Automotive HMI Redefined

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Human Machine Interfaces, or HMIs, traditionally consist of multiple systems which allow drivers to interact with their vehicle. In today's automotive designs, the HMI also displays any feedback from the vehicle to the driver. This interaction begins the instant one unlocks the car door, continues while driving, and ends the moment the driver gets out and locks the car. It involves the optimal balance of the driver's sensory inputs to make the driving experience both safe and enjoyable. Some of the more commonly recognized HMI system modules for enhancing the driver's experience are keyless entry, power seats control, side mirror control, occupant detection, and most importantly, the vehicle's center stack where the majority of human-machine interactions take place.

Today, more and more companies are venturing to introduce technologies one would expect to be consumer electronics features into vehicles. In addition, the HMI is being extended to allow drivers to control and access personal electronics devices, from cell phones to mp3 players, through the car's infotainment system.

How drivers interact with these systems is also changing as mechanical buttons give way to capacitive touch inputs, resistive touch screens to capacitive touch screens, standard bulbs to high brightness LEDs, and standard color to color mixing solutions.

The automotive industry is going through a Human Machine Interface revolution that continues to change the way drivers and passengers interact with their cars. Looking back at some of the new products introduced during the past few years, and knowing what exists in the development pipeline, one can, with some confidence, project what features drivers might be able to select from when buying a new car.

One challenge the automotive market faces is how quickly it can adopt and adapt to these new technologies. Today, semiconductor companies offer a wide range of automotive qualified products with integrated development tools to empower automotive system designers to design-in, test, optimize, and launch designs one might otherwise only see in the consumer electronics arena. Capacitive touch technology, for example, offers flexibility and a high level of customization, enabling automotive designers to merge new features with already existing mechanical designs for functionality enhancement, button replacement, touchpad input device, capacitive touch screens, proximity sensing, or a combination thereof.

****Based on Cypress' PSoC family of mixed signal array products, CapSense expands the standard analog programmability of PSoC by providing a flexible and cost effective means for implementing capacitive sensing, proximity detection, and capacitive touch screens on a single chip. Scope of integration depends on product used and internal chip resources available.

Button Enhancement

Button enhancement refers to the use of capacitive sense technology to complement or expand the functionality of traditional mechanical buttons. With the functional integration in infotainment modules, buttons can be programmed to match driver preferences. Capacitive sensing provides important value by adding another functional layer as simple as button function preview or proximity detection as described in the proximity sensing section below.

Figure 1a - Button Enhancement - Function Preview

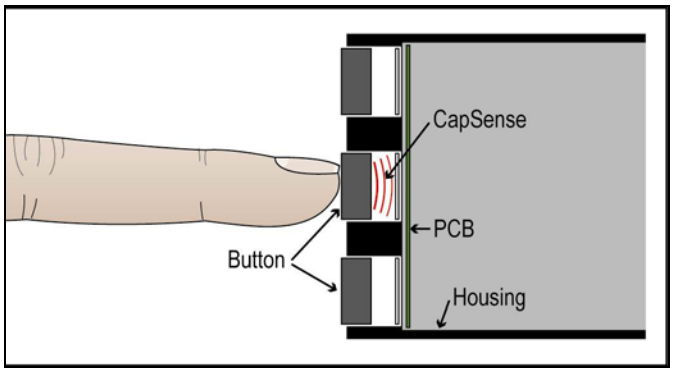


Figure 1b - Button Enhancement - Function Execution

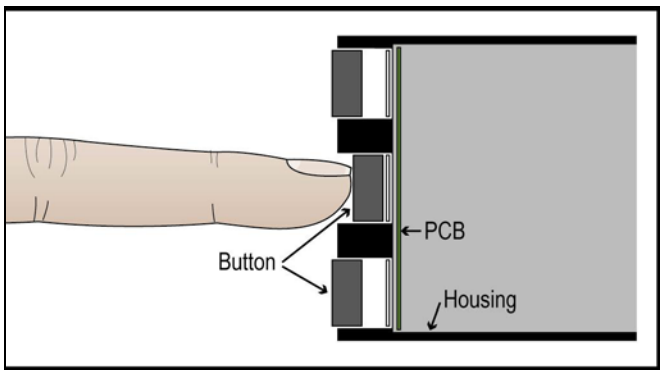


Figure 1 shows a conventional faceplate implementation using mechanical buttons in addition to capacitive sensing. By touching the button (Figure 1a), the display provides a preview of the programmed button function, and pushing the button executes the pre-programmed command (Figure 1b). Button functions can range from radio station presets, saved playlists, and phone number speed dials, to favorite destinations in navigation systems. Capacitive touch can also be used as a redundancy safety feature to detect a stuck-switch failure mode for function-critical mechanical switches such as an ESC (Electronic Stability Control) Off switch.

Button Replacement

Button replacement is the full implementation of capacitive touch buttons with the removal of all mechanical components from the module switch panel as shown in Figure 2. Capacitive sensing, in this case, provides freedom of design by removing restrictions imposed by mechanical designs such as curvatures, overlay material, and most importantly, manufacturability of complex designs.

