Investigating Trust Calibration During Highly Automated Driving

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Abstract

The development of self-driving cars is advancing every day. However, these cars are often perceived as a safety hazard. Possible users often do not know what an automated vehicle is capable of and do not trust the technology. The present study tried to identify when the trust by the user of an automated vehicle is calibrated. In addition, possible improvements for situations with uncalibrated trust were identified. The participants in this study experienced a simulated automated vehicle in various road situations and reported their trust in the vehicle. The trust reported by the participants was then compared with the reliability rating given by engineers of an automated vehicle to identify possible mismatches. A mismatch would cause either undertrust, meaning the user entrusts the vehicle with less than it is capable of, or overtrust, thus the user trusting the vehicle to perform beyond its capabilities. It was found that users often undertrust the vehicle in a situation with poor visibility and overtrust in situations with good visibility. The level of trust was also related to how *easy* participants perceived the situation which often did not align with the engineers' perspective. It is advised to use graphical representations of how the vehicle perceives its surroundings in order to calibrate trust. Important information and decisions made by the vehicle should also be presented to the user. Lastly, the simulator used in this study proved to have a comparable effect on trust as a real-life experience.

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Introduction

Automated systems are designed to take over tasks from humans since the industrial revolution. Most of these systems require human operators to be present, monitor the automation and intervene if something goes wrong. These joint cognitive systems often have multiple artificial and human agents and can become very complex very quickly (Woods & Hollnagel, 2006). Within the industrial setting, robots and automations are widely used to perform monotonous, precise and/or dangerous tasks. This superiority over human workers resulted in a growing market of highly specialised manufacturing robots. Expectations show an increase in the use of these robots of 71% in 2020 compared to 2016 (Armstrong, 2017). With the growing capabilities of intelligent software more and more daily tasks are automated.

Transportation is the next big domain. Fully automated road systems promise perfectly orchestrated driving situations without accidents and low CO_2-emissions (Salvendy, 2012). However, the current status of the technology is still far from a finished product that delivers on those expectations. Automated systems have already been implemented in public transport. Fully automated metros and trains are good examples of this advancement like metro lines in Barcelona and in Paris and the trains on the Yurikamone line in Tokyo. The step from rail to road is the next milestone and currently a field of high interest.

Levels of automation

The term *automated driving* is currently used for multiple stages of automation. To clarify the differences, this section will explain the different levels of automation in transportation. Automated vehicles are classified in the five categories (Table 1) proposed by the Society of Automotive Engineers (SAE). These levels vary from stability control to a fully autonomous operation by the vehicle itself (SAE International, 2018). Currently, extensive driving assistance like adaptive cruise control or lane-keeping assistance, are defined as level 2. These systems are widely accessible now and standard in many regular cars.

Table 1

Levels of automation as defined by the SAE.

Level	Name	Narrative definition	DDT: Sustained lateral and longitudinal vehicle motion control	DDT: OEDR	DDT fallback	ODD
Driver* performs part or all of the *DDT						
0	No Driving Automation	The performance by the *driver* of the entire *DDT*, even when enhanced by *active safety systems*.	*Driver*	*Driver*	*Driver*	n/a
1	Driver Assistance	The *sustained* and *ODD*-specific execution by a *driving automation system* of either the *lateral* or the *longitudinal vehicle motion control* subtask of the DDT (but not both simultaneously) with the expectation that the *driver* performs the remainder of the *DDT*.	*Driver* and *System*	*Driver*	*Driver*	Limited
2	Partial Driving Automation	The *sustained* and *ODD*-specific execution by a *driving automation system* of both the *lateral* and *longitudinal vehicle motion control* subtasks of the *DDT* with the expectation that the *driver* completes the *OEDR* subtask and *supervises* the *driving automation system*.	***System***	*Driver*	*Driver*	Limited
***ADS* ("*System*") performs the entire *DDT* (while engaged)**						
3	Conditional Driving Automation	The *sustained* and *ODD*-specific performance by an *ADS* of the entire DDT with the expectation that the *DDT fallback-ready user* is *receptive* to *ADS*-issued *requests to intervene*, as well as to *DDT performance-relevant system failures* in other *vehicle* systems, and will respond appropriately.	*System*	***System***	*Fallback-ready user (becomes the driver during fallback)*	Limited
4	High Driving Automation	The *sustained* and *ODD*-specific performance by an *ADS* of the entire *DDT* and *DDT fallback* without any expectation that a *user* will respond to a *request to intervene*.	*System*	*System*	***System***	Limited
5	Full Driving Automation	The *sustained* and unconditional (i.e., not *ODD*-specific) performance by an *ADS* of the entire *DDT* and *DDT fallback* without any expectation that a *user* will respond to a *request to intervene*.	*System*	*System*	*System*	**Unlimited**

Note. Dynamic driving tasks (DDT) summarise the actual driving of a vehicle, operational design domain (ODD) means the predefined Road situations, thus no free "improvisation". Reprinted from "Taxonomy and definitions for terms related to driving automation" by SAE International (2018).

Recent advances in the automobile industry have entered the category of conditional automation (Level 2), meaning that the vehicle is fully capable of operating on its own within its predefined operational design domain (ODD). Automakers can for example only enable self-driving capabilities on certain roads and can disable the automation if the vehicle leaves it's ODD. It still requires a driver being able to take over, because the vehicle can fail when it tries to adapt to situations outside its ODD. This stage of automation also serves as a testing ground and chance for improvement. Every resolved error of the system is a step towards higher automation, where a driver is not required anymore. The following two examples are good illustrations of automation technologies in real life. Tesla's Autopilot system (Tesla Inc., 2019) is a level 2 autonomy. Tesla has announced that "full automation" is possible, but only on very few roads and supervision is still required. Waymo, better known as the Google car, is aiming for level 4 automation. This implies a fully capable automation on all streets that the vehicle would encounter (Waymo, 2018).

The present study is integrated in the i- CAVE project. This research project deals with the challenges and possibilities automation offers to personal transportation. The goal of the project is the development of a level 4 automated vehicle (i-CAVE, 2018). This study will contribute to the development of a prototype that is currently under construction.

The goal of the i-CAVE project is to develop a level 4 automated car to carry goods and people around the campus of the University of Eindhoven. The base vehicle is a *Renault Twizy* electric car which is getting rebuilt into the prototype. The prototype will use Lidar and long range and short range Radar to map its surroundings (Schinkel et al., 2018). All sensors will map 360° around the vehicle. Cameras will provide additional visual information, so that the objects found by the sensors can be identified by the recognition software. GPS will provide the vehicle with constant information about its position.

Vehicle Safety and Trust

With the continuous development of automated vehicles, the technology is also perceived as more usable by the public. Today, more people see them as a safe option of transport than when the technology was first developed, but it is still not seen as safe enough by many (Feldman, 2019). Safety is the most important factor in purchasing a vehicle (Koppel et al., 2008; Shaw & Pease, 2010; Vrkljan & Anaby, 2011; Wogalter & Cowley, 2009). A car can have as many features as possible, but no one will adopt a new technology if it is not safe. This is also the case with automated vehicles. The driver has to trust the vehicle in order to feel safe.

Trust can be defined as a situation in which an agent actively acts on behalf of another agent (Lee & See, 2004). This means that the trustor (i.e. the driver) accepts a certain degree of vulnerability because of the expectation that the trustee (i.e. the vehicle) will succeed, thus creating a dependency (Earle, 2010; Rousseau et al., 1998). It does not matter whether the agent is human or not, the automation has to be perceived as reliable as a human driver. Without trust human agents will not accept the automation in the first place (Lee & Moray, 1994).

Trust calibration. When the trustor does not have too little or too much trust in the trustee, the trust is called calibrated (Lee & See, 2004; Muir, 1987). In other words, the amount of trust placed in the trustee is in accordance with its capabilities. In the context of automated cars, trust calibration can therefore be defined as bringing the user's trust to a level which is balanced with the capabilities of the vehicle. Thus, the user does not over- or under-trust the vehicle when it decides to do something.

Overtrust describes a situation in which there is too much trust given, meaning the trustor is overconfident (Mirnig et al., 2016). This mismatch can have unexpected consequences in an automation related context, because the machine “underperforms” in the eyes of the user. It would react poorly to a traffic situation in which the user would expect the vehicle to succeed. Undertrust describes a situation in which the trustor does not believe that the capabilities of the trustee are sufficient for the given task when they actually are (Kaindl & Svetinovic, 2019). In an automation situation, this can result in the user not trusting the automation and not using it at all or leave the user in a constant urge to take over. Even worse, users could choose to take over and cause errors the automation could have prevented (Hoff & Bashir, 2015).

Several factors have been identified as having influence on trust in an automation. Among these are training, the human operator, the robot agent and the environment (Hancock et al., 2011; Lee & See, 2004; Woods & Hollnagel, 2006). For this study, the training factor has to be disregarded, as we research first users’ impressions. First time users are chosen, because the present study is about the initial trust calibration of the users when they drive an automated car for the first time. If they would already have experience with automated vehicles, they could have knowledge about the capabilities of the technology and would therefore know how the vehicle would react in a specific traffic situation.

For the definition of the remaining three factors to be used for this research, the work of Schaefer, et al. (2016) is used. The human-related factors of interest are personal traits, cognitive factors and emotive factors. The robot-related factors are its features and capabilities for the task at hand. Finally, the environmental factors are the form of collaboration and the task itself.

Another important factor in driving safety in automated vehicles is the novelty of the situation itself. In a regular car, the safety depends highly on the driver. Research suggests that the ability to drive safe depends on the correct perception of a hazardous situation, which in turn depends on memory (Groeger, 2000). In an automated vehicle, this could cause mistrust in the drivers, because they have to oversee the automation, but do not know its capabilities (Koo et al., 2015). However, even experiencing a level 2 automated vehicle in real life increases the level of trust in the vehicle (Walker et al., 2018).

Trust has been established as a very important factor in adopting vehicles and automated systems in general (Feldman, 2019; Koppel et al., 2008; Shaw & Pease, 2010; Vrkljan & Anaby, 2011; Wogalter & Cowley, 2009). The present study aimed to assess the trust that is given to automated vehicles.

