EXPLORATION AND ASSESSMENT OF PROACTIVE USE CASES FOR AN IN-CAR VOICE ASSISTANT

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Abstract: More and more people tend to use voice assistants on their smartphones, at home or in the car. These assistants help people to find their way in a foreign city, call their friends or add items to the shopping list – mostly in a user-initiated manner. Whereas there have been several scientific publications on adaptive and proactive Spoken Dialog Systems (SDSs) in the past decade (e.g., [1], [2]), most of these primarily focused on the technical implementation, but none of them dealt with basic research on which proactive use cases a user of the respective assistant might actually wish for. In order to compensate for this, we explore and assess potentially suitable proactive use cases in this work as follows. First, we conducted a creative workshop in which expert teams brainstormed, rated, selected, elaborated and finally presented eight proactive use cases in a role play manner to internal study subjects. Second, according to the previous subjects' ratings, we selected and elaborated four primarily proactive use cases in order to present them to 20 external subjects in an interview study in a non-moving car. All of the latter use cases achieved high acceptance rates, while *Proactive Parking* both got the highest acceptance and the highest additional value score.

1 Introduction

In our previous works on user- and situation-adaptive dialogs ([3], [4]) we presented the results of a large scale online survey on adaptivity features for voice assistants. Concerning a voice assistant situated in a car, we found that especially the assistant's proactivity and adaptivity towards situations (e.g., driving situations) are favored by the participants compared to other adaptivity features. In the last decade there were several publications on adaptive and proactive Spoken Dialog Systems (SDSs), e.g., [1]. These publications primarily focused on the technical implementation, but none of them dealt with basic research on which use cases a user of the respective assistant might actually wish for.
Based on all of the named findings, we decided to conduct customer-oriented user studies to find out which proactive dialog use cases are most desirable to have. In this work we present how we explored proactive use cases for a potential in-car voice assistant in a creative workshop, and how we assessed the respective customer acceptance in a personal interview. The creative workshop consisted of five phases: 1) the participants containing in-domain (voice control) and out-of-domain experts (UX designers and others) brainstormed about prepared questions on intelligent vehicle behavior and wrote down their ideas, 2) these ideas were rated and clustered, 3) in- and out-of-domain experts built eight groups, 4) each one elaborated two proactive use cases, and 5) presented them to invited customers in a role play manner who gave their opinion on each of the use cases. Based on the customers' feedback, we selected four of the use cases, elaborated them in detailed dialogs and presented these to 20 participants. After a thorough analysis of the current work, we draw conclusions how to proceed with its results.

2 Related Work

In recent years, more and more research has been conducted on adaptive SDSs. There are works focusing on adaptive mechanisms in general [5], or presenting user-centered adaptive Dialog Management as in [6]. The works [2] and [1] introduce basic methods on proactivity in SDSs. Our research on SDSs is not limited to the in-vehicle domain, but there are domain-specific constraints that we have to take into account. Research on in-vehicle speech processing has already started in the beginning of the past decade [7]. Among others there have been works on how cognitive load influences how fluent people speak [8].

In [3] we investigated which aspects can be found both in the users' speaking style and in the system's speaking style when focusing on task-oriented applications and how these could be modeled adaptively. Furthermore in both our recent works [3] and [4] we compared the subjects' satisfaction with different voice assistants, the desired personalization features as well as the corresponding issues on data storage, security and privacy. What we have not investigated so far – and will be in this work – is the broad variety of customer needs in specific situations (primarily driving-related) and the corresponding use cases.

3 Study Design

In this section we present the study design. It consists of two parts: a creativity workshop for exploring suitable use cases (cf. subsection 3.1) and a customer study assessing the users' needs and ratings of exemplary dialogs with an in-car voice assistant (cf. subsection 3.2).

