2025 July

Exterior HMI

How Cars Will Communicate with the Outside World

Chris Schreiner

+44 1313 588 626

chris@userdrivenstrategies.com

www.userdrivenstrategies.com

USER DRIVEN STRATEGIES

TABLE OF CONTENTS

User Driven Strategies

User Driven Strategies

Introduction

Car HMI has traditionally focused on the driver and passengers interacting with interior controls and displays. However, the proliferation of sensors on the exterior of the vehicle, the development of autonomous vehicles, and new lighting technologies are providing opportunities for greater interaction with the exterior of the car.

This report examines exterior HMI use cases, publicly available demonstrations, and outlook for UX opportunities with exterior HMI in the following categories:

- Visual
  - Exterior gesture/voice control
  - Exterior touchscreens / displays
  - Ground light projection
- Audio
  - Vehicle-initiated audio communication

2. Exterior Gesture / Voice Control

User Driven Strategies

Use Cases:
Exterior Gesture/Voice Control

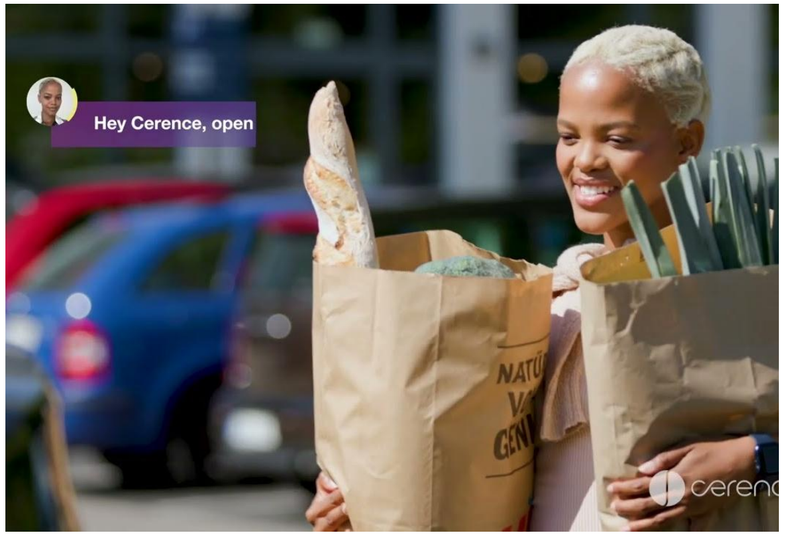
- Exterior gesture and/or voice control has been showcased primarily for vehicle access: unlocking and opening doors and tailgates.
- Some implementations have suggested additional use cases around vehicle control (e.g. starting the vehicle, initiating remote parking feature)
- Additional microphones would be necessary outside the vehicle to capture voice, while cameras or mmWave radar would be required to capture gestures.
- Power consumption is key as the vehicle is typically off during these use cases. A low-power monitoring solution is required to detect when a keyfob, phone, or person is nearby to wake the system up. Even so, too many false activations would have an impact on battery life and performance.

User Driven Strategies

Source: Continental

Continental

- At CES 2025, Continental showcased their Intelligent Vehicle Experience which utilises exterior biometrics and gesture recognition.
- The vehicle can use facial and gesture recognition to recognise authorised users of the vehicle and their intentions, prompting the vehicle to open and start the vehicle or proactively open the tailgate.
- Through biometrics it also identifies persons who are not authorised to use the vehicle and may approach it with criminal intent. In this case, the doors remain locked and a warning is activated.



Source: Cerence

Cerence

- Cerence began demoing the Cerence Exterior Vehicle Interaction concept in 2022.
- Using natural language and voice biometric identification, Cerence claims users would be able to open and close doors and tailgates, start the vehicle, and initiate remote parking.
- Using external speakers, drivers would also be able to communicate with people outside the car (e.g. pedestrians).

User Driven Strategies

Source: Voyah

Voyah

- At the Shanghai Auto Show in 2023, Voyah demonstrated their exterior gesture control capabilities in their Zhuiguang model.
- Exterior gesture control requires a wristband to authenticate, capture gestures, and communicate with the vehicle, providing an extra layer of security and improving accuracy.
- Gestures can also be used to open the tailgate and windows while outside the vehicle.

Source: Huawei

Huawei

- Huawei is implementing gesture recognition to unlock and open doors from the outside. Approaching drivers can point to the door they wish to unlock. Other demo videos show the user using gestures to “grab” the door and “pull” towards them to open.
- Passengers can also use gestures to close doors once inside the vehicle.
- In the new Huawei MAEXTRO S800, gesture control to close the doors is standard, but it does not seem that external gesture opening is enabled.