Designer-user mismatch

Even if a vehicle is designed to be safe and trusted by the user, knowledge gaps between the designer and the user can cause unsafe situations (Murakami et al., 2014). These gaps between user and designer can cause the user to unknowingly use the device in a way that was unintended by the designer. This section will explore possible reasons for such designer-user mismatches in automated vehicles.

It is a common bias for an engineer or a designer to project one's own knowledge about the technology on the user (Woods & Sarter, 2000). When a new technology like an automated vehicle is developed solely by its engineers such a mismatch between the engineer and the user can occur. This can cause the users to have insufficient knowledge about the capabilities of the vehicle and by that wrong judgements of these capabilities.

There are two possible outcomes of a designer-user mismatch in automated vehicles. One is a false negative, thus judging the vehicle incapable of performing a certain task, while it actually can. The second variant and the arguably worse is a false positive, thus deeming the vehicle capable of dealing with situations it cannot. This can cause an automation surprise and possibly an accident (de Boer & Hurts, 2017).

The present study aimed at identifying possible mismatches between users and the engineers within the i-CAVE project. If mismatches have been found by this study, it furthermore aims to identify the specific factors causing those mismatches. The research question is therefore formulated as follows: Is trust given in a vehicle with level four automation by first-time users calibrated to its capabilities?

In short, automated vehicles are a technology on the rise. As such, they are in an early adopting stage. It is suggested that in its current state, the technology is not trusted by most possible users (Feldman, 2019). Safety and trust are the most important factors when one considers buying a new car, so this mistrust is very limiting in doing so (Koppel et al., 2008; Shaw & Pease, 2010; Vrkljan & Anaby, 2011; Wogalter & Cowley, 2009). It is therefore important to identify why a user would mistrust an automated vehicle and how the trust in the technology could be calibrated towards the technology's actual capabilities. The goal of this study was to identify a possible designer-user mismatch and, if such a mismatch is found, suggest solutions for this mismatch. A driving simulator-based experiment was proposed for the present study to achieve this goal. The simulator had to present an automated vehicle in a virtual environment driving through different road situations. It was important that the drivers did not see how the vehicle would react to each situation. That knowledge could have an effect on trust in later scenarios. The drivers were potential first-time users with no experience with self-driving vehicles, so that they would not know what the technology is capable of. This is important, because the drivers had to judge whether or not they would trust the automation in the situations presented to them. Already having knowledge about the technology's capabilities would have an influence on trust calibration. The drivers' judgements were to be compared with the judgements of the vehicle's reliability made by designers of an automated vehicle on the same situations in order to identify a possible mismatch. Finally, the effect the experience of the simulated automated vehicle has on trust has to be compared with the effects of a real-life experience, because the simulator should emulate real life.

Method

Participants

The sample included 28 men and 34 women with an average age of M=21 (SD=3.94). Two participants were Bulgarian, 20 Dutch, one French, 38 German and one Swedish national. 61 participants were students at the University of Twente, one was a student at Kiel University. Each participant was rewarded for their participation. This reward consisted of either six euros or one point of the student credit system of the BMS faculty of the University of Twente.

The data for the reliability of the vehicle was gathered through three engineers of the i-CAVE project. These engineers were responsible for the two sub-projects *architecture and functional safety* and *cooperative vehicle control* of the automated vehicle. Architecture and functional safety dealt with the development of the architecture, quality assessment and redundancy of the safety systems. Cooperative vehicle control dealt with the development of controllers for the vehicle, path planning and a state estimator to provide feedback for the driver.

Materials & Apparatus

Pre-experimental Questionnaire. The pre-experimental questionnaire consisted of two parts. The first part contained questions about demographics; the second part was a modified version of the empirically determined (ED) trust scale by Verberne, Ham, & Midden (2012) based on Jian et al. (2000).

The demographics collected included age, gender, nationality, years of driving experience and the amount of driving. The modified version of the ED trust scale included seven items with seven-point Likert-scales in order to predetermine the overall trust in self-driving cars. The pre-test questionnaire can be found in Appendix A.

Post-test questionnaire. The post-test questionnaire (Appendix B) contained six of the seven items of the ED trust scale in a different order. The item “I assume that self-driving cars will work properly” was excluded, because the item assumes no experience with automated vehicles at all and that is not applicable to the post-experimental state.

Exit questionnaire. The exit questionnaire included questions about the performance of the simulated vehicle and possible improvements. The participants had to rate the speed of the vehicle, its steering and its on-board screen. Possible improvements concerned auditory and visual information and interaction possibilities. Finally, the behaviour of the automation compared to how the participants would expect a human to behave had to be rated, as well as the vehicle’s behaviour compared to the individual expectations of the participants. Three open questions were included as well in case the participant had additional ideas and thoughts. This questionnaire can be found in Appendix C.

Simulator. The simulator can be divided in three parts: the computer-setup, the mock-up vehicle and the projection system.

Three computers running Silab 6.0 rev 600 (64Bit) were used for the simulation. All computers ran an Intel Core i7-7700 CPU with Windows 10 Pro as the operating system. The

Final rendering of the three images used for the three projectors was handled with a NVIDIA GeForce GTX 1080 TI graphics card.

The overall projection field was 2.50m high over 220° on a distance of two metres to the participant. The mock-up vehicle was built within a steel frame roughly the shape of a small car. It included a driver seat together with functioning pedals and a functioning steering wheel. A tablet above the steering wheel served as the dashboard, indicating speed, rpm of the motor and the gear. The tablet ran the same version of Silab as the other computers, but on a Windows 10 Home operating system with an Atom x5-Z8350 chip by Intel. Next to that, a paper notepad was also given to the participants and they were instructed to write down their reasoning behind his or her rating of each scenario. The rear of the frame contained speakers as well. These speakers were facing towards the participant and provided the sound of the simulation. The cockpit and the dashboard setup are shown in Figures 1 and 2.

Figure 1

Cockpit setup of the simulator

Figure 2

View from the driver's seat at the beginning of each scenario including the dashboard.

Scenarios. Each session contained one training scenario and nine experimental ones. All scenarios had been created with the Silab Editor. All nine experimental scenarios started with the same environment and the same speed of 50km/h. This was done to create a baseline as only the critical situations of each scenario should be of an influence. The simulation stopped after the specific traffic situation was visible but before the vehicle would have to react. The following descriptions explain the specific traffic situations that would be encountered. Visualisations of all scenarios can be found in Appendix F.

Training scenario. The training scenario consisted of a two-lane motorway and it took five minutes to complete. At the start of each scenario no traffic was present. After the first 30 seconds, traffic was encountered that was going in the same direction. The goal speed of the automated vehicle was set to 140km/h, the traffic around was dialled to 130km/h, so the vehicle could shorten the distance to the traffic ahead. The vehicle reduced speed as soon as it got too close and continued at 140km/h from there on.

Free scenario. The first scenario was a right-hand curve in a city environment. There were cars parked on both sides of the street and oncoming traffic. The vehicle had to drive through the curve. The scenario ended right before the vehicle would have had to take the turn.

Roadblock scenario. At the end of a straight road, the way was blocked by concrete blocks and markings. There were no other streets branching off. The vehicle had to stop and turn around in order to find another route. The scenario stopped right before the vehicle would have had to brake for the roadblock.

Bus scenario. The vehicle encountered a bus standing still in a corner ahead. The bus would not move, so it had to be passed. In addition, buildings on the left side of the road were blocking the view in the corner. The scenario stopped right before the vehicle would have had to brake for the bus.

Boxes scenario. At the end of a straight road, the right lane was blocked by three traffic cones. There was no oncoming traffic. The vehicle had to pass the cones at the left to evade them. The scenario stopped right before the vehicle would have had to steer to the left.

Crosswalk scenario. After a left-hand turn with vehicles parked left and right, the vehicle came up to a crosswalk with a pedestrian on the right side ready to cross the road. The vehicle had to stop and let the pedestrian pass. The scenario stopped right after the pedestrian came into sight.

Junction scenario. This scenario contained a junction at the end of a corner. A lorry was coming from the right and had right of way. The participant's vehicle had to wait at the stop line of the junction and had the lorry pass. The scenario stopped right before the vehicle had to brake for the stop line.

Oncoming traffic scenario. After leaving the town environment, the vehicle encountered a long right-hand turn with trees on the right blocking the view. Vehicles were coming around the corner. The automated vehicle had to continue its way. The simulation stopped right after the oncoming vehicle came into sight.

Waiting vehicle scenario. This scenario featured a car driving up to a traffic light in front of the automated vehicle. The car tried to pull over into the right lane in order to take a right-hand turn at the intersection. But other cars that were already queueing prevented the car from entering that lane in its entirety. Thus, the rear of the car was still on the lane the automated vehicle had to take. Also, there was oncoming traffic, so the vehicle had to stop. The simulation stopped right before the vehicle would have had to brake for the waiting vehicle.

Roundabout scenario. After passing a parking vehicle, the automated vehicle encountered a roundabout with oncoming traffic. The vehicle had to enter the roundabout.

The simulation stopped right before the vehicle would have had to brake in order to enter the roundabout with an appropriate speed.

Reliability scoring. The engineers received the representations of the scenarios (Appendix D). They had to rate the reliability of the vehicle in every scenario.

Procedure

The experiment was conducted in a controlled environment. First the participants got the instructions (Appendix E) of the experiment read out to them. If there were no further questions, the participant was handed the informed consent form (Appendix F) and was asked to read it carefully before signing. If the participants signed the form, they were asked to fill in the pre-experimental questionnaire. After that, the training scenario was started.