3.1 Creativity Workshop

An extensive selection of in-domain (i.e. voice control) and out-of-domain (i.e. general UX designers and others) experts were invited to join a one-day creativity workshop. After a short kick-off and introduction into the intended workshop aim, all participants collaborated in a free brainstorming session. For this purpose some guiding questions on intelligent vehicle behavior had been prepared in advance. All ideas were written down, rated and clustered according to their relevance in a next step. A total of eight expert subgroups elaborated two of the proactive use case ideas each and presented them in a role play manner to different internal subjects, who had been invited for this particular purpose. The invited subjects rated the presented use case proposals and shared their opinions on them. Based on this feedback, finally four use cases were selected and subsequently elaborated and optimized to detailed primarily proactive dialogs. The four use cases were then presented to external study participants in the succeeding week as described in subsection 3.2.

3.2 Customer Study

After having prepared several proactive use cases and possible corresponding dialogs based on the creativity workshop and unbiased user feedback, an additional customer study was performed to further identify their relevance in an in-car environment. First the participating subjects will be briefly characterized (cf. subsubsection 3.2.1) before the study setup will be introduced (cf. subsubsection 3.2.2). Finally an overview of our four primarily proactive use cases will be provided (cf. subsubsection 3.2.3).

Table 1 – Subjects' use of Personal Assistants.

	in car	on phone	smart home
no. of subjects using PA	8	10	2
knowing most features	5	5	1
knowing all features	0	1	0
knowing used features	3	4	1
using 1-3 features	8	6	1
using 4-6 features	0	3	0
using > 9 features	0	1	1

3.2.1 Subjects

We invited 20 participants to take part in this follow-up user study. They were distributed into evenly divided age groups between 20-35 years (6 subjects), 36-55 years (8 subjects) and 56-99 years (6 subjects). The sex ratio was perfectly balanced with 10 male and 10 female participants. Among all participants, 11 indicated to mainly drive a Mercedes-Benz car (MB drivers). Concerning their mileage, 9 subjects considered themselves as experienced, traveling a lot with more than 20.000 km/year, whereas 7 belong to the average with between 10-20.000 km journey length per year. Only 4 claimed to drive less than 10.000 km/year. With a number of 16 the majority of participants frequently (i.e. more than 10 times per month) uses an SDS. Generally, half of our participants use some kind of Personal Assistant (PA) on their smartphone. 8 subjects use an in-vehicle PA, whereas only 2 indicated to employ a smart home device. The majority furthermore indicated to be familiar with either most or particularly the frequently used features for both PAs in the car and on mobile devices. Among those participants using a PA, only 8 indicated to use between 1-3 features, whereas 9 subjects declared to use between 1-3 or 4-6 features on their mobile devices.
A summary of the subjects' use of PAs can be found in Table 1.

3.2.2 Study Setup

1. Preliminary Interview
   Each participant was welcomed by the responsible interviewer and human assistant and received some introductory remarks concerning the study. It was highlighted that the declared intent was to assess the participant's individual thoughts of the desired behavior of an intelligent vehicle. Furthermore, the participant was introduced to the task of rating four different dialogs on the basis of their opinion. By means of a short questionnaire, personal information including the most frequently used car were requested, as well as a subject's ordinary usage and knowledge on several voice assistants.
   Each participant was instructed to open and unhesitatingly state their opinion since answers were not intended to be evaluated as either correct or wrong. Additionally, video and audio recordings were announced for the purpose of anonymized data analysis and the subject was informed about the monetary allowance for participation.

2. Interview Part 1: Diary Notes
   In the run-up to the study, participants had been asked to take diary notes facing the question in which situation they would have wished for an intelligently behaving vehicle. To classify and discuss the notes, the interviewer posed the following questions:

   - *Now in this situation the car should have been acting intelligently or it should have*

been suggesting something proactively (via speech, display or other types of actions). Please report in which situations you thought so?

- *Were these all situations you thought of? If yes, let us continue to speak about each situation separately.*
  (a) *In the first situation you wished the car to intelligently . . . What do you define as intelligent here and why is this intelligent for you?*
  (b) *Which of your needs does the car fulfill in this situation?*
  (c) optional: interviewer references to A class, if it offers a similar feature

3. Interview Part 2: Experiencing & Rating Prepared Dialogs
   In the second part of the study the participant was invited as one of few first testers of several prototypical dialogs for upcoming generations of the A class. This semi-guided interview took place in a brand new A class from 2018 (cf. Figure 2) with the participant sitting in the driver's seat (cf. Figure 1) next to the interviewer on the passenger seat. The human assistant's task in the fond was to trigger the answers of a simulated voice assistant employing iPhone TTS (Siri voice) according to the dialog states the participant passed through. See Figure 3 for a visualization of the study setup.
   Successively, the participant was introduced to the context of each of our selected use cases and asked to experience them in practice by interacting with the simulated voice assistant. After testing each use case, the participant was asked for a rating followed by a discussion of potential improvements suggested by the subject.

