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Modelling and Experimental Study for Automated Congestion Driving

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Abstract. Taking a collaborative approach in automated congestion driving with a Traffic Jam Assist system requires the driver to take over control in certain traffic situations. In order to warn the driver appropriately, warnings are issued ("pay attention" vs. "take action") due to a control transition strategy that reacts to lane change manoeuvres by surrounding traffic. This paper presents the outcome of a driving simulator study regarding the evaluation of a control transition strategy. The strategy was found to provide adequate support to drivers. However, driver acceptance can be increased. A refined model is proposed.

1 Introduction

Media frequently report on the progress made regarding automated driving, but it will expectedly take another few years before fully automated vehicles or robot taxis will appear on public roads. In the meantime car manufactures opt for collaborative driving, i.e. vehicles equipped with a combined longitudinal and lateral support system [1] still request human supervision and control take-over for driving situations. For instance while driving with TJA Traffic Jam Assist, the driver has to observe the traffic in parallel to the intelligent sensors of the TJA system, in particular during surrounding lane change manoeuvers. Automated driving with TJA requires a novel control transition strategy because it goes beyond studies [14, 15] that investigate congestion assistant systems supporting drivers by warning for upcoming traffic jams and by using pedal counterforce feedback.

Drivers are commonly alerted and engaged by means of so called 'soft' and 'hard' warnings [13]. Soft warnings are intended to ask drivers for attention – but do not require immediate intervention. They create awareness of the driver that a take-over request can happen at any time. However, if soft warnings are provided too often or are perceived inappropriate, this is likely to reduce the acceptance of a warning system. A clear transition with handover of control to the driver is demanded with 'hard' warnings: This type of transition requires a real and immediate action from the driver because the system ramps down its support within a defined time span.

The aim of this study is to create a control transition strategy that has a high level of usability. According to ISO 9241-11 usability is defined as: *The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use.*

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Here high usability means that the control transition strategy of the Traffic Jam Assist (1) effectively alerts or warns the driver in case control take-over, (2) at the same time limiting the number of warnings with compromising provided support (efficiency) and (3) ensuring that circumstances under which warning are issued are in line with drivers' acceptance (satisfaction).

A previous paper [11] revealed a list of physical indicators that are recommended for modelling the control transition strategy, among them the velocity of a TJA vehicle itself and the distance to the leading vehicle (primary object). This paper consisted of a naturalistic driving study NDS with traffic jam data of approximately 30 h and 900 lane change manoeuvers. Post-processing of the collected data allowed to identify and categorise relevant lane changes in the surrounding of the TJA vehicle. Video material of traffic scenes was selected that provide insight in indicators for lane change manoeuvres that would lead to hard warnings (i.e. transition of control required), so called "close cut-ins". Lane change manoeuvres that requested soft warnings (i.e. driver's attention) were labelled as "normal cut-ins" and "cut-outs".

This paper presents the outcome of a driving simulator study regarding the evaluation of a control transition strategy that reacts to lane change manoeuvres by surrounding traffic.

2 Modelling of Control Transition Strategy

The scope of modelling of the control transition strategy is to generate warnings effectively and efficiently in order to reach a high customer acceptance and maintain the comfort and benefit of a TJA system. Any lane change manoeuver can be a potential candidate for a warning. Based on the previous study, the velocity of a TJA vehicle (vehicle_speed) and the distance to the leading vehicle (PO_range) are introduced as indicators to lane change manoeuvers that require a warning. Complementary, the indicator Q is introduced, being the quotient of speed and range signals:

$$Q = \frac{\text{vehicle\_speed}}{\text{PO\_range}}$$

The lower the quotient Q, the less worrying and safety relevant a lane change manoeuver is likely to be for a TJA driver. A minimal threshold for Q might therefore be appropriate to limit the number of warnings provided to drivers. Q presents the inverse value of the time headway THW that is used e.g. in [3] to describe traffic flow. In addition drivers are obliged by traffic regulations like [4] to keep a safety margin at all times. The applied rule of thumb for city traffic and traffic jam speed below 50 kph is a time headway of 1 s, equivalent to a quotient Q = 3,6 kph/m. On rural roads and motorways this rule changes to a German byword "halber Tacho" that represents a quotient Q = 2,0 kph/m.

