Driver Reaction for Evaluating Autonomous Interventions – A Test-Track Method

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I. INTRODUCTION

Driver reaction is important in a critical traffic situation. Evaluating driver reactions is challenging. A combination of data from real world situations, including FOT/NDS, controlled test-track tests and driver simulator studies pose different advantages and challenges. Hence, a combination of different methods is essential to cover all different aspects when developing and evaluating active safety systems involving interaction with the drivers. Examples are Forward Collision Warning (FCW) and Lane Departure Warning (LDW) and other systems that interact in following, head-on or run off road scenarios.

The present study is part of a Swedish project that evaluates the driver's reactions during autonomous interventions, combining test-track tests and simulator studies. This presentation focuses on the test-track part. The advantages of a test-track test are to obtain realistic driver interaction behavior with real vehicle dynamics while still being able to control the safety of the driver during testing in critical situations.

II. METHODS

The test-track method includes scenarios, test vehicle, test equipment, 2^{nd} tasks, questionnaires and instructions to the drivers. Driver reactions are evaluated during vehicle autonomous interventions by braking and/or steering in scenarios, identified based on field data analysis as the most common or critical.

In the present method, the autonomous interventions are synchronized with some of the 2^{nd} task situations during the tests. The focus is on the driver's reaction when the driver is looking away from the road. FOT/NDS data show that about 70% are using one hand on the steering wheel in critical run off road scenarios. Based on these data a new 2nd task which forces the drivers to use one hand on the steering wheel was developed.

III. RESULTS

A pre-study involving 30 drivers was performed. The sequence of driver reaction to the vehicle intervention was valid in comparison to real world situations until the driver is looking up. Driver reactions depending on steering wheel grip, one hand or two hands, were studied in the pre-study in combination with different steering interventions. Test results did show a difference in maximum driver steering torque with different steering wheel grip. Results from tests with only one hand on the steering wheel showed a significant higher mean maximum driver steering torque and lower standard deviation. The pre-study also showed that it is possible to run repeated tests with autonomous steering interventions with very similar driver reactions.

IV. DISCUSSION AND CONCLUSIONS

Accurately evaluating driver reactions is essential to develop and evaluate new active safety systems interacting with the driver. In order to do this, data from real world studies, test-track tests and simulator studies in critical scenarios needs to be combined. By adding a virtual reality device in the vehicle, further expansions in driver exposure to the whole scenario can be made, combining the benefits of both test-track and simulator methods.

Ultimately, a driver model would help to reduce complexity in testing, moving more into virtual evaluation. A first generation of a driver model can be developed based on the data gained from tests with the method in this study. The driver model can be used for virtual development and evaluation or in a steering/braking robot for performance tests in a vehicle at a test track.

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