3.2.3 Use Cases

In this section, we introduce the use cases and their variations (e.g., "subject: requesting a cheaper gas station") which we assessed in this user study. Table 2 shows an overview of the sample dialogs that were presented to the participants.

1. Proactive Gas Refueling
   (a) PA: proactive suggestion
   (b) subject: requesting a cheaper gas station
   (c) subject: requesting clean toilets
2. Proactive Break Management (handling tiredness)
3. Proactive Car Parking
   (a) being in a relatively relaxed situation
      i. PA: proactive suggestion
      ii. subject: requesting closer parking spot
   (b) being under time pressure
      i. PA: proactive suggestion
      ii. subject: requesting cheaper parking spot
      iii. subject: requesting a broader parking spot
4. Suggestions along the route

Table 2 – Sample dialogs.

Gas refueling:	
examiner	*Imagine you have already been driving for two hours now on your way to an appointment in Göttingen. You still have to drive for another two hours.*
vehicle	`Hello, the fuel is low. Should I navigate you to the nearest gas station? [displaying screen]`
customer	Yes, please.
vehicle	`Ok, the navigation is being started.`
Break management (handling tiredness):	
examiner	*Imagine it's late Friday evening. You have already been driving for two hours and still have to drive for some time. You are getting tired.*
vehicle	`Hello, I assume based on your low pulse and and the duration you spent driving that you are tired. Would you like to take a break for a power nap or get a coffee near a service area or at a parking lot?`
customer	Yes, please.
vehicle	`Ok, the navigation is being started.`
Car Parking (relaxed situation):	
examiner	*Imagine you are on your way to meet friends and still have plenty of time.*
vehicle	`You will arrive at your destination in about fifteen minutes. Should I already look for a parking lot near your destination?`
customer	Yes, please.
vehicle	`Ok, the search is being started.`
Suggestions along the route:	
examiner	*Imagine you have already been driving for two hours now and would like to take a break.*
customer	I want to take a break.
vehicle	`Should I look for a service area, a specific fast food brand, or a parking lot?`
customer	Service area.
vehicle	`Ok, in about 20 minutes you'll reach service area ''Hohenbieber''. I added this service area as a waypoint.`

4 Evaluation

4.1 Diary Notes on Intelligent Behavior

This section shows the results of the interview part 1 on the participants' diary notes described in subsubsection 3.2.2. Table 3 gives an overview of the groups of needs that customers express on a desired voice assistant in the car. Based on 51 mentionings in total, 35.3% of the wished for use cases are convenient and save the customers' time simultaneously, such as notifications on running low on fuel as well as searching for gas stations.

4.2 Assessing Customer Acceptance of Use Cases

To assess the customers' acceptance of the presented proactive use cases, the examiner directly asked them in the second part of the study: "How did you like the dialog with the vehicle?".

Figure 1 – Interieur view.

Figure 2 – Car setup.

