Sense-Drive
Assistance in unpredictable situations

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Abstract
In this paper we introduce the results of the course "design workshop 2" which was held in cooperation between University of Munich, Technical University Munich and BMW Group in 2015.
Under the main topic "shape changing surfaces" we explored new ways for haptic feedback in the distant future of five to ten years in the automotive context. We later focused on two major issues, which are present in today's cars. These are the lack of affordance with current gearshift generations regarding the driving direction and the lack of driver assistance in unpredictable situations, e.g. when turning into a risky crossing. Both issues are known to cause not only major accidents but also a large number of injured or dead road participants every year. To counteract these problems we generated a concept, then a concrete design and ultimately we implemented a fully working, high fidelity and high resolution prototype.

What is it?
Sense-Drive is a haptic interface that is integrated into a car's center console and its armrest. It is designed to give on demand feedback if the driver places one hand on top. To make it convenient for usage Sense-Drive has a round and ergonomic shape. The core functions can be split into two parts. First, Sense-Touch provides vibration feedback in unpredictable or dangerous situations, e.g. if there are any obstacles around the car and also at dangerous and unpredictable crossings, it helps the driver to decide whether to turn in at the crossing or whether to wait for a hidden and passing car. The driver can even distinguish between the directions of a warning. Our prototype consists of six vibration segments for direction feedback from front left, front right, left, right, rear left and/or rear right. The second part of Sense-Touch is a clear and palpable driving mode feedback. There are two additional segments for this purpose in the front and back. Depending on the mode the front segment or the back segment moves out of the round shape. The spatial arrangement of these segments makes it easy and intuitive to see, feel and map the current driving mode with the direction of car movement. We have included a glass area in the center of our prototype, which can be used like a touch pad for gestural touch input to change the driving mode and could be replaced by a real touch display in future.

How does it work?

The Sense-Drive prototype consists of six identical 3D printed vibration segments, which are hollow to incorporate a vibration motors each. Further consists our prototype of two direction segments, which can be lowered or retracted by a rod system connected to the two servomotors. For controlling altogether we are using an Arduino Mega 2560. It is connected to a combined and custom-made power, DC motor driver, servomotor and capacitive sensing board. This second board provides 5V DC power to the two servomotors and a manually adjustable voltage range output between 1V and 5V DC for the six 3V vibration motors (we used 1V in the end). The capacitive sensing should be able to detect finger swipes for driving direction switching. However we encountered too much noise in the signals and could not implement it reliable.
The prototype needs an active serial connection via USB cable to a computer to receive action commands. To control Sense-Drive we have implemented an application that provides an easy to use GUI.

Values and Potential

In our initial research phase we found that in current car generations with automatic transmissions the gearshift is often a push button only. That means there is no spatial hint anymore that maps the selected gear or driving direction to the position of the gearshift in an intuitive way. We found that this is one minor source of road accidents, especially with elderly drivers, and we believe that this can be improved. Therefore Sense-Drive will give a visual and palpable feedback to communicate clearly the driving direction. Apart from the shape changing driving mode feedback we can imagine that a shape changing gearshift could transport different messages like e.g. fuel consumption, too.

However, we stick to this concrete issue and in addition we think that in the given time frame of five to ten years cars might be connected among each other and will be equipped with many more sensors. The so gathered information could be used to warn the driver if hidden cars are coming from a certain direction and if obstacles are around the car. The latter forms the second part of our prototype. We have vibration feedback segments for a coarse direction distinction. It is imaginable that in future connected cars can provide assistance to the driver at risky or unpredictable crossings. However the information for this interface needs to be fed in through a channel that currently does not exist. In any case we found that according to accident statistics unpredictable crossings respectively turning into a street, where it is not visible if there is a car coming or not, causes major accidents and even dead road participants every year. We believe that our on demand feedback system – if properly integrated – could be used to decide whether to take the turn or wait until it is safe to drive, thus decrease this number of road accidents.

Next Steps

The most important next step is to improve further the ergonomic aspects of our prototype. At our final presentation we found out that even though we took the average human hand size into account while designing the device, some users still had issues putting their hands on top in a confortable way. We also believe that the protruding height should be increased for the same reason. Perhaps a different non-symmetric shape should be considered, too.
Further next steps could be replacing the glass touch surface by an actual round touchscreen.