H1 2020

EXECUTIVE LENS

Summarized insights for Human Machine Interface w.r.t. trends in technology, market, and players

FutureBridge

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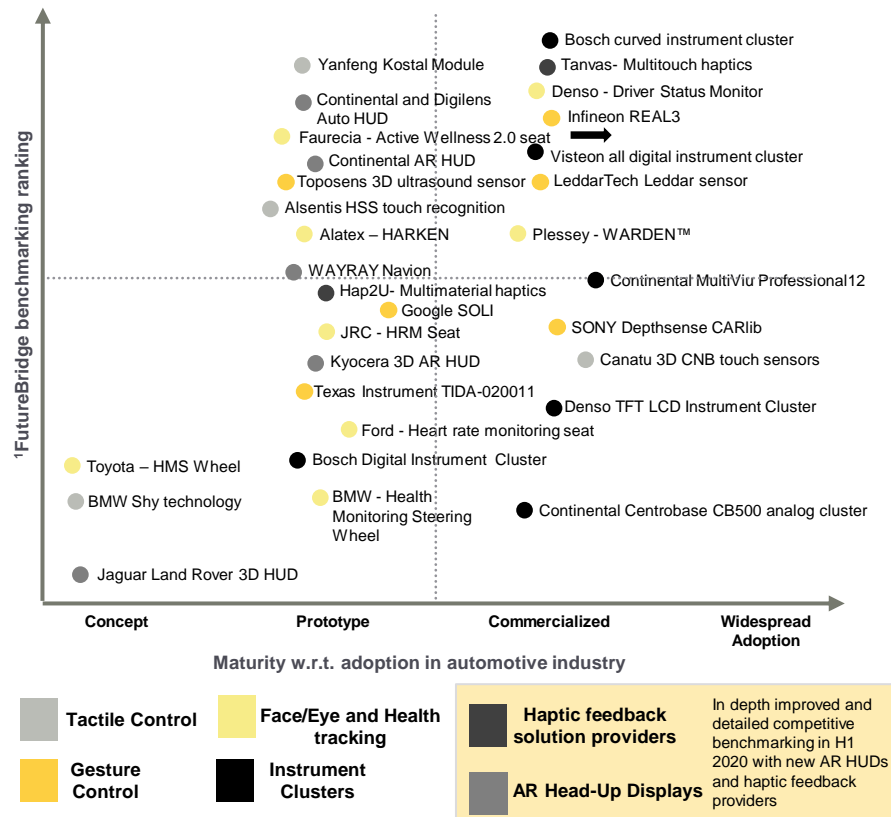COVID-19 impact on HMI

FutureBridge

State of the Trend

Technological advancements pave the way for 3D integration into displays, HUDs and Instrument Clusters. Systems are becoming more intuitive and predictive with the use of voice control technology. Multimodal input was also explored by players to increase the efficiency of the system

'FutureBridge benchmarking ranking (Y-axis)

- Yanfeng Kostal Module
- Bosch curved instrument cluster
- Tanvas- Multitouch haptics
- Continental and Digilens Auto HUD
- Denso - Driver Status Monitor
- Infineon REAL3
- Faurecia - Active Wellness 2.0 seat
- Continental AR HUD
- Visteon all digital instrument cluster
- Toposens 3D ultrasound sensor
- LeddarTech Leddar sensor
- Alsentis HSS touch recognition
- Alatex – HARKEN
- Plessey - WARDEN™
- WAYRAY Navion
- Continental MultiViu Professional12
- Hap2U- Multimaterial haptics
- Google SOLI
- JRC - HRM Seat
- SONY Depthsense CARlib
- Kyocera 3D AR HUD
- Canatu 3D CNB touch sensors
- Texas Instrument TIDA-020011
- Denso TFT LCD Instrument Cluster
- Ford - Heart rate monitoring seat
- Toyota – HMS Wheel
- Bosch Digital Instrument Cluster
- BMW Shy technology
- BMW - Health Monitoring Steering Wheel
- Continental Centrobase CB500 analog cluster
- Jaguar Land Rover 3D HUD

X-axis: Concept | Prototype | Commercialized | Widespread Adoption

Maturity w.r.t. adoption in automotive industry

Legend:
- Tactile Control
- Face/Eye and Health tracking
- Gesture Control
- Instrument Clusters
- Haptic feedback solution providers
- AR Head-Up Displays

In depth improved and detailed competitive benchmarking in H1 2020 with new AR HUDs and haptic feedback providers

- Academic Research developments and Industry player developments were aligned and both focused on the development of voice and display technologies
- Our *Academic Research Synopsis* shows that publications concentrated on contactless HMI technologies like HUDS, displays, voice recognition and Gesture control
- Technology Developments in displays, such as product launches, prototypes, key announcements, incremental technology developments, dominated HMI output activities, followed by voice on the input side
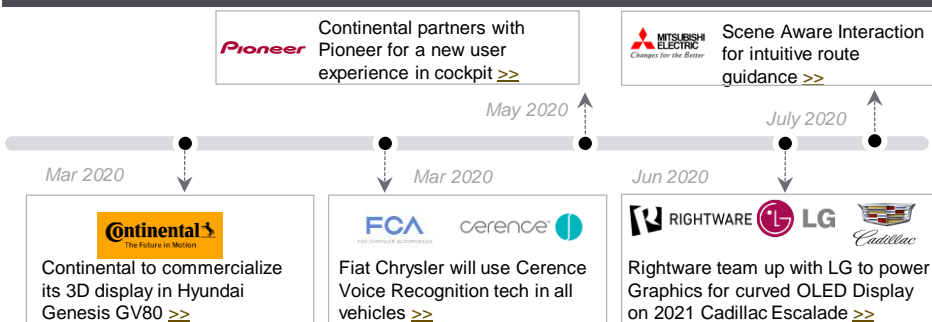
Displays → H1 2020 saw commercialization of 3D displays, curved displays and HUDs. Read more in our Key Supply Chain activities in H1 2020

Voice Control → Voice assistants are getting more advanced with the incorporation of emotional intelligence. New start-ups are emerging which are developing solutions to address the issues faced during speech recognition in voice control. Read more in our Challenges and Solutions highlights

Key Developments in past 6 months

Pioneer — Continental partners with Pioneer for a new user experience in cockpit >>
May 2020

MITSUBISHI ELECTRIC — Scene Aware Interaction for intuitive route guidance >>
July 2020

Mar 2020

Continental — Continental to commercialize its 3D display in Hyundai Genesis GV80 >>

Mar 2020

FCA / cerence — Fiat Chrysler will use Cerence Voice Recognition tech in all vehicles >>

Jun 2020

RIGHTWARE / LG / Cadillac — Rightware team up with LG to power Graphics for curved OLED Display on 2021 Cadillac Escalade >>

Y-axis: FutureBridge Benchmarking Ranking – Outcome of benchmarking analysis performed based on weightage based model. For more details, please check 'Benchmarking section' >>

Strictly Confidential | FutureBridge

Emerging trends

Startups are seen developing multi haptic solution and are adding sensory intelligence to make the feedback feel more realistic and intuitive. On the other hand steering wheel is seems to be critical wherein players are trying to integrate various functionalities for ease of use and to reduce distraction

- With advancements in newer technologies in interior cabin and rise in automation, wellness, convenience and safety plays a vital role
- Earlier touchscreens were used to provide basic vibrotactile mechanism to provide haptic feedback, now players are devising newer ways to provide better user experience
- One of the main problem with the current technologies within vehicles comes from the infotainment center console, where driver is taking their eyes off the road to see if their input was accepted
- Thus, different players are seen coming up with innovative solutions for the same and using different solutions not only to provide haptic feedback but also to advance it and enhance the UI by providing the feeling of texture and mid air haptic

- Cars offer an increasing number of infotainment systems as well as comfort functions that can be controlled by the driver
- Players are finding spaces to incorporate interaction techniques that aim to make it easier to interact with these systems while driving.
- Many of the technology developers are seen utilizing steering wheel as an additional interaction surface by integrating different control and monitoring parameters like gesture, touch, health monitoring, etc. into the wheel itself. Support with benefits and advantages

Technology advancements in haptic feedback is gaining traction

Tanvas — Start-up Tanvas has developed a multi haptic solution which creates the haptic with the help of electrostatic forces and piezoelectric actuators >>

hap2U — Hap2U has developed a haptic technology that can integrate sensory intelligence in touch surfaces >>

DS AUTOMOBILES / ultraleap — The DS AERO SPORT LOUNGE to use Ultraleap's technology in its vehicle. The gesture controls and haptic feedback uses ultrasound technology and hand tracking for mid air haptic sense of touch >>