In contrast to cut-ins a completed cut-out manoeuver extends the gap to the next leading vehicle. As a consequence the TJA vehicle will accelerate in order to readjust to a standard safety distance. This can directly be perceived by the TJA driver. A warning interest in this situation could be assumed because the traffic flow is dynamic. A bigger gap might inspire some other drivers from the neighboring lanes to use this space for a cutting-in lane change.

It is unknown how many and which soft warnings are requested and accepted by TJA drivers and which threshold for indicator Q is desired. Figure 1 presents exemplarily the distribution of Q for 433 normal cut-in manoeuvers identified within the NDS data of the previous study. Approximately 50 % of warnings can be reduced with a threshold quotient $Q_{cut\text{-}in} < 1{,}0$ kph/m. Dependent on the chosen threshold the model for the control transition strategy defines whether a lane change generates a soft warning. It is expected that the chosen threshold will directly affect the warning acceptance by individual TJA drivers. This study will therefore investigate the validity of the model.

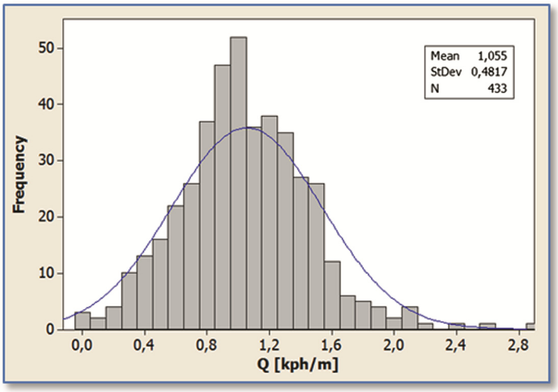

Fig. 1. Distribution of Q for cut-in manoeuvers

A draft model is represented by Fig. 2. It outlines a strategy how the quantity of warnings can be influenced by freely varying and combining thresholds for the indicators Q, Speed and Range with an emphasis on Q. In this phase of the study the number of hard warnings is considered non-reductional, as they are necessary to ensure traffic safety and their acceptance can be tested rather than their efficiency.

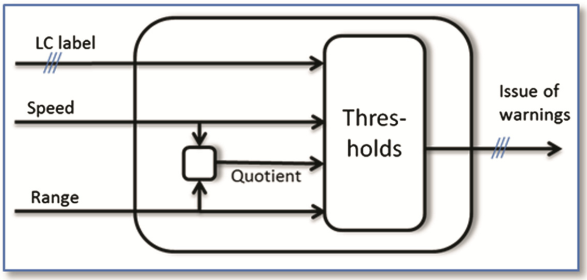

Fig. 2. Preliminary warning model

In short, the draft model for reduction of warnings is led by the hypothesis that TJA drivers will appreciate a warning system that warns for relevant lane change manoeuvers only. This hypothesis stresses that limiting the pure quantity of warnings should not be the target while designing collaborative automated driving but that issuing correct, relevant warnings is essential for the acceptance of the TJA driver. To verify this hypothesis a driving simulator experiment is conducted.

3 Simulator Experiment

Basic aim of the driving simulator study is to explore and understand the acceptance of drivers regarding the proposed control transition strategy for a Traffic Jam Assist, and learn more about drivers' preferences. Within the study, participants will be confronted with video material of traffic scenarios including lane change manoeuvers of surrounding traffic, selected from the available NDS data. As part of the presented traffic scenarios TJA warnings are issued in correspondence to the proposed control transition strategy. Participants are asked to indicate for each presented scenario whether the issued warning or non-warning is relevant, efficient and satisfactory. Furthermore drivers are asked to indicate whether the type of warning issued (i.e. soft or hard) is considered appropriate. Finally participants are asked to fill out a questionnaire that aims to detect further indicators for a transition strategy independent of the preliminary model.

