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# USE AND ACCESS POSSIBILITIES IN THE FIELD OF TRAINING FUTURE DRIVERS USING A VEHICLE SIMULATOR

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Abstract. Novice drivers between the ages of 18 and 24 have a higher risk of accidents, which results from long-term published statistical data. The goal of training at driving schools should be the comprehensive preparation of future drivers for all traffic situations under various weather conditions. Using vehicle simulators allows this practice and training of future drivers, which can be fulfilled and practiced in all weather conditions. Moreover, the vehicle simulator practice can be subsequently (machine) evaluated. Based on the analysis of such driving, complex erudition and readiness of the future driver behavior in real road traffic can be achieved.

This article discusses the capabilities of simulator software that can be applied to the education and training of future drivers. The article aims to present possibilities of evaluation software and related practical use in driver education in driving schools. At the end of the article, the expected benefits in the design of the evaluation software for the vehicle simulator are discussed, emphasizing road safety in the education of future drivers.

Keywords: Evaluation software, novice driver, driver training, driving school, driving simulator, simulator scenario, accident rate, road safety.

## 1. Introduction

Vehicle simulators are becoming increasingly popular in driver training and help educate young and novice drivers. There are several reasons why simulators can be applied in driving schools. Simulator training has been proven to reduce the risk of accidents, allow young drivers to learn from mistakes without consequences, and teach them to drive in a safe and calm environment. Moreover, simulator training is cost-effective.

### 1.1. Accidents of young and novice drivers

According to statistics from the Czech Statistical Office (ČSÚ), 94 794 traffic accidents were recorded in the Czech republic in 2020 [1], with the number of accidents caused by drivers aged 18–24 being 8 743.

This means there drivers caused roughly 9.22 % of all traffic accidents in the Czech republlc in 2020.

This statistic shows that of the total number of 518 people killed in the traffic accidents in 2020, 66 were caused by drivers aged 18–24. These drivers also caused 239 serious injuries and 3 298 minor injuries [2].

It is important to remember that young and novice drivers have a higher risk of being involved in traffic accidents than experienced drivers. Therefore, these drivers must gain as much experience and skills as possible through practice and training.

## 2. Vehicle simulators in driving school

Due to their general characteristics, vehicle simulators contribute to the education of future drivers. This involves training in vehicle control and gaining experience from traffic situations in a simulated environment, which provides safer conditions compared to real traffic. The second significant advantage of vehicle simulators is the reproducibility of individual situations [3]. Drivers can be presented with any critical situations they may encounter only once in their lives, but overall safety depends on their correct decision-making.

Because of these features, the modern interactive vehicle driving simulators [4] are popular in the field of driving education and particularly contribute to acquiring the necessary experience for future drivers [5]. However, nowadays, vehicle simulators only provide driving simulations, during which the future driver gains the correct driving habits and experience to solve complex situations. Nevertheless, it is only up to the subjective assessment of the trainer whether the driver has already gained enough driving experience on the simulator and is ready to drive in real traffic. Based on the study [6], the trainer's assessment should be supported by data analyses of the drives.

However, with the development in computer technology and the several-fold increase in the computing power of today's computers, simulators can provide an accurate diving experience (thanks to their well-developed mathematical models [7] and relevant hap-

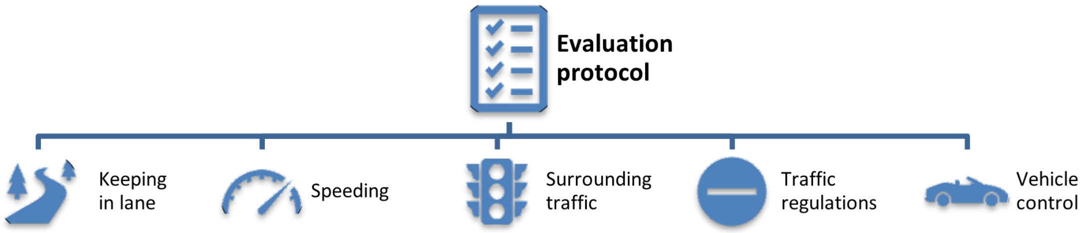


Figure 1. A proposed structure of the evaluation protocol.