Read more in our Q1 2020 Pulse

Steering wheel with integrated functionalities to pave its way into cockpit
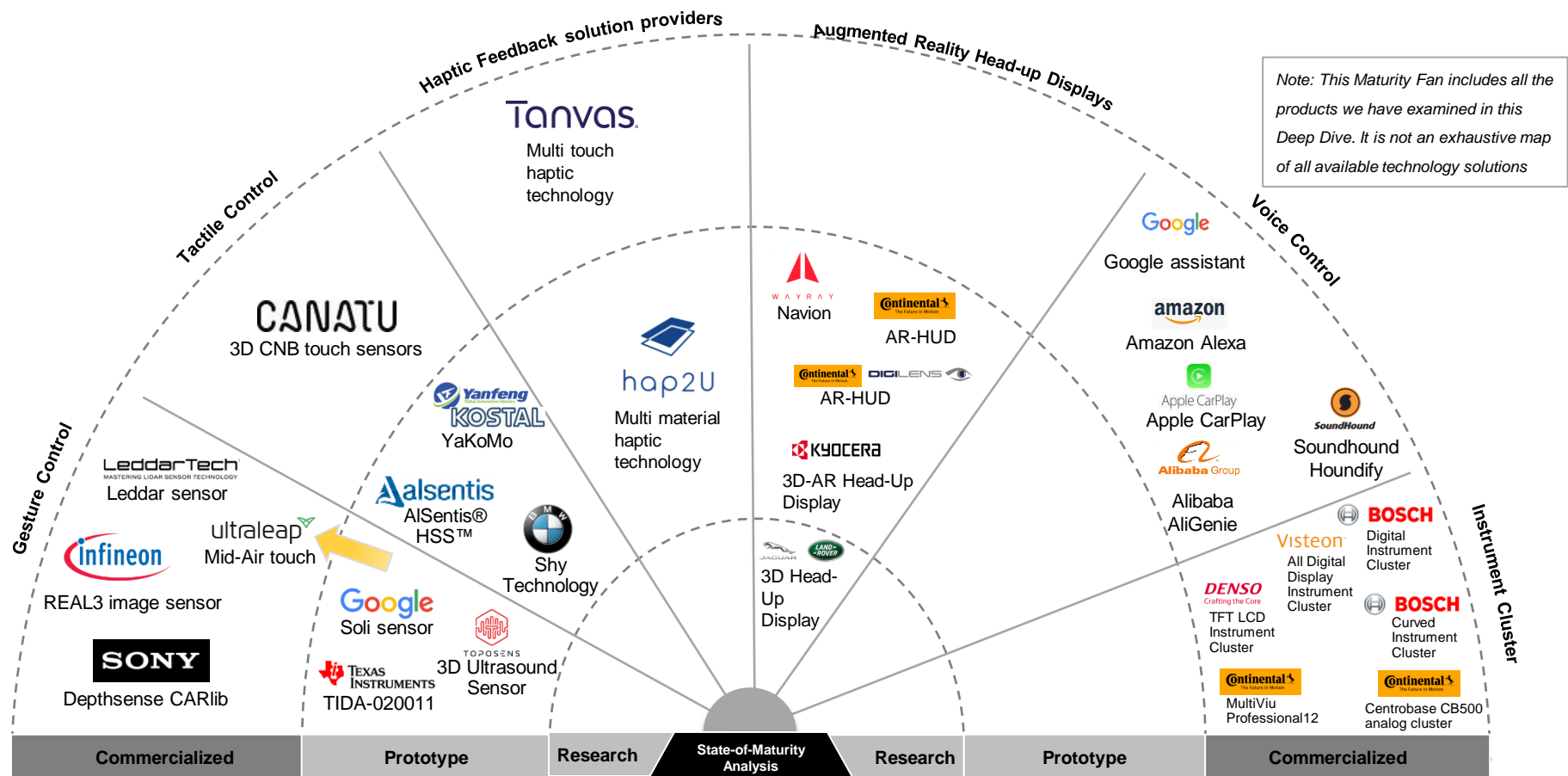
EDAG / HYUNDAI — The EDAG assisted the Hyundai Motor Europe Technical Centre (HMETC) with the development of an innovative virtual cockpit and steering wheel >>

TESLA — Tesla patents steering wheel with gesture control, touchpads. A digitally controlled steering wheel will make navigation more efficient and safer >>

INVENTHELP — An inventor from InventHelp has developed the SMART WHEEL, an automotive steering wheel and app which will stop drunk and marijuana-impaired drivers from operating motor vehicles >>
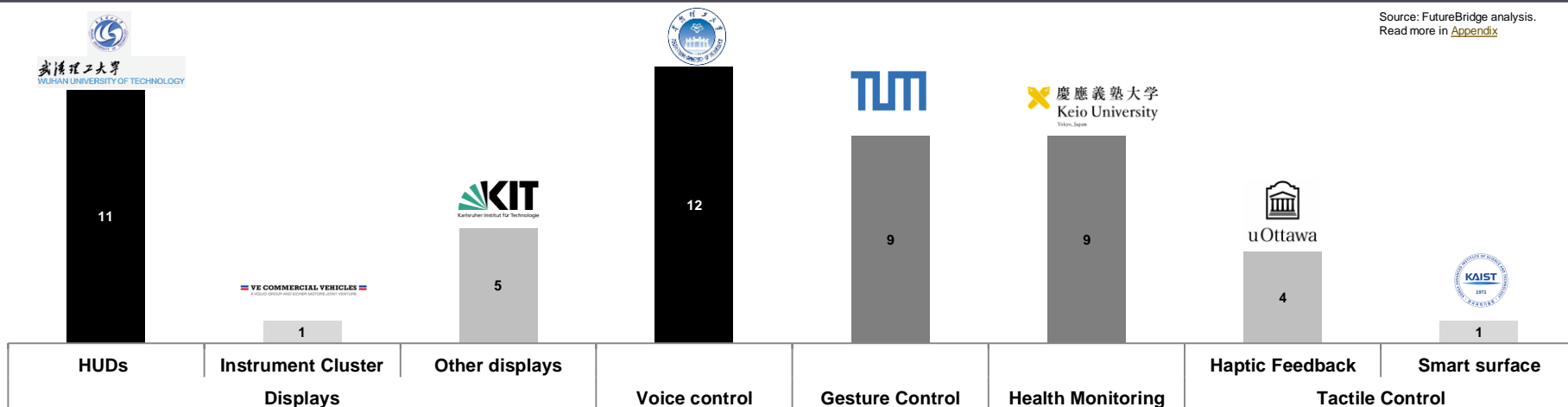
Read more in our Q1 2020 Pulse

Maturity Fan Diagram

Note: This Maturity Fan includes all the products we have examined in this Deep Dive. It is not an exhaustive map of all available technology solutions

Haptic Feedback solution providers

Augmented Reality Head-up Displays

Tactile Control

Gesture Control

Voice Control

Instrument Cluster

Tanvas
Multi touch haptic technology

CANATU
3D CNB touch sensors

WAYRAY Navion

Continental AR-HUD

Google
Google assistant

Yanfeng KOSTAL
YaKoMo

hap2U
Multi material haptic technology

Continental DIGILENS
AR-HUD

amazon
Amazon Alexa

LeddarTech
Leddar sensor

Alsentis
AlSentis® HSS™

KYOCERA
3D-AR Head-Up Display

Apple CarPlay
Apple CarPlay

SoundHound
Soundhound Houndify

infineon
REAL3 image sensor

ultraleap
Mid-Air touch

BMW
Shy Technology

JAGUAR LAND ROVER
3D Head-Up Display

Alibaba Group
Alibaba AliGenie

BOSCH
Digital Instrument Cluster

Visteon
All Digital Display Instrument Cluster

SONY
Depthsense CARlib

Google
Soli sensor

TOPOSENS
3D Ultrasound Sensor

DENSO
Crafting the Core
TFT LCD Instrument Cluster

BOSCH
Curved Instrument Cluster

TEXAS INSTRUMENTS
TIDA-020011

Continental
MultiViu Professional12

Continental
Centrobase CB500 analog cluster

Commercialized	Prototype	Research	State-of-Maturity Analysis	Research	Prototype	Commercialized

Academic research showed increased focus towards the development of contactless HMI technologies