3.1 Setup

A fundamental constraint of the experiment lies in using a driving simulator in lieu of a field study test in real life traffic. Due to the laboratory setting, one should be careful in generalising of the research findings. The application of driving simulators that uses a video method is however known in the field of automotive research. Exemplarily [12] describes a simulator experiment with traffic videos and labels. The reasoning to select a laboratory study as experimental research is founded in the high controllability as well as the assurance of participant safety at current stage of TJA development.

To ensure internal validity of the simulator study the experimental set-up is constructed consciously in accordance with [5, 10]: The simulator is located in a quiet environment that avoids acoustic and visual distraction of the participants. The acoustic scene contains only a constant low driving noise in order to concentrate on the chimes for soft and hard warnings. A stop button is used to interrupt the video when scene separators appear to fill in the assessment sheet. Intentionally it is not possible for all participants to replay a scene a second time. These environmental conditions are applied constantly and equally to all test persons.

3.2 Participants and Procedure

Participants were selected on a voluntary basis. All 25 participants understood the subject of automated driving well and had at least 5 years of driving experience. This quantity of participants is aligned with the recognitions from related literature [8] to confirm significance of the chosen video experiment setup. The complete conduct of the experiment is presented in Fig. 3. It was reproduced in the same way for all participants, starting with a briefing and guided examples prior to the independent video sequences. In order to exclude a fatigue effect for the participants on a particular video scene the sequence of the traffic scene videos is changed by the rules of partial counterbalancing as proposed by [7].

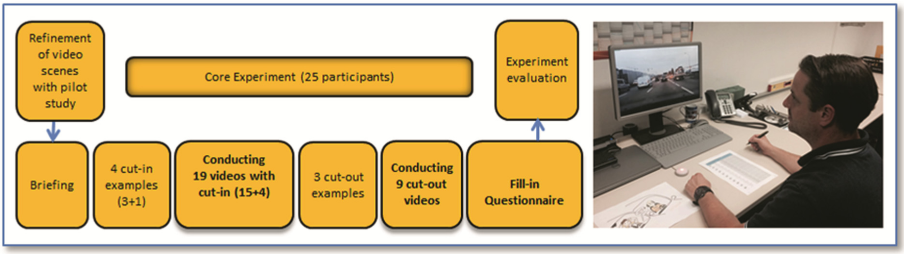

Fig. 3. Test sequence and environment

Prior to the core experiment a pilot-study was conducted [2] with six randomly selected participants. The results turned out to proof a successful setup of the experiment with a manageable structure for the data analysis. To be more representative for potential users of a TJA system, it is aimed that ca. 50 % of participants should have experience with ACC systems (Adaptive Cruise Control) in the core experiment to understand whether they distinguish from non-ACC drivers.

The procedure supports the research question: Does the preliminary model for a control transition strategy satisfy TJA drivers to bring the warnings to a high level of usability? Based on the results of the experiment the model shall be confirmed, refined or to redefined consequently.

3.3 Stimulus Material

In alignment with the proposed model a list of independent variables is provided as chosen stimuli:

(1) Type of lane change manoeuvre
(2) Speed, Range and Quotient
(3) ACC driving experience

As additional indicator the near-field distance to the cutting-in object is available for some cut-in manoeuvers. The dependent variables of the experiment are the percentile agreement to hard transitions due to close cut-ins and the percentile agreement to soft transitions due to normal cut-ins and cut-outs.

Table 1 presents the selection of scenes that are divided into three categories: normal cut-ins, close cut-ins and cut-outs. It shows the compilation of the selected lane changes with characteristic indicators. One can perceive that a wide variation of indicators was chosen. This serves to determine if the initial threshold is sufficient to satisfy the participants and if more indicator thresholds shall be used.