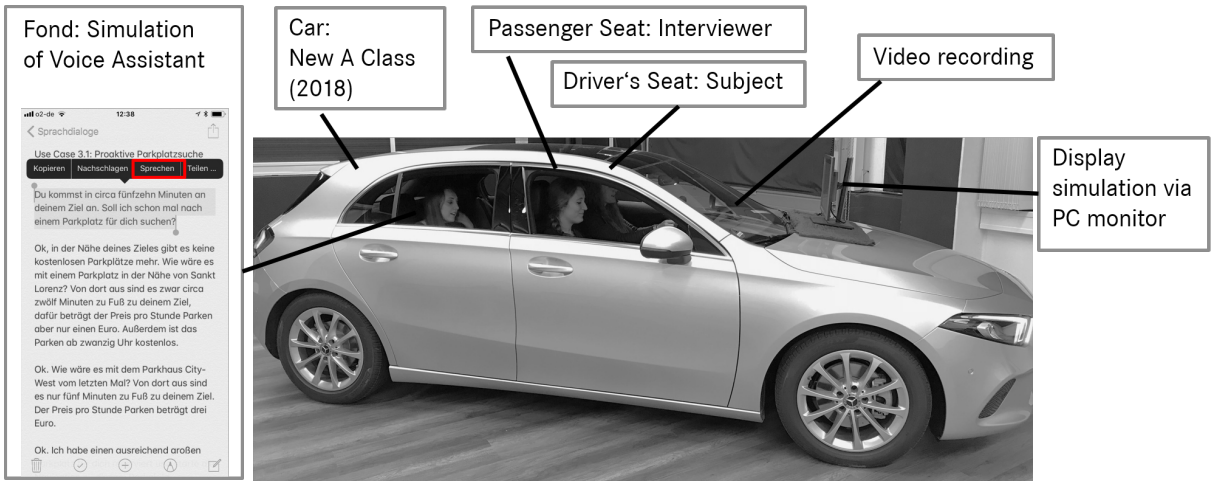

Figure 3 – Complete study setup.

Table 3 – Relation of mentioned needs, desired to be accomplished by the voice assistant.

Need	**%**	**Example**
Convenience & saving time	35.3%	low fuel/range notification, search for gas stations
Preventing risks	23.5%	"new message by Anna – should I read it out?"
Convenience	17.6%	search for a parking spot, show it and navigate to it
Easy usability	9.8%	vehicle functions, e.g. switch on seat heating via voice
Information	7.8%	opening hours, traffic rules abroad
Saving time	5.9%	able to enter multiple requests right after each other

As a second step, they were given a questionnaire saying: "Concerning the presented dialog on <USECASE> how strongly do you agree with the following statements?"

We asked the subjects to rate these six positive statements on a 5-point Likert scale from 1 (strongly disagree) to 5 (strongly agree). The results are shown in Figure 4. If we take a look at the average ratings accumulating all six statements for each use case, we come up with the results shown in Table 4. The results for Car Parking are significant regarding Suggestions along the Route ($p < 0.05$).

Finally, if the current PA in the vehicle already contains a similar function to the one presented, we asked the customers to rate both the additional value and the reason to buy on a 11-point Likert scale from 0 (no additional value/reason to buy) to 10 (absolute additional value/reason to buy). The results are displayed in Figure 5. The graphic shows that proactive dialog use cases are only minor reasons to buy a car with these features. The results marked with an asterisk (*) are significant regarding Break Management and Suggestions along the