The researcher led the participants to the simulator and started the scenario. As the training scenario's only purpose was to get the participants used to driving in the virtual environment, the participants did not engage the automation themselves. At the end of the training scenario, the researcher explained that, in every following scenario, the simulation would stop just before entering a specific traffic situation. Because of the training environment, the participants were given a warning this time, so that they could get accustomed to the procedure of the experiment. Then, the traffic situation was explained. After the training scenario had ended the first scenario was started. The participants were presented with the scenarios in one of four possible orders to control for a possible effect of the order of scenarios (Table 2). The first scenario was always *Free*, because the relevant part was a curve that was also used in other scenarios. Thus, if this scenario would not be the first one, the participants would already have experienced that the vehicle was able to deal with the traffic situation of the scenario *Free*. The last scenario was always

Roundabout, as it featured the automated vehicle braking and an earlier encounter of this scenario would have given participants more knowledge about the vehicles' capabilities. This could have influenced a participant's judgement on the following scenarios. Many of the scenarios are about how the vehicle would react to its surroundings and therefore this knowledge would be undesired.

Table 2

Order of scenarios for each group

Group			
1	2	3	4
Free	Free	Free	Free
Bus	Roadblock	Bus	Oncoming vehicle
Oncoming vehicle	Boxes	Junction	Waiting vehicle
Waiting vehicle	Junction	Waiting vehicle	Roadblock
Crosswalk	Crosswalk	Roadblock	Bus
Junction	Waiting vehicle	Oncoming vehicle	Crosswalk
Boxes	Oncoming vehicle	Boxes	Boxes
Roadblock	Bus	Crosswalk	Junction
Roundabout	Roundabout	Roundabout	Roundabout

At the beginning of each scenario, the participant had to switch on the automation by pressing a marked button on the steering wheel. After the simulation had stopped, the traffic situation was explained to the participants. They had to rate their trust in the capability of the vehicle by answering the question "On a scale from one to five where one is not at all and five is absolutely, how sure are you that the vehicle can handle this situation?". The answer had to be written down, together with a short elaboration of the reasons behind the rating. The instructions for every scenario can be found in Appendix G.

After the last scenario had ended, the participants were given the post-test questionnaire and the exit questionnaire. If the participants had no further questions, they were thanked for their participation and the session was finished.

The scenarios were also sent to the engineers as the representations seen in Appendix D. As the engineers had to rate the reliability of the vehicle, the question "What is the maximum reliability the vehicle can achieve in this situation?" had to be answered on a scale from one to five where one was minimum reliability and five was maximum reliability. They were asked to use their knowledge of the capabilities that the i-CAVE project's vehicle will have. In addition to that, the engineers were asked to explain their reasoning if the rating was below 5.

Statistical procedures

The quantitative data (i.e. the demographics) the rating of the situations and all Likert-scales from the questionnaires were converted into one dataset and analysed with SPSS 25. The qualitative data, meaning the possible answers to the open questions of the exit questionnaire and the reasoning behind the ratings of the scenarios were coded with Atlas.ti (Scientific Software Development GmbH, 2017). Thus, every trust related statement of the participants was marked and listed in a category (i.e. code).

Analysis

First, the effects of the four different orders of the scenarios (Table 2) on the trust ratings were compared with an independent samples Kruskal Wallis test per scenario in order to test for a possible effect of the order in which the scenarios were presented.

After that, the scores on trust per scenario were compared with the engineers' reliability score of each scenario through a one-sample Wilcoxon signed rank test. These engineers are the ones building the prototype this simulator-study is based on and they estimated the capabilities of the vehicle for each scenario. The scores on the pre- and post-experimental ED trust scale were compared with a related samples Wilcoxon signed rank test for the possible effect the experiment had on trust.

The qualitative data of the reasoning forms was analysed in Atlas.ti. All answers were coded for factors influencing the decision of a participant. These were then summarised in order to find common factors. After coding the answers, the frequencies of the used codes were compared. This was done after the frequencies had been normalized. This was done because comparing the absolute counts of used codes between datasets of different sizes would yield distorted results. The same was done with the exit questionnaire data, but normalisation was not necessary.

Lastly, an independent-samples Mann-Whitney U test was performed to compare the distributions of all items of the exit questionnaire individually across two groups per scenario. These groups were defined as being above and below the reliability scores given by the engineers.

Results

The independent-samples Kruskal-Wallis test performed on each scenario across the four groups returned one significant difference between the groups in the scenario *junction* (p=.011). All other scenarios showed no significant difference between the groups, indicating no influence of the order in which the scenarios were presented on the rating of trust apart from the scenario *junction* (Table 3).

Table 3.

Effect of the order of scenarios on trust-rating

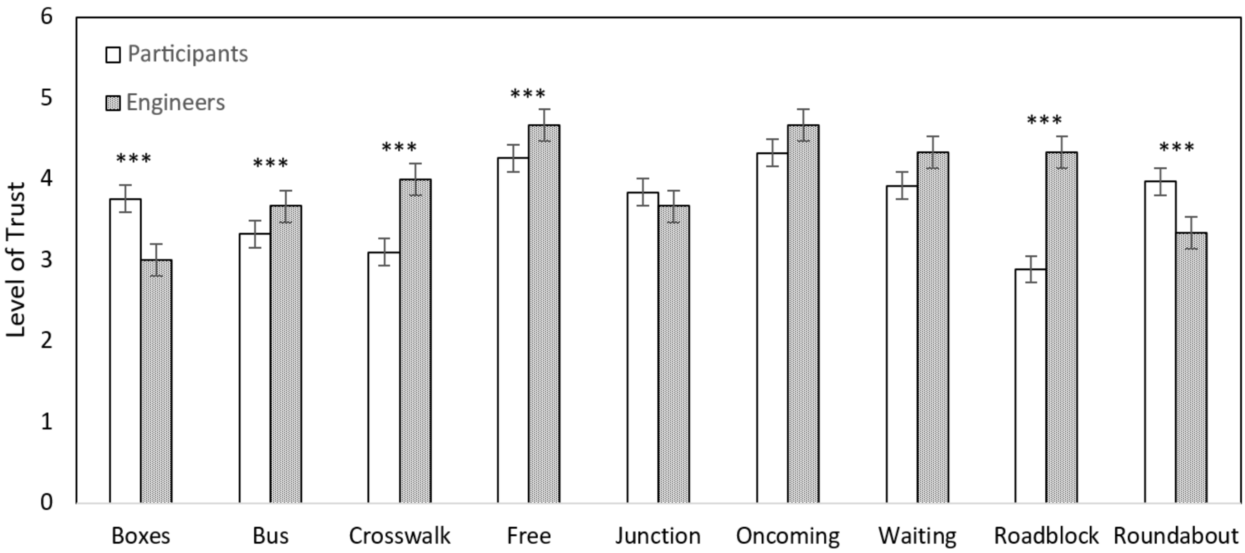
Scenario	Significance
Boxes	.058
Bus	.972
Crosswalk	.228
Free	.967
Junction	.011*
Oncoming traffic	.711
Waiting vehicle	.953
Roadblock	.278
Roundabout	.063

Note. Results of the independent samples Kruskal-Wallis test per scenario performed across the groups in order to test for an influence of the order in which scenarios were presented on the trust ratings. The result with asterisk was significant.

The scores of the participants and the engineers are shown in Figure 3. The Wilcoxon signed ranks tests returned the following results (Table 4). As these were multiple measurements on the same sample, a Bonferroni correction was applied returning α=.05/9=.006.

Figure 3

Comparison of the mean trust-scores of Engineers and Participants per scenario.



Note. Error bars represent standard errors, results marked with *** were significant.

Table 4

Comparison of trust in the vehicle and reliability of the vehicle

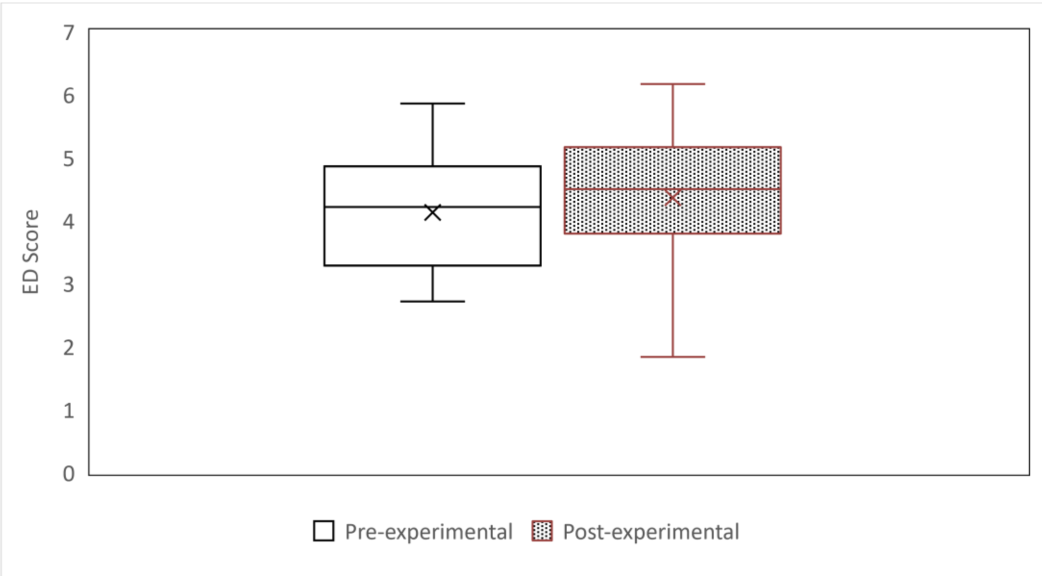
Scenario	Over./Under.	N	Mean Rank	Sum of Ranks	*Z*	*p*
Boxes	Overtrust	44	27.82	1224	-4.215	<.001*
	Undertrust	10	26.1	261		
Bus	Overtrust	28	20.21	566	-2.905	.004*
	Undertrust	34	47.79	1387		
Crosswalk	Overtrust	11	13.5	148.5	-4.727	<.001*
	Undertrust	38	28.33	1075.5		
Free	Overtrust	27	14	378	-4.279	<.001*
	Undertrust	35	45	1575		
Junction	Overtrust	40	27.65	1106	-.917	.359
	Undertrust	22	38.5	847		
Oncoming traffic	Overtrust	34	17.5	595	-2.738	.006
	Undertrust	28	48.5	1358		
Waiting vehicle	Overtrust	19	34	646	-2.346	.019
	Undertrust	43	30.4	1307		
Roadblock	Overtrust	5	17	85	-6.301	<.001*
	Undertrust	57	32.77	1868		
Roundabout	Overtrust	45	36.87	1659	-4.847	<.001*
	Undertrust	17	17.29	294		

Note. Results of the Wilcoxon signed ranks test comparing trust scores of the participants with the reliability scores given by the engineers. Results with asterisk are significant (α=.006).

