Designing infotainment systems that are interactive, not distractive

Texas Instruments

Mike Claassen
General Manager, Infotainment Systems
Texas Instruments

A key selling point in new vehicles today is the technology. Where consumers have historically given preference to a car's road performance, today, it is the performance of the electronics that has many consumers paying a premium, and this trend shows no sign of slowing down.

At the hub of a car's technology is the infotainment system, conveniently located in the vehicle's head unit in the center console, near the instrument cluster behind the steering wheel, and comfortably within arm's reach of front-seat passengers.

The challenge: providing enhanced functionality with safer driver interaction

The vehicle cockpit is evolving with innovations such as the transition to electrification from mechanical components, the availability of real-time driving information from advanced driver assistance systems (ADAS), as well as entertainment features that make driving more fun. Enhancements to the infotainment system are popular with drivers and provide a point of distinction for automotive brands.

While distracted driving is a problem as old as the car itself, responsible infotainment designs must account for and mitigate the risks of distraction.

A recent AAA study indicates that the majority of today's infotainment systems are complex and frustrating. AAA studied 30 systems: all placed a major burden and demand on the users. According to the study, the most distracting functions were using navigation systems, texting and placing outgoing phone calls.

If technology has hastened distracted driving, technology can also address it. Automotive engineers are dedicated to solving distracted-driving challenges, while staying cognizant of consumer demand and the growing expectations that drivers and passengers have for the connected car.

In this white paper, I'll review how infotainment systems are evolving to give drivers all of the benefits of automotive technology while making it safer and simpler to use.

> As cars become more automated, passengers will have higher expectations for in-vehicle entertainment and connectivity, particularly given the ultimate future of self-driving cars and robotaxis.

The infotainment system explained

The infotainment system is a central monitoring and control system that manages the necessary functions for entertainment, comfort and safety. The console system that houses the central infotainment function has a mix of features such as those depicted in **Figure 1**, but can also vary considerably with different manufacturers.

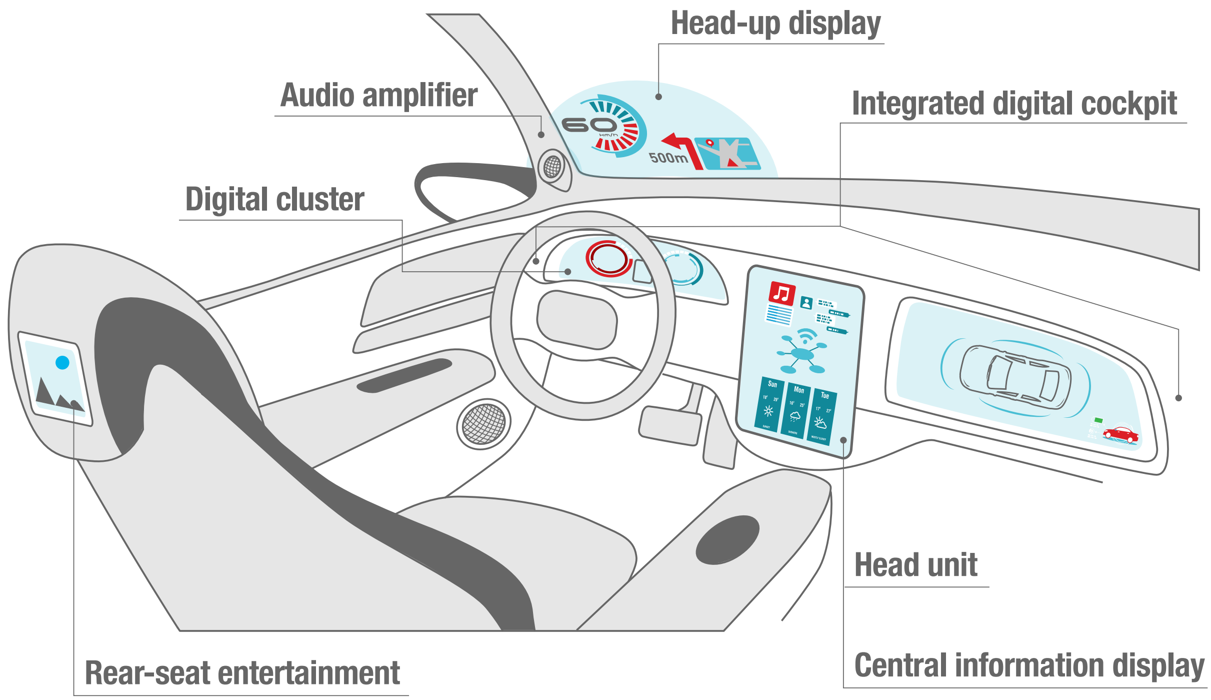

Figure 1. Components of an infotainment system.

