SILENSE | (ultra)Sound Interfaces and Low Energy iNtegrated SEnsors

PROJECT NEWS

Some time has passed from the first project newsletter focusing on application of ultrasound for underwater communication and localization in wearables domain. In this second newsletter, we would like to give you an insight into the applications of ultrasound technology in automotive domain, especially in personal cars.

In the meantime, the project consortium has taken a further step to successfully implement the project ideas and initial plans. On 6th of June the SILENSE project review meeting took place in Brussels, Belgium. All work packages and demos leaders presented achieved results and project outcomes after the first year of successful partnership as well as showed future activities planned for upcoming years of the project. The whole review day of intensive work filled with comprehensive presentations finished with initial positive feedback and helpful recommendations from the reviewers and relaxing evening reception with distinguished guests from European institutions.

The next day was focused on the end-users workshop, which took place in the beautiful premises of South Moravia Region office in Brussels. Final specification and planned features of designed project demonstrators and necessary technology for their construction have been deeply discussed between demo leaders, other industrial partners and technology end-users within the consortium. The workshop brought new insights into the planned developments and specified necessary actions for the near future to avoid shortcomings in utilization of SILENSE technology to the final demonstrators.

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PROJECT PROGRESS

In the summer months, the project team has been intensively working on new ultrasound transducers to be applicable in the next generation of planned demonstrators for all application domains. The first large batch of ultrasound transducers made by INFINEON has been available for project partners. They are unique in their operation while they are able not only to receipt the ultrasound signal, but generate enough ultrasound signal to the nearest environment by the same device.

TNO researchers also performed ultrasound channel soundings and ambient noise measurements at their premises in The Hague with assistance from NXP and Elliptic Labs. These important experimental data are now available for signal processing and gesture detection algorithms development and testing within the consortium. Moreover, our industrial partners presented project ideas and results during several technological events – "ECSEL in Germany" congress in Dresden and MEMS Summit 2018 in Grenoble.

There was further an intensive work on updating the exploitation plans and standardization plans definitions. Our dissemination team has in addition been preparing a propagation video of SILENSE technology, which will be firstly shown during next meeting and then available for public to increase interest in this technology and intended application ideas. In upcoming months, you can hear about the latest project outcomes during EFFECS - European Forum for Electronic Components and Systems event in Lisbon, where the project dissemination team will be actively participating with SILENSE booth presenting the ultrasound technology for wearables, smart homes and buildings and automotive. Project management team has been also preparing next meeting of the whole consortium to be held in premises of our British partner SPEEDO in London for three days from 17th of October.

All publishable outcomes of the project are available on the project website at www.silense.eu.

OUR FOCUS ON IN-CABIN SYSTEMS FOR AUTOMOTIVE DOMAIN

Learnt from the last decade, the market for autonomous driving vehicles is emerging and developments take place at a rapid pace. Soon drivers will become passengers and behave differently. While in level 2 vehicles the driver needs to fully monitor the environment and remain engaged with the driving task at all time, in level 3 the driver just needs to be able to take control with notice, he does not need to monitor the environment anymore and may do other things in the meantime. In level 4 manual driving is optional. With the ongoing evolution towards electrical and autonomous vehicles, the automotive industry has become the fastest growing industry for smart sensors, as car manufacturers are searching to reflect this evolution in the vehicles' interior designs.

New and improved HMI solutions are one aspect of these changed concepts and should become an integral element of the vehicles' interior parts. Interior parts are the realization of the OEM's design concept inside the vehicle. Thus, they generally have complex, curved and non-standard shapes composed of different layered materials. Any sensor to be integrated into those parts has to adapt to those characteristics, otherwise – still the common approach – it is just another clipped-in module interfering with the design concept. One of such examples is the technology of functional surfaces for the driver's cab of the future already developed by our project's associated partner CONTINENTAL.

ECSEL JU

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NOVEL HUMAN-MACHINE INTERFACE SOLUTIONS FOR CARS

Evolving automotive market of human-machine interfaces is in focus of CONTINENTAL company for several years. Now they came up with a new technology for operating elements inside HMIs and developed such elements that only take shape as needed and help to create integrated and harmonious driver's cabs. To be able to achieve such novel technology, a combination of material innovation, sensors, electronics, and electro-mechanics has been necessary. In this case, proven capacitive proximity sensors behind the surface of the dashboard have been used and recognize the human hand and then activate the buttons. The buttons can move forward through the reversibly stretchable multilayer surface material and their function can be shown by means of LED illumination. Additionally, the driver's finger pressure is measured, and a tactile signal is triggered when there is sufficient force. This gives the driver a feedback, telling him that he has successfully activated the function. More information can be found on CONTINENTAL website https://www.continental-corporation.com.