The related-samples Wilcoxon signed rank test comparing the mean score of the pre- (*M*=4.129, *SD*=.11) and post-experimental (*M*=4.36, *SD*=1.002) empirically derived trust scale showed a significant difference (*Z*=-2.353, *p*=.019). This indicates a positive effect of the experiment on the trust in self-driving cars in general (Figure 4).

Figure 4

Pre- and post-experimental empirically derived trust scores in automated vehicles



Eleven codes were identified in the qualitative analysis of the answers given as reasons for the trust scores for each scenario (Table 4). In the scenario *Boxes,* the participants trusted the sensors to identify the obstacles and that the car would safely evade them. In the scenario *roundabout*, participants saw the vehicle as being capable of entering and driving through the roundabout and that the sensors were working.

For the scenario *junction,* the participants spoke of it as an every-day situation with good visibility of signs and the other vehicles. In the scenario *oncoming vehicle*, participants were confident that nothing out of the ordinary would happen, as it was an easy situation for the car. The scenario *waiting vehicle* made the participants mostly speak of the vehicle being able to detect the obstacle in front and that an overtake is impossible, so it was expected to stop.

Within the scenario *bus*, participants stated that they were sceptical that the vehicle would be able to recognise the bus and especially that the situation was unsafe because traffic coming around the left-hand turn ahead was not visible. For the scenario *crosswalk* participants stated that they were sceptical that the vehicle could recognise the pedestrian in time and also predict that the pedestrian was going to move across the street. In the scenario *free* the situation was seen as safe in general, but simulator based steering problems caused some insecurity in participants in this scenario. Although a very minor issue, some participants reported discomfort because of it. However, no such thing was reported in any of the following scenarios, no matter the order they were presented in. Lastly, in the scenario *Roadblock* participants trusted the car to stop but turning around to find another way was seen as too complicated.

Anthropomorphism was found in every scenario. The vehicle was attributed with human characteristics, such as “thinking”, “being confused”, “seeing” and “driving carefully”.

Table 4.

Frequencies of the codes used per scenario.

	Scenario								
Code	Boxes	Bus	Crosswalk	Free	Junction	Oncoming Traffic	Parked vehicle	Roadblock	Roundabout
Anthropomorphism	19%	13%	13%	5%	12%	6%	11%	14%	14%
Danger	2%	15%	9%	11%		6%	4%	4%	7%
Different to human		2%	1%	5%	1%	2%	2%		
Easy	6%	8%	5%	2%	17%	22%	13%	3%	14%
Safe	16%	4%		37%	6%	18%	7%	5%	6%
Sceptical	10%	13%	13%	3%	19%	16%	18%	14%	14%
Sensor	23%	12%	29%	8%	31%	14%	38%	15%	24%
Steering	2%	3%		15%		4%	2%	1%	1%
Too complicated	10%	13%	8%		5%	2%	5%	41%	8%
Too fast	1%	2%	5%	5%	1%				
Visibility	11%	14%	18%	10%	16%	12%	2%	3%	11%

The Spearman correlations of the exit-questionnaire items with all scenarios (Table 5) yielded two significant results. A Bonferroni correction is applied, returning α=.006. The scenario *free* showed a significant negative association with the item *speed* (rs(62)= -.396, p=.001). This indicates participants had less trust in the vehicle when it was perceived as too fast. The trust scores in the scenario *waiting vehicle* showed a significant positive association with the item *dashsize* (rs(62)= .422, p=.001). This indicates that the participants had more trust when the size of the on-board screen was perceived as sufficient.

Table 5

Correlations of items of the exit-questionnaire and trust ratings of the scenarios

Variable	N	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1. Speed	62	-																				
2. Steering	62	-.173	-																			
3. D.board Info	62	.008	-.002	-																		
4. D.board size	62	-.046	.310	-.228	-																	
5. D.board style	62	-.101	.116	.223	.002	-																
6. Audio	62	.011	.056	-.107	.163	.018	-															
7. Touch	62	-.123	.179	.050	-.008	.311	.280	-														
8. Voice Input	62	.122	.081	-.058	.159	.281	.194	**.521***	-													
9. Voice Com	62	.028	.189	.037	.101	.226	**.488***	**.429***	**.572***	-												
10. Amb. Light	62	-.090	**.459***	.054	.084	.142	.121	.257	.159	.225	-											
11. Humanlike	62	-.241	-.010	-.158	.200	.120	-.154	-.107	.142	-.024	.090	-										
12. As Expected	62	-.074	.023	-.245	.107	.040	-.054	-.024	-.015	.035	.121	**.368***	-									
13. Boxes	62	-.215	-.006	-.061	-.003	.104	.028	.030	-.004	.096	.055	.116	.228	-								
14. Bus	62	-.183	-.039	-.126	.177	-.035	-.078	.015	.031	-.022	-.050	.084	-.015	.126	-							
15. Crosswalk	62	-.028	-.125	-.051	.089	-.067	-.072	-.046	-.183	-.021	-.149	-.033	.006	.215	-.049	-						
16. Free	62	**-.396***	.284	-.269	.248	.043	.123	.212	.086	.090	.294	.174	.182	.129	.258	.123	-					
17. Junction	62	-.177	-.182	.097	.160	.029	.007	.075	-.040	.075	-.165	-.009	.061	**.422***	.175	**.563***	.162	-				
18. Onc. Traffic	62	-.049	.210	-.130	.031	.005	.011	-.107	-.026	.175	.124	.134	.152	.259	-.025	.001	.227	.152	-			
19. W. Vehicle	62	-.164	.174	-.247	**.422***	-.115	.082	.022	.030	.207	.182	.149	.237	-.003	.113	.244	.253	.291	.149	-		
20. Roadblock	62	.134	-.053	-.137	.069	-.119	-.057	.099	.071	.058	.052	.147	-.012	.136	.329	.008	-.022	-.081	-.028	.181	-	
21. Roundabout	62	-.249	-.058	-.021	.033	.127	-.130	-.095	-.095	.029	.039	.060	.090	**.492***	.238	.322	.160	**.559***	**.367***	.251	.147	-

Note. D.Board = Dashboard, concerning on-board screen; Amb. Light = Ambient Lighting; Occ. Traffic = scenario *oncoming traffic;* W. Vehicle = scenario *waiting vehicle.* Significant correlations are marked with an asterisk (α=.006).

An Independent Mann-Whitney U test was performed across all Likert scale items of the exit questionnaire per scenario (Table 6). The scores of each item were grouped based on undertrust and overtrust per scenario. Significant differences were found for the on-board screen size in *waiting vehicle* and *free* and for the amount of information of the on-board screen in *free*. This indicates that participants with undertrust in the scenario *waiting vehicle* perceived the screen size as too small. Participants with undertrust in the scenario *free* perceived the screen as too small and with not enough information about the vehicle and its surroundings. Participants with undertrust in the scenario *free* also did not perceive the performance of the vehicle as expected.

Table 5

Comparison of scores in the exit-questionnaire between under- and overtrusting participants per scenario

	Scenarios								
Item	Boxes	Bus	Crosswalk	Free	Junction	Oncoming Traffic	Waiting Vehicle	Roadblock	Roundabout
Speed	.375	.593	.487	.241	.077	.770	.270	.264	.104
Steering	.602	.082	.088	.068	.706	.134	.405	.900	.215
D. Info	.857	.695	.356	**.024***	.175	.351	.576	.450	.856
D. Size	.967	.584	.375	**.009***	.104	.460	**.031***	.580	.845
D. Style	.115	.682	.725	.860	.517	.429	.179	.707	.117
Audio	.760	.732	.665	.564	.716	.531	.706	.099	.615
Touch	.557	.441	.873	.462	.320	.482	.245	.940	.726
Voice Inp.	.828	.294	.219	.316	.879	.667	.539	.465	.531
Voice Com.	.992	.628	.751	.376	.289	.977	.386	.980	.317
Amb. Light	.929	.239	.501	.351	.369	.117	.850	.861	.253
Humanlike	.394	.816	.434	.078	.749	.224	.716	.264	.896
As expected	.878	.964	.822	**.046***	.825	.187	.731	.802	.261

Note. D. = On-board screen; Voice Inp. = Voice Input; Voice Com. = Voice Communication by the vehicle; Amb. Light = Ambient Light; Results with asterisk are significant (p<.005).

Seven codes were identified in the answers to the question which behaviour of the vehicle did not meet the expectations of the participants. Twelve codes were identified in the answers given to the questions about what features the participants were missing and which additional information they would have liked to be provided with. These codes are summarised in table 7.

The question about unexpected behaviour revealed that participants did not expect the vehicle to drive so “robotic”, meaning rapid steering, shifting into gears fast and keeping an exact speed at almost all times. Although this is possible for an automated vehicle, it was perceived as uncanny and sometimes even careless. The constant speed was also perceived as too fast when the vehicle approached a situation the participants saw as potentially dangerous.

In general, participants would have liked an indication of how confident the vehicle is in itself. Next to that, participants would have liked some representation of the vehicle's decision-making process and a representation of the vehicle's view. In addition to that, the question about missing features of the vehicle revealed that participants would have liked some form of interaction with the vehicle, for example via a voice interface. In addition, participants missed an indication of what status the vehicle was in, thus if it was operating automatically or if the driver would need to take over soon.

Table 7

Frequencies of the codes used in the exit questionnaire

	Question		
Code	Additional Information	Missing Features	Unexpected Behaviour
AR	3%	4%	
Confidence Indication	23%	4%	
Confirmation	9%	8%	
Rep. of decision-making	18%	4%	
Navigation system	9%	11%	
Rep. of V.'s view	35%	19%	
Throttle/Brake Indication	3%	4%	
Alerts		8%	
Awareness Conf. of Driver		4%	
Interaction		15%	
State Awareness		11%	
Voice		8%	
Careless			4%
Constant Speed			3%
Fast Shift			11%
Better than Expected			11%
No Communication			5%
Steering			48%
Too Fast			18%

Note. Additional information N=30, Missing Features N=28, Unexpected Behaviour N=35

Discussion

The results of the pre- and post-test questionnaire show that experiencing the simulated vehicle caused an overall increase of trust. This suggests that the simulator used had an effect on trust that was comparable to a real-life experience of automated driving (Walker et al., 2018).