Table 1. Experiment stimulus material

NORMAL CUT INS				CLOSE CUT INS				CUT OUTS			
Scenes	Speed	Range	Quotient	Scenes	Speed	Range	Quotient	Scenes	Speed	Range	Quotient
A1	31	23	1,35	A5	18	27	0,67	E1	12	15	0,80
A2	25	36	0,69	B5	20	12	1,67	E2	30	20	1,50
A3	37	26	1,42	C5	35	20	1,75	E3	36	13	2,77
A4	26	14	1,86	D4	12	12	1,00	F1	20	20	1,00
B1	21	18	1,17					F2	31	21	1,48
B2	41	34	1,21					F3	27	19	1,42
B3	10	14	0,71					G1	23	20	1,15
B4	31	28	1,11					G2	6	11	0,55
C1	27	21	1,29					G3	35	15	2,33
C2	31	37	0,84								
C3	30	21	1,43								
C4	38	28	1,36								
D1	24	26	0,92								
D2	40	26	1,54								
D3	24	16	1,50								

As a starting point it was selected to apply thresholds for Q that reduce the quantity of soft warnings by half of the occurrence of lane changes (e.g. $Q_{cut\text{-}in}$ > 1,0 kph/m).

For those scenes that exceed the thresholds soft warnings were issued to the driver by means of an according warning chime. In Table 1 these scenes are shadowed like A1. There are exceptions to this rule in cases that show an underlined scene number, e.g. A2 or C3. For the exceptions the participants have actively to contradict to the actual warning. The participants were explicitly encouraged in the preparation phase that a dislike of a warning proposal is possible.

Four close cut-in scenarios are selected, each accompanied by a hard warning with an according warning chime. A reduction of quantity is not intended so far. However - with scene A5 the experiment also offers a manoeuver with a low quotient Q = 0,67 kph/m to investigate whether the issued warning is still accepted by the participants.

After the video sessions the participants are asked for further details in a questionnaire. The questions serve

- to describe the profile of chosen participants.
- to explore whether (separately from the chosen model indicators) participants apply their own indicators, e.g. the influence of weather or lighting conditions
- to evaluate the appreciation of TJA as automated driving with cooperative approach. What is the acceptance of automated driving with cooperative approach in general?

3.4 Experiment Results and Discussion

In Table 2 the percentile agreement for the proposed control transition strategy is listed. The second column presents results separately for ACC drivers and non-ACC drivers. This is reflected by showing percentages in three ways: An overall percentage in bold numbers and the distributed percentages for ACC drivers and non-ACC drivers.

Table 2. Agreement to warning model (ACC|non-ACC drivers)

	General Agreement to Model-proposed warning type		Agreement to Model-proposed warnings	Agreement to Model-proposed non-warnings	Optimization	Theoretical max due to voting
Close cut-ins	84%		-	-	-	+ 0%
	80%	89%				
Normal cut-ins	66%		70%	56%	+ 3%	+ 5%
	65%	67%				
Cut-outs	76%		65%	79%	+ 0%	+ 2%
	72%	80%				

Concerning the quantity of warnings it can be stated that ACC drivers are more critical toward the issue of warnings than non-ACC drivers. This specially applies in direct comparison for close cut-in and cut-out manoeuvers. The significance of the difference between ACC drivers and non-ACC drivers is investigated by a Chi-Square test. The null hypothesis H_0 states that there are no differences between the two types of participants in the core experiment. The results of Chi-Square testing [6] in all three types of lane changes cannot reject the null hypothesis H_0 ($P > 0{,}05$) and thus there are no significant differences between ACC drivers and non-ACC drivers to consider in further experiments.

For all three lane change manoeuver types a review of the proposed warning model is provided below. Furthermore an analysis was performed to identify individual traffic scenes with peculiarities. To support the discussion of the warning model a scatterplot with linear fit in Fig. 4 is used. It shows the participants' agreement as a function of Q.