An instrument panel for the car of the future, how it is expected and visualized by CONTINENTAL, is on the next figure.

SILENSE is tapping into this market trend by developing novel solutions for human-machine interface in the cabin, exclusively based on ultrasound gesture detection for control of different systems in the car (navigation, entertainment, illumination and climate), capable to be integrated into interior parts. Developments necessary for design and realization of this novel HMI for car cabin contains design and implementation of new ultrasound transducers, sufficient packaging technology, which will use existing cabin surfaces and not influence their properties, gesture recognition algorithms and successful integration into existing systems in the car using standardized interfaces.

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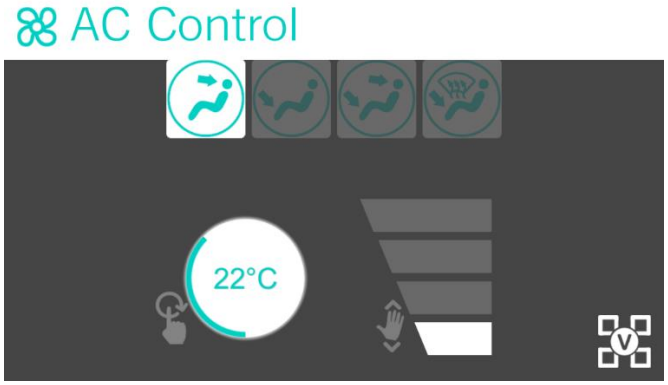
CURRENT GESTURE DETECTION SYSTEMS IN CAR CABINS

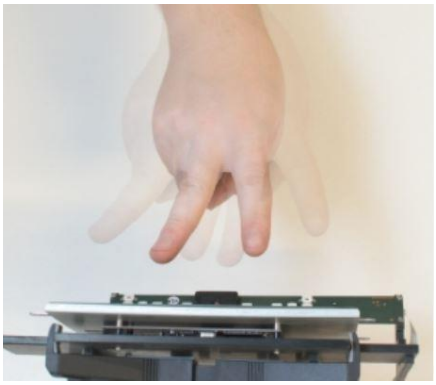
Need of new technology for controlling the services in cars arose from increasing number and complexity of such services. These new complex services in car cabins add to luxury, but not always to safety. Dangerous distraction lies around the corner. Gesture control helps to limit the time drivers spend looking for the right knob or control switch and therefore makes driving much safer. No need to take your eyes off the road. Just move your hands close to the area of the desired function and make a gesture. Passengers also benefit, as their comfort improves.

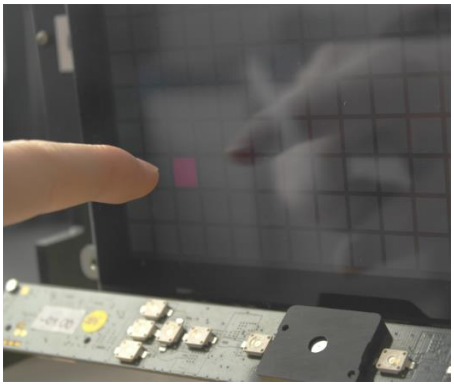
What will people do in the car when driving is not needed anymore? Maybe they will work, play with the kids, watch a movie or sleep. Maybe they want to learn about their surroundings and point at objects to get more information. Whatever they do, they will probably not remain seated in a safe and upright position at all times. So, for the future in-cabin scenario there are two main challenges:

- tracking the passenger's behaviour to control the vehicle safety features more effectively
- provide a natural form of interaction that can be used even when the traditional buttons and switches are out of reach



Current tracking and gesture control solutions are mostly based on optical systems, whether it is a 2D camera that is observing the driver to track his state of his awareness or a 3D sensor that is creating a 3D map to track movements or gestures. Today, the first systems of gesture recognition, which are integrated into devices in the car cabin, are available only in the top-range segment. Besides the high price point for the 3D sensor hardware, there are a few drawbacks of such systems: There are often sensitive to direct sunlight, which can be problem especially for safety related functions. Furthermore, passengers might feel observed when a camera is constantly watching them. This can have a huge impact on the acceptance of such systems, as the car is a private retreat and a room that should support the well-being of its inmates. This is where ultrasound-based systems become a really interesting alternative. Not only can they be integrated more effectively into the vehicle, they also convince in price, robustness and user acceptance.