Trust calibration was found in the two scenarios *junction* and *waiting vehicle*. *Junction* featured the automated vehicle approaching a junction with a lorry coming from the right. In addition, there are clear “give way” signs and stop lines. *Waiting vehicle* showed the automated vehicle approaching a queue of vehicles with no possibility to overtake due to oncoming traffic. Both scenarios involved the automated vehicle encountering scenarios the participants perceived as easy. The situations had good visibility of vehicles involved and road signs. Both scenarios also showed interactions with other vehicles, but also in road situations that are often encountered in real life. The participants stated in both scenarios that they trusted the vehicle to recognise all signs and objects involved.

The scenarios in which the vehicle was undertrusted involved situations with low visibility. In general, the participants did not feel safe in these situations. In the scenarios *free* and *bus* the view of the relevant area was obstructed. In *free,* parked cars blocked the view of the upcoming turn to the right. In the scenario *Bus*, the view on the left-hand turn behind the bus was blocked by buildings on the left and by the bus. Both situations were perceived as unpredictable. In addition to that, situations that were judged as too complicated for the vehicle also caused undertrust, even though the vehicle was capable of handling the situation. In these situations, the participants missed information of what the vehicle would recognise and would do. It can be concluded from the results shown in the present study, that it would be an improvement to implement a representation of the recognized objects on the street. The results of the exit questionnaire revealed that this could for example be achieved with a larger on-board screen or a heads-up projection that highlights points of interest.

The scenarios in which the vehicle was overtrusted featured long approaches to traffic situations that were rated with a lower reliability by the engineers. *Boxes* featured the automated vehicle approaching traffic cones on a straight road. The participants had plenty of time to analyse the situation and could see that no traffic was approaching. To most participants, the situation seemed clear and they overestimated the capabilities of the sensors. They stated that they were confident that the vehicle will identify the obstructions, when small objects with unusual shapes can be a challenge, especially in not-ideal lighting conditions (Sharma et al., 2016). In the scenario *roundabout*, the vehicle approached the complex situation of a roundabout with oncoming traffic. The approach towards this situation was also very long, giving the participants much time to analyse the situation and giving them confidence in the capabilities of the vehicle. However, driving through a roundabout is very demanding, as the steering operation is rapid and other vehicles may not be visible to sensors. Research shows that an almost human-like approach to roundabouts is necessary (De Beaucorps et al., 2017). This would explain, why the scenario seemed not as complicated to the participants as it does to the engineers.

The mismatch in both scenarios *boxes* and *roundabout* could be solved by a representation of the identified objects and clear information of what the vehicles next step would be. The driver needs a way to easily see, if the vehicle's sensors missed possible danger.

The scenarios were not presented to the engineers and the participants in the same way, as the engineers did not drive in the simulator. Although the two groups did not experience the scenarios in the same way, the approach of this study is still valid, because the measurements were different. The engineers had to rate the reliability of the vehicle, where the participants had to rate trust. The engineers had to be aware of the situation the vehicle would be in, but the participants had to experience the scenario in order to rate their trust.

Anthropomorphism, the tendency to project human characteristics on nonhuman agents (Epley et al., 2007), was a very consistent part of the answers. The vehicles actions were described with words like “thinking”, “confused”, “careful” and “seeing”. This can be utilised in improvements to the interface. An automated car becomes more approachable when it gets humanised (Forster et al., 2017). The idea of a voice interface was much liked by the participants. This can be used for providing important information like decisions, danger and uncertainty. However, other research suggests, that anthropomorphic features are difficult to implement correctly as their effectiveness is highly dependent on the specific user (Aremyr et al., 2019).

In general, the participants would have liked an indication of confidence by the car itself. This would require a continuous graphical representation of how confident the car “feels”. This means more than indicating that a driver has to take over as Seppelt and Lee (2019) suggest. The present study suggests a continuous real-time indication of the self-confidence of the vehicle and not just alerting the driver when the control of the vehicle has to be handed over. However, it can also be argued that if such a confidence indicator would be used, the driver would not be able to see why the vehicle would state a specific self-confidence. This would result in the same problem, as the driver would have to trust the vehicle’s self-evaluation without any means of monitoring. One way of solving this issue would be a representation of the recognised surroundings, as suggested by the results of the present study. Together with an indication of the self-confidence of the vehicle in real-time, a driver would have the possibility to check if the self-confidence of the vehicle is not based on false information about its surroundings, but a representation of what it is doing. This should be done visually or auditory.

Limitations

Due to the limitations of Silab with automation, the steering ratio had to be lowered so the vehicle would have a greater tolerance for leaving the middle of its lane. This had to be done, so that the vehicle was able to drive through narrow reverse curves. But this higher tolerance meant that the vehicle needed time to recover a straight course on straight street elements after exiting a curve. This caused the car to oscillate for a couple of seconds. Participants reported some unease because of this effect during the first scenario *free*. However, this oscillation was not reported in any of the scenarios after *free*.

Some participants mentioned the lack of mirrors in the simulator. This had a negative impact on immersion, but also on the general oversight a participant could have.

The simulation had to be paused at the end of every scenario, so the participants could reflect on the situation they were in, which was important for the goal of this study. Of course, this is unlike a real-life situation, but this is a general limitation that every study using a driving simulator must face. It is advised to also track the trust of a participant continuously in future research.

Finally, the sample size of engineers was very small (N=3). As their ratings concerned the reliability of the automated vehicle and they were experts in their field, this limitation should be minor, but the reliability scores used are nevertheless less reliable.

Conclusion

The present study wanted to answer the research question *Is trust given in a level four automated vehicle by first-time users calibrated to its capabilities?* It can be concluded that trust in automated vehicles is often not calibrated. The users' trust was calibrated in situations that feature high visibility and low complexity. Overtrust occurred when a situation was perceived as easy due to high visibility and/or frequent occurrence in real life but featured a high complexity that was not apparent to the user. Undertrust occurred when a situation featured possible danger and/or low visibility according to the user when its complexity was in fact low. These misalignments can have serious consequences in the real world when they are not solved, as the users' perceptions of the vehicle's capabilities and its actual capabilities are different.

A representation of what the automated vehicle "sees" and a visual or auditory representation of the status of the vehicle are needed to calibrate the trust of the users. With such representations, the users would have possibilities to monitor the automation so that they are aware of its capabilities and decisions.

The present study presented a method to investigate trust calibration in automated vehicles and suggested improvements to the safety and ultimately the usability of this developing technology. The presented method and the suggested improvements are a great addition to our way towards the future of personal transportation.

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Appendix A

PRE-TEST QUESTIONNAIRE

PART 1:

Age:

Gender:

Nationality:

Years of driving experience (i.e. Years that passed since when you first got your driving licence):

On average, how often do you drive on European roads (including Dutch roads)?

- Never
- Once per month
- Once per week
- Twice per week
- Every day

PART 2:

Through this brief questionnaire we would like to measure your attitudes toward self-driving cars.

We understand that your knowledge on self-driving cars might be limited, so please answer based on your ideas and expectations.
Please respond as truthfully as possible, and keep in mind that there is no "correct" answer.

1. I am cautious about self-driving cars

Not at all ◻ ◻ ◻ ◻ ◻ ◻ ◻ Extremely

2. Self-driving cars are reliable

Not at all ◻ ◻ ◻ ◻ ◻ ◻ ◻ Extremely

3. I would entrust my car to self-driving functions for lane changing, automatic braking, etc.

Not at all ◻ ◻ ◻ ◻ ◻ ◻ ◻ Extremely

4. I can count on self-driving cars

Not at all ◻ ◻ ◻ ◻ ◻ ◻ ◻ Extremely

5. Self-driving cars can have harmful consequences

Not at all ◻ ◻ ◻ ◻ ◻ ◻ ◻ Extremely

6. I trust self-driving cars

Not at all ◻ ◻ ◻ ◻ ◻ ◻ ◻ Extremely

7. I assume that self-driving cars will work properly

Not at all ◻ ◻ ◻ ◻ ◻ ◻ ◻ Extremely

Appendix B

POST-TEST QUESTIONNAIRE

Please respond as truthfully as possible, and keep in mind that there is no “correct” answer.

8. I can count on self-driving cars

Not at all □ □ □ □ □ □ □ Extremely

9. I trust self-driving cars

Not at all □ □ □ □ □ □ □ Extremely

10. Self-driving cars can have harmful consequences

Not at all □ □ □ □ □ □ □ Extremely

11. I would entrust my car to self-driving functions for lane changing, automatic braking, etc.

Not at all □ □ □ □ □ □ □ Extremely

12. I am cautious about self-driving cars

Not at all □ □ □ □ □ □ □ Extremely

13. Self-driving cars are reliable

Not at all □ □ □ □ □ □ □ Extremely

Appendix C

EXIT QUESTIONNAIRE

The speed of the vehicle was

Too slow □ □ □ □ □ Too fast

The steering of the vehicle was

Too loose □ □ □ □ □ Too stiff

The information provided by the dashboard was

Sufficient □ □ □ □ □ Insufficient

Was the size of the dashboard sufficient?

Not at all □ □ □ □ □ Extremely

Do you prefer a digitally styled dashboard over an analogue style?

Not at all □ □ □ □ □ Extremely

Would you like audio information?

Not at all □ □ □ □ □ Extremely

Would you like to be able to interact with the car via a touch interface?

Not at all □ □ □ □ □ Extremely

Would you like to be able to interact with the car via voice input?

Not at all □ □ □ □ □ Extremely

Would you like the vehicle to communicate to you with a voice?

Not at all □ □ □ □ □ Extremely

Would you like ambient lighting to provide information inside the car?

Not at all □ □ □ □ □ Extremely

Was the behaviour of the car humanlike?