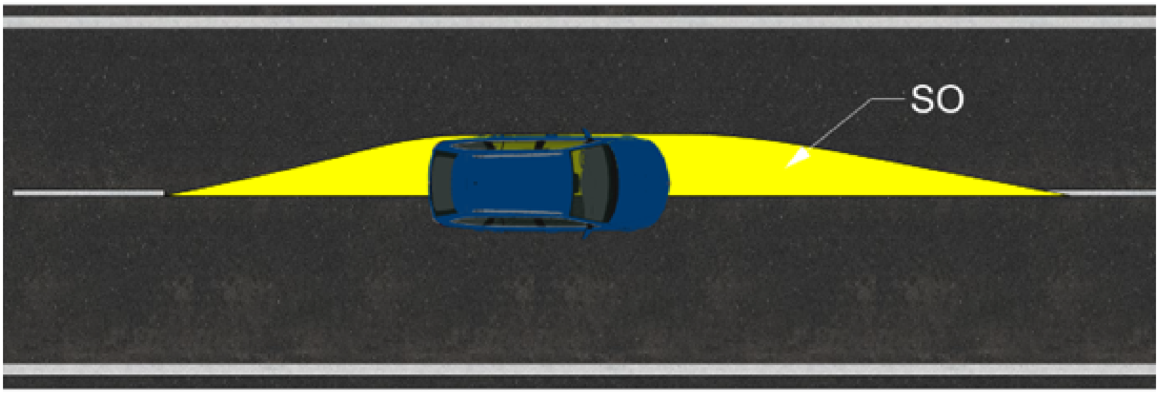


Figure 2. Diagram of the driver's lane stability indicator information.

tic [8] and motion responses – e.g. [9]) but they are also capable to analyze the course of driving itself and evaluate the correct behavior during driving. With this idea, a newly developed vehicle simulator was created at the Faculty of Transportation Sciences, Czech Technical University in Prague, on which evaluation software for analyzing drivers' driving was developed [10].

## 3. Evaluation software of future drivers

The developed simulator for teaching in driving schools is a standard design of a single-seater vehicle simulator with 180° projection using 3 32" monitors. All of the vehicle's controls are obtained using a Logitech gaming set modified as part of this development to receive all information from all inputs of the steering wheel module. Simulator software was developed in the Unity game engine, which has high-quality visual output and is simple to use when creating scenarios [10]. The module itself, which evaluates drivers' driving, is built on this engine.

The driving evaluation software obtains parameters in real time about the environment and the vehicle, the values of the input parameters, the current vehicle position in the virtual scene, the vehicle's speed, and others. These parameters are recorded and evaluated to provide meaningful information about the quality of the drive based on objective indicators. The indicators are divided into five groups according to the assessed areas. The software's output provides an evaluation report with driving results from individual areas (see Figure 1).

In the area of lane-keeping evaluation, the software provides information regarding the stability of the drivers following their lane. The AOO – Area of Out indicator is evaluated for this information, calculating the proportion of the vehicle's exit area and the distance traveled. The exit area TS is defined as the sum of the individual areas of the vehicle outside its lane (SO). The unit of this indicator is $\mathrm{m^2\,km^{-1}}$. Other indicators are the time spent outside one's lane, the number of departures, and the maximum deviation from one's lane as shown in the picture – Figure 2.

The second evaluated area is the driver's speed compliance. As part of developing scenarios for a new type of simulator, areas are set up in the virtual environment based on their permitted speed, for example, village areas with a speed of $50\,\mathrm{km\,h^{-1}}$ and a residential zone with a speed of $20\,\mathrm{km\,h^{-1}}$. This set of scenarios makes it possible to evaluate whether the driver complies with the speed limits. As part of the evaluation protocol, information is provided from this area regarding the number of speed limit violations, a list of areas in which speed was exceeded, and by what amount the speed was exceeded. Information is also provided regarding the time for which the speed

