MOBILITY INDUSTRY INSIDER

Q1 2020 | Pulse
Human Machine Interface

FutureBridge

WHAT'S INSIDE!

Q1 2020 saw technology advancements in haptic feedback with start-ups focusing to enhance the haptic interaction by using ultrasound, electro adhesion, etc. in vehicles in order to improve user experience.

On the other hand, players were seen integrating multiple functions in the steering wheel for driver comfort and safety

Start-ups captured in Q1 2020 had their focus on tactile control and holography in displays and HUDs.

01 Emerging trends

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Technology advancements in haptic feedback is gaining traction

CONTEXT

- 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

Developments

- Start-up **Tanvas** has developed a multi haptic solution which creates the haptic with the help of **electrostatic forces** and **piezoelectric actuators**. It creates electroadhesion by applying an electric field below the touch interface, which creates an inverse polarity. The electroadhesion can be modified at high frequency and pixel by pixel

- **Hap2U** has developed a haptic technology that can integrate sensory intelligence in touch surfaces. It has combined hardware and software solution. The hardware consists of a thin **piezoelectric film** solution which is approximately 2 micron in thickness and the software is responsible to provide haptic feeling in the exact place where the touch has occurred

- The DS AERO SPORT LOUNGE to use **Ultraleap's** technology in its vehicle. The gesture controls and haptic feedback uses **ultrasound** focused on the user's hands via **hand tracking** technology to create the sense of touch in mid-air

DEVELOPMENTS Emerging Trends

- 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

immersion ⟷ Continental

Source

What should you investigate

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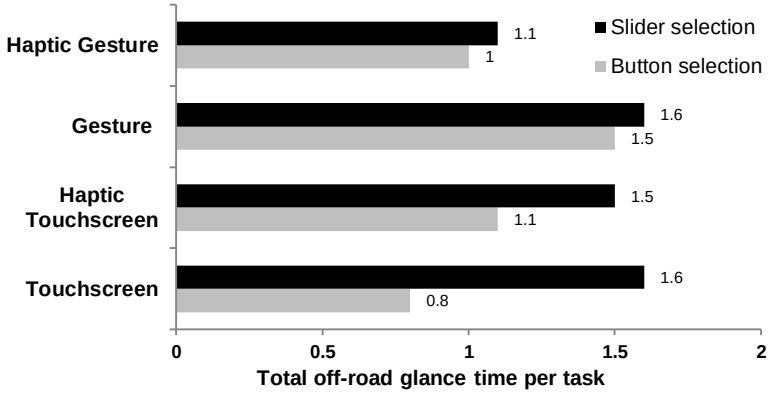
FutureBridge on advancements in haptic feedback solutions

- **Challenges**: Haptic feedback has been around in car cabins giving a sense of indication to the users. Technology Developers especially start-ups are taking a step forward and are trying to bring advancement in the way we feel haptic. With the traditional haptic feedbacks providing vibration on surfaces, there was a concern amongst players wherein they had to fit dampening mechanism, as the actuators producing vibrations at high frequencies to get the desired physical haptic effects came with issues like buzzing noises and resonances which need to be dampened
- **Solution**: As vehicles are coming up with bigger and curvier screens, dampening them becomes more of a cumbersome task. Tanvas claims to resolve this issue by using a solid-state technology that is implemented without any moving parts or dampening
- **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

Haptic feedback used for distraction reduction



Collaboration for Haptic technology integration

Bosch to incorporate Kyocera's haptic feedback technology >>

TDK Electronics Teams Up with Aito for Haptics Innovation >>

immersion

Partnered with other suppliers

- TDK: For bringing Haptics to PowerHap Piezo Actuators >>
- ALPINE: To add haptics in vehicle touchscreens >>
- To add haptics in vehicle touchscreens >>
- Continental: For using haptics in automotive interfaces >>

What should you investigate?

What are the costs and design challenges to add the additional hardware and software feature?

How reliable are the haptic technologies used for providing the feedback in vehicles?