Not at all □ □ □ □ □ Extremely

Was the behaviour of the vehicle in line with your expectations?

Not at all □ □ □ □ □ Extremely

If not, which behaviour of the vehicle did not meet your expectations?

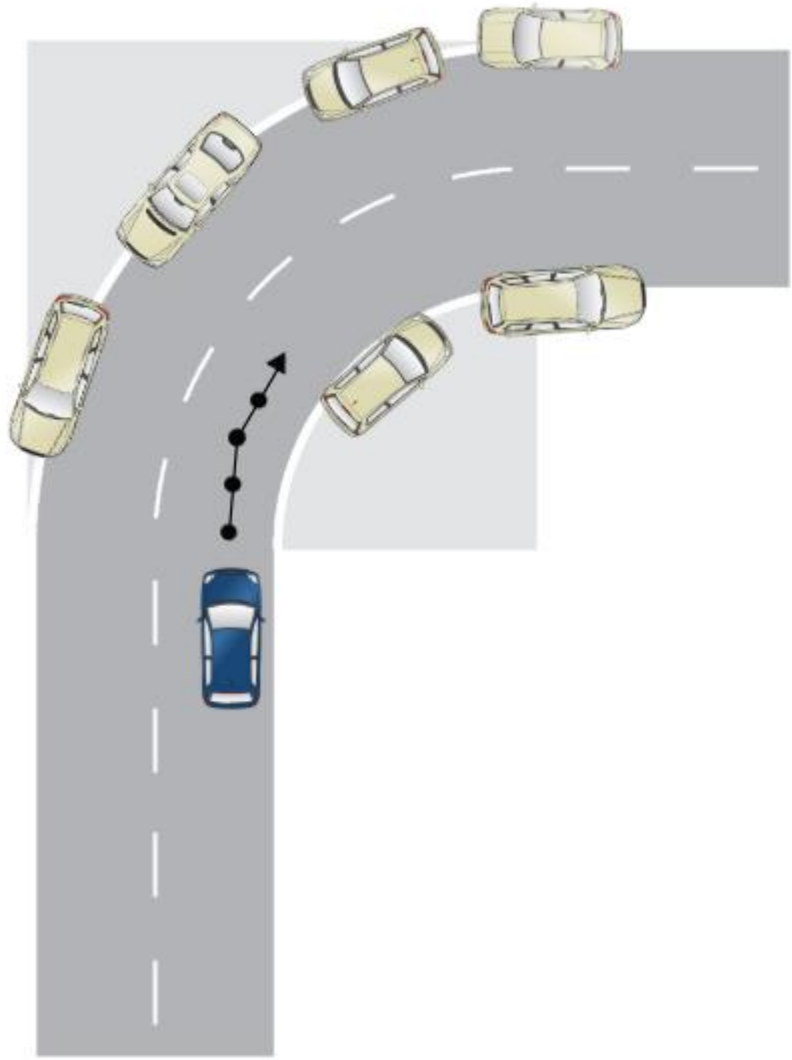
Is there any additional information that you would like to be provided with?

Are there any other features that you missed in the automated vehicle?

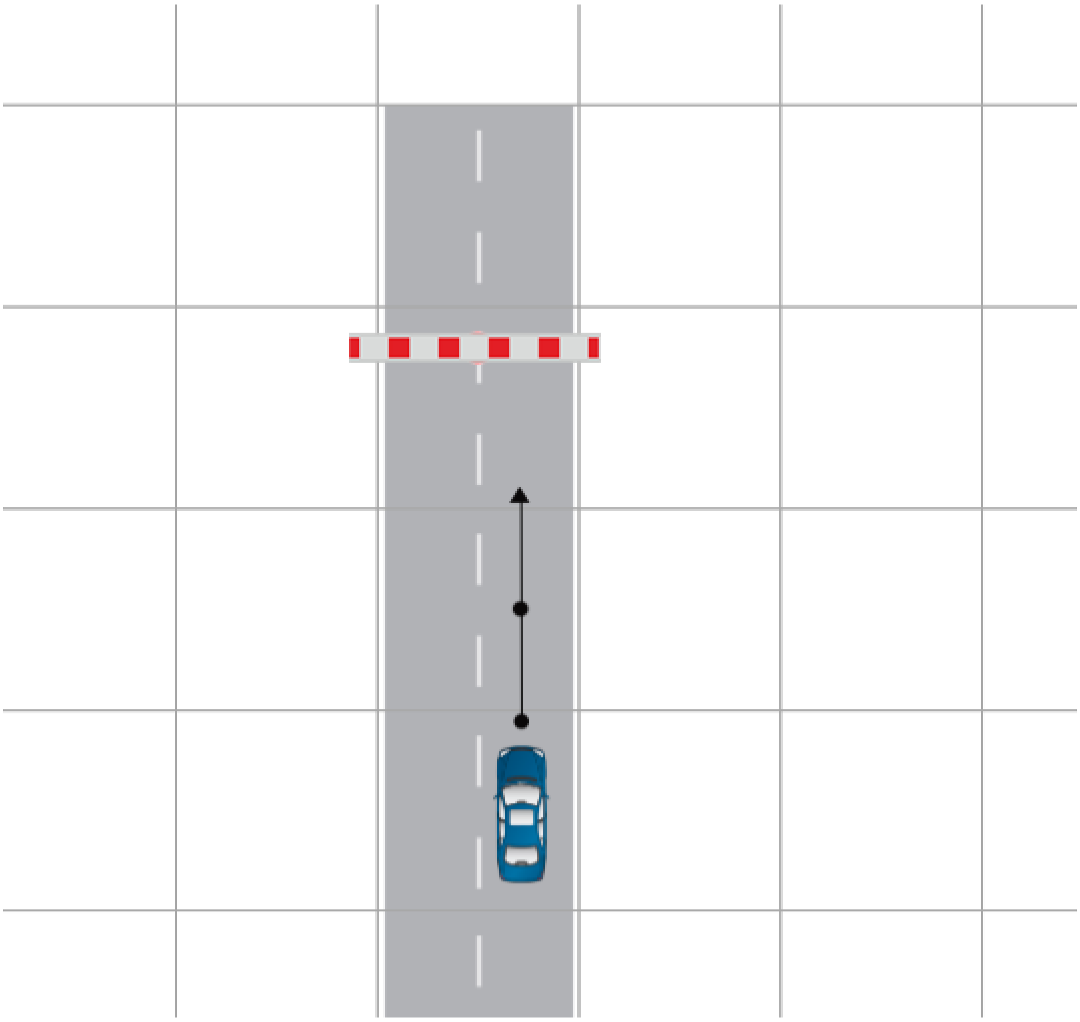
Appendix D

GRAPHICAL REPRESENTATIONS OF THE SCENARIOS

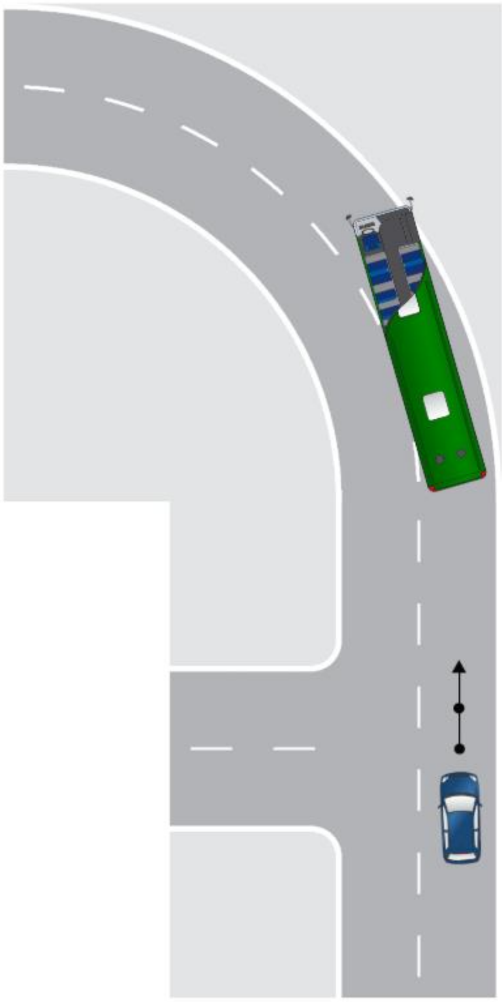
Visualisation of Scenario "Free"