Technology Developers tried to solve challenges faced in some key technologies in contactless HMI. The effect of technology in real driving scenario and to estimate distraction to the driver caused by these technologies was also focused by some of them
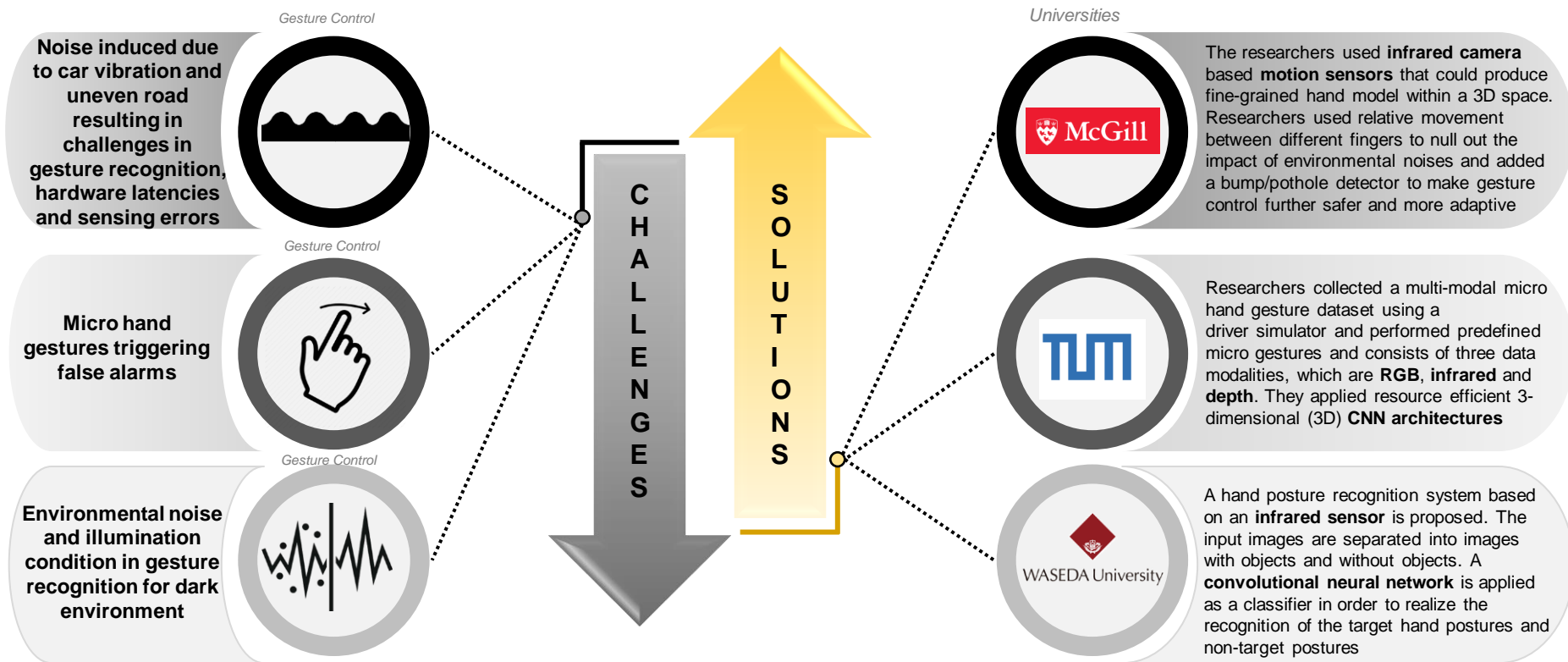
Academic Research publications in 2020

Source: FutureBridge analysis.
Read more in Appendix

Displays			Voice control	Gesture Control	Health Monitoring	Tactile Control	
HUDs	Instrument Cluster	Other displays				Haptic Feedback	Smart surface
11	1	5	12	9	9	4	1

- Non Contact HMI such as voice control, HUDs and gesture control techniques captivated the attention from researchers as there is increased development to include additional mode of interaction in vehicles along with safety and convenience
- Voice Control is an area of interest as technology developers are coming up with solutions that can mitigate the challenges like noise during speech recognition, evaluation of driver distraction because of voice assistants. We expect that the development in the speech recognition system has the highest impact on the technology as the environmental and background noise is one of the major concerns during a conversation. Not only researchers are finding ways to mitigate the effect of noise and filter it but also players are developing solutions to enhance speech recognition in voice control systems in vehicles
- HUDs received increased focus in 2020 wherein researchers like the ones from Wuhan university of technology, were seen using correction algorithms to mitigate the effect caused due to vehicle vibration on HUDs. Also researchers from Dankook University presented methods to quantitatively analyze and correct the distortions and biocular parallaxes in a head-up display (HUD). Majority of researchers were focused to see the impact of these displays on drivers whether they are distracting the driver
- Other displays include development in transparent displays on vehicle glass and holographic micro-mirror arrays as projection screens for transparent display
- Non contact health monitoring with the help pf RADAR received focus from researchers. Read more in our Q2 2020 Pulse PM. Though non contact health monitoring faced some challenges like inefficiency and inaccuracy in detection in an actual driving scenario, researchers in 2020 tried to mitigate it with the help of their proposed systems that suppress false detection and provides solutions to other challenges faced

Key Findings: Technical Challenges and solutions proposed by academia (1/3)
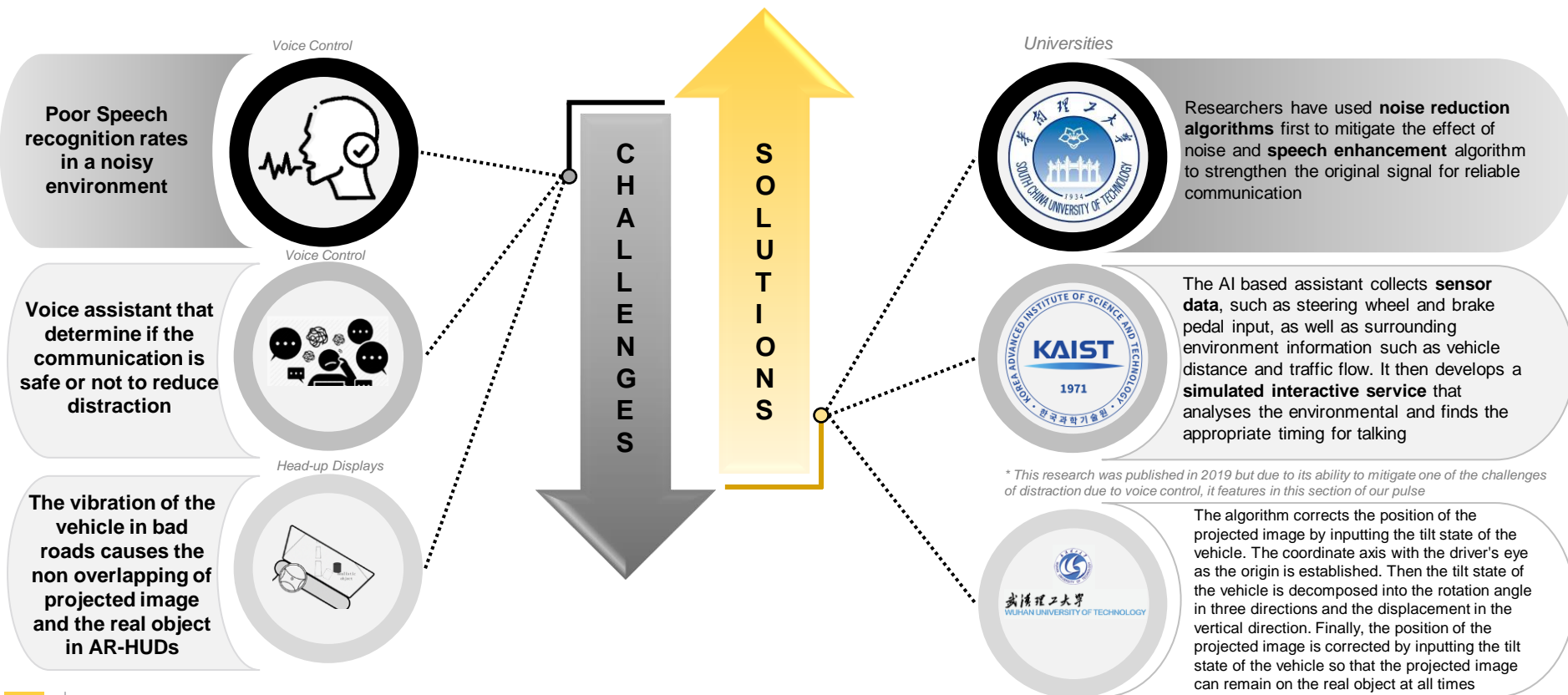
Noise, Errors in recognition, Car vibration, Micro hand gesture and illumination were some of the challenges faced by researchers in gesture recognition. They proposed the use of Infrared camera sensors and CNN architecture to mitigate these challenges
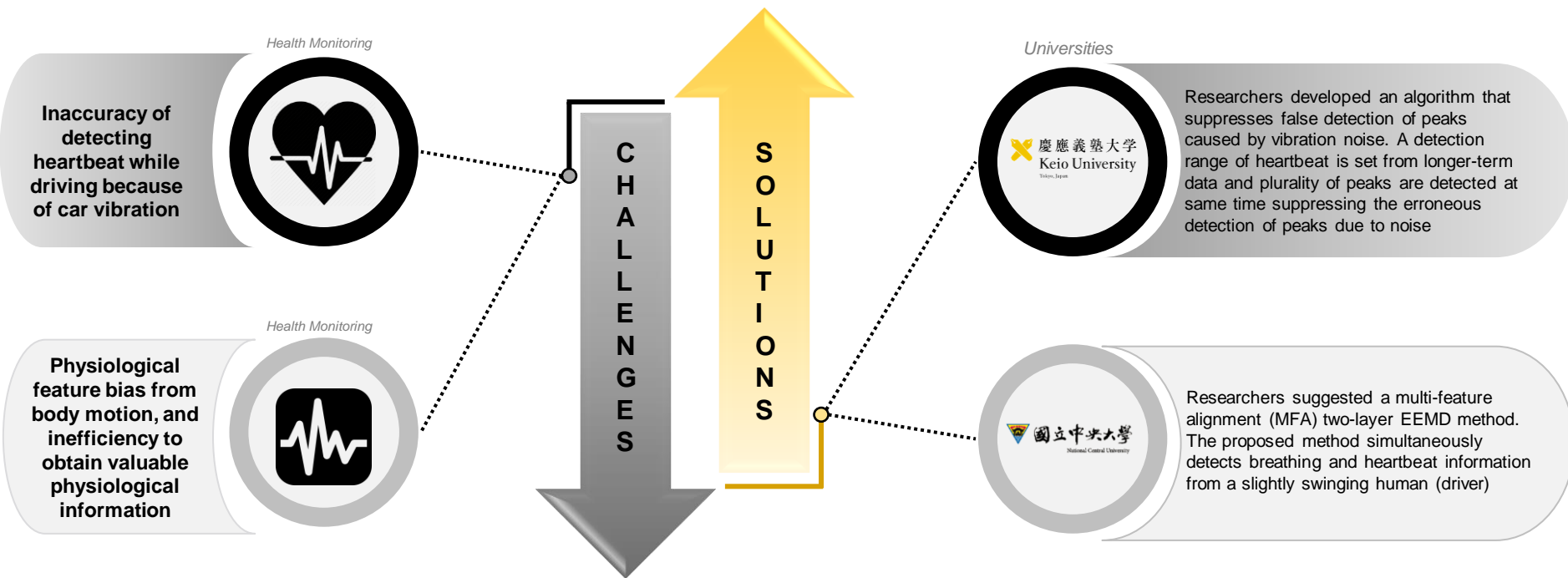
NEW