User Driven Strategies

Geely/Baidu

- The JiYue 01, a joint venture between Geely and Baidu, has exterior voice recognition.The vehicle was launched in Q4 of 2023.
- Using SIMO, backed by Baidu’s Ernie Bot AI engine, users can open and close doors and access valet parking.
- An external mic and speaker accompany a small display above the front left side wheel. The lights blink when to indicate status.

Source: Huawei

Changan

- The Changan Nevo A07, also launched in 2023, allows voice commands outside the vehicle.
- The system uses iFlytek’s XTTS 4.0 engine.
- From outside the vehicle, users can operate the air conditioning, audio, lights, windows, doors, rear tailgate, charging cover, and valet parking.

User Driven Strategies

User Driven Strategies

Analysis: Gesture & Voice Control

- Chinese OEMs are leading the way in showcasing the potential for gesture-based door opening as a means of differentiating luxury vehicles.
  - This suits that specific vehicle type in that specific market but are not worth the investment in additional hardware and software for other markets, apart from the already implemented foot gesture to open tailgates.
- Voice is an even more difficult proposition to justify the hardware given the limited use cases and accuracy of speech recognition at a distance in an outdoor environment.

3. Exterior Touchscreens / Displays

User Driven Strategies

Use Cases:
Exterior Touchscreens & Displays

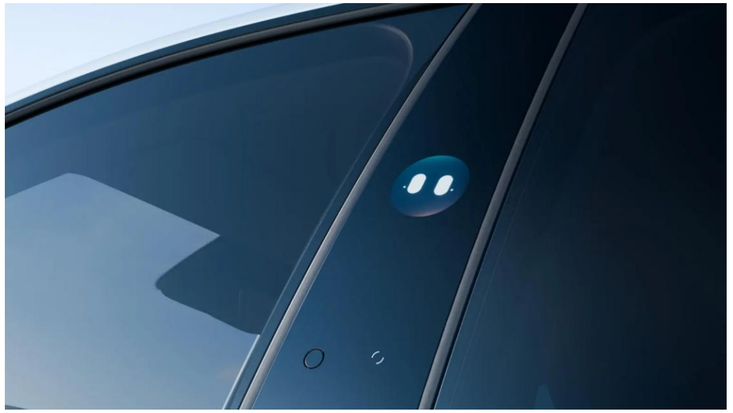
- There are two in-production use cases for exterior touchscreens and displays:
  - Vehicle access. Capacitive touch, a small display, and cameras and other sensors to detect presence are used to unlock the vehicle and open/close doors.
  - EV charging status. More of an informational display than an interactive element, battery life and charging information are displayed.
- These features are becoming more prevalent in Chinese premium vehicles as they continually strive for tech-forward features.
- A third future use case is for autonomous vehicles communicating intent with pedestrians and other road vehicles.

User Driven Strategies

Source: Continental

Continental

- An exterior display is also part of Continental's Intelligent Vehicle Experience for unlocking and opening doors.
- A camera integrated into the B-pillar checks the visual match with an authorised user and allows for the recognition of real skin to protect against images being used for access.
- Their demo shows a display on the B-pillar to communicate system status.



Source: Zeekr

Zeekr

- The Zeekr 7X is equipped with a ToF 3D camera and a multimedia touchscreen.
- It is used with a camera for facial recognition for access and also displays battery charging information.

Source: Human Horizons

Human Horizons

- The HiPhi X from Human Horizons has a similar display on the B-pillar as Zeekr.
- It is used with a camera for facial recognition for access and also displays battery charging information.

User Driven Strategies

User Driven Strategies

Analysis: Touchscreens & Displays

- Having an external display the driver can call up to check charging status is an excellent use case for an exterior display.
- Vehicle access via touchscreen can be limited to premium vehicles as there are other methods in production that can achieve similar ease of entry without the added cost of an external touchscreen.
- Much research has been conducted on appropriate messaging for AVs when communicating with pedestrians (link). At least some of these enhancements should be safety features across ALL vehicles.

4. Ground Projection

User Driven Strategies

Use Cases: Ground Projection

- Ground projection was initially implemented for branding and style purposes, projecting the brand logo on the ground when the doors were opened.
- These systems could also be used as advertising mobility services. For example, a carsharing vehicle not in use could project a QR code to reserve the vehicle.
- Ground projection is evolving to become one part of the AV to pedestrian communication solution which can also be implemented in all vehicles, signalling vehicle intent (e.g. about to turn).
- A more niche use case would be implemented with additional sensors to detect and highlight standing water outside the vehicle so occupants avoid a puddle.