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Steering wheel with integrated functionalities to pave its way into cockpit

CONTEXT

- **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**

Developments

- The **EDAG** assisted the **Hyundai** Motor Europe Technical Centre (HMETC) with the development of an innovative virtual cockpit and steering wheel. EDAG's specialists replaced all of the mechanical keys on the steering wheel with **touch-sensitive controls** in the form of touch displays. The driver will have to touch with more pressure to eliminate false commands and he will also get notified about the press using haptic feedback

- **Tesla** patents steering wheel with **gesture** control, **touchpads**. A digitally controlled steering wheel will make navigation more efficient and safer. The new driving controls additionally comes with indicators for selective gear engagement, and these will be placed at the lower end of the steering wheel. Illuminated signs will indicate park, reverse, neutral, or drive modes

- An inventor from **InventHelp** has developed the SMART WHEEL, an advanced automotive steering wheel and app. The steering wheel will stop drunk and marijuana-impaired drivers from operating motor vehicles. It is also designed to prohibit incoming/outgoing text messages, emails and social media access while driving. It will alert sleep-deprived motorists and monitor heart rates related to possible heart attacks. This is done with the use of an app that is connected to the steering wheel while using wireless technology for communication.

DEVELOPMENTS

- Players are seen incorporating different functionalities like gesture control, touch pad, health monitoring etc. This not only reduces the ease of access but also reduces the driver distraction caused due to looking at dashboard.

- OEMs like Toyota, BMW and startups like Vastra are taking interest towards the development of steering wheel with health monitoring functionalities as it seems to be preferred way due to drivers continuous contact with the steering wheel while driving

What should you investigate ?

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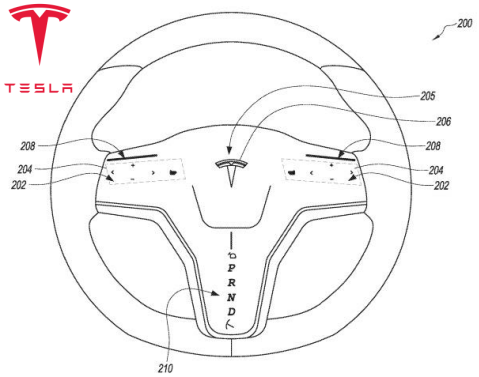
Tesla's new patent for steering wheel to improve user interface for vehicle and reduce driver inconvenience



- **Traditionally steering wheels were used to control the movement of vehicle**
- **With the advancements in technology, players are trying to incorporate other control functionalities in steering wheel**
- **Tesla's recent patent is one of the example that describes about adding more control functionalities in the steering wheel**

Tesla filed a patent titled "User Interface for Steering Wheel - WO 2020/028625 A1" which was filed in 2019. It describes integration of gesture, haptic and visual functionalities in a steering wheel in order to reduce inconvenience caused to driver while driving and keep driver's hand on steering wheel. The steering wheel is able to provide following HMI functionalities:

TESLA

- The user interface is configured to recognize gesture movements made by a user and allows navigation of a set of controls associated with a menu provided through the user interface based on gesture movements
- A haptic feedback is provided whenever the touch occurs on the screen and the amplitude of the haptic feedback changes based on an increase or decrease in functionality provided through user interface
- A badge provided on a front face of the steering wheel provides visual illumination indicating selection or change in functionality. The patent also describes a console configured to provide a notification in the form of symbol

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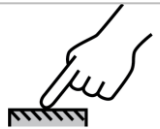
Hyundai's Virtual Cockpit Concept features touch steering wheel for safe driving

- EDAG has assisted Hyundai in the development of innovative virtual cockpit and steering wheel.
- The specialists replaced all of the mechanical keys on the steering wheel with touch-sensitive controls in the form of touch displays
- Hyundai Motor has released its study on the future of the cars cockpit integrating some of its latest and upcoming technologies in an i30 test car

Features of touch steering wheel concept

Driver can control functions like radio, volume, seat heating, etc. using these displays

The controls called up via the steering wheel are displayed on a full-screen monitor(multi-layered display) in the instrument cluster



Haptic feedback is integrated with the displays that allows blind operation while driving

Jaguar Land Rover's sensory steering wheel to reduce driver distraction

How the technology works?

- Jaguar Land Rover's Sensory Steering Wheel provides thermal cues by using heat to tell drivers when to turn left or right with the help of navigation data.
- The cues work on both sides of steering wheel, indicating direction to turn by rapidly warming or cooling one side by a difference of up to 6℃.

