5 Hypotheses and Research Questions

5.1 Interaction Modalities

The focus of this research work is on automotive interfaces and in-vehicle interaction. Out of the five human senses vision, audition, tactition, olfaction and gustation, the last two (smell and taste) provide only marginal contributions to Driver-Vehicle Interaction. Of the remaining three, the modalities vision and hearing are highly stressed\textsuperscript{21} in today’s human-machine interfaces – the utilization of the sense of touch is relatively uncommon and originally emerged from communication systems for the visually or hearing impaired [4], such as “Braille” or “Tadoma” (see appendix E: “Alphabets Related to Touch”). Further potential can be seen in the class of physiological senses, for example in the vestibular sensory system (also known as balance).

5.1.1 Articulation

Explicit input, which is common in today’s Driver-Vehicle Interfaces, requires active participation of the driving person for (i) initiating actions (e.g. for manually switching controls or operating pedals) and (ii) identification or authentication tasks, such as looking into a retina scanner or putting a finger onto a finger reader. Unfortunately, this effort may generate additional cognitive load, which subsequently distracts from the primary task of driving.

Gesture-based interaction emerges into different fields of application in which an individual has to communicate with a computer or machine [170] (e.g. multimedia gadgets such as the Nintendo Wii or Apple iPhone). Operating vehicle assistance systems via gestures from hands or body, the head, or the eyes could be imagined; however, they might violate the “hands on the steering wheel” or to a lesser extent the “eyes on the road” strategies [168, p. 3].

A solution for the problem of excessive cognitive load is potentially found in the disposition of the modality touch for driver-vehicle input. Posture patterns implicitly captured on a driver’s seat and backrest have the chance to revolutionize Human-Computer Interaction, particularly in the automotive domain.

Enabled by technological advances, Driver Assistance Systems are already aware of the vehicle’s state; pressure sensing technology and pattern analysis methods allow a driver’s condition to be determined – the combination of both parameters would enable a vehicle to react automatically to changing environmental and personal conditions.

\textsuperscript{21}This is a good choice because there is evidence that the biggest part of information in vehicles is delivered via these two senses, e.g. in [25], [49]. For instance, for the visual sense, Verwey et al. stated [164] that “[..] the most dominant source of danger in vehicles is not looking in the appropriate direction”.

5.1.2 Perception

In the automotive domain, many situations in which the visual and auditory channels of perception are highly stimulated are known. Under these circumstances, messages or warnings from the vehicle can suffer from inattentiveness due to information overload. A viable approach to solving this problem could be the additional employment of the sense of touch for (i) raising a driver’s attention and (ii) reducing the high burden on the visual and auditory sensory channels.

Another aspect legitimizing the application of perception based on the sense of touch is the compensation of limitations of the visual (e.g. reflecting sun on crossings controlled by traffic lights, changing light conditions when driving through a road tunnel, poor visibility in foggy situations, bad weather) or auditory senses (engine noise, superimposition of voices in communication with passengers or while using the cell phone, etc.).

The chosen approach of implicit vehicle-driver notifications opens new perspectives for the task of driving, such as a decline in road accidents and casualties, a discharge of cognitive load, and finally operator convenience and driving comfort.

5.2 Research Questions

The scope of this work can be defined by the two terms Driver-Vehicle Input and Vehicle-Driver Output as described above. The interrelationship between the research focus and the overall Driver-Vehicle Interaction demand is depicted in Fig. 5.2 on p. 33).

It should be noted that the vehicle-driver domains shown in that figure are not separated strictly – a crosslink among the different domains is conceivable, for instance between the classes “Navigation system” and “Entertainment”. Furthermore, it is important to remark that the classifications and their associated actions may be tentative in a few places.

5.2.1 Objective

The goal of this research work is to give substantiated suggestions on how to use the sense of touch (if applicable at all) in the automotive domain for the purpose of reducing a driver’s cognitive load (or compensating for his/her distraction).

Accordingly, several studies in the two domains (i) input and (ii) output have been conducted, considering issues like (i) the feasibility of sitting posture patterns for identification tasks, correlation between dynamic sitting postures and driving activities, etc., and (ii) interaction performance of the different sensory modalities (vision, hearing, touch), interrelationship between age and/or gender and reaction times, etc.