Gesture Control

Universities

Noise induced due to car vibration and uneven road resulting in challenges in gesture recognition, hardware latencies and sensing errors

Gesture Control

Micro hand gestures triggering false alarms

Gesture Control

Environmental noise and illumination condition in gesture recognition for dark environment

C H A L L E N G E S

S O L U T I O N S

McGill

The researchers used **infrared camera** based **motion sensors** that could produce fine-grained hand model within a 3D space. Researchers used relative movement between different fingers to null out the impact of environmental noises and added a bump/pothole detector to make gesture control further safer and more adaptive

TUM

Researchers collected a multi-modal micro hand gesture dataset using a driver simulator and performed predefined micro gestures and consists of three data modalities, which are **RGB**, **infrared** and **depth**. They applied resource efficient 3-dimensional (3D) **CNN architectures**

WASEDA University

A hand posture recognition system based on an **infrared sensor** is proposed. The input images are separated into images with objects and without objects. A **convolutional neural network** is applied as a classifier in order to realize the recognition of the target hand postures and non-target postures

Key Findings: Technical Challenges and solutions proposed by academia (2/3)
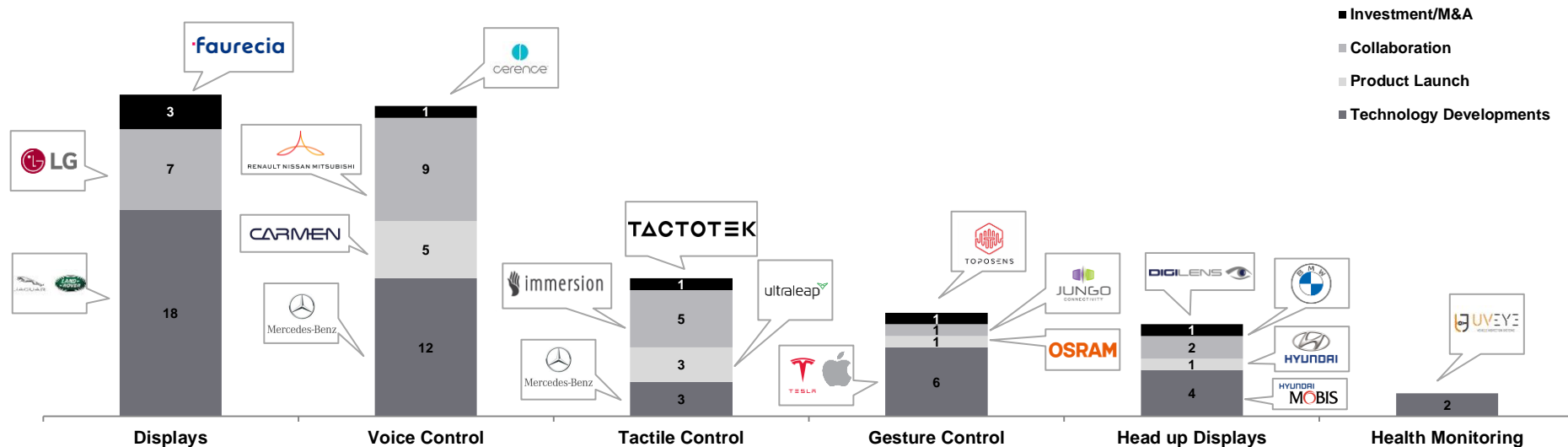
Speech recognition in a noisy environment continue to be a major challenge for researchers as well which they tried to mitigate using noise reduction algorithms. Researchers also proposed a system that reduces driver distraction and communicates only under non hazardous situations

NEW

Voice Control

Poor Speech recognition rates in a noisy environment

Voice Control

Voice assistant that determine if the communication is safe or not to reduce distraction

Head-up Displays

The vibration of the vehicle in bad roads causes the non overlapping of projected image and the real object in AR-HUDs

CHALLENGES

SOLUTIONS

Universities

Researchers have used **noise reduction algorithms** first to mitigate the effect of noise and **speech enhancement** algorithm to strengthen the original signal for reliable communication

The AI based assistant collects **sensor data**, such as steering wheel and brake pedal input, as well as surrounding environment information such as vehicle distance and traffic flow. It then develops a **simulated interactive service** that analyses the environmental and finds the appropriate timing for talking

* This research was published in 2019 but due to its ability to mitigate one of the challenges of distraction due to voice control, it features in this section of our pulse

The algorithm corrects the position of the projected image by inputting the tilt state of the vehicle. The coordinate axis with the driver's eye as the origin is established. Then the tilt state of the vehicle is decomposed into the rotation angle in three directions and the displacement in the vertical direction. Finally, the position of the projected image is corrected by inputting the tilt state of the vehicle so that the projected image can remain on the real object at all times

Key Findings: Technical Challenges and solutions proposed by academia (3/3)

Speech recognition in a noisy environment continue to be a major challenge for researchers as well which they tried to mitigate using noise reduction algorithms. Researchers also proposed a system that reduces driver distraction and communicates only under non hazardous situations

NEW

Health Monitoring

Inaccuracy of detecting heartbeat while driving because of car vibration

Health Monitoring

Physiological feature bias from body motion, and inefficiency to obtain valuable physiological information

C H A L L E N G E S

S O L U T I O N S

Universities

慶應義塾大学
Keio University
Tokyo, Japan

Researchers developed an algorithm that suppresses false detection of peaks caused by vibration noise. A detection range of heartbeat is set from longer-term data and plurality of peaks are detected at same time suppressing the erroneous detection of peaks due to noise

國立中央大學
National Central University

Researchers suggested a multi-feature alignment (MFA) two-layer EEMD method. The proposed method simultaneously detects breathing and heartbeat information from a slightly swinging human (driver)

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H1 2020 saw major developments in the area of Displays and Voice control technology

Technology Developments in displays, such as product launches, prototypes, key announcements, incremental technology developments, dominated HMI output activities, followed by voice on the input side

Legend:
- ■ Investment/M&A
- ■ Collaboration
- ■ Product Launch
- ■ Technology Developments

Chart stacked bar values:

Segment	Investment/M&A	Collaboration	Product Launch	Technology Developments
Displays	3	7		18
Voice Control	1	9	5	12
Tactile Control	1	5	3	3
Gesture Control	1	1	1	6
Head up Displays	1	2	1	4
Health Monitoring				2