Applications

- The technology has been applied to gear-shift paddles to indicate when to hand over from driver to autonomous control in future self-driving vehicles

- Technology could be useful when visibility is reduced through poor weather or the layout of road

Driver Alerts

Turn left or right

Changing lane

Approaching junction

Notifications Eg: Fuel running low

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FutureBridge on steering wheel with integrated functionalities

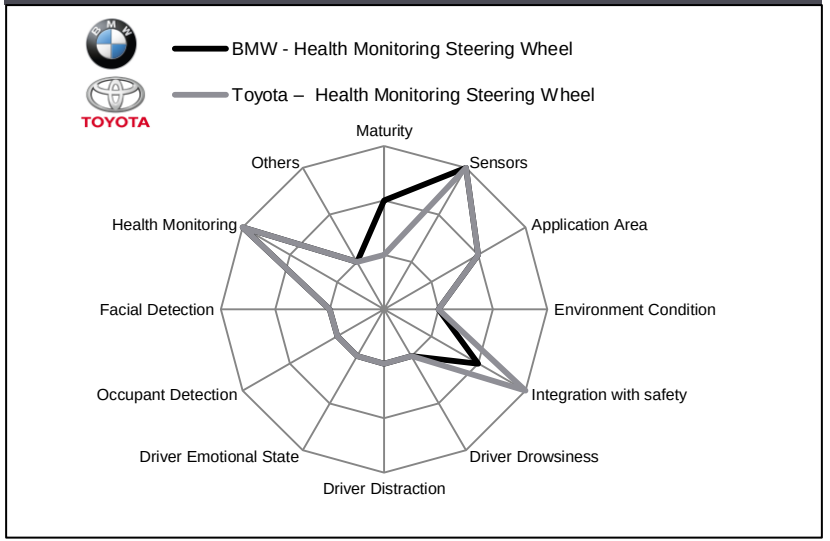
- Players like Jaguar are seen bringing innovation in steering wheel by bringing Sensory Steering Wheel that provides thermal cues by using heat to tell drivers when to turn left or right with the help of navigation data. The major reason of the players bringing such innovations seems to be driver distraction reduction which is a growing concern for automakers and regulatory authorities
- OEMs were mostly attracted towards implementation of health monitoring systems and sensors in steering wheel. The competitive benchmarking of the health monitoring steering wheel from BMW and Toyota is shown in the graph. The technological innovations are leading to the use of flexible sensor system in steering wheel like the one used by the start-up CurveSyS which is not only used for driver monitoring but also has the mechanism of hand recognition for autonomous driving registration
- The idea of incorporating various functionalities like gesture touch, etc. is developed by many technology developers but it comes with a challenge. The system should be accurate not to detect the false commands and take the input when desired. Haptic technology with pressure sensing and feedback can come as saviour for this challenge which may ensure that false commands shouldn't be processed as it may require driver to press with certain pressure and if false commands occurs it should be known to the driver via feedback
- There will also be a need to incorporate cyber security at the vehicle level, as it takes safety up a gear by integrating multi-layer cyber security at a steering system level for maximum protection. These cyber security technologies may consist of specifically designed hardware modules on the semiconductor level, as well as a multi-layered cryptographic software structure, that identifies and authorizes information and command flow between the steering system and other in-vehicle or external controllers
- While the timelines for autonomous future is shrinking, it will be crucial for players to think if these integrated functionalities in steering wheel disappear in due course of time for L4 and L5 scenarios where vehicles will come without steering wheel

What should you investigate?

What are the multiple technologies that are deployed onto steering wheels?

Future offerings in steering wheels for driver safety in higher levels of automation ?

Health Monitoring steering wheels by OEMs



Other players developing solutions for integrating various functionalities in steering wheel

TOYODA GOSEI — Steering wheel with haptic feedback >>

Mercedes-Benz — Steering wheel with haptic feedback >>

Read more about these systems and their benchmarking in our H2 2019 Passenger Monitoring Deep Dive