Proximity sensing can also be integrated to provide a higher level of integration by disabling controls or turning off panel backlighting until proximity is detected, at which point the system wakes up and returns to full operation. Another value is the added system reliability provided by the elimination of mechanical components which can fail over time and the ability to use a single-piece panel design that provides a sealed design against elements found in the passenger cabin (i.e., all liquids and particles such as dust). Button replacement does pose new design challenges, however, as it can be overcome. Mechanical buttons provide tactile feedback while capacitive touch-based designs rely on feedback from other human sensory inputs such as vision (LED button status) and hearing (buzzer).

Figure 2a - Button Replacement (with optional proximity detection)

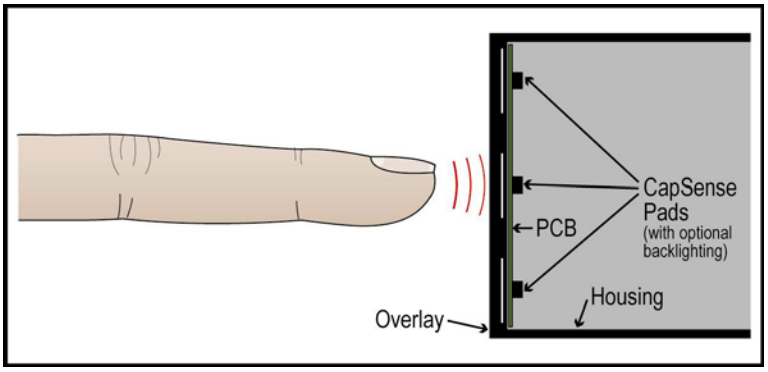
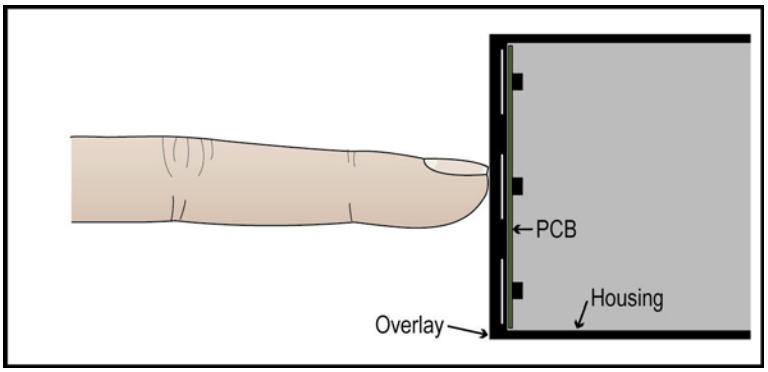


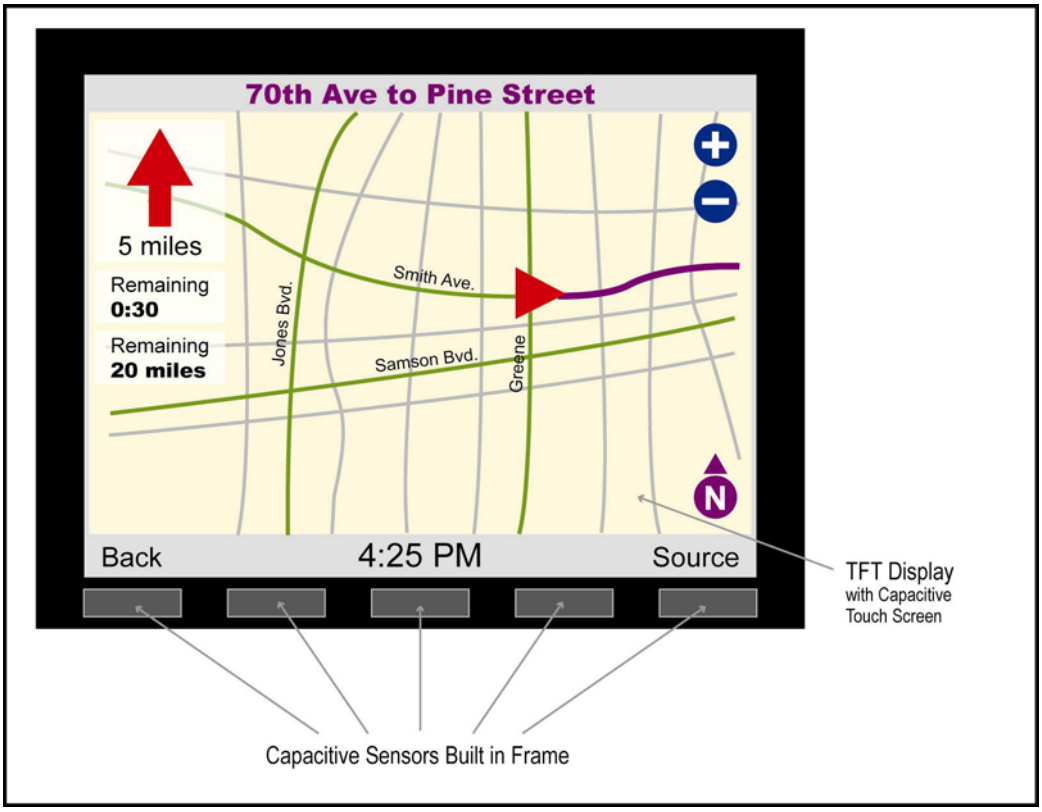
Figure 2b - Button Replacement - Function Activation