Functionality varies by manufacturer, but may include:

- A large center console on the dashboard, typically with a color LCD screen.
- A cluster display.
- Touchscreen controls, with some separate controls or switches.
- Voice activation and control.
- USB and *Bluetooth*® connectivity for cellphones and other peripherals.
- AM, FM, digital audio broadcasting, satellite radio controls and CD players.
- An in-vehicle Wi-Fi® hot spot.
- Audio controls.
- Telematics communications for emergency calling services and more.
- GPS navigation and the integration of maps.
- Display for backup cameras.
- ADAS alerts and actions.

Designing a head unit

Design requirements for cars at different price points can vary. See the head-unit reference designs

A better infotainment system: clearer, simplified and more intuitive

New innovations and thoughtful design can mitigate distractions while further improving safety and convenience, and differentiating infotainment systems from the competition.

Center Information Display (CID) in the center stack and beyond

Digital displays have become the centerpiece of the infotainment system, with digital menu systems and touchscreens increasingly replacing rows of mechanical switches and knobs throughout the cabin. This functionality is a key component in the technology presented to the driver, and it must provide clear and accurate real-time information at a glance, with minimal attention from the driver.

Higher resolution, higher-quality images

Like TVs, if you ask consumers if they want bigger screens in their cars, they'll undoubtedly say yes. Larger screens became popular in premium vehicles and are becoming more prevalent across the fleet. But carmakers understand that it's the resolution of a display that makes a more impactful image, not only the size of the screen. Premium vehicles are now incorporating high-resolution displays providing crisper, easier-to-see images that improve car-to-driver communication.

Higher video frame rates are also rendering better video quality. A typical video might show 24 frames per second. Each frame is a flash of the image; our brains fill in the gaps so that it appears to be a continual feed. The more frames that are displayed, in some cases 50 or 60 frames per second, the richer the image appears.

Driver communication at a glance

Improved visual-display methods are possible for formatting and displaying information. A best practice for displaying data for the driver is to replace text with graphics, icons, animation, simulations and other visuals. Static images are relatively standard in vehicles and are mainly utilized on demand. These can be the simple menu system or an image of the vehicle when a door open chime is sounded. Motion graphics, on the other hand, can aid in the driver's quick comprehension of real-time information such as turn-by-turn, street-view navigation or digital representation of the analog gauges used for speedometers or tachometers.

Designing a cost-optimized digital cluster

The Jacinto™ automotive processor digital cluster automotive reference design is a cost-optimized design for reconfigurable digital cluster systems.

Multiple, smaller screens for specific functions

Smaller screens can also be more effective when they are strategically located throughout the vehicle displaying information that is timely (for example, a camera feed displaying the car's rear-view should be positioned where the rearview mirror would traditionally be) or in context (navigation information in a side-view mirror is only useful for upcoming turns). This can also be as simple as interactive display to control the cabin's comfort located in the center stack to the more revolutionary transparent window display.

Watch the DLP® window display in action in this video.

Light adjustment

Light-detecting sensors can enhance safety by automatically adjusting screen brightness, whether it's day, night or something in between, such as a cloudy day or driving through a parking garage. Dials and gauges that display messages by glowing brighter or shining with different colors don't require much more than peripheral vision or a quick glance from the driver. Local dimming can further increase the readability and visual aesthetic of these displays by turning off unneeded backlights, creating truer blacks, higher contrast and less light bleed. Adjusting the lights is also easier on the eyes and can reduce eye strain.

Conserve power and extend the life of LCDs

This local dimming backlight reference design enhances automotive display quality through high dynamic range or localized dimming technology.

Mirror replacement and enhancement

Car mirrors as we know them will become obsolete – replaced by cameras. Rear-facing cameras have already changed the way drivers drive in reverse; additional cameras will alleviate blind spots from the back seat's C and D pillars. Replacing exterior mirrors with cameras can expand driver visibility while also improving aerodynamics and overall fuel efficiency. Filtering techniques can provide a more clear rear view in direct sunlight or low-light conditions.

Head-up display

Drivers can keep their eyes on the road with future head-up displays (HUDs) that span the entire width of the windshield. An augmented reality (AR) HUD maximizes the windshield as usable space by projecting real-time information and augmenting its view. As an ADAS feature, AR HUDs overlay the ADAS sensor object/threat data directly in the drivers line of sight to improve situational awareness and reduce reaction times.

Better than reality

This reference design provides an electronics subsystem designed to drive an automotive AR HUD. DLP® technology enables bright, crisp, highly saturated head-up displays that project critical driving information onto the windshield.