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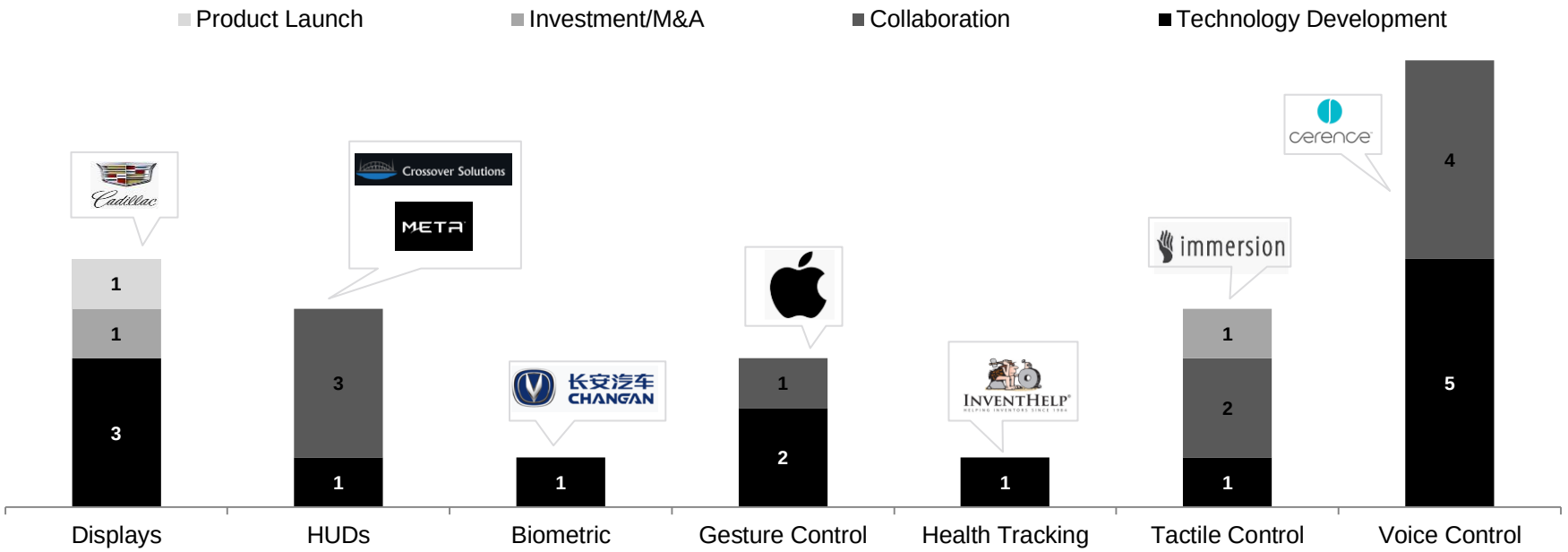
Industry Development Summary for Q1 2020



- Product launch was seen in voice control segment where there was an increase in activities observed by a start-up Cerence. A company that announced its products and also collaborated with players like LG, HERE, Geely and Fiat Chrysler either to deploy its product in their vehicle or to enhance its technology
- As far investment, players like Tactotek has recived €23M Series C funding to develop smart surfaces in vehicles
- Collaborative business models is see between players X and Y to develop Z technology (major ones)
- As per as technology development, there was increased activities in this Tactile Control as start-ups like Ultrasense, Tanvas, Hap2U, etc were seen presenting their innovating solutions. Displays also saw innovations in terms of curved and holographic displays and their commercialization into vehicles like Cadillac and Hyundai

02 Quarterly review of early-stage research

Improvement of driver active interventions during automated driving by displaying trajectory pointers—A driving simulator study

(2019, Ono, Sasaki, Kumon, Toyota Corp, Fuwamoto , Kondo, Narumi, Tanikawa, Hirose, University of Tokyo)

Background

- The handover of vehicle control from automated to manual operation is a critical aspect of interaction between drivers and automated driving systems (ADS). In some cases, it is possible that the ADS may fail to detect an object. In this event, the driver must be aware of the situation and resume control of the vehicle without assistance from the system. Consequently, the driver must fulfill the following 2 main roles while driving: (1) monitor the vehicle trajectory and surrounding traffic environment and (2) actively take over vehicle control if the driver identifies a potential issue along the trajectory. An effective human–machine interface (HMI) is required that enables the driver to fulfill these roles

Methodology

- This research used the Toyota Dynamic Driving Simulator to evaluate the effect of the proposed HMI and compares the proposed HMI with an HMI that notifies the driver when the vehicle trajectory changes. A total of 48 test subjects were divided into 2 groups of 24: One group used the HMI that constantly indicated the future position of the vehicle and the other group used the HMI that provided information when the vehicle trajectory changed.
- The following instructions were given to the test subjects: (1) to not hold the steering wheel and to allow the vehicle to drive itself, (2) to constantly monitor the surrounding traffic environment because the functions of the ADS are limited, and (3) to take over driving if necessary.
- The driving simulator experiments were composed of an initial 10-min acclimatization period and a 10-min evaluation period. Approximately 10 min after the start of the evaluation period, a scenario occurred in which the ADS failed to detect an object on the vehicle trajectory, potentially resulting in a collision if the driver did not actively take over control and manually avoid the object.