Companies/logos referenced: faurecia, cerence, LG, RENAULT NISSAN MITSUBISHI, CARMEN, Mercedes-Benz, Jaguar/Land Rover, immersion, TACTOTEK, ultraleap, Tesla, Apple, TOPOSENS, JUNGO CONNECTIVITY, OSRAM, DIGILENS, BMW, HYUNDAI, HYUNDAI MOBIS, UVEYE

- Display showed increased focus from players as suppliers were seen developing components like ICs and sensors for IVI systems. Displays was the first segment that we observed in HMI that had impact due to COVID-19. Players such as Japan Display shifted some automotive panel production from China to Japan as COVID-19 disrupted its supply chain. OEMs accelerated the development with Mercedes Benz's MBUX showing COVID-19 testing centres in the head units and Jaguar developing technology for contactless touchscreen. Mercedes s class and Hyundai Genesis are the vehicles that are going to come up with AR-HUD and windshield HUD respectively
- Voice control is showing significant development due to player like Cerence who was on of the most active player in this domain. Cerence not only collaborated with players like Audi, FCA, Geely, etc. for the deployment of its product but also came up with solutions that can make voice control technology reliable. Researchers like the ones from TRL published a study that suggested safer voice assistants can cut the driver distraction. Mitsubishi Electric was seen developing an innovative scene aware interaction technology that senses the surrounding parameters like images, audio, video and uses them to generate intuitive sentences for guidance
- Tactile Control technology experienced increased collaboration wherein players such as Tactotek was seen coming up with smart surfaces solutions by collaborating with different suppliers such as Canatu, Siili Auto, Rightware and Lightworks. The company also received €23M Series C funding. Ultraleap announced the debut of its mid air haptic technology in DS automobiles. Mercedes Benz was amongst the OEMs which was active and launched capacitive sensing steering wheel
- Gesture Control technology is becoming prominent as players such as Apple and Tesla filed a patent that includes gesture control and it has been observed that gesture control comes with other functionalities like voice paving the way for multimodal input in HMI. Also OSRAM has launched ultra-compact infrared LED to enable gesture control in car interior
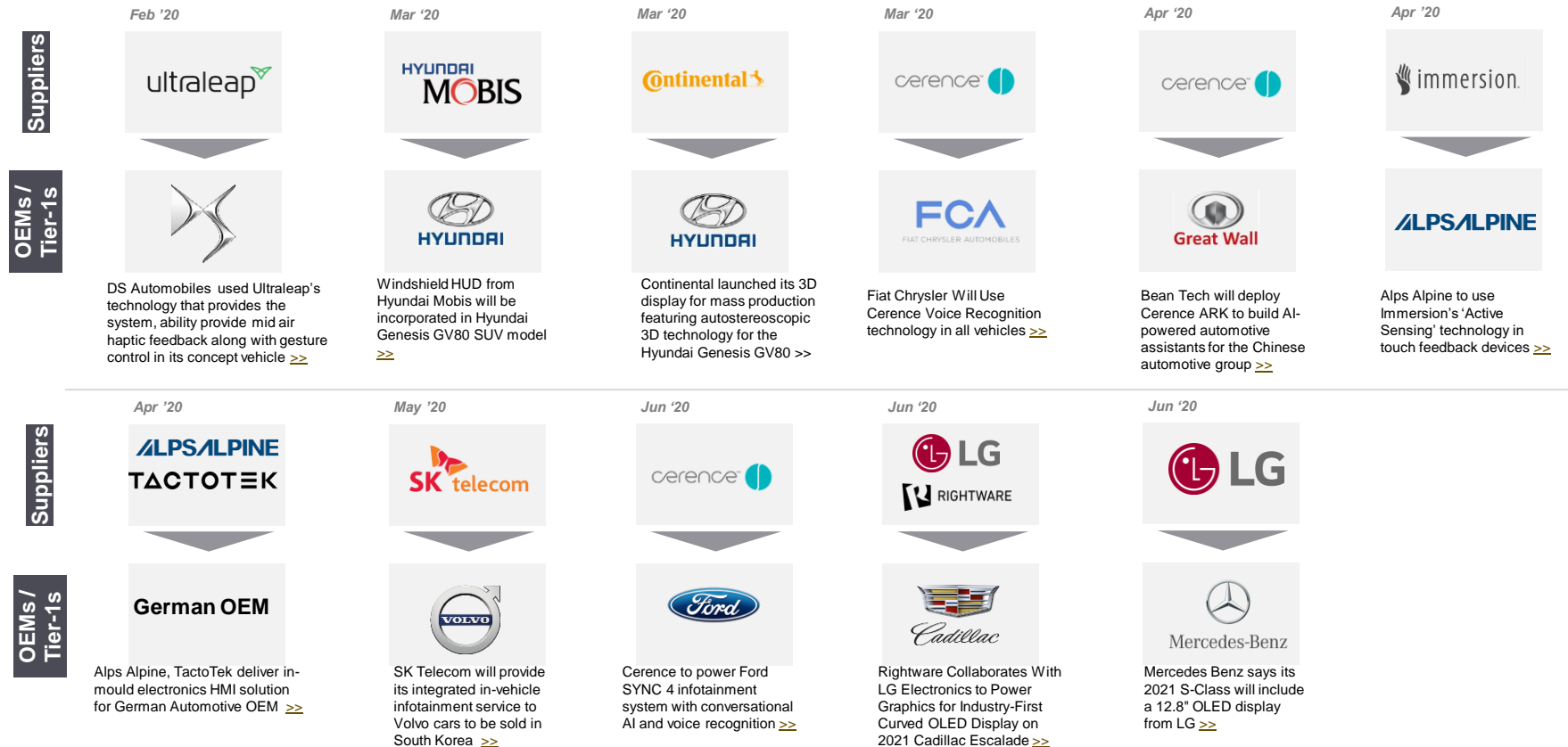
Challenges & Solutions provided by Industry Players

Cerence has developed a solution that allows multiple voice assistants to be used via a single interface. Speech recognition seems to be an area with more developments wherein players are trying different techniques to improve the rate for reliable communication. Compact solutions to enable intuitive functionalities like gesture control with less hardware and power is developed by Osram
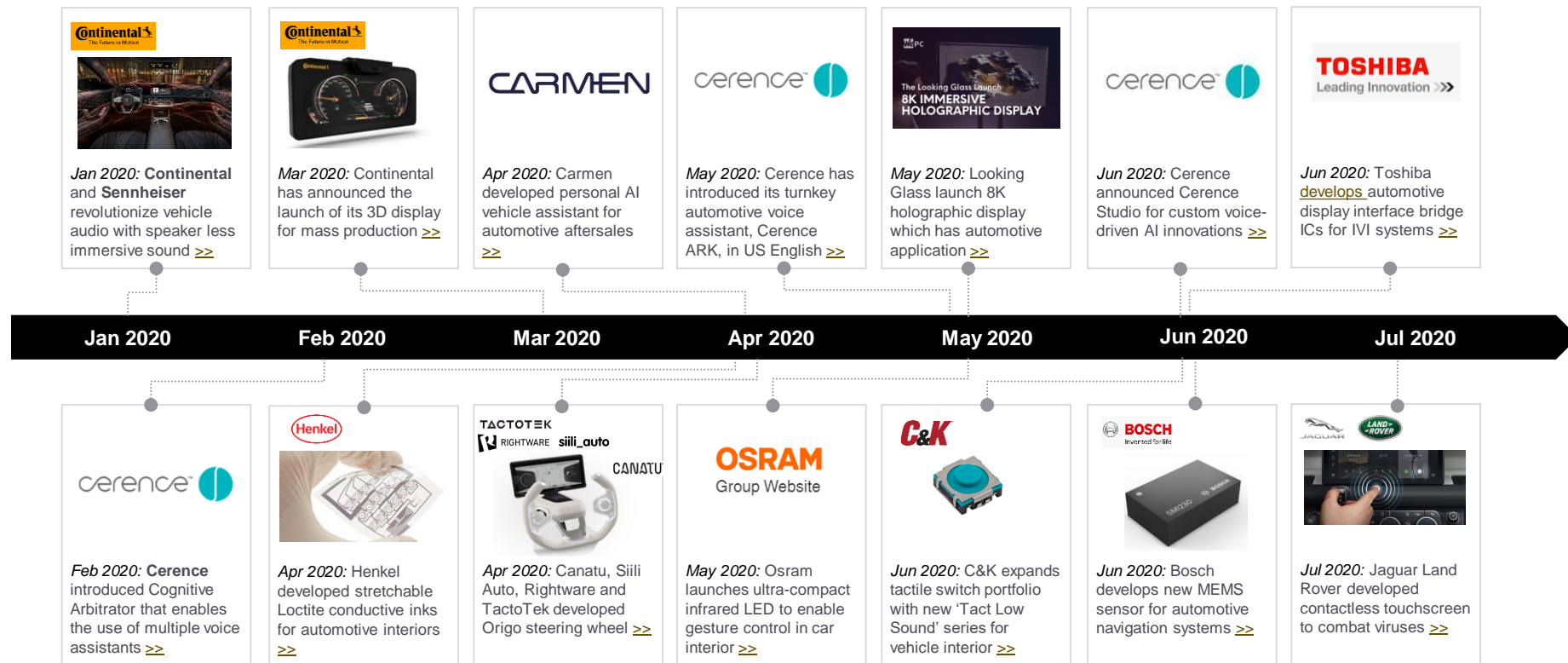