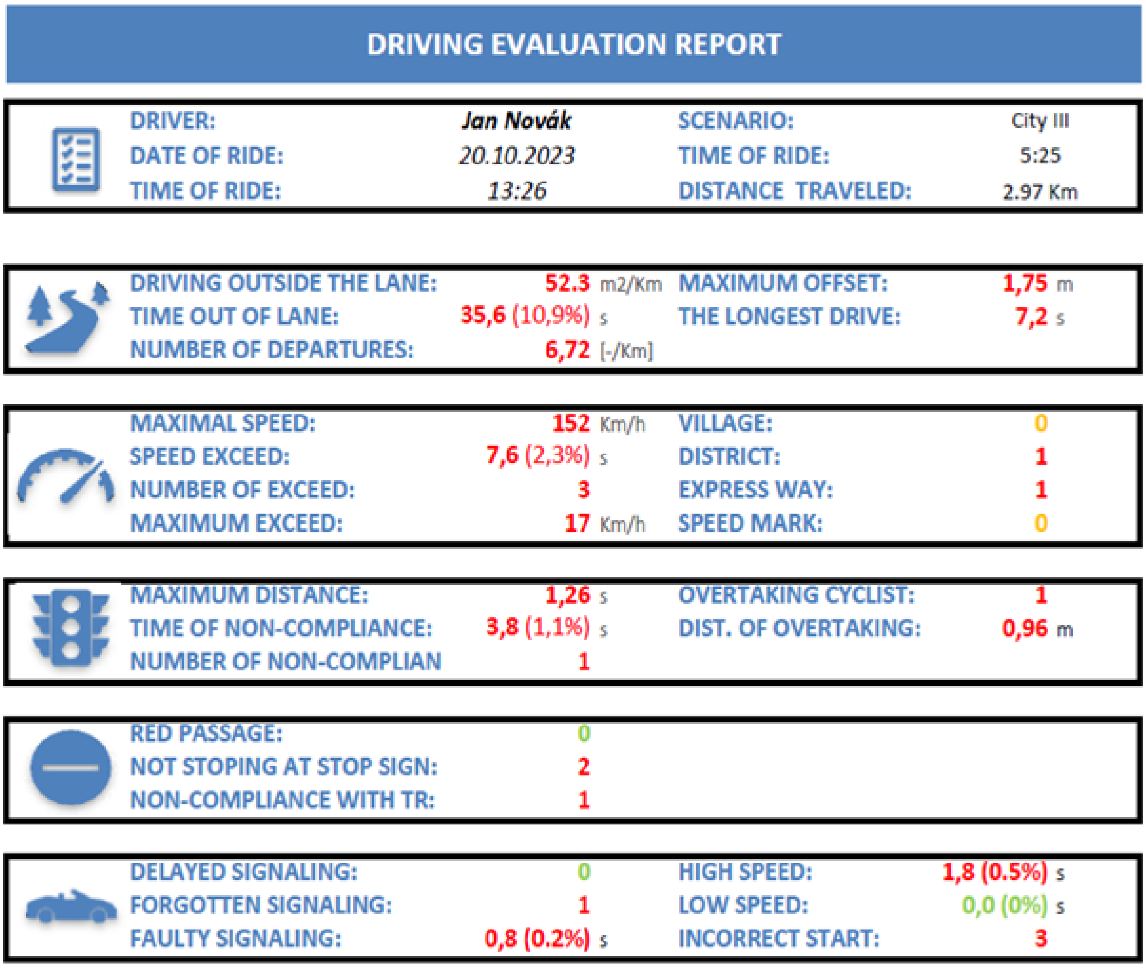


FIGURE 3. The proposed model of the evaluation protocol.

has been exceeded and the maximum value of the speed limit.

The third area is the evaluation of driving in relation to the surrounding traffic; the time safety distances compared to other vehicles are primarily evaluated. The safety time gap for this evaluation software was set at 2 s. The indicators provided in the evaluation sheet are how long drivers did not keep the safety distance, how many times they failed to maintain the safe time gap and the minimum time gap from the vehicle. If a cyclist appears on the scene, the evaluation software also provides information regarding the lateral distance during overtaking.

Regarding traffic regulations, the following indicators are evaluated: the number of vehicle crossings at red lights, the number of violations of traffic rules based on vertical road signs, and the list of violated rules. Speeding is not assessed in this area.

The last group of indicators is focused on the correct control of the vehicle concerning safety and its wear. From the safety point of view, the accurate and timely use of turn signals is primarily evaluated. For each intersection, areas are created where turn signals should be switched on. In these areas, it is possible to assess whether drivers can timely signal their intention of the driving direction and, if not, calculate the delay. The second area assesses parameters for the correct vehicle control that does not lead to vehicle malfunction. The proper vehicle shifting, engine revving, and low-speed driving parameters are evaluated. In this area, the assessed indicators are, for instance, the number of engine shutdowns, the ratio of driving at low to high revolutions, and the number of engine revolutions exceeded.

All the evaluated areas are subsequently generated into an evaluation sheet, which contains general information in the header, such as the name of the driver, the date of the simulation, and the name of the simulated scene. Currently, the evaluation report is provided through a PDF file generated after the completed drive (see Figure 3).

## 4. Conclusion

The article further explores the utilization and potential of Unity software, which can be enhanced and currently adapted to meet the demands of simulator training for young and novice drivers through further development.

With the advancement of computing technologies, there is now the possibility of a multiple-fold increase in the computational power of today's computers. This allows vehicle simulators to analyze the course of simulated driving and subsequently evaluate both correct and incorrect driver behaviors during the drive.

In the individual driving simulation scenarios, the following factors are evaluated and categorized into these areas: evaluation of driving based on lane-keeping, the second area focuses on the driver's adherence to speed limits, the third area evaluates driving behavior concerning surrounding traffic, such as maintaining safe distances from other vehicles. The fourth area involves evaluating the vehicle's adherence to traffic regulations. This includes assessing the number of times the vehicle crosses a red light and violations based on vertical traffic signs, as well as ensuring proper vehicle control with a focus on safety and wear, particularly evaluating the correct and timely use of turn signals.

Further steps in software development could involve providing information through an online database solution and utilizing artificial intelligence (AI) to create individual scenarios. This would enable future drivers to have access to information online, where both the driver and instructor could monitor progress in training. Problematic areas for the driver should also be visible. The instructor could then focus on specific areas where the future driver is having difficulties. Utilizing this data could also benefit examiners, who could use it during the final exam to systematically test whether the driver safely controls problematic areas.

Current computer software technologies allow for implementation into vehicle simulators at acceptable prices, even for driving schools. The presented software environment, utilizing virtual reality in scenarios, opens up further possibilities for modernizing and improving software intended for driver training in this field.

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