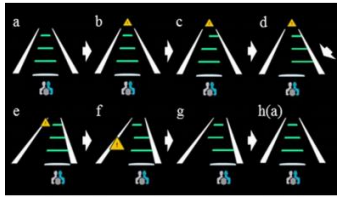


Fig: Example of display transition of CTP-based HMI when avoiding an object on the road.

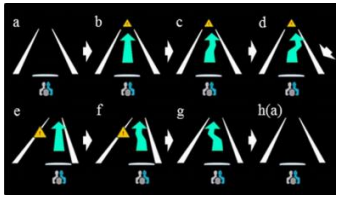


Fig: Example of display transition of NTC-based HMI when avoiding an object on the road.

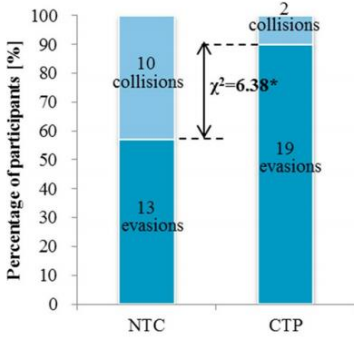


Fig: Cumulative total of collisions.

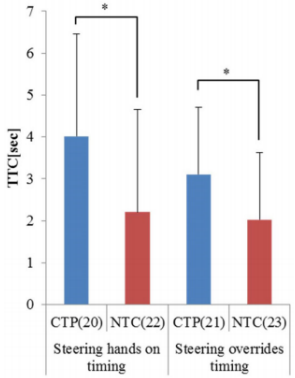


Fig: Steering wheel hands-on timing and steering override timing (average and SD)..

Conclusions

- The collision avoidance rate of the HMI that constantly indicated the future position of the vehicle was higher than that of the HMI that notified the driver of trajectory changes, $\chi 2 = 6.38$, $P < .05$. The steering wheel hands-on and steering override timings were also faster with the proposed HMI (t test; $P < .05$)
- This research confirmed that constantly indicating the position of the vehicle several seconds in the future facilitates active driver intervention when an ADS is in operation.

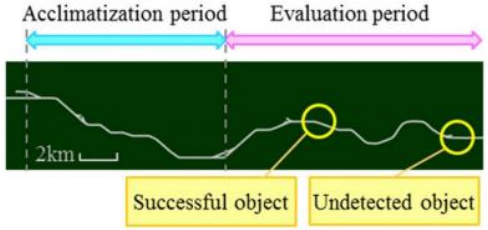


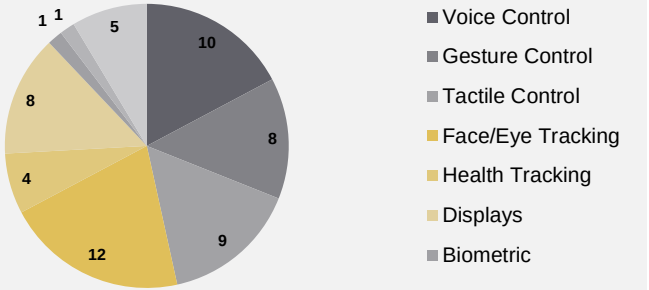
Fig: Experiment route (all participants followed the same route).