Use of multiple voice assistants through a single voice enabled interface

Inaccuracy in speech recognition in car

Enable complex designs for interior functions and reduce the size of hardware

C H A L L E N G E S

S O L U T I O N S

Cerence developed Cognitive Arbitrator which serves as a voice router, listening, understanding and routing users' requests to the assistant or content service best suited to accomplish the task. It uses conversational speech and cognitive AI to serve the purpose. >>

Kardome focuses on the Signal to Interference plus Noise Ratio (SINR) improvement module comprising an acoustic echo canceler, beamformer, and post-filter to increase the performance of voice user interface >>

Osram has launched an ultra-compact infrared LED to enable gesture control in car interiors. Osram has developed an extremely compact infrared LED (IRED) for its Oslon Piccolo to better enable complex designs for interior functions, such as in-car gesture control >>

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Key Supply Chain activities in H1 2020

Major technologies like displays, HUDs and voice control saw increased penetration in vehicles. Advanced display technologies like 3D displays, curved were seen getting commercialized this year

Suppliers / OEMs / Tier-1s

Feb '20 — ultraleap → DS Automobiles
DS Automobiles used Ultraleap's technology that provides the system, ability provide mid air haptic feedback along with gesture control in its concept vehicle >>

Mar '20 — HYUNDAI MOBIS → HYUNDAI
Windshield HUD from Hyundai Mobis will be incorporated in Hyundai Genesis GV80 SUV model >>

Mar '20 — Continental → HYUNDAI
Continental launched its 3D display for mass production featuring autostereoscopic 3D technology for the Hyundai Genesis GV80 >>

Mar '20 — cerence → FCA FIAT CHRYSLER AUTOMOBILES
Fiat Chrysler Will Use Cerence Voice Recognition technology in all vehicles >>

Apr '20 — cerence → Great Wall
Bean Tech will deploy Cerence ARK to build AI-powered automotive assistants for the Chinese automotive group >>

Apr '20 — immersion → ALPSALPINE
Alps Alpine to use Immersion's 'Active Sensing' technology in touch feedback devices >>

Apr '20 — ALPSALPINE TACTOTEK → German OEM
Alps Alpine, TactoTek deliver in-mould electronics HMI solution for German Automotive OEM >>

May '20 — SK telecom → VOLVO
SK Telecom will provide its integrated in-vehicle infotainment service to Volvo cars to be sold in South Korea >>

Jun '20 — cerence → Ford
Cerence to power Ford SYNC 4 infotainment system with conversational AI and voice recognition >>

Jun '20 — LG RIGHTWARE → Cadillac
Rightware Collaborates With LG Electronics to Power Graphics for Industry-First Curved OLED Display on 2021 Cadillac Escalade >>

Jun '20 — LG → Mercedes-Benz
Mercedes Benz says its 2021 S-Class will include a 12.8" OLED display from LG >>

Product Launches in H1 2020

Major suppliers are seen developing innovative technologies specially in the segment of displays, voice control and tactile control

Jan 2020: **Continental** and **Sennheiser** revolutionize vehicle audio with speaker less immersive sound >>

Mar 2020: Continental has announced the launch of its 3D display for mass production >>

Apr 2020: Carmen developed personal AI vehicle assistant for automotive aftersales >>

May 2020: Cerence has introduced its turnkey automotive voice assistant, Cerence ARK, in US English >>

May 2020: Looking Glass launch 8K holographic display which has automotive application >>

Jun 2020: Cerence announced Cerence Studio for custom voice-driven AI innovations >>

Jun 2020: Toshiba develops automotive display interface bridge ICs for IVI systems >>

| Jan 2020 | Feb 2020 | Mar 2020 | Apr 2020 | May 2020 | Jun 2020 | Jul 2020 |

Feb 2020: **Cerence** introduced Cognitive Arbitrator that enables the use of multiple voice assistants >>

Apr 2020: Henkel developed stretchable Loctite conductive inks for automotive interiors >>

Apr 2020: Canatu, Siili Auto, Rightware and TactoTek developed Origo steering wheel >>

May 2020: Osram launches ultra-compact infrared LED to enable gesture control in car interior >>

Jun 2020: C&K expands tactile switch portfolio with new 'Tact Low Sound' series for vehicle interior >>

Jun 2020: Bosch develops new MEMS sensor for automotive navigation systems >>

Jul 2020: Jaguar Land Rover developed contactless touchscreen to combat viruses >>

Source: Industry Developments

Startup Summary of total 63 start-ups in our Startup Tracker

Voice control and face/eye tracking are the major centre of focus of start-ups with USA and Germany showing significant efforts in terms of start-up activity

Startups by technology

Pie chart legend:
- Voice Control
- Gesture Control
- Tactile Control
- Face/Eye Tracking
- Health Tracking
- Displays
- Biometric
- AR/VR
- Head-Up Displays

Labels:
- AR/VR, 1
- Biometric, 1
- Head-up Displays, 5
- Voice control, 11
- Gesture control, 8
- Tactile control, 9
- Face/Eye tracking, 12
- Health tracking, 5
- Displays, 11
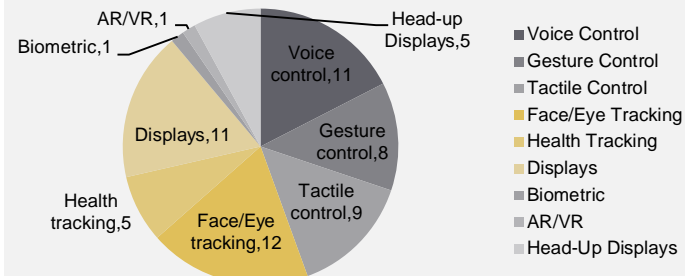
Funding received by start-ups in 2020

TOPOSENS — Raised additional undisclosed funding amount which will be used to enhance Toposens' sensor technology and software

TACTOTEK — TactoTek announced that it has closed €23M in Series C equity financing co-led by Nordic Option Oy and Valeado AB. Bryan

DIGILENS — DigiLens announced that Samsung Venture has increased its investment in DigiLens. Samsung Ventures first invested in DigiLens' Series C round and has again invested through a convertible debt instrument

Startups with Commercialized and Pipeline products

- Commercialized products, 31
- Pipeline products, 32

Startups by geography

- Luxembourg: 1
- Sweden: 1
- Finland: 3
- United States: 13
- United Kingdom: 7
- Switzerland: 1
- Spain: 2
- South Korea: 1
- Slovakia: 1
- Norway: 1
- New Zealand: 1
- Israel: 7
- India: 1
- Germany: 9
- France: 3
- Croatia: 1
- China: 2
- Canada: 6
- Belgium: 1
- Australia: 1
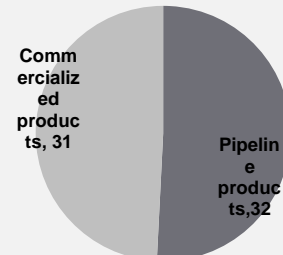
Start-up Incorporation Year

- 2001: 1
- 2002: 3
- 2003: 1
- 2004: 2
- 2005: 5
- 2007: 1
- 2008: 2
- 2009: 5
- 2010: 4
- 2011: 5
- 2012: 3
- 2013: 4
- 2014: 4
- 2015: 7
- 2016: 6
- 2017: 5
- 2018: 1
- 2019: 3
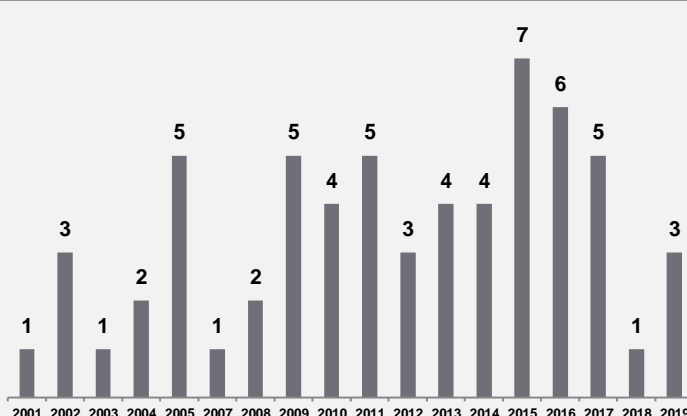
Number of Startups Tracked

- Q3 2019: 8
- Q4 2019: 6
- Q1 2020: 5
- Q2 2020: 5

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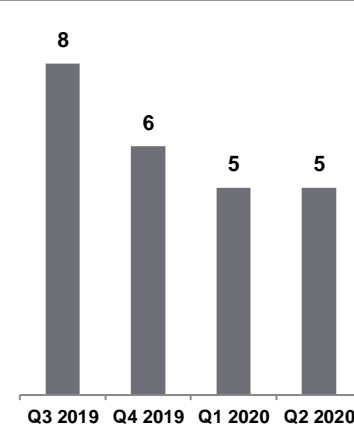
Head Up displays moving from standard to augmented reality

Augmented reality (AR) head-up displays (HUDs) seems to be the next evolution towards creating a better driving experience with less distraction than the conventional ones as it provides the information in driver's line of sight

NEW

Why Augmented Reality HUDs over traditional HUDs?

