300 MHz, 32-bit dedicated bus is available for connection to external DDR2-SDRAM at up to 2.4 GB/s. A 64-bit wide local bus is available for connecting peripherals.

but do not have to be placed next to each other. Data coming from the DSP needs to be executed quickly.

Poppel added that TMS470-based MCUs and TMS320C6x DSPs will also be used for adaptive cruise control, and the MCUs are currently used for dashboard control. Those devices include up to 1 MB of flash as well as stepper motor control outputs for connection to as many as six gauges and an LCD output.

TI recently added four new 32-bit digital signal controllers to its TMS320C2000 family. Poppel said the flash-based TMS320F2809 and TMS320F2802 and custom ROM-based TMS320C2801 devices combine the real-time performance of a DSP with the programming efficiency of a microcontroller. They all include a patent-pending pulse-width modulator (PWM) with 150 ps resolution and 16-bit accuracy in a 100 kHz control loop (12 bits at 1.5 MHz).

Freescale (www.freescale.com) offers the 885 MIPS MPC5200B for next-generation telematics and infotainment applications. The MCU features a double precision floating-point unit, memory management unit-based architecture with DDR memory support, and integrated CAN and J1850 networking.

The need to recognize objects outside the vehicle demands more real-time processing power, according to Paul Sykes, segment marketing manager for the automotive business unit at Renesas Technology America Inc. (www.renesas.com).

Renesas’ 600 MHz, 1080 MIPS SH7785, with half again as much performance as its current-generation devices, targets next-generation driver information systems (Figure 3). Its four-way set-associative cache memory is divided into two 32 kbyte areas, one for instructions and the other for data. A 300 MHz, 32-bit dedicated bus is available for

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connection to external DDR2-SDRAM at up to 2.4 GB/s. The SH7785 has a 64-bit-wide local bus for connecting high-performance ASICs, a 32-bit PCI bus controller, and an on-chip display unit that can produce a superimposed display of up to three SVGA (800 x 600), four WVGA (800 x 480 pixel) or six 480 x 234 screens. The display unit also offers advanced control capabilities such as transparency processing and overwriting of text information during streaming video playback.

Sykes noted that for a navigation system, the SH7785 display unit can produce an annotated 3-D picture of what the driver can see through the windshield, based on the vehicle’s location, speed and direction. He added that chipsets are giving way to integrated devices like the SH7785 and current-generation SH7770 and SH7780. The SH7770, for example, a 400 MHz processor with a floating-point unit, integrates a GPS baseband, 2-D and 3-D graphics engines, and nearly 50 peripherals. “Five years ago, similar functionality used to require two separate devices,” he said.

Cameras are critically important in advanced driver assistance systems (ADAS) applications, according to Fabio Marchio, deputy general manager of STMicroelectronics’ (www.st.com) powertrain and safety group. ST recently introduced a single-chip, 1.3 megapixel CMOS camera subsystem, VS6624, integrating a CMOS sensor with a digital image signal processor (ISP) and analog system functions in an SmOP2 module that measures 8 x 8 x 6 mm, including passive components.

The VS6624 integrates a 1/3.7-inch optical-format sensor with a 1280 x 1024 active pixel array based on ST’s 3.0 µm pixel design. The ISP provides pixel defect correction, sharpness enhancement, gamma correction, color space conversion, anti-vignetting algorithms and automatic white-balance control, all to optimize picture quality in varying light conditions.

It produces an industry-standard digital video stream at up to 15 frames per second (fps) with full SXGA resolution and up to 30 fps at VGA resolution in a low-power video mode. An image-scaling feature optimizes data for display in non-native resolution settings.

Integrated GPS navigation systems are increasingly common thanks to smaller and less costly GPS chips that offer greater sensitivity and better performance, according to Lars Boeryd, director of automotive marketing for SiRF Technology (www.sirf.com). SiRF’s SiRFstarIIA GPS system on a chip is based on a 32-bit ARM720T RISC processor with MMU and four-channel DMA.

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