03 Startups Tracker highlights in Q1’20

Startup Summary after adding 5 entities in our Startup Tracker

The analysis of total 58 start-ups shows that voice control and face/eye tracking are the major center of focus of startups with USA and Germany showing significant efforts in terms of startup activity

Startups by technology



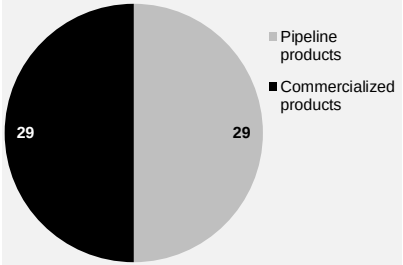
Some key startups

CurveSYS → Develops flexible sensor system that can be deployed on steering wheel

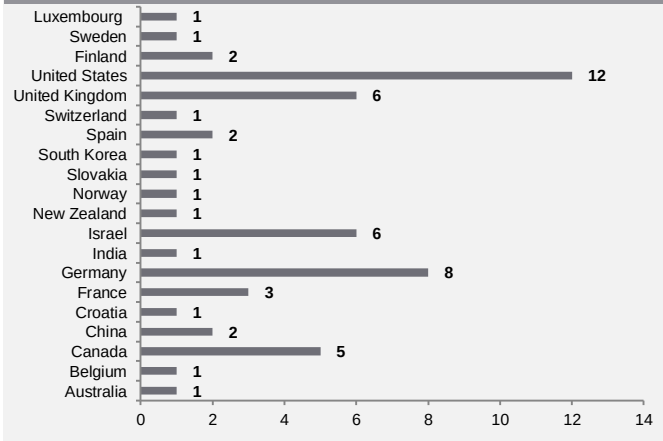
CERES HOLOGRAPHICS → Holographic technology for HUDs and transparent displays

FORCIOT → Develops stretchable electronics

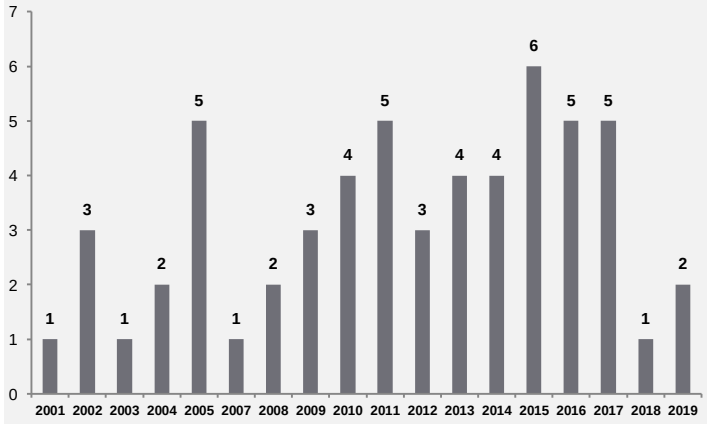
Startups with Commercialized and Pipeline products



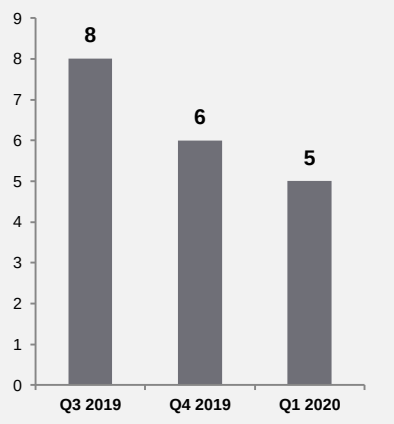
Startups by geography



Start-up Incorporation Year



Number of Startups Tracked



FutureBridge

What are the hubs of startup innovation for HMI

Q1'20 saw US in the front seat in terms of startup activity. Startups continue to develop innovative solutions for in cabin HMI

