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# Automated Driving: Shifting the Primary Task from the Center to the Periphery of Attention

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**Abstract**

The field of peripheral interaction has gained importance in recent years. Researchers explored how to design systems, which can be used in the center but more importantly also in the periphery of users' attention. After developing and evaluating systems for desktop and teaching environments, it is time to apply these insights to other application areas. With this position paper we try to add peripheral interaction to the discussion on automated driving in the automotive domain.

**Author Keywords**

peripheral interaction, automotive, automated driving

**Introduction**

Peripheral interaction is built onto the concept of calm technology, describing the interaction with systems that can shift between the center and the periphery of attention [11]. Peripheral interaction focuses on the design of interactions that can take place in the periphery and move to the center of attention whenever it becomes important to a user [1]. By now it has mainly been explored and evaluated for computer tasks in the desktop environment [3][4] and during classes in schools [1].

When driving a car, several activities need to be performed in parallel, demanding a high amount of cognitive resources. They can be defined by three categories [10]. Primary tasks describe everything directly involved in the driving task, such as steering and accelerating. Secondary tasks support driving, including activating the windshield wipers or the headlights. Tertiary tasks are carried out to control in-vehicle infotainment systems, such as radio or navigation system. Due to safety reasons, the primary driving task should always be in the center of attention. However, secondary and tertiary tasks move into the center of attention for short amounts of time.

In recent years, there was a paradigm change in the automotive domain towards automated driving. By adding different sensors, e.g. for rain or light, secondary tasks can now be covered by the car. By using advanced driver assistance systems (ADAS), the car is also able to automatically keep a certain speed or the distance to a car ahead, taking over parts of the primary task. Moreover, novel input modalities such as speech or freehand gestures allow the driver to perform tertiary tasks non-visually while keeping the driving task in the center of attention. This trend will eventually lead towards fully automated driving [5].

This automation in cars will lead to more cognitive resources available for tertiary tasks. In the automotive community, this raised a discussion on how this trend has an influence on the behavior of the driver concerning safety issues and responsibility in case of an accident.

In this paper we will give examples for this behavior change and how this can lead to activities moving from

the center of attention to the periphery and vice versa. Finally, we will highlight how this discussion can potentially benefit from the research in the field of peripheral interaction.

### **Cars as we have Known them**

When carrying out the primary task of driving a car back in the days, it required most of our attention to fulfill the driving task in a safe manner. We had to watch the traffic around us, use the gas pedal to speed up and hit the brake at stop lights or when getting too close to a car in front of us.

Secondary driving tasks such as using the windshield wiper or turning on the headlights did not require visual attention, because controls were placed around the steering wheel and easy to reach and remember. The act of noticing that we actually need to perform the task and the task itself needed little mental resources and moved into the center of our attention for only a short amount of time. Thus, we were able to perform these secondary tasks in our periphery.

Tertiary tasks in general are more complex and require longer execution times as well as focus and attention shifts compared to secondary driving tasks. Therefore, when having a conversation with a co-driver or choosing a destination on our navigation screen, both, primary and tertiary tasks, move back and forth between the center and the periphery of our attention. This can lead to dangerous situations: as soon as the driving task is in the periphery for too long, we might leave our lane or overlook a child running after a soccer ball. In cars without any driving assistance, the primary task must be in the focus of our attention at all times.

### **Cars as we Know them**

Cars today come with a variety of assistant systems. As a result, many secondary tasks do not have to be carried out by the driver and thus can be ignored. A rain sensor triggers the activation of the windshield wiper and adjusts the frequency to the amount of rain. Data from light sensors can be used to adjust the headlights. The resources freed by the car taking over can now be used for the primary task, in the best case.

But also parts of the primary task are taken over by advanced driver assistant systems. Adaptive Cruise Control (ACC) is able to keep a certain speed and a safe distance to the car ahead. When activated, the system takes care of acceleration and braking. In city traffic, it is able to stop the car behind the one ahead, e.g. at a red light. Besides holding the steering wheel and watching traffic, the driver is relieved from significant parts of the primary task.

Concerning tertiary tasks, automation plays an important role as well. The goal is to reduce the drivers' visual distraction to help them keep their eyes on the road. An example is the integration of the phone into the infotainment system of the car. When receiving a phone call, the radio is automatically muted. Numbers can be dialed using speech input, avoiding visual attention and moving parts of this task to the periphery. Gestural input can also help to perform tertiary tasks in the periphery of attention, like muting the radio in stressful situations [6].

### **Cars as we will Know them**

When taking a look at research projects and recent concept cars, automation in the automotive context is increasing and will eventually lead to fully automated

driving in the future. Google shows how their Self-Driving Car [7] is able to reach destinations without needing the driver to steer or to use the pedals. It manages to halt at a stop sign, turn into a parking lot and take a turn at a traffic light without human input. The primary task of driving, or at least large parts of it, can in theory move to the periphery of attention.

On the other hand, infotainment systems will be more mature, increasing the amount of available information and the ability to entertain the car's passengers. Tesla offers a large touch screen in their Model S [9], enabling drivers to stream music, surf the Internet or read emails. They can find the nearest charging or fuel station or simply explore the area on digital maps.

### **Primary Tasks in the Periphery of Attention**

When combining the automation of the primary and secondary driving tasks with the rich availability of infotainment systems in the car, we can conclude that seemingly clear assumptions of what should be in the focus and what in the periphery of attention become questionable. Tertiary tasks start to move into the center of attention more often [5], as a significant amount of cognitive resources will be no longer claimed by the primary task. Studies on driving behavior in fully-automated cars [5][8] show benefits for driver safety but ironically also hint to the increased distraction from the primary task and thus to improper and therefore dangerous behavior in critical driving situations.

We argue that research on peripheral interaction, with its goal to design for interactions that can shift between the center and the periphery of attention, can benefit the discussion on automated driving.

Following problems need to be addressed:

1. The definitions of primary, secondary and tertiary tasks in the car need to be linked to the definition of peripheral interaction.
2. Studies on the change of driving behavior in fully-automated cars need to be interpreted with the research done in the area of peripheral interaction in mind.
3. Further investigations on which tasks move when into the center or the periphery of attention during automated driving are needed.
4. Next to the ongoing development of non-distracting infotainment systems, it will be essential to focus on how to successfully shift the driving task back to the center of attention in critical situations.

### Conclusion

In this paper, we tried to show links between research done in the fields of peripheral interaction and behavioral change due to automated driving. Assistant systems gradually take over primary and secondary driving tasks and thereby free cognitive resources for the driver to concentrate on tertiary infotainment tasks. A close look on attention shifts away from and especially to the driving task in critical situations will be necessary. This discussion in the automotive domain can benefit from theoretical models and study results of peripheral interaction research.

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