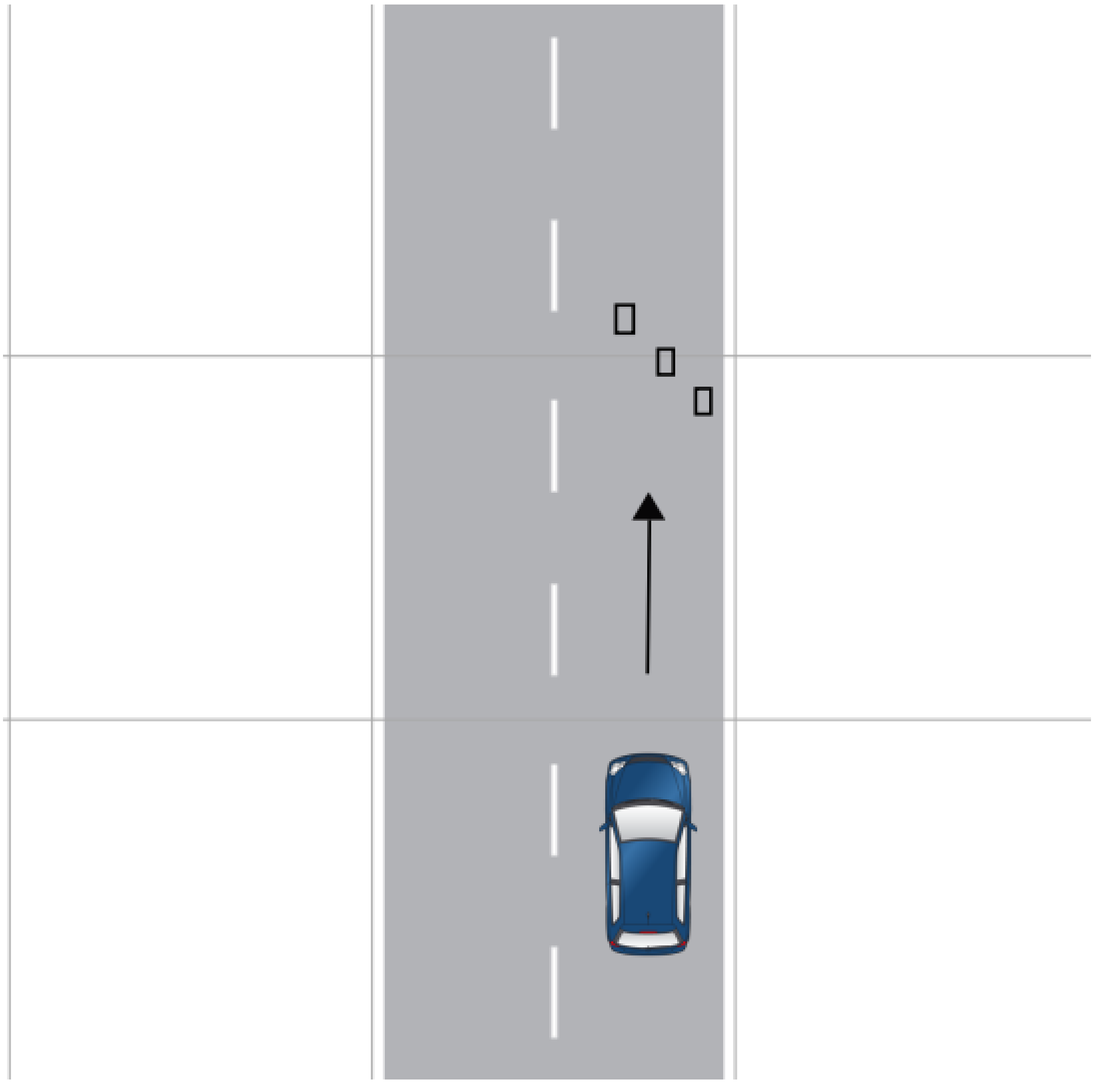
Visualisation of Scenario “Roadblock”



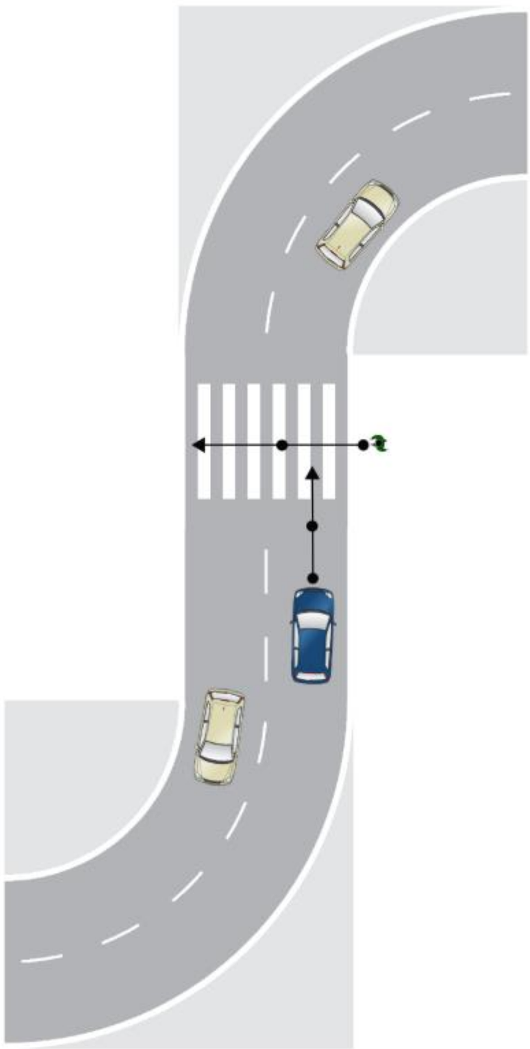
Visualisation of Scenario “Bus”



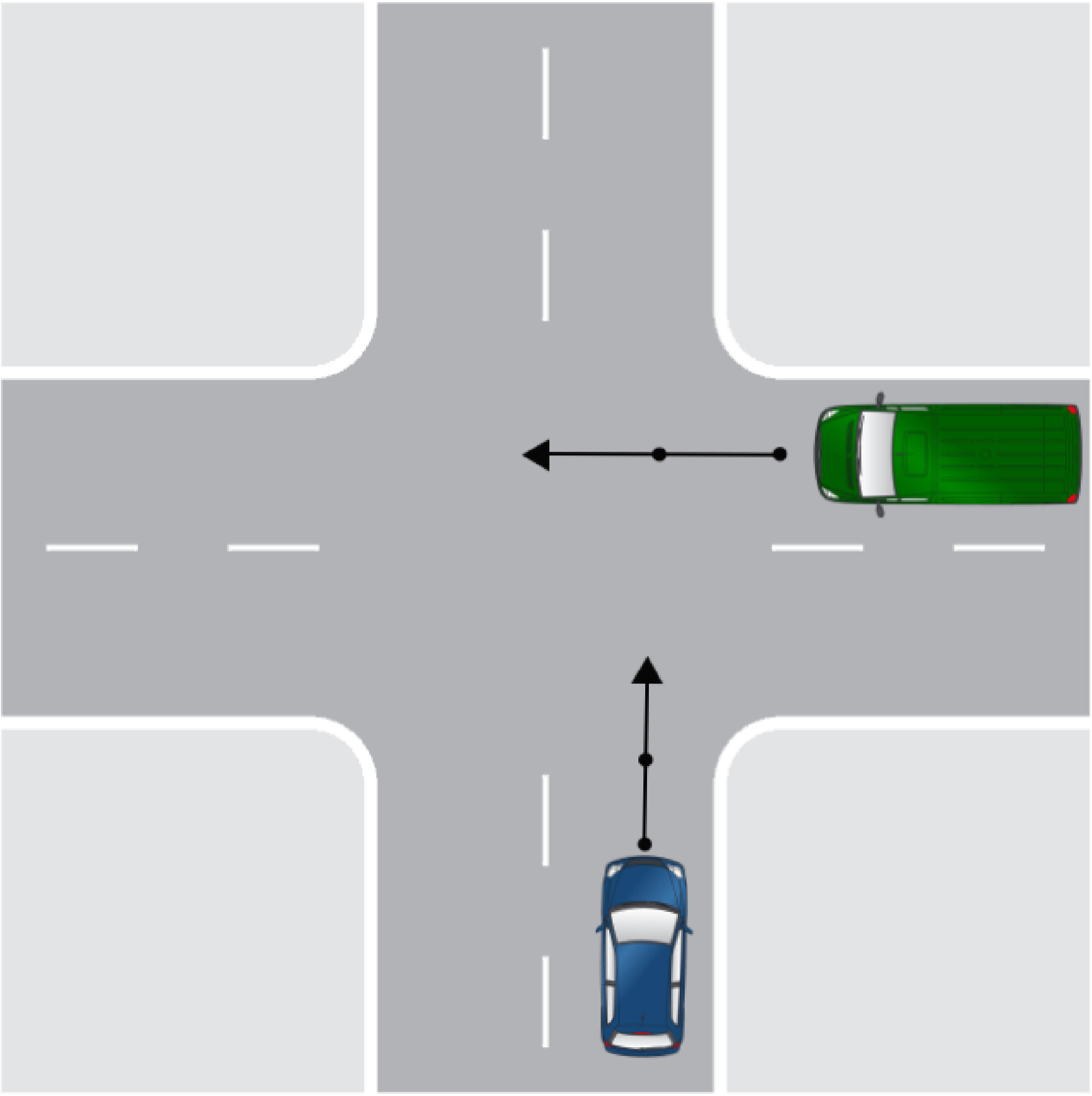
Visualisation of Scenario “Boxes”



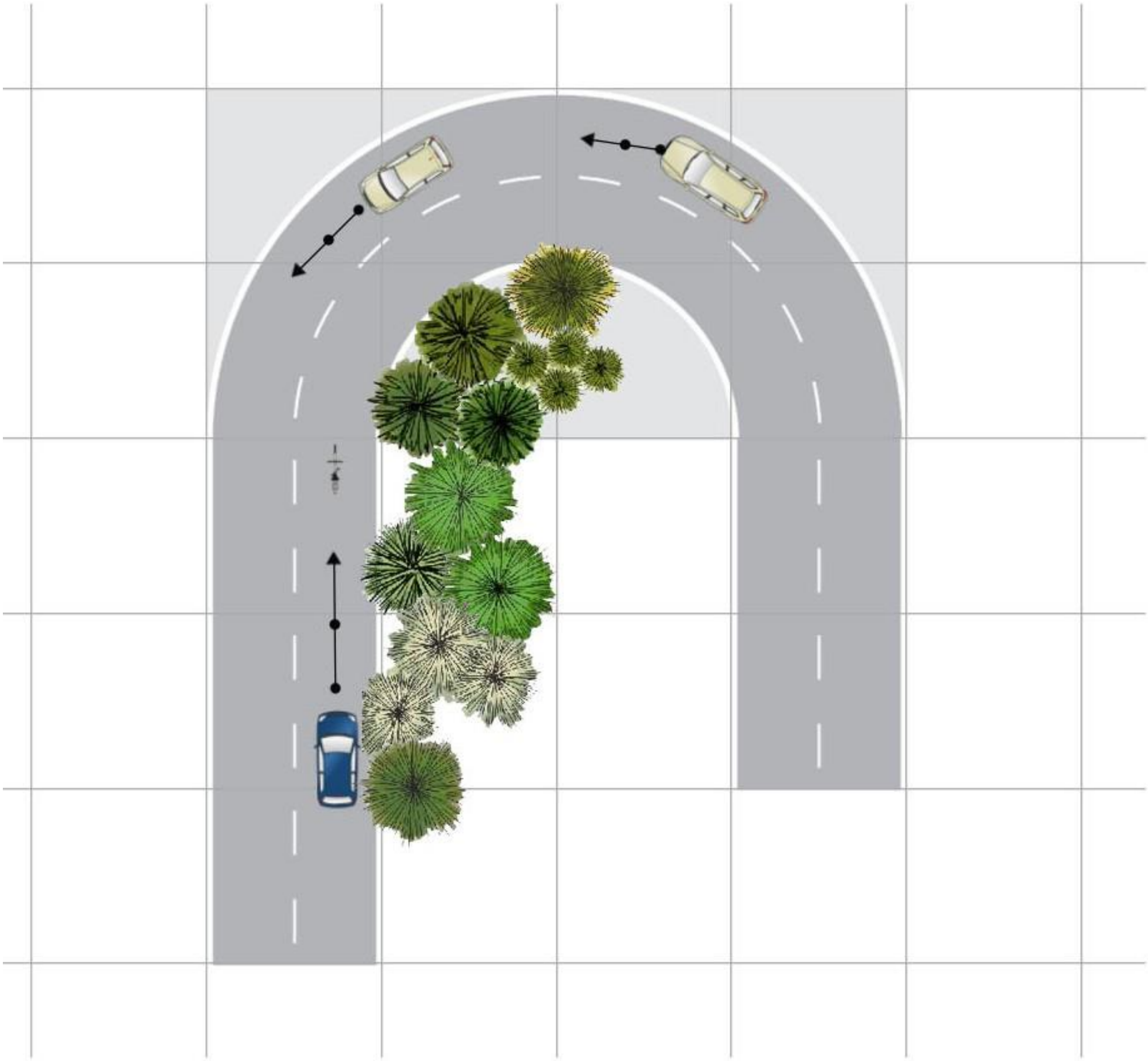
Visualisation of Scenario "Crosswalk"