- Out of the total **58** startups in our Tracker

21% → **Face/Eye tracking**

17% → **Voice Control**

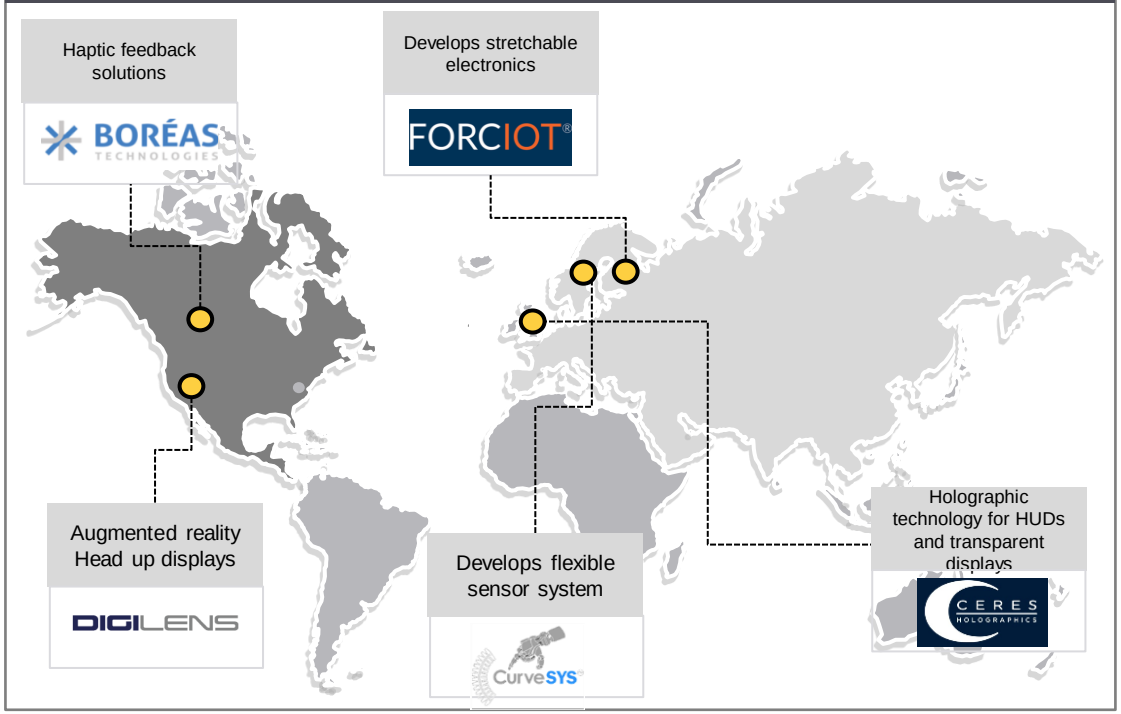
- Leading Start-up hubs

21% →  **United States**

13% →  **Germany**

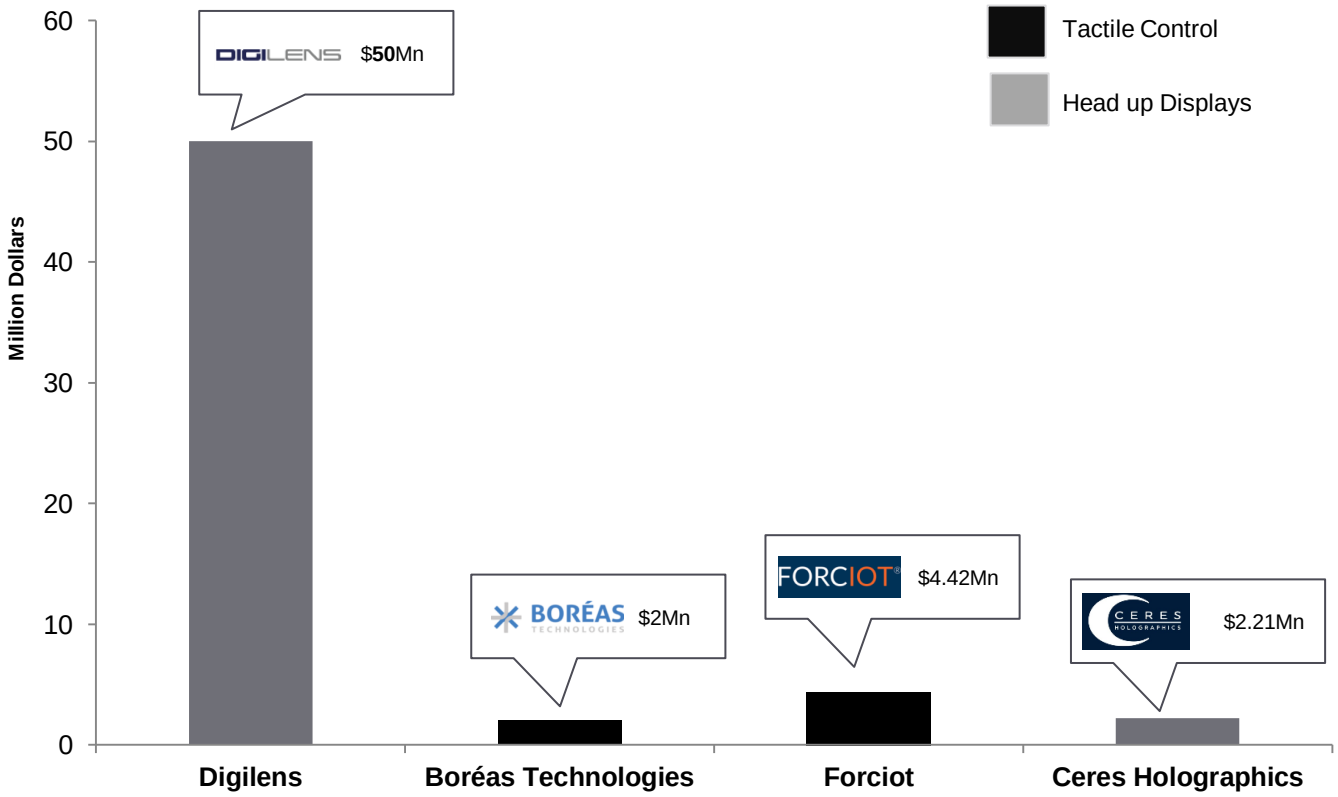
- In Q1 2020 we saw majority of the start-ups focused on technologies like flexible electronics, holographic effect in displays and HUDs and providing haptic feedback in automotive interfaces
- Leading innovation in terms of user experience in vehicles is observed this quarter and the start-ups coming up with unique solutions in order to enhance the experience in vehicles will lead to more intuitive interaction in vehicle cabin