User Driven Strategies

Hyundai Mobis

- As part of their "MOBION" electric vehicle showcase at CES 2024, Hyundai Mobis demonstrated new ground projection lighting.
- During diagonal or lateral movement, MOBION can illuminate the vehicle's direction on the ground across a 360-degree spectrum.
- MOBION can also generate crosswalk stripes for pedestrians to use when they are detected.

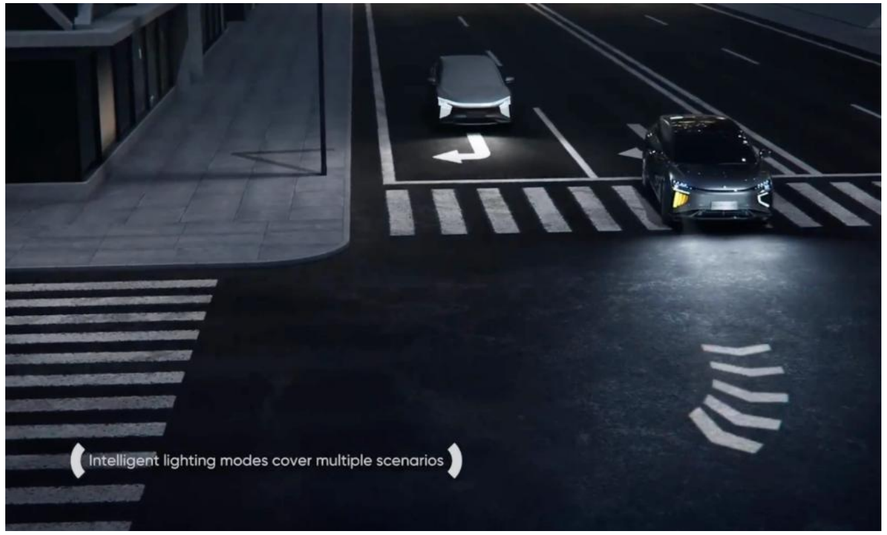
Continental

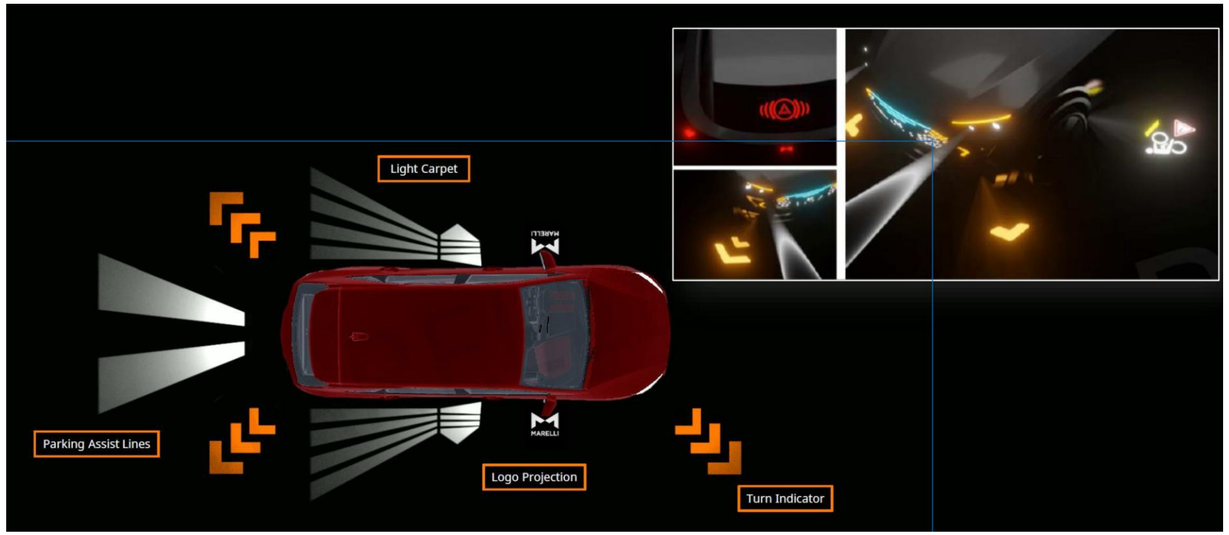
- At Shanghai 2025, Continental showcased their new near-field projection based on laser beam scanning (LBS).
- It can project high-precision images or information like navigation guidance, safety alerts, and personalized driver messages onto the ground – even in colour.