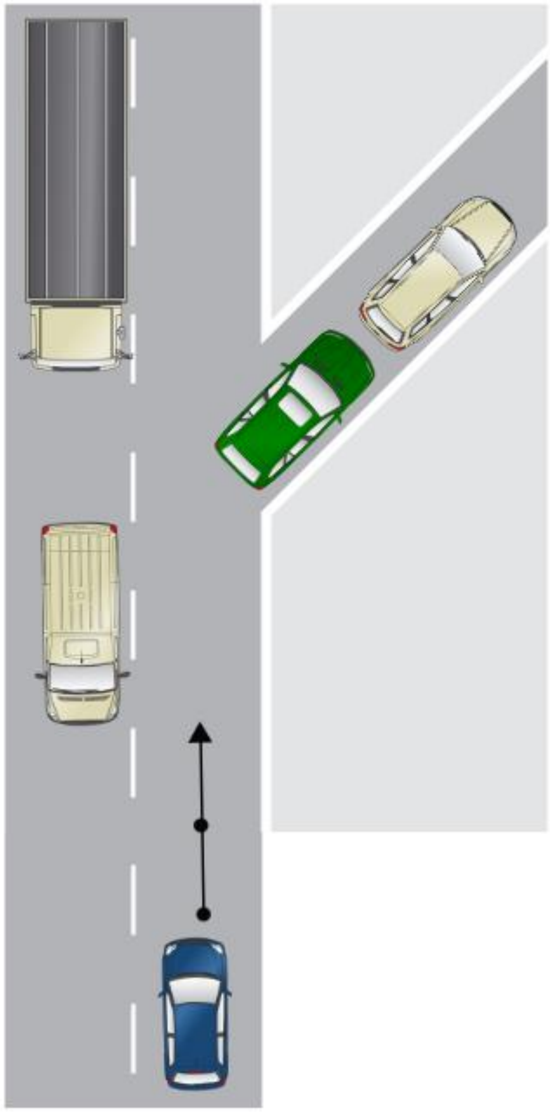
Visualisation of Scenario “Junction”



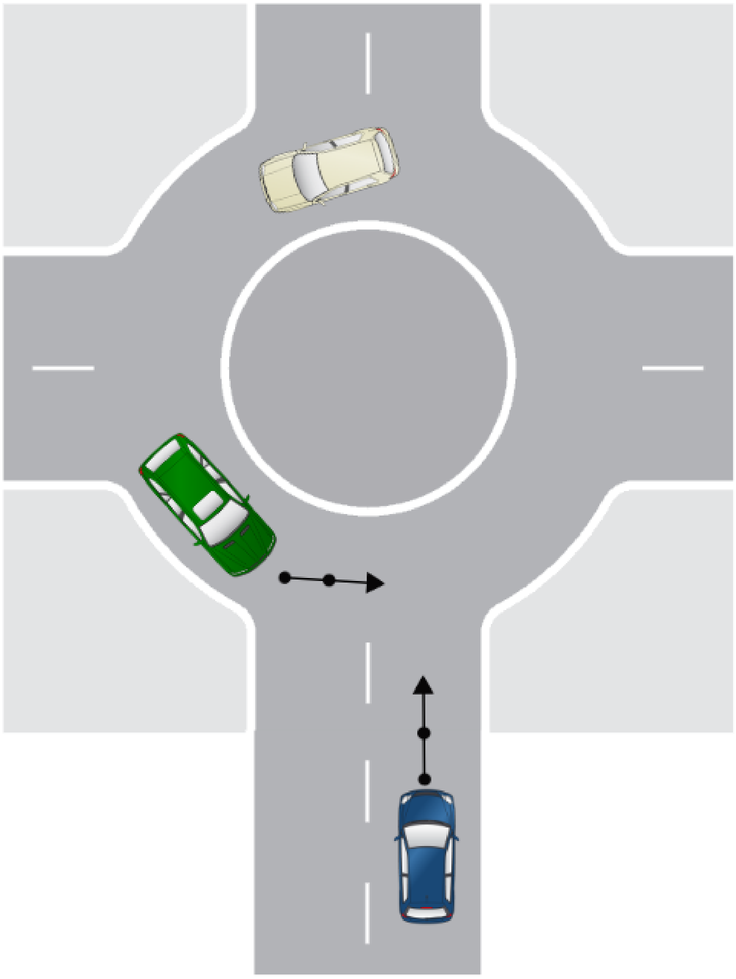
Visualisation of Scenario “Oncoming traffic”



Visualisation of Scenario “Waiting vehicle”



Visualisation of Scenario “Roundabout”



Appendix E

Instructions

These instructions were read to the participants before the start of the experiment.

The goal of this study is to assess a user's trust in an automated vehicle. As a participant, you will have to report your trust in a simulated automated vehicle in different scenarios.

You will have time to familiarize yourself with the simulator, after that the vehicle will drive through nine different scenarios. With the current state of the real-life technology, a driver is still required to supervise the vehicle and to take over if necessary. Today, you are the driver. It is your task to observe the virtual environment the vehicle drives through and to supervise the automation. However, intervention is never required.

Each scenario will end in a traffic situation that you will have to judge. The simulation will stop there, so please keep paying attention at all times. When a scenario ends, you will be asked to indicate whether or not the vehicle will be capable to deal with the situation and if you would need to intervene.

You can stop with the experiment at any moment without giving a reason. If you are feeling stressed or nauseated, please tell the researcher. If you have any further questions, feel free to ask.

Appendix F

INFORMED CONSENT

On a voluntary basis, I decided to participate in an experiment in which my trust in a simulated automated vehicle in general and in specific situations is measured.

The experiment consists of a questionnaire assessing trust in automation and multiple traffic situations I will encounter in a simulated virtual environment.

I have been informed about the specific purpose of the research and I will have the opportunity to ask further questions after the experiment. If I have additional questions later on, I can always contact the researcher *********** (********@student.utwente.nl).

I have the right to stop with the experiment at any given moment without a reason.

I understand that the data gathered in this experiment will be used for a thesis and might be published. My anonymity and the anonymity of my data is assured.

________________________ ________________________

Name Participant ************ (Researcher)

____

Signature Participant

Enschede,_______________

Date

Appendix G

Script for each Scenario

The following instructions were read to the participants after each specific scenario had ended.

Boxes
Three traffic cones are blocking the way and they have to be evaded. There is no oncoming traffic. On a scale from 1 to 7 where 1 is not at all and 7 is absolutely, how sure are you, that the vehicle can handle this situation?
Please centre the steering wheel
Bus
The Bus ahead is standing still and has to be overtaken. On a scale from 1 to 7 where 1 is not at all and 7 is absolutely, how sure are you, that the vehicle can handle this situation?
Please centre the steering wheel
Crosswalk
A pedestrian ahead wants to cross the road. The vehicle has to stop and wait. On a scale from 1 to 7 where 1 is not at all and 7 is absolutely, how sure are you, that the vehicle can handle this situation?
Please centre the steering wheel
Free (stop at corner of modified crosswalk)
There are vehicles parked left and right in the corner ahead. The vehicle has to take this corner. On a scale from 1 to 7 where 1 is not at all and 7 is absolutely, how sure are you, that the vehicle can handle this situation?
Please centre the steering wheel
Junction
The lorry to the right has the right of way. The vehicle has to stop at the waiting line and let the lorry pas. On a scale from 1 to 7 where 1 is not at all and 7 is absolutely, how sure are you, that the vehicle can handle this situation?
Please centre the steering wheel
Oncoming traffic
The corner ahead twists out of sight behind the trees and uphill. The oncoming vehicle comes around that corner. On a scale from 1 to 7 where 1 is not at all and 7 is absolutely, how sure are you, that the vehicle can handle this situation?
Please centre the steering wheel
Waiting vehicle
The car ahead has left your lane, but not entirely. The rear is still on your lane. On a scale from 1 to 7 where 1 is not at all and 7 is absolutely, how sure are you, that the vehicle can handle this situation?
Please centre the steering wheel
Roadblock
The road is closed entirely. The vehicle cannot continue on this path. On a scale from 1 to 7 where 1 is not at all and 7 is absolutely, how sure are you, that the vehicle can handle this situation?
Please centre the steering wheel
Roundabout
The vehicle has to enter the roundabout with oncoming traffic. On a scale from 1 to 7 where 1 is not at all and 7 is absolutely, how sure are you, that the vehicle can handle this situation? Please centre the steering wheel