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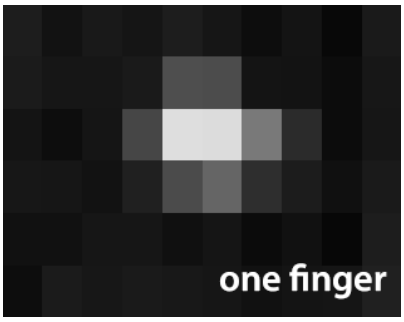
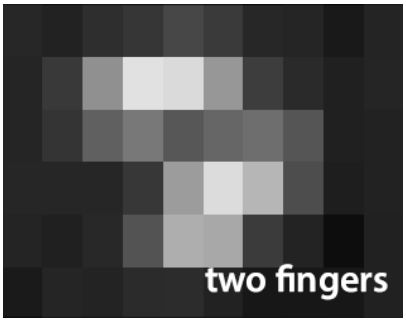
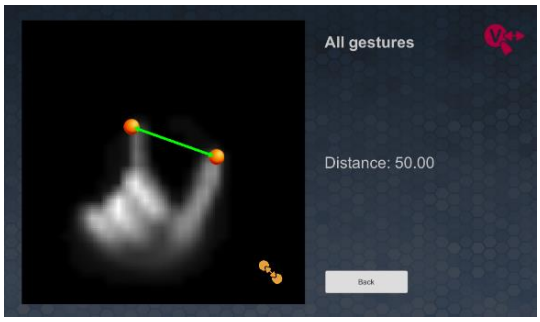
COMPARISON OF GESTURE DETECTION SYSTEMS FOR CAR CABINS

Several different technologies can be used for gesture detection systems in car cabins. There has already been detection based on optical systems producing 3D data or capacitive proximity sensing systems. Ultrasound systems could be similar to capacitive proximity systems in the level of details available in the sensed data, but their potential is much higher due to extended range. Ultrasound data really differs from the typical 3D data that is produced by a time-of-flight camera. The level of detail can be expected to be fairly low in comparison to current used optical systems, so gesture detection solutions cannot easily be ported to work on ultrasound data. We need to rethink how to track human beings, the characteristics of hands, fingers, movements. Based on low resolution sensor data features like fingertip positions, hand poses and movements can be detected and interpreted. The results can then be used to control certain functionalities like interacting with an entertainment system or identifying a pointing target. Those systems have been proven to work with optical sensors, now the challenge is to adapt them to the ultrasound environment. Thus, gesture detection based on innovative ultrasound technology can provide a low-power and low-cost alternative or complement to existing solutions and might speed up the implementation of gesture control throughout all car segments.







ULTRASOUND GESTURE RECOGNITION SYSTEM IN CAR

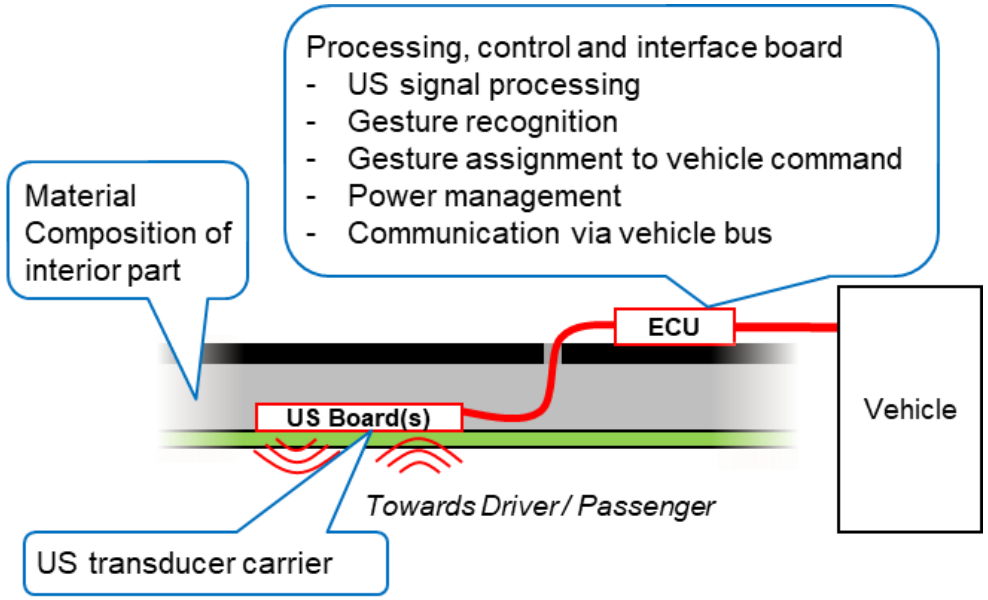
Essential goal for the automotive market within the SILENSE project is to develop a low-profile array of ultrasound transducers for gesture detection on a flexible substrate, which could be inserted in-between the interior parts' layered structure in a way that it would be hidden for the user. An additional use of ultrasound technologies in vehicles, which is being explored in the project, is the implementation of passenger posture detection for vehicle automatic adjustment to passengers.