Limited virtual image distance (VID) makes it difficult to align, or overlay, conformal graphics onto real-world objects

The traditional HUDs offer a **small field of view** (FoV) from the driver's vantage point. This limited FoV places constraints on the types of image(s) that can be displayed and where those image(s) can appear in the driver's view

Disadvantages of traditional HUDs

Driver has to continuously shift the focus from real world to HUD symbol which can act as a **distraction** while driving

A projected image **is small in space** and typically displayed 2 to 3 m out in front of the driver, which places the image near the front bumper of the car

OEMs planning to adopt AR HUDs

Mercedes-Benz

Mercedes Benz's 2021 S-class is going to debut AR HUD which uses digital mirror device from Texas Instruments >>

DS

DS automobiles has present a concept which is an all-electric Aero Sport Lounge crossover which is claimed to come with AR-HUD in its dashboard >>

Audi

 Audi's head designer, Marc Lichte, discussed the brand's future design direction that the company could include an **augmented reality heads-up display in their vehicles** >>

Challenges persist, but can be mitigated

- **Size**: The size of HUD becomes a challenge wherein larger Field of view may require larger eye box that needs more space in cabin increasing the package size
- Continental is trying to solve this issue by using waveguide technology. Other technologies like Digital Light processing and suing holographic element may be used to mitigate this challenge
- **Solar load**: It is magnified onto a very small area of the HUD's imager panel which can create sever thermal challenges. To mitigate this challenge intermediate diffuser screen architecture can be used that can withstand the thermal loads caused by the magnification of sunlight

Future design approaches

- Automotive system designers are working on developing effective and efficient ways to accurately capture, process, and display this sensor data in real time.
- HUD designs need to support real-time vehicle sensor data and human-machine interaction software to accurately overlay symbols on a dynamic environment
- Taking sensor data from multiple systems and representing it visually in the real world so that drivers can understand it and take action requires complex systems to communicate and process vast amounts of data

FutureBridge Benchmarking assessment of Augmented Reality HUDs

Augmented Reality HUDs from Continental performs better than other in our benchmarking assessment as it has an advantage of projection size and HUD size over other HUDs

Audi models	State of Maturity	Field of View	Area of projection	Projection Distance	Projection size	HUD Size	Functionalities
WAYRAY Navion	Prototype	8° horizontal	combiner screen	9 metre	61.6 x 3.08 inches	Not specified	
Augmented-Reality HUD (Continental)	Prototype	10° horizontal	windshield	7.5 metre	51.18 x 23.62 inches	Not Specified	
Auto-HUD (Continental / DIGILENS)	Prototype	20° horizontal	windshield	10 metre	102.36 x 34.25 in	10 Litres	
3D-AR Head-Up Display (KYOCERA)	Prototype	Not specified	windshield	7.5 metre	Not Specified	Not Specified	
3D Head-Up Display (JAGUAR / LAND ROVER)	Research	Not specified	windshield	Not Specified	Not Specified	Not Specified	

FutureBridge Benchmarking Assessment

Low   Medium   High

- *Refer our* technology profile *and* benchmarking *section to know more about:*
  - ➢ *Technology used in the HUDs*
  - ➢ *Their description and functionalities*
  - ➢ *Benchmarking and ranking according to the benchmarking score*
  - ➢ *The range of the given parameters on which we have defined the score of low, medium and high*

FutureBridge

FutureBridge Benchmarking assessment of Haptic feedback solution providers

We chose Tanvas and Hap2U which provides haptic feedback technology. The two players closely competes with each other and were active during the course of H1 2020 in our development tracker

Audi models	State of Maturity	Technology	Sensors	Type of vibration	Multitouch haptic capability	Haptic feedback capability on any surface like wood, plastic, etc	Funding received by company	Number of patents published by company
Multi material haptic technology (hap2u)	Prototype	Piezoelectric film solution	Uses existing touch sensors	Ultrasonic vibration to reduce friction	Yes	Yes	$4.71M	4
Multi touch haptic technology (Tanvas)	Commercial	Friction modulation - Electrostatic	Touch sensors	Electroadhesion	Yes	Yes	$6M	4

Key Trends observed in haptic feedback technology developments in H1 2020

Majority of the players are using **piezoelectric actuators** because of their capability of creating multi-touch point arrays in multi touch haptic, static deflection, independent frequency, amplitude, and phase control capabilities

Start-ups are focusing on providing an innovative solution where the user can actually feel the texture of the touch either by deploying ultrasound or piezoelectric technology

OEM like DS Automobile and Tier 1s like Continental are deploying haptic in their vehicles and product offerings from Ultraleap and Immersion respectively in order to provide more engaging user interaction and experience

Analyst comment

- Tanvas performs better in our benchmarking due to its capability to solve the challenge of dampening in the displays as the company provides technology that can be implemented without any moving part and dampening. Refer our technology profile section for more details
- **Need for cost competitive and accurate systems:** With the timelines for the autonomous future shrinking, there will be a need for integration of haptic in huge and curved displays so the technology needs to be developed considering user experience in the cockpit of the future. There may arise a need for a system which integrates microcontroller that can incorporate both the touch sensing and haptic functions, without having to synchronize two different components which will be proved as a cost-competitive solution and accurate
- **Reduced driver distraction:** Haptic is not only limited to displays but players like Ultraleap are taking it a step forward by integrating gesture and haptic feedback to provide a haptic sense in mid-air. Where studies are claiming that the infotainment systems cause more distraction to the driver, such interfaces with gesture and mid-air haptics will be beneficial over these claims. It can not only reduce distraction but also eyes off road according to the other studies. This can be seen in the graph that shows the combination of haptic and gesture reduces the off-road glace time as compared to the combination of other technologies

FutureBridge Benchmarking Assessment: Low | Medium | High

*For ranking and benchmarking assessment refer our Benchmarking section

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02

COVID-19 Impact on HMI

1   Trends observed in HMI during the COVID-19

2   Competency building in the existing systems to provide information for COVID-19 centers

3   Technology Development to mitigate the effect of driver distraction and curb the spreading of germs and viruses

4   Players are using different sensors for contactless health monitoring in vehicles

COVID-19 disrupted the supply chain of display manufacturers. OEMs were seen focusing on development and advancements of technologies. Health monitoring received acceleration due to COVID considering health and wellbeing of the passengers

NEW

Health Monitoring is becoming an area of interest in this pandemic considering the need of passengers and drivers to be screened while driving. Players are using different sensor technologies to deploy contactless health monitoring in vehicles

- **UVeye** has developed contact-free inspection systems equipped with **infrared thermal sensors** that can detect passengers and drivers with potential coronavirus fever through the windshield. Infrared thermal sensors can read the body temperature of occupants, helping to flag possible COVID-19 carriers
- **Vayyar** announced that its **4D imaging sensors** will be used by Israeli government to fight the spread of COVID-19. Vayyar's intelligent sensors provide touch less, remote and confidential monitoring to detect and monitor vital signs that can indicate early-stage COVID-19 symptoms

These systems may be essential in ride hailing services, public transport wherein contactless health monitoring of different people is important. In passenger cars this domain was always of an interest so having high acceptability is expected

- Japan Display plans to bring some automotive panel production back to Japan after novel coronavirus (COVID-19) pandemic disrupted its supply chain
- As part of the plan, Japan Display will increase production at its Tottori plant in western Japan to supply automotive display panels to Japanese OEMs

Japanese firms reducing their reliance on China as a manufacturing base. The Japanese government is offering subsidies to companies who may want to ship out of China and open their subsidiaries in Japan

- Mercedes-Benz Research and Development India (MBRDI) has equipped the third-gen of the new GLS launched recently with the MBUX multimedia infotainment system
- The infotainment system will allow the drivers to access details of or navigate them to the nearest COVID-19 testing center when needed. With this feature, the vehicle owners can request the COVID-19 testing center related information using voice commands and gestures
- The company has collaborated with **MapmyIndia**, who already provides this feature on its platform, along with giving real-time updates related to COVID-19
- MBUX to show COVID-19 testing centres in the head units across the **key metro cities in India**