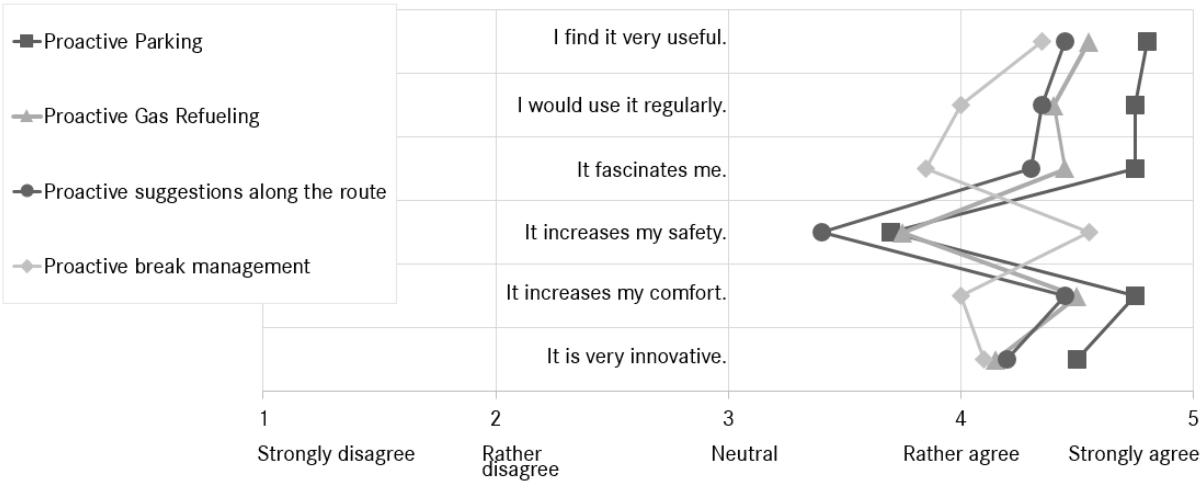

Figure 4 – Subjects' Ratings on Acceptance Statements.

Table 4 – Accumulated average ratings per use case and percentage of accepted suggestions.

	avg.	% accepted by
Gas Refueling	4.30	85%
Break Management	4.14	75%
Car Parking	4.54*	70% (100%)
Suggestions along the route	4.19	-

Route ($p < 0.05$).

4.3 Participants' Additional Feedback

Shortly we would like to point out that there was of broad variety of user feedback on the presented use cases.

Generally speaking most participants seem to wish for more precise information. For example, if the in-car assistant knows that the fuel is on a low level, it should tell the driver the exact remaining range additionally. Or if the assistant suggests a "cheap" gas station, it should state what exactly "cheap" means plus name the price per liter for the specific gas type of this car. Furthermore, if a parking lot is suggested, the expected remaining time between arrival at the parking lot and arrival at the appointment should be stated.

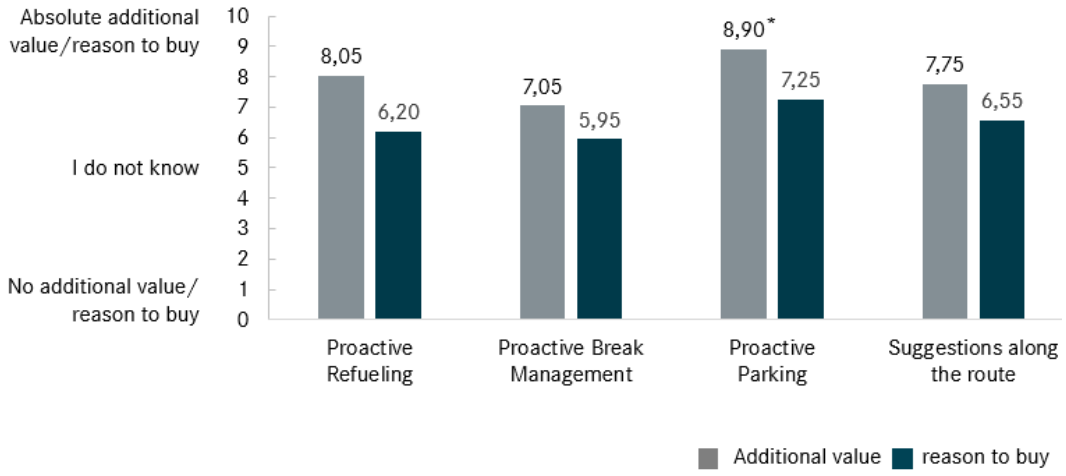

Figure 5 – Subjects' Ratings on Additional value/Reason to buy.

5 Conclusion & Future Work

All four use cases selected for the interview study, three of them being entirely proactive, got a high acceptance score by the 20 participants with over 4 points on average. The use case *Proactive Parking* got the highest acceptance rate and the highest additional value score. For us these results are very promising as we can conclude from them that proactivity focused on these driving-related use cases has a high potential for customer satisfaction. Nevertheless, we still know that proactivity as such is a sensitive topic – especially because this current study did not include any driving.

To reproduce our findings that proactivity and adaptivity towards situations are favored by the study participants, in future planned work we are going to apply the derived suitable use cases to a more realistic study setting in a driving simulator. To evaluate both proactivity and adaptivity towards situations, we design a two-factorial within-subject study in a Wizard of Oz setup. Based on the findings in this current work, we are going to include the following use cases – both as proactive and non-proactive versions: rerouting due to traffic jam, car parking, news service, break management, gas refueling, and appointment assistance.

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