SILENSE unites several key players in the automotive sector such as GRUPO ANTOLIN, CONTINENTAL and GESTIGON, joining together with technology providers and research partners such as INFINEON, BCB and PRODINTEC.

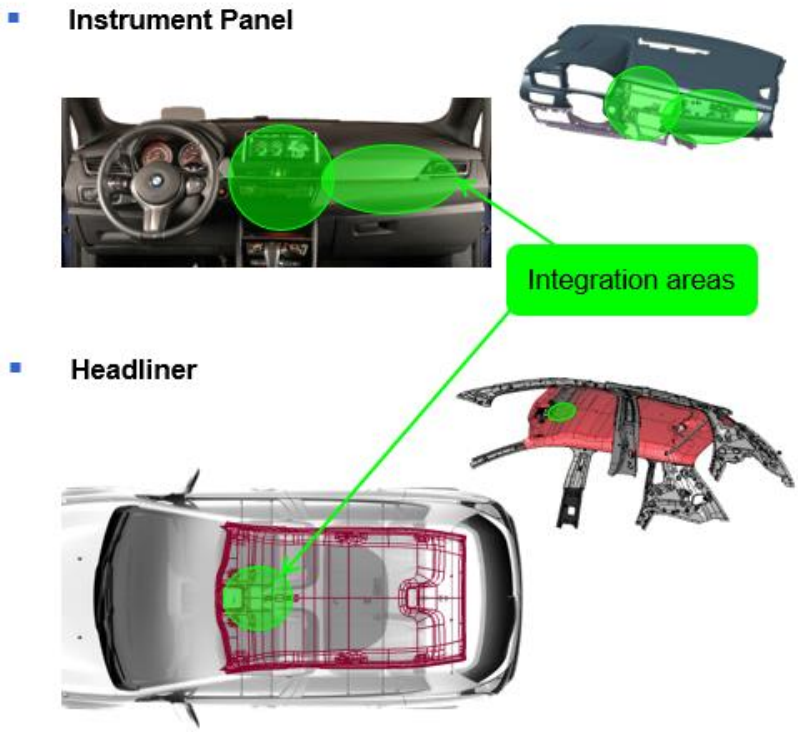
During the first year of the project, work has focused on defining the specific requirements for the intended applications and developing the concept design of the demonstrators. Also, main building blocks of the ultrasound detection system have been defined and possible location of the detection system inside car cabin has been proposed.

The main building blocks of the system are:

- US board: An array of ultrasound transducers over flexible foil to be assembled by roll-to-roll technologies. The flexibility of the array system, together with the low weight and thickness are key factors towards cost reduction. The array contains also drivers for the basic control of the transducers.
- ECU: The electronic control unit (ECU) contains all the necessary electronics for the processing of the signals including read-out and activation electronics for the transceivers; abstraction layer that translates the US transceivers' processed data into high level commands; interface with the vehicle and power supply.



Two interior parts are considered as possible valid locations: the instrument panel (IP) and the headliner (HL). Each of these parts has different material compositions and manufacturing processes as well as different geometries and available space. Packaging materials and assembly processes for the transceiver matrix will take into account the subsequent integration of the matrix in the automobile interior part.



Initial prototypes are currently under development, and during the remaining time of the project they will be optimized and validated in terms of functionality, performance and compatibility for the automotive industry in a relevant environment, with the target of taking the technology to TRL 5.

You can look forward to more details about interesting applications for the smart home and smart building domain in the next newsletters and our project website: silense.eu.