We expect that the mapping and location intelligence features provide a means of convenience for occupants. This feature seems to be critical for now, but eventually, it seems to fade in the coming years
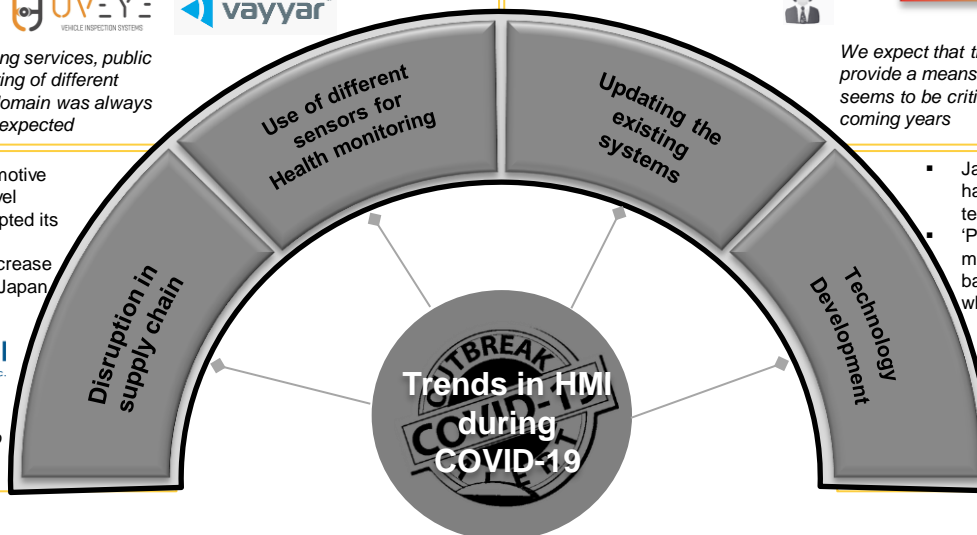
- Jaguar Land Rover and the University of Cambridge have developed a contactless touchscreen technology to help combat viruses and bacteria
- 'Predictive touch' works by tracking users' movements through vision-based or radio frequency-based sensors and an eye-gaze tracker to infer which buttons they intend to press.

We believe that interacting with a system that doesn't give a feedback about the touch and needs the user to see at the screen to see where it points so the system takes the input correctly, may be disorienting

Use of different sensors for Health monitoring

Updating the existing systems

Disruption in supply chain

Technology Development

Trends in HMI during COVID-19

Acceptability Impact Post-COVID-19

Low — High

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Competency building in the existing systems to provide information for COVID-19 centers

NEW

Infotainment

Health Monitoring

Mercedes-Benz

- Mercedes-Benz Research and Development India (MBRDI) has equipped the third-gen of the new GLS launched recently with the MBUX multimedia infotainment system
- The infotainment system will allow the drivers to access details of or navigate them to the nearest COVID-19 testing center when needed. With this feature, the vehicle owners can request the COVID-19 testing center related information using voice commands and gestures

Mercedes Benz's response to COVID: MBUX to show COVID-19 testing centres in the head units >>

MapmyIndia

The company has collaborated with **MapmyIndia**, who already provides this feature on its platform, along with giving real-time updates related to COVID-19. The recently launched third-generation Mercedes-Benz GLS has been updated with this feature, and other models equipped with the 12.3-inch MBUX infotainment system like the GLC, GLC Coupe will be updated in due course.

NTG 6 navigation system with MBUX will feature Corona Testing Centres as Points of Interest for customers. MBUX will also be able to show the **direction to Corona Testing** Centers in select cities as a POI

MBUX to show COVID-19 testing centres in the head units across the **key metro cities in India**

Technology Impact Post-COVID

LOW — HIGH

- Players have come up with solutions to monitor the driver and maintain cabin hygiene in response to COVID-19. On HMI front Mercedes is a player who is amongst the first respondent of COVID situation and make updates in their systems for the same
- According to the company, earlier this year, they were instrumental in launching an innovation for the Korean market where the infotainment system helps in navigating to stores with N95 masks/ respirators
- We expect that the mapping and location intelligence features provide a means of convenience for occupants. This feature seems to be critical for now, but eventually, it seems to fade in the coming years

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Technology Development to mitigate the effect of driver distraction and curb the spreading of germs and viruses

NEW

Infotainment | Health Monitoring

- The patented technology, known as 'predictive touch', uses artificial intelligence and sensors to predict a user's intended target on the touchscreen – whether that's satellite navigation, temperature controls or entertainment settings – without touching a button

Jaguar Land Rover developed contactless touchscreen to combat viruses ≫

UNIVERSITY OF CAMBRIDGE

Jaguar Land Rover and the University of Cambridge have developed a contactless touchscreen technology to help combat viruses and bacteria

The technology uses artificial intelligence to determine the item the user intends to select on the screen early in the pointing task, speeding up the interaction. A **gesture tracker** uses **vision-based or radio frequency-based sensors**, which are increasingly common in consumer electronics, to combine contextual information such as user profile, interface design and environmental conditions with data available from other sensors, such as an **eye-gaze tracker,** to infer the user's intent in real time

This software-based solution for contactless interactions can be integrated into existing touchscreens and interactive displays, so long as the correct sensory data is available to support the machine learning algorithm. The company claims the technology could reduce a driver's touchscreen interaction effort and time by up to 50%.

Technology Impact Post-COVID

LOW   HIGH
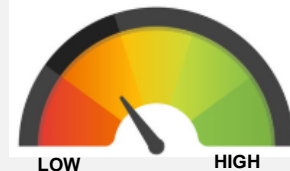
- Though, the system tries to bring safety and hygiene in the vehicle cockpit but advancements are needed before it comes into production
- The system seems to be developed to mitigate the effect of driver distraction and curb the spreading of germs and viruses. We believe that interacting with a system that doesn't give a feedback about the touch and needs the user to see at the screen to see where it points so the system takes the input correctly, may be disorienting. OEMs such as BMW and VW have a gesture-based system with gestures that can control the functionalities in vehicles and have optional auditory feedback every time an option is selected

Players are using different sensors for contactless health monitoring in vehicles (1/2)

NEW

Infotainment	**Health Monitoring**

UVEYE

UVeye's thermal sensor to detect passengers and drivers with Covid-19 fever ≫

Detects vehicle **occupant's temperature** (potential **COVID** symptom) along with mechanical flaws in vehicles

Uses **infrared thermal sensors** that work by measuring the infrared energy emitted from the body that is equal to the **temperature**

Accurate within **0.3 degrees Celsius**

The stations equipped with infrared thermal imaging sensors can be used by **rental car agencies, fleet, etc.**

Technology Impact Post-COVID

LOW | HIGH

- **Contactless health monitoring** is a viable segment with many players working for the development of systems that are capable of monitoring various vital parameters
- For the time COVID is around, this seems to be a **good move** from the company, adapting according to the whole situation
- The system can speed up the process of identifying infected people in other domains but considering the competition in mobility industry wherein players like Philips, SMK-Caaresys are already seen innovating in terms of contactless health monitoring inside the cabin, this system which claims to detect the fever from outside the vehicle and can be operated from a dedicated station seems to lag in the competition post-outbreak

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Players are using different sensors for contactless health monitoring in vehicles (2/2)

NEW

Infotainment	**Health Monitoring**

Israeli Government partners with Vayyar to combat COVID-19 symptoms using touch-less sensors ≫

Vayyar's intelligent sensors provide **touchless**, remote and confidential **monitoring** to detect and monitor vital signs including **pulse**, **heart rate** variability and **respiratory rate**, are all measured remotely, without the need for touch

Vayyar uses **4D radar imaging sensors** that are used to recreate 4D images in real time and sense the vital signs of the person without making any contact

The sensors are unaffected by **line-of-sight**, **lighting** or **weather conditions** and since they do not use cameras, personal privacy is always protected.

- Vayyar announced that its 4D radar imaging technology will be used by Israeli government to fight the spread of COVID-19
- Vayyar's intelligent sensors provide touchless, remote and confidential monitoring to detect and monitor vital signs that can indicate early-stage COVID-19 symptoms

Technology Impact Post-COVID

LOW   HIGH

- This system is expected to have a high impact and maybe potentially adopted post-COVID with the increased deployment of health monitoring systems in vehicles
- Valeo has already partnered with Vayyar to implement its technology in automotive vehicles
- Such contactless sensors that provide information may be essential in ride-hailing services, public transport wherein contactless health monitoring of different people is important
- In passenger cars this domain was always of interest so having high acceptability is expected and thus we can expect this system to have a high impact during and post COVID outbreak to monitor the health of people

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