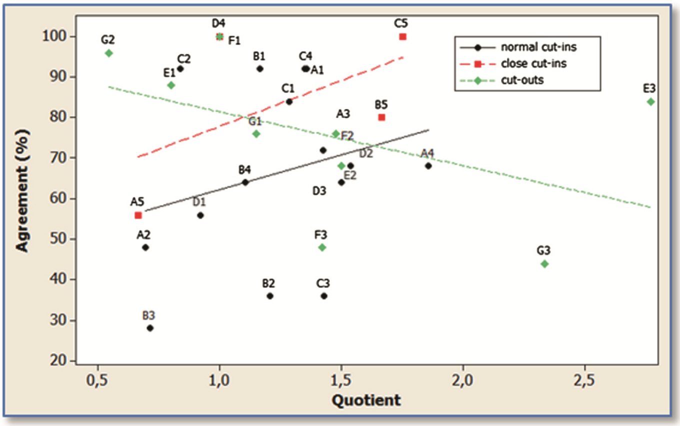

Fig. 4. Agreement vs. Quotient by lane change type

Close Cut-ins. The agreement of 84 % is on a significant high level. At first instance optimization is not possible due to the binding relation of close cut-in labels to hard warnings.

Peculiarities: Scene A5 has a remarkably low agreement factor of 55 %. This can be connected to an eye-catching low value of Q = 0,67 kph/m. It shows that indicator Q would be feasible to confirm or reject close cut-in manoeuvers and consequently hard warnings. Since the model uses Q with a minimal threshold it can be stated from Fig. 4 that the agreement rises with higher values of Q. The Pearson correlation of the graph is 0,567 (P = 0,433). Further it is recommendable to replace the subjective close cut-in labels by objective measurements. A preliminary study of this recommendation was presented by [11] and outlines a significant correlation of close cut-in labels with the indicators of near-field sensor values and values of Q.

Normal Cut-ins. For the traffic scenes including normal cut-in manoeuvers a percentile agreement of 66 % was found while using solely the threshold of $Q_{cut\text{-}in}$. This result is seen as a moderate success only. By combining the dominant threshold of Q with those of indicators speed (e.g. >20 kph) or range (e.g. <33 m) only offers a limited optimization potential of 3 % higher agreement.

Figure 4: The Pearson correlation of the graph is 0,253 (P = 0,364) and shows that with higher values of Q there is increasing agreement. Thus the model threshold of Q supports the results of the simulator experiment and validates parts of the model.

Peculiarities: A consensus to the proposed warning model is more difficult to achieve when the participants have to contradict actively to the model: scenes A2 and C3 need an active dissent to comply with the model. This might be the cause for the lower percentage of agreement.

Scene B2 also had a very low agreement of 36 %. A peculiarity in the known indicators could be identified that provides a plausible cause: The scene deals with a rather high range value (34 m). Scene A4 had strong demand to change to hard warning with a high value of Q = 1,86 kph/m which supports the importance of Q as an indicator for soft and hard warnings. An underlying near field sensor value confirms the tendency to convert to the desired close cut-in type manoeuver. Another aspect is that the lane changing vehicle was a police car. In the participants' comments there were hints that it has influenced the subjective ratings of video scene A4. Likewise in scene D3 several participants demanded a hard warning - with Q = 1,5 kph/m. Surprisingly for scene B3 as a non-warning scene with Q = 0,7 kph/m they also demanded a hard warning. An in-depth investigation unveiled that in both cases – D3 and B3 – the TJA prototype vehicle has failed to keep the normal distance after a lane change. This is a sacrifice for using real video scenes in lieu of composing an artificial simulator experiment. In retrospect these two scenes can be declared as invalid for the experiment. All these peculiarities have led to the unsatisfactory results in acceptance (66 %) for normal cut-in warnings. Therefore the results of the questionnaire shall specifically be considered in order to identify model improvements.

Cut-outs. A moderate model acceptance of 76 % was achieved. It is worth to mention that only two participants (8 %) reject all warnings for cut-out manoeuvers, all other accepted or demanded at least one scene for a soft warning.