The next-generation of driver inputs and alerts

Knobs, dials and buttons still have their place, but as more information is provided to the cockpit many driver input functions will evolve.

Driver monitoring through eye-tracking

Another way for the vehicle to interact with the driver is by tracking eye movement. This can be a powerful way for the vehicle to understand the needs of the driver and to provide relevant real-time views. In one scenario, the eye-movement of a driver that glances from the rear-view mirror to the passenger-side mirror may show the intention to switch lanes. The vehicle then might highlight another car coming up rapidly into the merging lane.

Small cameras for a bigger view

This camera module reference design addresses the need for small cameras in automotive systems.

Touchscreens and haptics feedback

Another popular feature is larger and more responsive touchscreen-button selection. Many buttons today are too small and require precise pressing motions to achieve the desired action. At the same time, without the tactile feedback of buttons, finicky touchscreens can require drivers to take their eyes off the road to make a selection.

Device integration

Smartphones, tablets and other devices have become integral to our modern lifestyle. With all of their conveniences, these devices are also increasingly connected, data dependent, and pinging for our time and attention. The challenge for original equipment manufacturers is to incorporate smart devices into vehicles without allowing them to distracting driver. Display mirroring applications such Apple CarPlay or Android Auto allow touchscreens already in the vehicle to run applications with data provided by the smart device. Hands-free audio and virtual assistants such as Alexa or Siri greatly enhance hands-free interaction with the smart devices. Vehicle occupants will expect these systems to seamlessly integrate with infotainment systems as we progress toward autonomous vehicles.

Rear-seat entertainment

As vehicles become more autonomous the best seat in the car won't be the driver's seat or even the front seat, it will be the rear passenger-side seat. This seat is optimal because it allows the passenger to safely exit the vehicle curb-side. If you remove the passenger front seat or move it forward, it has the clearest view forward and the most leg room.

One subtle evolution of smart-device integration is coming in rear-seat entertainment (RSE) systems. Whereas RSE systems previously played content through DVD players, now smart devices deliver content; the rear seat experience has evolved more to connected displays, with charging capabilities, better audio and control the vehicle's rear-seat comfort systems.

Gesture recognition

As innovative as touchscreens have been for personal electronics, many require deliberate attention to perform commands. Gesturing capabilities enable drivers to manage systems with minimal attention. With a simple swipe of the hand or twirl of the finger, drivers can control systems for comfort and convenience without taking their eyes off the road. Next-generation vehicles will offer straightforward contextual menu selection, screen manipulation or even a combination of gesturing paired with voice control.

Gesture recognition with mmWave sensors

Watch a short gesture recognition demonstration.

Haptics

Haptics feedback can provide a tactile feel to a smooth surface such as a screen or a touchpad. It has been around for a while in smartphones, smartwatches, tablets and other personal electronics. Haptics technology is not widely deployed in automotive today, but the ability to interact with a controls through non-visual feedback helps make these touch surfaces less distractive. Simulating the touch of a simple key press or more complicated zoom or scroll actions helps validate to users that the desired action has been initiated in a nonvisual way. Haptics enables users to engage with the touchpad without requiring their full attention.

Voice activation and response

Voice recognition is already standard in most modern automotive infotainment systems. For instance, the popular hands-free Bluetooth® calling feature has already proven to be effective and even necessary as hands-free cell phone laws go into effect worldwide. Audible alarms like buzzers and chimes do not require drivers to take their eyes off the road. One question is how to present multiple audio effects that drivers can distinguish, interpret their meanings and the level of urgency they represent. An innovative audio profile design will enable drivers to easily learn and recognize various sounds.

Voice activation and response capability through far-field microphone arrays can also initiate action without distracting drivers. While voice command capability is available in some vehicles, these systems can be further improved by adopting the technology of the more highly developed and effective virtual assistants in smart speakers. Artificial intelligence voice software offers improved recognition of voice commands as well as more detailed responses. Far-field microphone arrays help improve voice recognition accuracy within noisy vehicles. Voice-activated systems may be one of the best solutions to the distraction problem. Drivers will eventually learn and become more comfortable with voice commands.

Designing infotainment for the senses

Infotainment system designers can explore ways to maximize the human senses of sight, touch and sound to provide advanced functionality with minimal distraction while driving. Keeping their eyes on the road, drivers can receive alerts and perform functionality with their other senses, such as their voice or through gesturing. Human senses have limits that can be overcome through technology, such as filtering sunlight on cameras.

The ultimate goal is to design infotainment systems that enhance the driver's ability to drive safely while enjoying the ride.

Find infotainment systems design resources at TI.com/infotainment.