Touchscreen and Touchpads

Although visually similar to capacitive touchscreens, resistive touchscreens still have mechanical properties – resistive touchscreens are based on pressure detection rather than touch sensing – which affect their durability and performance in automotive environments and over the life of the vehicle. Capacitive touchscreens will gain traction in new infotainment systems due to their durability over time and across the automotive temperature range as well as their resistance to scratches and higher transparency versus resistive touchscreens. As higher transparency is directly correlated to system power consumption since it requires lower backlighting intensity, this in turn reduces overall power consumption in systems where power management is highly complex due to the tight packaging and location of the electronic modules. Figure 3 shows an example implementation of a navigation unit with capacitive touch pads embedded in the bezel.

Figure 3 - Capacitive Touch screen with optional input pads

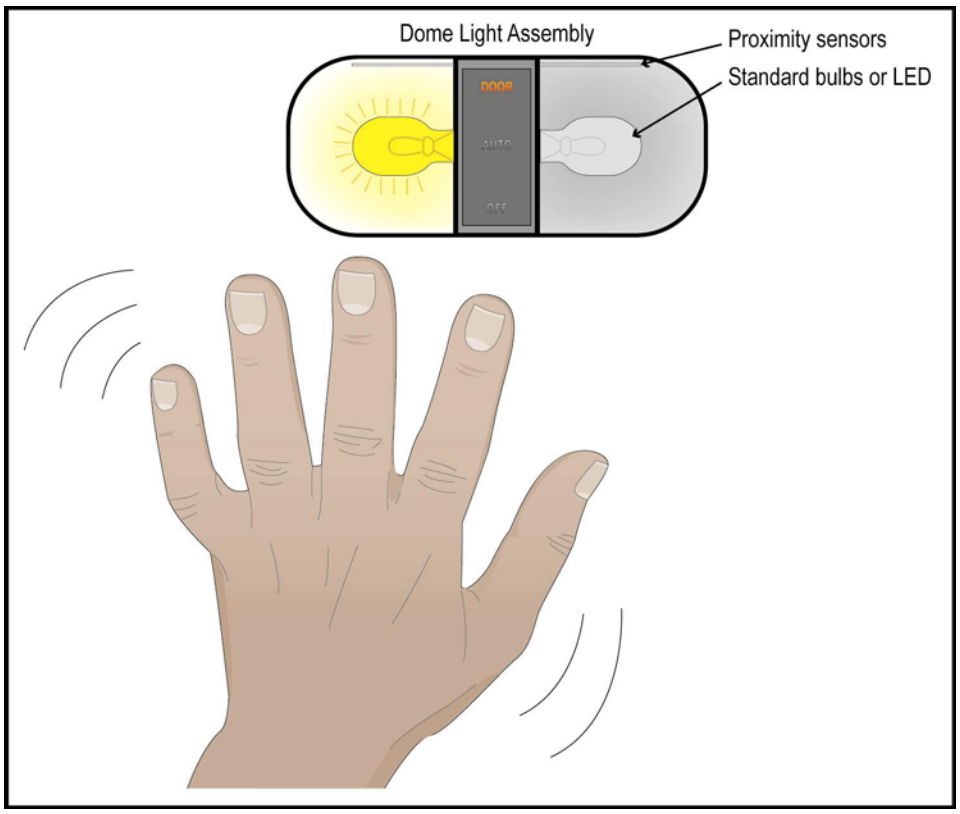


For center stack designs utilizing a mechanical input controller (joystick-like controller) rather than a touchscreen, touchpads offer, in addition to conventional menu control (similar to a laptop touchpad), extended features such as handwriting recognition and all the advantages a touch sense device offers compared to a mechanical design.

Proximity Sensing

Proximity sensing goes beyond button enhancement and button replacement. With proximity sensing, buttons can be completely removed, giving way to full design flexibility and module packaging as well as increased reliability. Proximity sensing applications are mainly tied to illumination control and can be implemented in dome light assemblies (see Figure 4), door pocket lighting applications, and storage compartments. User detection is another proximity sensing application when implemented in the door handle (passive keyless entry) and in the vehicle center stack (to detect whether the driver or passenger is reaching for the controls and to customize button functions accordingly.)

Figure 4 - Proximity Illumination Control - Dome Light Control



Conclusion

With the single concept of capacitive sensing, HMI designs will be re-invented without being limited by the constraints previously set by mechanical components. Time will tell how quickly and widely Tier 1 and OEM will adopt this technology, but seeing the traction capacitive sensing made in the consumer market, many car enthusiasts hope the process will be quick and across all major automotive platforms.

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