Peculiarities: Scenes F3 and G3 have gained low level of agreement to the model. In scene F3 we find a special behaviour of cut-out because the vehicle that leaves the lane drives over a shaded area, i.e. the participants regard this as a driving rule violation of the leading vehicle and would have expected a warning due to this fact although the model identifies this as a non-warning scene.

An explanation for the evaluation of scene G3 could not be found as the high value for Q = 2,33 kph/m fully contradicts the model to suppress a warning.

Figure 4: The Pearson correlation of the graph is -0,485 (P = 0,185). The negative value is contra-productive for the validity of the proposed model that uses a higher Q for warnings in cut-out manoeuvers. The result can lead to reject the use of Q further-on for the warning strategy of cut-out manoeuvers.

Another attempt was made to identify thresholds and a correlation between the agreement and the model indicators Speed and Range. Initially the Speed indicator with a lower threshold was considered, e.g. proposing warnings only for Speed <25 kph. But a well agreed warning for scene E3 at higher speed discards the proposal. Despite the fact that only 8 % of participants do not agree with any warning the strategy for cut-outs could be redesigned not to consider any warnings for theses manoeuvers at all because a suitable model with indicator thresholds cannot be identified.

Questionnaire Findings. The profile of participants shows a fair gender distribution and a wide age profile (20–60 years). With 56 % the envisioned target of experienced ACC drivers was reached. The question about the subjective reasons to agree or disagree to a lane change warning is treated in Fig. 5.

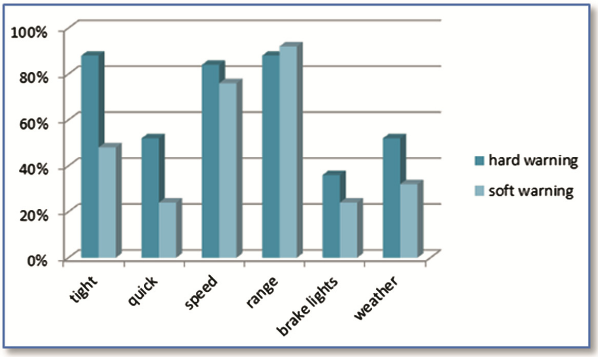

Fig. 5. Rationales to accept a warning

It is worth to discuss the levels above 50 %: Hard warnings are expected if the lane changing vehicle is in tight distance (88 %) to the TJA vehicle. This recognition can serve again as argument to use near-field sensor measurements to identify acceptance for close cut-ins and the related hard warning. Two further indicators above 50 % for close cut-ins are to be mentioned: Rapidity (“quick”) and weather conditions could be other motivating factors to postulate a hard warning.

High relevancy was found for the indicators *Speed* and *Range* for both hard and soft warnings (76–92 %). The choice of indicators from the data analysis is in accordance with the subjective rating of the participants. Another relevant indicator for soft warnings is the attribute "tight" showing ca. 45 % of relevance. This attribute deals with the distance measurement to the cutting-in vehicles: Independent from the mentioned near-field measurement which was partially available in the NDS data this implies to use a new indicator that represent the distance of the TJA vehicle to the relevant secondary object for every cut-in manoeuvers.

The pie charts in Fig. 6 show the results of two questions that deal with an overall judgment and efficiency of the tested TJA system with warnings and transitions in control. It is represented on the Likert scales from x = 1 (no agreement) to 5 (full agreement). A simplified level of agreement is presented by a percentage summary factor P. Due to [9] this factor is only applicable if the 5 steps of the Likert scale are considered equidistant. The arithmetic mean values for the questions are calculated for ACC and non-ACC drivers:

$$P = \frac{1}{n}\sum_{1}^{n} 0,25(x-1)$$

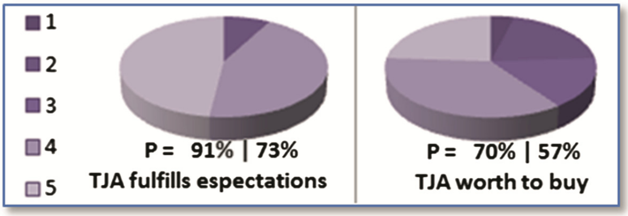

Fig. 6. TJA judgment (ACC divers | non-ACC drivers)

ACC drivers turn out at a more enthusiastic level with the proposed TJA design as a collaborative system: in the answer of TJA worthiness they gave higher credits to the proposed TJA system. In several cases the participants mentioned that the actual added value would depend on the cost of ownership.