Texas Instruments

- Dynamic ground projection using DLP technology from Texas Instruments provides high resolution projections within a discreet and compact system which can be mounted inside car doors, side mirrors, bumpers, headlights, and taillights.
- DLP supports the full colour range and can cover branding, personalisation, pedestrian communication, navigation, and safety warning use cases.

User Driven Strategies





Human Horizons

- The HiPhi X from Human Horizons is equipped with its ground projection lighting system called Intelligent Signal Display (ISD).
- ISD can highlight current vehicle trajectory and project vehicle intent when a turn signal is activated.

Marelli

- In 2023 Marelli introduced the h-Digi® microLED module, enabling image projection. Marelli h-Digi® microLED can project warnings or driver assistance images on the road, directly in the driver's field of view.
- They also support near-field ground projection.

User Driven Strategies

User Driven Strategies

Analysis: Ground Projection

- Ground projection systems have the significant drawback that they only work well at night.
- Since crash rates are higher at night, safety use cases such as signalling vehicle intent would be a welcome addition, provided that they do not distract (e.g. if too many vehicles were projecting their intent all at once).

5. Car-Initiated Audio Communication

User Driven Strategies

Use Cases:
Car-Initiated Audio Communication

- Car initiated audio communication is currently confined to robotaxi use cases and EVs/hyrbids which use fake engine sounds to alert pedestrians of their presence.
- With robotaxis, audio communication can be used if a pedestrian is in the way or interfering with the vehicle. An alert and message can be played to request the pedestrian move out of the intended path of the robotaxi.
- Audio communication is also helpful if the robotaxi has unexpectedly stopped or encountered an issue by communicating vehicle status and providing updates (e.g. “This vehicle has encountered an issue and services are on their way”).
- There have been prototypes of audio communication between human drivers and external pedestrians either through canned messages or actual voice.

User Driven Strategies

Waymo

- Waymo implemented external audio alerts in 2023 to alert pedestrians if they are in the intended path of the vehicle or to inform pedestrians that Waymo is working to get the vehicle moving.
- Alerts to prevent intentional tampering with Waymo vehicles progress through levels of severity, including warning that authorities will be called.

Zoox

- Zoox also provides external speakers in its vehicles to ward off “bad actors” with a series of pre-canned messages.

User Driven Strategies

User Driven Strategies

Analysis:

Car-Initiated Audio Communication

- Audio communication with pedestrians are still necessary for robotaxis.
- We do not recommend their use with human-driven vehicles due to the potential for misuse (e.g. road rage or harassment).

6. Conclusions

User Driven Strategies

User Driven Strategies

Conclusions

- With the proliferation of sensors and displays, and the emergence of software-defined vehicles, there has been more attention provided to external HMI.
- Use cases are primarily around vehicle access and communication with pedestrians or other vehicles.

- **Vehicle Access**
  - The vehicle access use case is dubious as there are already suitable low-effort and low-cost means of access – for over a decade cars drivers have been able to unlock their vehicle by pressing a button on the door handle if a keyfob is nearby. Using facial recognition or speech to do the same may provide a certain premium value but is also less accurate. We expect these to be confined to premium or ultra-premium vehicles primarily in China.

User Driven Strategies

Conclusions

- **Safety use cases**
  - Overall, safety use cases look more promising, but still have limitations.
  - Visual and audio communication from robotaxis to pedestrians and other vehicles is likely necessary, particularly in areas like the UK and parts of Europe where driving is more collaborative (e.g. giving way or turn taking on narrow streets).
  - Projecting vehicle intent on the forward roadway has a central paradox that will be difficult to overcome: the effect is best when little traffic is around, but that leads to minimal benefit. When traffic is congested would provide the biggest benefit, but if too many vehicles have the feature it becomes confusing and distracting.
  - Ground projection will best be suited for near-vehicle information (e.g. communicating path when reversing, providing a carpet of light to assist find a vehicle in a car park).

MORE INFORMATION

Chris Schreiner

Principal / Founder

+44 1313 588 626

chris@userdrivenstrategies.com

For more details about the data described herein, or for User Driven Strategies clients with inquiry privilege who would like additional analyses for this data set, please contact the author of this report.

Chris Schreiner is a renowned expert in automotive HMI and UX, with over 25 years of specialized expertise improving the usability and efficacy of UI for human transport. Chris has worked for automotive OEMs, suppliers, academic research institutions, and consultancies, providing objective and actionable guidance impacting design.

Beyond cars, Chris's work spans many other segments including digital health, mobile devices, smart home, and other consumer electronics. He has conducted research across the globe, chaired and presented at international conferences, and authored numerous technical reports and peer-reviewed publications.

USER DRIVEN STRATEGIES