Key startups from major hubs in automotive Human Machine Interface



Funding distribution & activities

Startups working on Head up displays are attracting major amount of funding



- Automakers and suppliers are trying to integrate flexible electronics and haptic feedback in vehicle surfaces which is driving the demand for such systems and startups are getting invested
- Majority of the funding is attracted by start-ups working on Head up display by either integrating holographic effect or augmented reality technology which in turn can reduce the driver distraction and display navigation and other information in driver's field of view and provide a more interactive experience

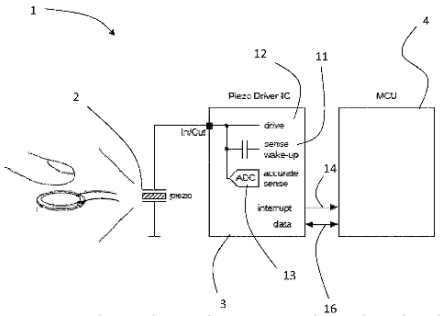
Startup highlight – BORÉAS TECHNOLOGIES Boréas Technologies, a provider of haptic feedback solution

Key PATENTS

EP3627704A1

Zero-power wake-up sensing circuit in piezoelectric haptic feedback

Figure 1



- The present invention relates to a piezoelectric circuit comprising:
- An object of the present invention is to overcome the shortcomings of the prior art by providing a wake-up circuit that does not draw power when not applying pressure but is capable of detecting pressure applied to the piezo actuator, generate a power-up signal to the actuating circuit, and initiate a haptic feedback with lowlatency
- The present invention relates to a wake-up circuit, and in particular to a wake-up circuit for use in a haptic feedback system including a piezoelectric actuator

TECHNOLOGY

- CapDriveTM Technology is scalable high-voltage piezo driver architecture. It has been designed from the ground up specially for piezoelectric haptic actuators
- The piezo haptic drivers, which are all based on CapDriveTM Technology, allows OEM all over the world to easily integrate high-definition haptic effects into every form factor

BOS1901 WLCSP
2.1 x 2.2 mm

BOS1901 QFN
4 x 4 mm

- The BOS1901 is a single-chip piezo actuator driver with energy recovery, based on patented CapDrive™ technology. It can drive actuators with up to 190 Vpk-pk waveforms while operating from a 3-5.5 V supply voltage. Low power and small size make it suitable in a variety of applications where power consumption and heat dissipation must be minimized.

ACTIVITIES

Competitors

Tanvas

hap2U

Funding

Oct, 2018 | $2M – Series A

News

Jan 2020 | Boréas Technologies' Piezo Driver chip advanced realistic Haptic Feedback in Automotive HMIs

May 2019 | Boréas Technologies announced relationship with TDK Electronics to advance touch-response for Automotive

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