4 Conclusions and Outlook

In the framework of automated driving with cooperative approach this study presents a control transition strategy that is built on surrounding lane change manoeuvers. A model is developed with the target to provide a high level of usability for hard and soft warnings. As core indicator for warnings quotient Q was identified that takes vehicle speed and distance into account. A simulator experiment based on video scenes was conducted to assess model validity. This study revealed an overall positive attitude of drivers towards an automated driving technology with cooperative approach. Previous experience with ACC driving proved to be of no significant effect on the acceptance of the proposed warnings.

The results of the experiment showed overall a moderate and adequate perceived usability of the current model and led to the following recommendations for further development of the strategy: For hard warnings it will be beneficial to consider objective indicators like near-field distance and Q. For soft warnings a redesign and refinement is proposed. Normal cut-in manoeuvers have a significant correlation with indicator Q and can potentially be enhanced by an indicator that represents the distance to the cutting-in vehicle. Cut-out manoeuvers showed a rather uncontrollable behaviour with indicators. A revised strategy could consider neglecting any warning for cut-outs.

A follow-up driving simulator experiment will be conducted to assess driver acceptance with respect to this revised control transition strategy as well as the proposed refined warning model.

References

1. Schaller, T.: Congestion assistance – supporting the driver in lateral and longitudinal guidance in congestion situations, dissertation TU Munich, Garching (2009)
2. Henel, C.: Analyse und experimentelle Nutzung von naturalistischen Fahrdaten für automatisiertes Fahren, RWTH Aachen (2014)
3. Gilchrist, R., et al.: Three-dimensional relationships among traffic flow theory variables. Transp. Res. Rec. **1225**, 99–108 (1992)
4. BMJ: Straßenverkehrsordnung. German Road Traffic Regulation, Ministry of Justice, Berlin (2013)
5. Krauth, J.: Experimental Design. Elsevier/Saunders, München (2000)
6. Minitab Inc.: Minitab Handbook (2007)
7. Pelham, B., Blanton, H.: Conducting Research in Psychology, Measuring the Weight of Smoke, 4th edn. Wadsworth/Cengage Learning, Belmont (2013)
8. International Telecommunication Union: Methodology for the subjective assessment of the quality of television pictures, Geneva (2012)
9. Rost, J.: Lehrbuch Testtheorie, Testkonstruktion Huber, Bern (1996)
10. Sadish, W.: Experimental and Quasi-Experimental Designs for Generalized Causal Inference. Houghton Mifflin, Boston (2002)
11. Urhahne, J.: Analysis of Traffic Congestions for Automated Driving with Cooperative Approach, FISITA World Congress, Maastricht NL (2014)
12. Stutts, J.: Distractions in Everyday Driving, AAA Foundation for Traffic Safety, Washington (2003)
13. Damböck, D., Kienle, M., Bengler, K., Bubb, H.: The H-metaphor as an example for cooperative vehicle driving. In: Jacko, J.A. (ed.) Human-Computer Interaction, Part III, HCII 2011. LNCS, vol. 6763, pp. 376–385. Springer, Heidelberg (2011)
14. Brookhuis, K. et al.: Driving with a congestion assistant; mental workload and acceptance. Appl. Ergon. **40**, 1019–1025 (2008). (Elsevier)
15. Van Driel, C., et al.: Impacts of a congestion assistant on driving behaviour and acceptance using a driving simulator. Transp. Res. Part F **2**, 139–152 (2007). (Elsevier)